Department of Energy

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MAY 29 2018

PPPO-02-4807299-18B

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 C-400 VAPOR INTRUSION STUDY ADDENDUM TO THE FIVE-YEAR REVIEW FOR REMEDIAL ACTIONS AT THE PADUCAH GASEOUS DIFFUSION PLANT, PADUCAH, KENTUCKY (DOE/LX/07-1289&D2/R1/A3)

Enclosed for approval is the C-400 Vapor Intrusion Study Addendum to the *Five-Year Review for Remedial Actions at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/LX/07-1289&D2/R1/A3 (Addendum). This Addendum contains the additional actions for the C-400 Interim Remedial Action protectiveness determination required by the U.S. Environmental Protection Agency (EPA) on September 30, 2014. This action included conducting a vapor intrusion study of the C-400 Building. Based upon this completed action, the protectiveness determination for the C-400 Interim Remedial Action is determined to be protective in the short-term as follows:

"The IRA for the VOC contamination at C-400 building is protective of human health and the environment in the short-term. 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. However, in order to establish long-term protectiveness, additional remedial actions will be evaluated and selected, as necessary, under the C-400 Complex Operable Unit (OU)."

The U.S. Department of Energy (DOE) anticipates that the current version of the Addendum satisfactorily addresses EPA's comments in support of evaluation of DOE's protectiveness statement and for issuance of a revised protectiveness determination.

In accordance with the Federal Facility Agreement, there is a 90-day review and comment period for the Addendum.

If you have any questions or require additional information, please contact Cynthia Zvonar at (859) 219-4066.

Sincerely,

Tracey Duncan
Federal Facility Agreement Manager
Portsmouth/Paducah Project Office

Enclosures:
1. C-400 Vapor Intrusion Study Addendum to Five-Year Review for Remedial Actions, DOE/LX/07-1289&D2/R1/A3—Clean
2. C-400 Vapor Intrusion Study Addendum to Five-Year Review for Remedial Actions, DOE/LX/07-1289&D2/R1/A3—Redline

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DOE/LX/07-1289&D2/R1/A3
Secondary Document

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

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DOE/LX/07-1289&D2/R1/A3
Secondary Document

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

Date Issued—May 2018

Prepared for the
U.S. DEPARTMENT OF ENERGY
Office of Environmental Management

Prepared by
FLUOR FEDERAL SERVICES, INC.,
Paducah Deactivation Project
managing the
Deactivation Project at the
Paducah Gaseous Diffusion Plant
under Task Order DE-DT0007774

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CONTENTS

FIGURES

TABLES

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ACRONYMS

AM	Action Memorandum
AOC	area of concern
AR	Administrative Record
ARAR	applicable or relevant and appropriate requirements
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
D&D	decontamination and decommissioning
DCS	derived concentration standard
DNAPL	dense nonaqueous-phase liquid
DOE	U.S. Department of Energy
DPT	Direct Push Technology
EE/CA	Engineering Evaluation/Cost Analysis
EI	environmental indicator
EIC	Environmental Information Center
ELCR	excess lifetime cancer risk
EM	environmental management
EMP	Environmental Monitoring Plan
EPA	U.S. Environmental Protection Agency
EQ	equalization
ERH	Electrical Resistance Heating
EU	exposure unit
EW	extraction well
FC	final characterization
FFA	Federal Facility Agreement
FS	feasibility study
FY	fiscal year
GDP	gaseous diffusion plant
GPRA	Government Performance Results Act
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
KDOW	Kentucky Division of Water
KDWM	Kentucky Division of Waste Management
KEEC	Kentucky Energy and Environment Cabinet
KPDES	Kentucky Pollutant Discharge Elimination System
KRS	*Kentucky Revised Statutes*
LATA Kentucky	LATA Environmental Services of Kentucky, LLC
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 Contingency Plan
ND	nondetect
NEPCS	Northeast Plume Containment System
NPL	National Priorities List
NSDD	North-South Diversion Ditch
NWPGS	Northwest Plume Groundwater System
O&M	operation and maintenance
OREIS	Oak Ridge Environmental Information System
OSWER	Office of Solid Waste and Emergency Response
OU	operable unit
PGDP	Paducah Gaseous Diffusion Plant
PHEA	Public Health and Ecological Assessment
PRG	Preliminary Remediation Goal
RA	remedial action
RAO	remedial action objective
RAR	Removal Action Report
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
SWMU	solid waste management unit
SWOU	Surface Water Operable Unit
TBC	to be considered
TSCA	Toxic Substances Control Act
TSS	total suspended solids
TVA	Tennessee Valley Authority
UCRS	Upper Continental Recharge System
USCA	*United States Code Annotated*
USEC	United States Enrichment Corporation
VOC	volatile organic compound
WAG	waste area group
WKWMA	West Kentucky Wildlife Management Area

EXECUTIVE SUMMARY

The cleanup strategy under the Site Management Plan (SMP) (DOE 2014) of the *Federal Facility Agreement for the Paducah Gaseous Diffusion Plant* (FFA) establishes five operable units (OUs) to be accomplished as part of the pre-gaseous diffusion plant (GDP) shutdown phase. These include the Groundwater OU (GWOU), the Surface Water OU (SWOU), the Soils OU, Burial Grounds OU (BGOU), and the Decontamination and Decommissioning (D&D OU) (EPA 1998). Each OU is scoped to remediate areas and media associated with the Paducah Gaseous Diffusion Plant (PGDP). A final Comprehensive Site OU evaluation will occur following plant shutdown and completion of D&D of the GDP, D&D of the Depleted Uranium Hexafluoride (DUF_6) Conversion Plant, and completion of post-shutdown cleanup of each of the post–GDP specific OUs. The specific scopes and further discussions for each OU and associated follow-up actions are addressed in the SMP.

The U.S. Environmental Protection Agency (EPA) defines the 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, policy, and discretionary reviews because PGDP has implemented both removal and remedial actions.

This Five-Year Review encompasses the remedial actions that the U.S. Department of Energy (DOE) has taken under the respective OUs, plus the Water Policy removal action, Surface Water Interim Corrective Measures, and Surface Water On-site Sediment Removal. The FFA for PGDP includes requirements for synchronizing Five-Year Reviews of remedial actions (Section XXX). The triggering action for this review is the five-year anniversary of the third synchronized five-year review conducted at PGDP in 2008 for activities associated with response actions from 2003 through 2007. [*Five-Year Review for Remedial Actions at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 2009a)]. This Five-Year Review encompasses activities associated with response actions from 2008 through 2012. A form summarizing PGDP, issues from the review, recommendations, and protectiveness statements is presented as Table ES.1. This form is the updated 2011 version of the form from Appendix F of EPA guidance document *Comprehensive Five-Year Review* (EPA 2001).

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): Cynthia Zvonar		
Author affiliation: U.S. Department of Energy		
Review period: 01/01/2013–08/29/2013		
Date of site inspection: 01/17/2013–02/19/2013		
Type of review: Statutory, Policy, and Discretionary		
Review number: 4		
Triggering action date: 12/30/2008		
Due date (*five years after triggering action date*): 12/30/2013		

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

OU(s): Groundwater, Northwest Plume	**Issue Category:** Remedy Performance
	Issue: The Northwest Plume is an interim remedial action (IRA) designed to initiate hydraulic control of the high trichloroethene (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.
	Recommendation: Additional action, if necessary, for long-term protection should be evaluated and documented in the final decision document for the Dissolved-Phase Plume and the Comprehensive Site Operable Unit (CSOU).

Affect Current Protectiveness	Affect Future Protectiveness	Implementing Party	Oversight Party	Milestone Date
No	Yes	Federal Facility	EPA/State	09/30/2029*

*Date reflects Dissolved-Phase Plume ROD.

OU(s): Groundwater, Northeast Plume	**Issue Category**: Remedy Performance
	Issue: The Northeast Plume remedial action 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 remedial action objectives (RAOs) were met, additional mass removal can be achieved by an optimization.
	Recommendation: The FFA parties recommended optimization of the Northeast Plume treatment system to increase TCE and 1,1-dichloroethene mass removal and enhance the contaminant capture in the Northeast Plume in the vicinity of the eastern edge of the PGDP facility. The optimization is planned to occur in fiscal year 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 extraction wells (EWs).

Affect Current Protectiveness	Affect Future Protectiveness	Implementing Party	Oversight Party	Milestone Date
No	No	Federal Facility	EPA/State	12/30/2017

OU(s): Groundwater, Northeast Plume	**Issue Category:** Remedy Performance			
	Issue: The Northeast Plume is an IRA designed to initiate hydraulic control of the high TCE concentration area within the Northeast Plume and does not achieve final cleanup of the groundwater contamination. A follow-up evaluation is needed to ensure long-term protectiveness.			
	Recommendation: Additional action, if necessary, for long-term protection should be evaluated and documented in the final decision document for the Dissolved-Phase Plume and the CSOU.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	Federal Facility	EPA/State	09/30/2029*

*Date reflects Dissolved-Phase Plume ROD.

OU(s): Groundwater, Water Policy	**Issue Category:** Remedy Performance			
	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.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	Federal Facility	EPA/State	12/30/2014

<table>
<tr><td rowspan="3">OU(s):
Groundwater,
C-400 Electrical Resistance Heating (ERH)</td><td colspan="4">Issue Category: Remedy Performance</td></tr>
<tr><td colspan="4">Issue: The ROD selected ERH to address the volatile organic compound (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 the RAOs in the Upper Continental Recharge System and the upper Regional Gravel Aquifer (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.</td></tr>
<tr><td colspan="4">Recommendation: 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.</td></tr>
<tr><td>Affect Current Protectiveness</td><td>Affect Future Protectiveness</td><td>Implementing Party</td><td>Oversight Party</td><td>Milestone Date</td></tr>
<tr><td>No</td><td>Yes</td><td>Federal Facility</td><td>EPA/State</td><td>TBD</td></tr>
</table>

<table>
<tr><td rowspan="3">OU(s):
Groundwater,
C-400 ERH</td><td colspan="4">Issue Category: Remedy Performance</td></tr>
<tr><td colspan="4">Issue: 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. A follow-up evaluation is needed to ensure long-term protection.</td></tr>
<tr><td colspan="4">Recommendation: Additional action, if necessary, for long-term protection should be evaluated and documented in the final decision documents for the GDP Groundwater Sources OU and the CSOU.</td></tr>
<tr><td>Affect Current Protectiveness</td><td>Affect Future Protectiveness</td><td>Implementing Party</td><td>Oversight Party</td><td>Milestone Date</td></tr>
<tr><td>No</td><td>Yes</td><td>Federal Facility</td><td>EPA/State</td><td>TBD*</td></tr>
</table>

*****The GDP Groundwater Sources OU evaluation will occur following GDP ceases operation and a decision has been made to proceed with D&D of the GDP.

OU(s): Groundwater, C-400 ERH	**Issue Category:** Remedy Performance			
	Issue: 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 and, therefore, 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.			
	Recommendation: To ensure that the remedy is protective for vapor intrusion, it is recommended that a vapor intrusion analysis be performed consistent with the PGDP Risk Methods Document as part of any subsequent follow-up C-400 actions (e.g., GDP Groundwater Sources OU, Dissolved-Phase Plume project).			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	Federal Facility	EPA/State	09/30/2029*

*Date reflects Dissolved-Phase Plume ROD.

OU(s): Groundwater, Southwest Plume	**Issue Category:** Remedy Performance			
	Issue: The Southwest Plume project is a remedial action under construction. The remedial action is designed to address VOC releases to groundwater. A follow-up evaluation is needed to ensure long-term protection.			
	Recommendation: 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 Plume project).			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	Federal Facility	EPA/State	09/30/2029*

*Date reflects Dissolved-Phase Plume ROD.

<table>
<tr><td rowspan="3">OU(s): Surface Water, NSDD Sections 1 and 2</td><td colspan="4">Issue Category: Institutional Controls</td></tr>
<tr><td colspan="4">Issue: The 2008 Five-Year Review recommended that a residual risk evaluation be performed to determine if the remedy could be optimized, leading to the removal of institutional controls and/or cessation of the five-year reviews. 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.</td></tr>
<tr><td colspan="4">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 (LUCAP) 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.</td></tr>
<tr><th>Affect Current Protectiveness</th><th>Affect Future Protectiveness</th><th>Implementing Party</th><th>Oversight Party</th><th>Milestone Date</th></tr>
<tr><td>No</td><td>No</td><td>Federal Facility</td><td>EPA/State</td><td>12/30/2014</td></tr>
</table>

<table>
<tr><td rowspan="3">OU(s): Surface Water, C-746-K Landfill</td><td colspan="4">Issue Category: Monitoring</td></tr>
<tr><td colspan="4">Issue: The shaft of monitoring well (MW) 301 has buckled so that any repair/replacement of the pump would not be possible.</td></tr>
<tr><td colspan="4">Recommendation: 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.</td></tr>
<tr><th>Affect Current Protectiveness</th><th>Affect Future Protectiveness</th><th>Implementing Party</th><th>Oversight Party</th><th>Milestone Date</th></tr>
<tr><td>No</td><td>No</td><td>Federal Facility</td><td>EPA/State</td><td>12/30/2015</td></tr>
</table>

<table>
<tr><td rowspan="3">OU(s): Surface Water, Interim Corrective Measures (ICM)</td><td colspan="4">Issue Category: Institutional Controls</td></tr>
<tr><td colspan="4">Issue: An evaluation of both sign programs [Surface Water ICM signs with Environmental Indicator (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.</td></tr>
<tr><td colspan="4">Recommendation: Specifically, the evaluation proposes that, where the signs are co-located, 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 (see Figure ES.1).</td></tr>
<tr><th>Affect Current Protectiveness</th><th>Affect Future Protectiveness</th><th>Implementing Party</th><th>Oversight Party</th><th>Milestone Date</th></tr>
<tr><td>No</td><td>No</td><td>Federal Facility</td><td>EPA/State</td><td>12/30/2014</td></tr>
</table>

Protectiveness Statement(s)

<table>
<tr><td>Operable Unit:

Groundwater OU, Northwest Plume</td><td>Protectiveness Determination:

Short-term Protective</td><td>Addendum Due Date (if applicable):

N/A</td></tr>
<tr><td colspan="3">Protectiveness Statement:

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 plume, need to be evaluated for long-term protection.</td></tr>
</table>

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

Protectiveness Statement:

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, need to be evaluated for long-term protection.

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

Protectiveness Statement:

The remedy for the Cylinder Drop Test Area 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 remedial action shall be selected and implemented…" as part of the CSOU.

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
Groundwater OU, 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 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, need to be evaluated for long-term protection.

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
Groundwater OU, 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, 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. However, in order to establish long-term protectiveness, additional remedial actions will be evaluated and selected, as necessary, under the GDP Groundwater Sources OU.

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
Groundwater OU, Southwest Plume	Will be Protective	N/A

Protectiveness Statement:

The remedial action for VOC sources at Southwest Plume 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.), has addressed adequately known exposure pathways that could result in unacceptable risks originating from the Southwest Plume.

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 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 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.

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

Protectiveness Statement:

The remedy for the C-746-K Landfill 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 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 remedial action shall be selected and implemented…" as part of the CSOU.

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
Surface Water Interim Corrective Measures	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. However, in order to establish long-term protectiveness, additional remedial actions 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 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 remedial action 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 currently is being 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: N/A	*Addendum Due Date (if applicable):* N/A
Protectiveness Statement: N/A	

*Off-site is defined as off DOE property for this document unless otherwise noted.

The assessments of this 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 Five-Year Review.

Table ES.2. Decision Document and Site/Project Name Included in 2013 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	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	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 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	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 Landfill	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	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	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 (i.e., ROD or AM). This 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.

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1. INTRODUCTION

The purpose of this Five-Year Review is to determine whether the remedies at the Paducah Gaseous Diffusion Plant (PGDP) 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. This Five-Year Review is part of the Administrative Record (AR) at PGDP.

The U.S. Department of Energy (DOE) has conducted this 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 (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 March 17, 2013, announcing the Five-Year Review had been initiated and requesting that any suggestions, issues, questions, or concerns regarding this review be provided from March 18 through March 22, 2013. 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 for any operable unit (OU). EPA Guidance (OSWER 9355.7-21) defines the following 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 remedial action [RA], hazardous substances, pollutants, or contaminants will remain on site above levels that allow for unlimited use and unrestricted exposure; and

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

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

- A pre- or post-SARA remedial action 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 remedial action 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 NPL [National Priorities List] 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 remedial action 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 Northwest Plume, Northeast Plume, C-400 Electrical Resistance Heating (ERH), Water Policy, Surface Water Interim Corrective Measures (ICMs), and Surface Water On-site Sediment Removal. The Northwest Plume project, C-400 ERH, and Northeast Plume project are being conducted as Policy Reviews because these actions are interim remedial actions (IRAs) whereby the objectives are not intended to obtain health-based levels to achieve unlimited use and unrestricted exposure and/or may operate for five years or longer. Five-Year Reviews are being conducted for the Water Policy, Surface Water ICM, and Surface Water On-site Sediment Removal as Discretionary Reviews. No Five-Year Addendum reviews are being conducted.

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 PGDP. Various remedial action projects at PGDP 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 will 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 remedial action is implemented as part of the Surface Water Operable Unit (SWOU). The Surface Water On-site Sediment Removal 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 2013 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	Ground-water Operable Unit (GWOU)	Northwest Plume

Table 1.1. Decision Document and Site/Project Name Included in 2013 Five-Year Review (Continued)

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 at the Northeast Plume, Paducah Gaseous Diffusion Plant, Paducah, Kentucky, DOE/OR/06-1356&D2	Northeast Plume	GWOU	Northeast Plume
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 or LasagnaTM	GWOU	Solid Waste Management Unit (SWMU) 91
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	GWOU C-400 ERH, currently underway
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	New to Five-Year Review, currently underway
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 Ditch (NSDD) Source Control	SWOU	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	SWOU	New to Five-Year Review
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 Landfill	SWOU	Waste Area Groups (WAGs) 1 and 7, 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	SWOU	WAGs 1 and 7, SWMU 100
Interim Measure Report for Institutional Control of Off-Site Contamination in Surface Water, DOE/OR/07-1206&D1	Surface Water Interim Corrective Measures	SWOU	Surface Water Interim Corrective Measures
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	New to Five-Year Review

Table 1.1. Decision Document and Site/Project Name Included in 2013 Five-Year Review (Continued)

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 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	Burial Grounds Operable Unit (BGOU)	WAG 22, SWMU 2

*On-site is defined in this document as on DOE property.

The FFA includes provisions for combining Five-Year Reviews of remedial actions 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 (KEEC).

DOE is the lead agency for these response actions, and EPA and the Kentucky Department for Environmental Protection (KDEP) provide regulatory oversight pursuant to the FFA. This Five-Year Review contains reviews of completed projects and summaries of projects currently underway. The triggering action for this review is the five-year anniversary of the third combined Five-Year Review conducted at PGDP [*Five-Year Review for Remedial Actions at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 2009a)].

This 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 life-cycle 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). PGDP subsequently developed a site-specific Memorandum of Agreement (MOA) and Land Use Control Assurance Plan (LUCAP) (DOE 2000a). The PGDP 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. The effectiveness of the institutional controls or LUCs is addressed in this Five-Year Review. The PGDP 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 remedial action(s) resulting from the anticipated land use changes; and

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

The review of the completed response actions was conducted during January through April 2013 for the period extending from January 2008 through December 2012. DOE and its prime remediation contractor, LATA Environmental Services, LLC, (LATA Kentucky) 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 PGDP.

Table 2.1. Chronology of Significant Site Events at PGDP

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	PGDP 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	PGDP 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 for hydraulic containment and treatment of high concentrations of off-site TCE contamination in the Northwest Plume.	Northwest Plume	GWOU	26	201	Ground-water	IRA
Mar–1994	Issued ROD that instituted action to treat certain plant effluent and control the migration of contaminated sediment associated with the NSDD.	North-South Diversion Ditch	SWOU	25	59	Surface water	IRA
May–1994	PGDP is placed on NPL.	N/A	N/A	N/A	N/A	N/A	N/A
Aug–1994	Action memorandum approved for extended municipal water line to residents affected by off-site groundwater contamination.	Water Policy	GWOU	26	201, 202	Ground-water	Non-time-critical Removal action
Jun–1995	Issued ROD for hydraulic containment and treatment of high concentrations of off-site TCE contamination in the Northeast Plume.	Northeast Plume	GWOU	26	202	Ground-water	IRA
Aug–1995	Northwest Plume Groundwater System begins operation.	Northwest Plume	GWOU	26	201	Ground-water	IRA

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

Date of Action	Response Description	Site/Project Name	OU	WAG	SWMU	Media	Response Type
Sept–1995	The interim 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 SWMU 2.	C-749 Uranium Burial Ground	BGOU	22	2	Soil and Ground-water	IRA
Feb–1997	Northeast Plume Groundwater System begins operation.	Northeast Plumes	GWOU	26	202	Ground-water	IRA
Feb–1998	FFA is signed with the 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 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	Non-time-critical removal action
Sep–2002	Remedial action for Sections 1 and 2 of the NSDD	North-South Diversion Ditch	SWOU	25	59	Sediment and soil	IRA
Dec–2003	First combined 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 PGDP (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 Lime House, C-405 Incinerator	D&D	30	480 & 55	Building structures	Non-time-critical removal action
Nov–2008	Second combined Five-Year Review is issued.	All applicable projects	Applies to all activities associated with all OUs.				
Apr–2009	Action Memorandum (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 PGDP.	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	Non-time-critical removal action
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	Non-time-critical removal action
Nov–2009	Issued addendum to document a change in scope of the C-410 removal action to 1) expand the scope of the existing non-time-critical removal action 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	Non-time-critical removal action

Table 2.1. Chronology of Significant Site Events at PGDP (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	Non-time-critical removal action
Sept–2010	Issued an Explanation of Significant Differences to the ROD for the IRA of Northwest Plume. The Northwest Plume Groundwater Treatment System was optimized by placing existing southern extraction wells (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: SWMU 1—*In situ* source treatment using deep soil mixing with interim LUCs. SWMU 211-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. SWMU 211-B—*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 & -B	Soil	Remedial Action

*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.

3. BACKGROUND

3.1 PHYSICAL CHARACTERISTICS

PGDP is located in northwestern 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 PGDP is approximately 650 acres located within a fenced security area. Surrounding the industrial portion of the reservation is the West Kentucky Wildlife Management Area (WKWMA).

Several groundwater-bearing zones are present in the PGDP area. 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 PGDP (MMES 1992). The RGA is the dominant groundwater flow system at PGDP and contains the on-site and off-site contaminant plumes.

Groundwater flow is predominately vertically downward in the UCRS, providing recharge to the RGA. Rainfall infiltration and leakage from PGDP 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 PGDP (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 PGDP, but upward near the Ohio River.

The Porters Creek Clay is a confining unit to groundwater flow south of PGDP. A shallow water table flow system is developed in gravels that overlie the Porters Creek Clay south of the PGDP industrial area and underlies the C-746-K Landfill, (the Terrace Gravel flow system). Discharge from the Terrace Gravel flow system provides baseflow to Bayou Creek and underflow to the UCRS under PGDP.

3.2 LAND AND RESOURCE USE

During the January 2008 through December 2012 review period, PGDP remained an active uranium enrichment plant. The plant is owned by DOE and was leased to and operated by the United States Enrichment Corporation (USEC) during the review period. Enrichment operations began in 1952, and the plant became fully operational in 1955. Hazardous, nonhazardous, and radioactive wastes have been generated, stored, and disposed of at PGDP. The industrial portion of PGDP, 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 PGDP converts DUF_6 stored at Paducah into a more stable chemical form suitable for beneficial reuse or disposal.

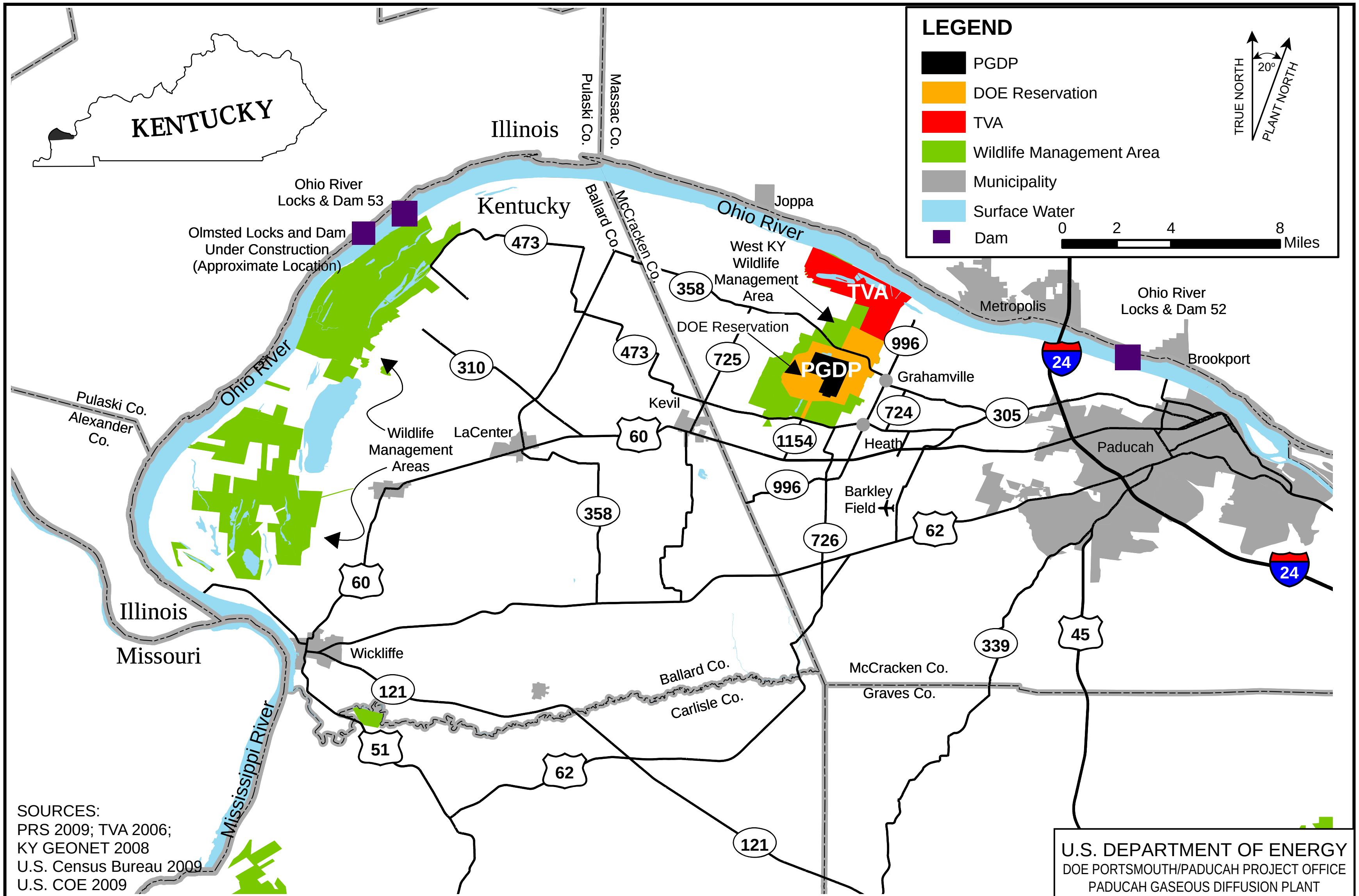
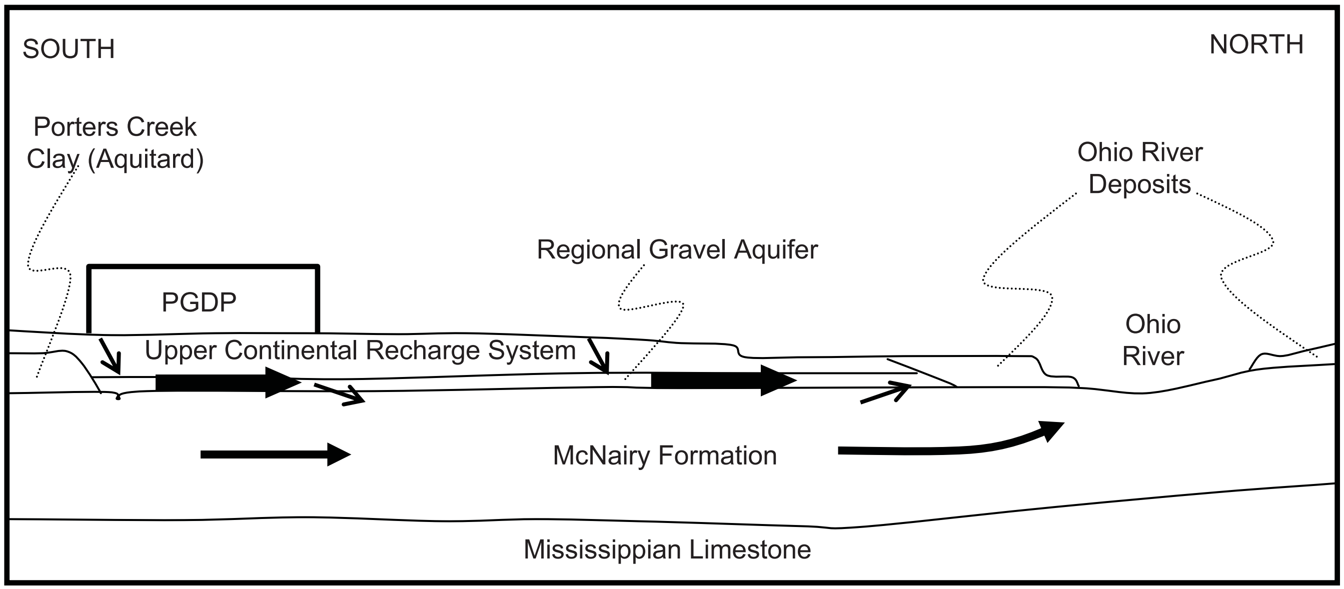


Figure 3.1 PGDP Site Location



Arrows indicate groundwater flow direction Vertical Exaggeration = 10X

Figure 3.2. Water-Bearing Zones in the PGDP Area

DOE currently holds a lease agreement with USEC for the production facilities at PGDP and 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 the 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 PGDP.

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.

As noted above, PGDP 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 PGDP is approximately 534,000. Based on population data from the 2010 census, approximately 104,000 people live within 20 miles of PGDP and homes are scattered along rural roads around the plant. The population of Paducah, based on the 2010 U.S. Census, is 26,307. The closest communities to PGDP are the unincorporated towns of Grahamville and Heath which are 1.24 and 1.86 miles east of the plant, respectively. The nearest schools are Heath Elementary, Middle, and High Schools. These are 1.86 miles southeast of the plant near the Heath community. The nearest hospitals are located in Paducah. PGDP 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 PGDP and connects to the Illinois Central Gulf Railroad. The nearest airport is Barkley Regional Airport located approximately 3.7 miles southeast of the PGDP. Metropolis, Illinois, and Kevil, Kentucky, are the nearest municipal areas and are shown as urban residential land use (see Figure 3.3).

The Ohio River is navigable along its entire length and, near PGDP, has a downstream connection to the Mississippi River and an upstream connection to the Tennessee River. Dams (i.e., Locks and Dams 52 and 53) are located on the Ohio River, both upstream and downstream of PGDP. The Olmstead Locks and Dam currently are under construction to replace Locks and Dam 52 and 53, with an estimated operational date of 2020. In addition, the Kentucky Lock and Dam is located on the Tennessee River near its confluence with the Ohio River. Figure 3.1 is a map showing the land use areas surrounding PGDP. PGDP 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, PGDP is within the drainage areas of the Ohio River, Bayou Creek (also known as Big Bayou Creek), and Little Bayou Creek.

The plant 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 the plant that flows generally northward to the Ohio River. Little Bayou Creek becomes a perennial stream at the east outfalls of PGDP 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 PGDP. Contributions from PGDP comprise approximately 85% of flow within Bayou Creek and 100% of flow within Little Bayou Creek.

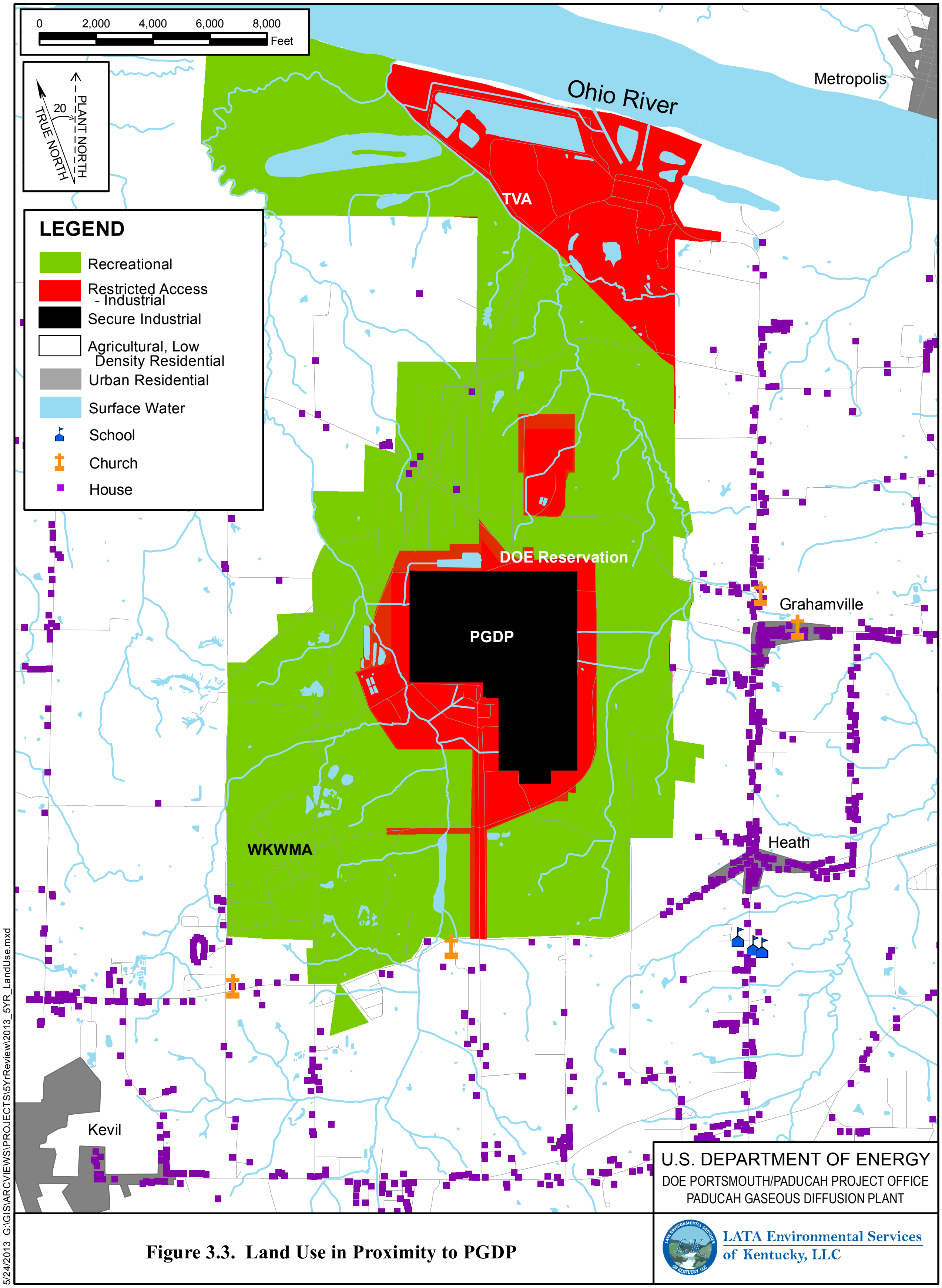
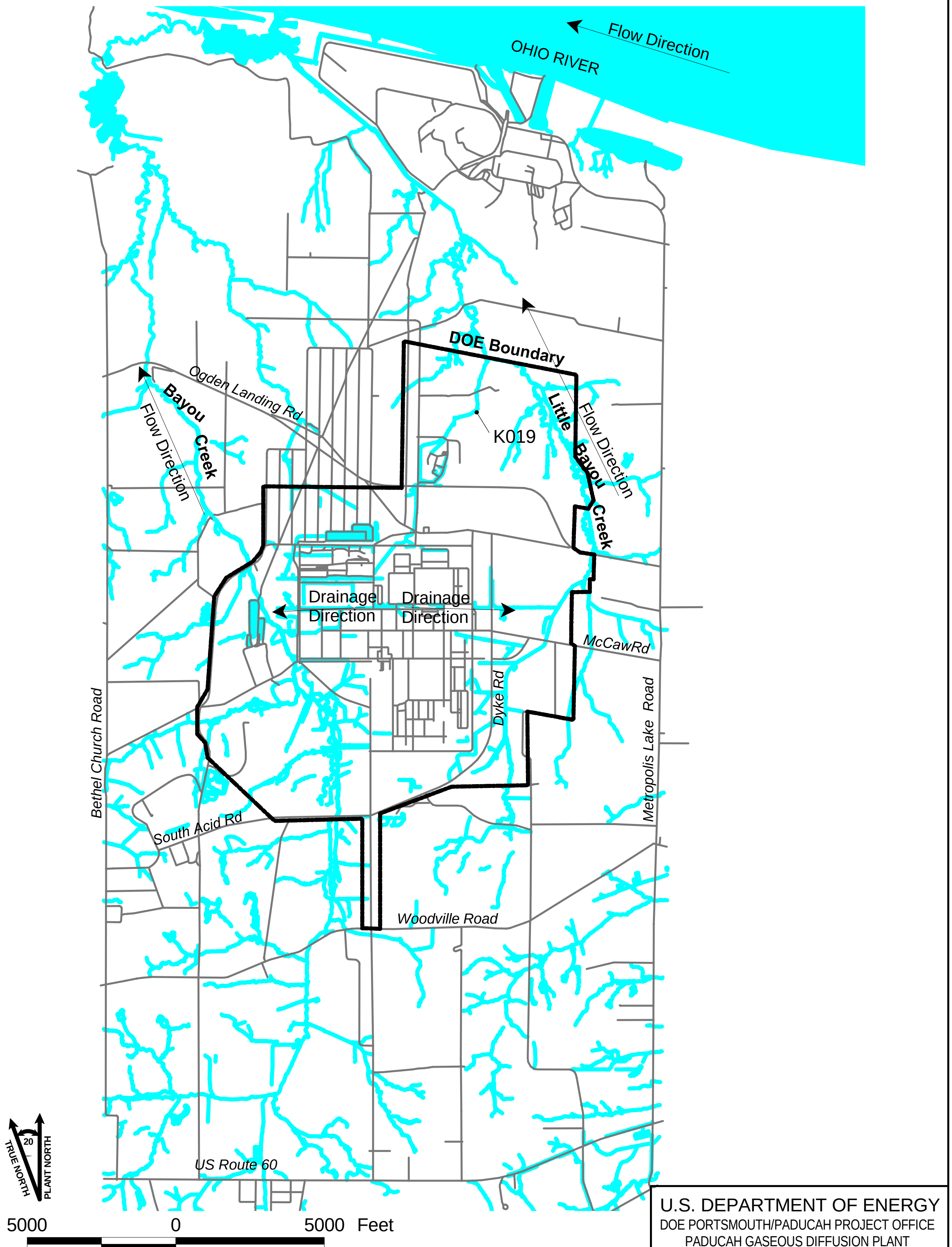


Figure 3.3. Land Use in Proximity to PGDP



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

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

LATA Environmental Services of Kentucky, LLC

Figure No. Fig 3-4 Revised 4-13.pdf
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3.3 HISTORY OF CONTAMINATION

Historical activities at PGDP 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 PGDP 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 PGDP facility. DOE placed 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 PGDP in 1953 as a contaminant in feed material during a program in which spent nuclear reactor fuel was fed into the plant processes.

Further sampling showed that a commonly used solvent, TCE, also was present in off-site wells. TCE had been used as a cleaning solvent at PGDP since its construction, but has not been used since 1993 (DOE 2001a). 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 PGDP 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 plant construction. Waste TCE was disposed of in on-site landfills and in a historical landfarming operation. In PGDP cylinder drop test, TCE was placed into a pit and used as a refrigerant in tests to determine cylinder integrity (Chapter 7).

PCBs have been found in sediment and fish downstream of the plant. PCBs have been used extensively as an insulating, nonflammable, thermally conductive fluid in electrical capacitors and transformers at PGDP. 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 plant 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 PGDP 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 where uranium was washed into ditches and creeks.

3.4 INITIAL RESPONSE

After the discovery of groundwater contamination in 1988, DOE placed affected residences and businesses on an alternate water supply and began an intensive monitoring and investigation program to define the extent of contamination. PGDP was proposed for the National Priorities List 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 Northwest Plume Groundwater System and the Northeast Plume Containment

System, and surface water institutional controls to reduce further the risks posed to human health and environment by releases from PGDP.

After addressing immediate off-site risks, DOE identified potential areas of contamination at PGDP (e.g., burial grounds, spill sites, and container storage areas) as SWMUs and areas of concern (AOCs). DOE then grouped most of the SWMUs and AOCs 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 PGDP. This restructuring reflects the accomplishment of sitewide remedial objectives through an OU approach based on the primary exposure pathways.

At PGDP, site cleanup will be implemented in a phased approach including cleanup activities that currently are being conducted prior to shutdown of the operating gaseous diffusion plant (pre-GDP Shutdown activities), followed by post-GDP Shutdown cleanup activities, and then by implementation of the Final Comprehensive Site OU (CSOU). Through implementation of these three phases, a series of prioritized response actions through which short-term protection goals, intermediate performance goals, and long-term final cleanup goals will be attained. Within this approach, the short-term protection goals are to control risks to humans and the environment; intermediate-term performance goals are to reduce, control, or minimize contaminants found in source areas; and long-term goals are to evaluate and pursue additional actions determined necessary to achieve the contaminant level reductions to provide long-term protectiveness. To achieve these goals, DOE and the regulatory agencies have agreed that PGDP cleanup activities will occur in a sequenced approach consisting of (1) pre-shutdown scope, (2) post-shutdown scope, and (3) CSOU scope. The pre-shutdown scope is associated with media-specific OUs initiated prior to shutdown of the operating GDP (pre-GDP shutdown activities). These media-specific OUs were established by developing a site conceptual risk model for each source area. This process included a qualitative evaluation of contaminant types and concentrations, release mechanisms, likely exposure pathways, estimated points of exposure, and potential receptors based on current and reasonably foreseeable future land groundwater uses. The source areas for the pre-GDP shutdown scope have been grouped into five media-specific OUs as follows (DOE 2014):

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

The Site Management Plan (SMP) (DOE 2014) identifies the actions that have been reviewed as part of this Five-Year Review as IRAs or removal actions (with the exception of Southwest Plume). Each of these interim actions and the Southwest Plume will be subject to further evaluation to support long-term protectiveness for future final decisions. The final action to support National Priorities List 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 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	GDP Groundwater Sources
GWOU: Southwest Plume	Dissolved-Phase Plumes OU
SWOU: NSDD Source Control	SWOU
SWOU: NSDD Sections 1 and 2	SWOU
SWOU: C-746-K 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 considerations such as regulator expectations, risk-based decision making, compliance with other programs, technical considerations associated with GDP operations, mortgage reduction, and demonstrated progress toward completing the environmental management (EM) mission. Both the FFA and the SMP document 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 screening 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 plant 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 volatile organic compound (VOC) contamination at the C-400 Cleaning Building area, which is part of the GWOU.

In order to keep residents and the community informed of the remedial efforts taking place at PGDP, 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 PGDP. 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.

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 PGDP, contaminants by media, and results of site investigations are included in the following sections. Table 3.1 contains the COCs by media addressed by the actions included in this Five-Year Review.

Table 3.1. COCs by Media

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

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 the previous Five-Year Review are listed in Table 4.1. The location of the discussion of each action within this document is shown on Figure 4.1, the latest approved plume map, which shows the TCE plume based on 2012 data.

Table 4.1. Site/Project with Response Actions Taken at PGDP

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 Electrical Resistance Heating, currently underway
10.	Southwest Plume	GWOU	New to Five-Year Review, currently underway
11.	NSDD Source Control	SWOU	NSDD Source Control
12.	NSDD Sections 1 and 2	SWOU	NSDD Sections 1 and 2
13.	C-746-K Landfill	SWOU	WAGs 1 and 7, SWMU 8
14.	Fire Training Area	SWOU	WAGs 1 and 7, SWMU 100
15.	Surface Water Interim Corrective Measures	SWOU	Surface Water Interim Corrective Measures
16.	Surface Water On-site Sediment Removal	SWOU	New to Five-Year Review
17.	C-749 Uranium Burial Ground	BGOU	WAG 22, SWMU 2

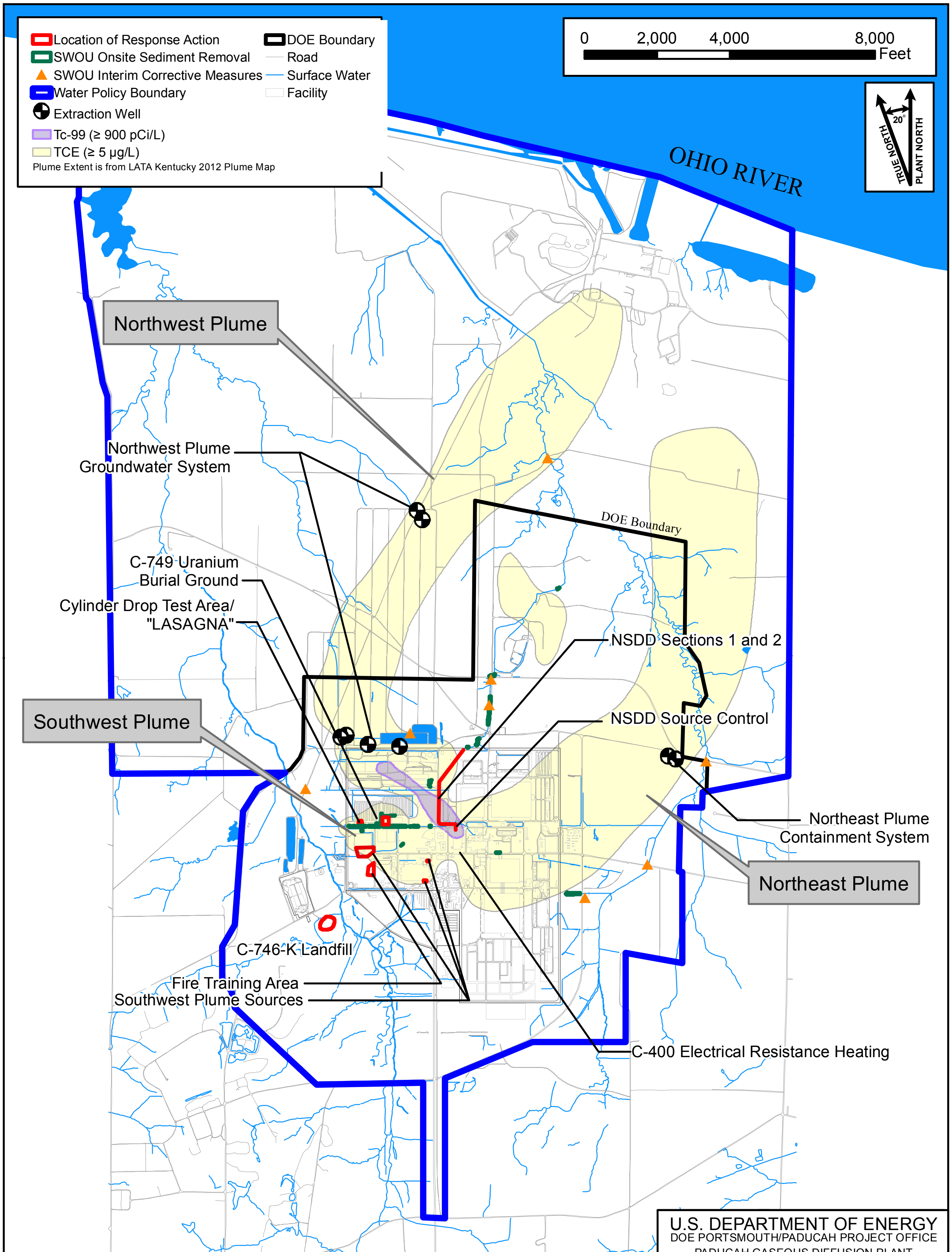

Figure 4.1. Locations of Response Actions Taken at PGDP

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5. NORTHWEST PLUME

After the initial discovery of contamination at PGDP in August 1988, DOE conducted a site investigation (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.

Outside of the immediate vicinity of its PGDP 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) 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 controlled by the PGDP and the TVA Shawnee Fossil Plant and sparsely populated areas between the two reservations. 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. The DOE maintains a Water Policy (evaluated in Section 8) that controls access to the groundwater through a license agreement process with landowners with private wells in the area of the plume, whereby DOE provides a household water supply to the area residents in return, 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 Northwest Plume Groundwater System (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 2012, which is the latest available plume map (LATA Kentucky 2014). 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 Northwest Plume Groundwater System has continued to operate since August 1995.

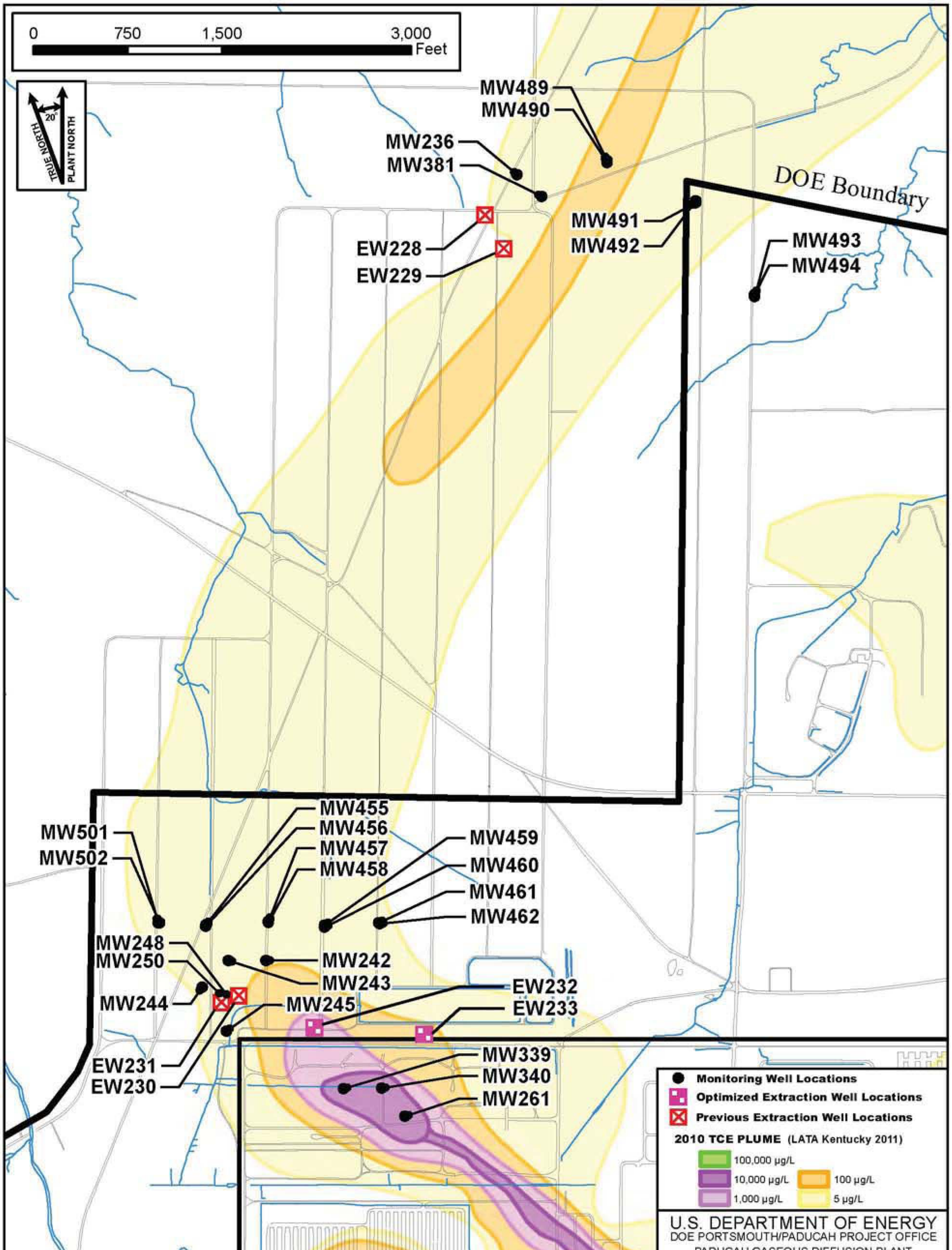

Figure 5.1. NW Plume EW Fields with 2010 TCE Plume Map

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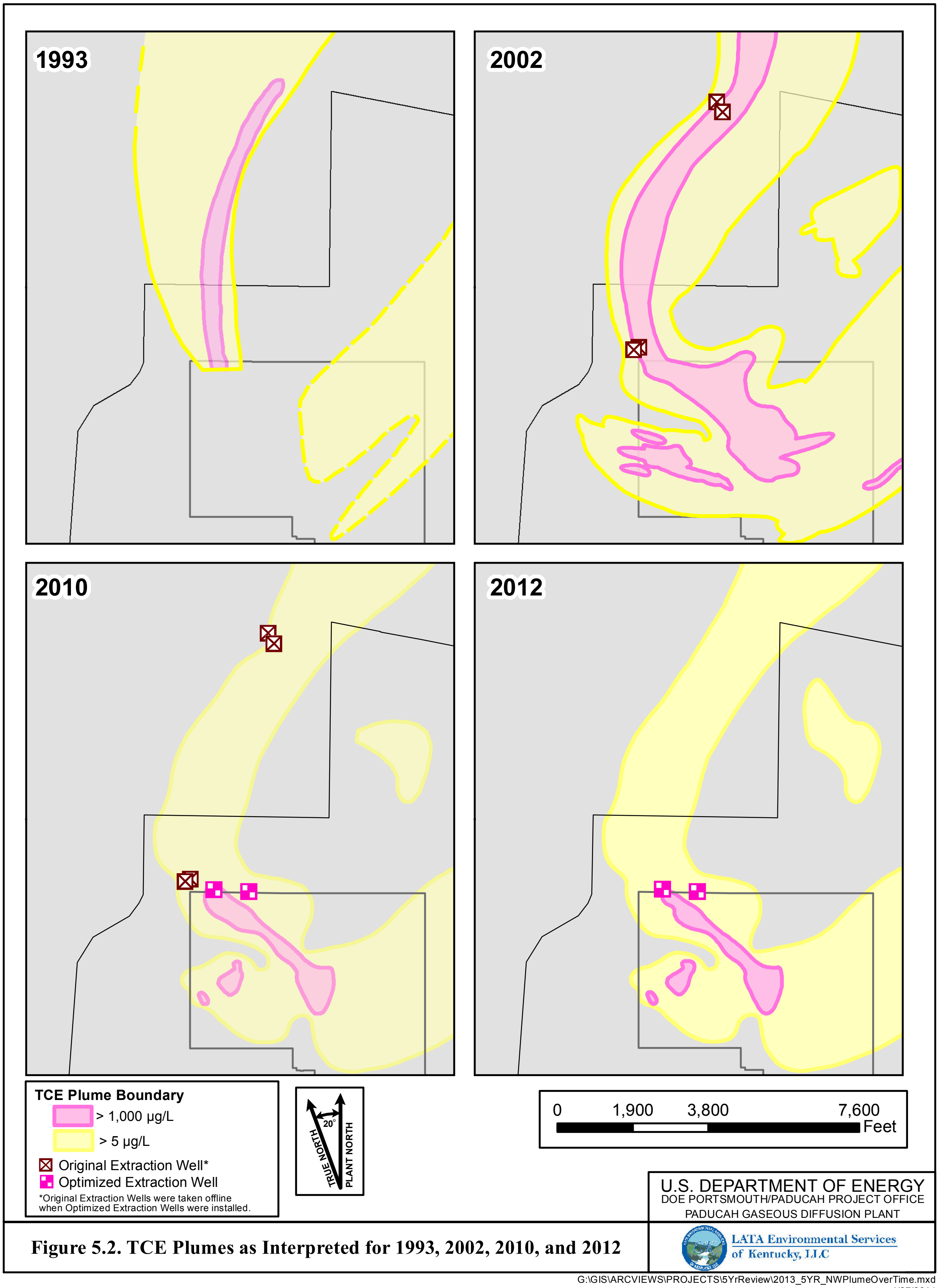


Figure 5.2. TCE Plumes as Interpreted for 1993, 2002, 2010, and 2012

The *Record of Decision for Interim Remedial Action of the Northwest Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* delineated the remedial action 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 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 permitted 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 and remedial action work plan (RAWP) was issued in May 1994 (DOE 1994a). 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, as well as 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, as installed, 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 plant;

- 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 on-line volatile organic analyzer; and

- Support equipment installed in the facility including backwash, 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 remedial action (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 remedial action 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 PGDP. 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 further evaluate natural attenuation processes. 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 PGDP 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. The strategies to increase extraction near the south wellfield included the addition of extraction locations to the east of the original EWs.

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 2010a). The latest revision (September 2010) was prepared to support the Northwest Plume IRA Optimization. Routine and preventive maintenance has been conducted in accordance with the *Paducah Plume Operations Maintenance, Calibration, and Testing Plan* (LATA Kentucky 2012a).

Since initial operations, the frequency of repair to the system has been normal and routine. The Northwest Plume treatment system had processed 1,756,903,636 gal of water, as of December 31, 2012. Mass balance evaluations indicate that the treatment system has removed approximately 34,766 lb (2,871 gal) of TCE.

The costs associated with the O&M of the NWPGS and the Northeast Plume Containment System (separate GWOU action discussed in Chapter 6) are tracked jointly and have been since fiscal year (FY) 2002. The cost for both systems for the five-year reporting period is $3.42M, or an average of $684K per year. This average annual O&M cost of $684K is less than the combined original estimates of $1.5M to $2.0M for the NWPGS and $240K for the Northeast Plume Containment System; the reduction is due primarily to efficiencies gained through continued long-term operation. The total operation cost for both the NWPGS and the Northeast Plume Containment System was $28.6M by the end of December 2012.

No major modifications to the treatment system were made during this reporting period (i.e., replacement of primary equipment). The activated carbon units are changed routinely due to contaminant loading. Only infrequent replacement of the ion exchange resin is required. The two lag ion exchange columns were changed out in April 2010; the two lead columns last were changed in April of 2004. Beginning in August 2010, the NWPGS switched from withdrawal 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 110 gal/minute each).

The Northwest Plume IRA treatment system has continued to operate as intended during the 2008–2012 period.

5.4 PROGRESS SINCE LAST FIVE-YEAR REVIEW

The 2008 Five-Year Review contained the following statement of protectiveness for the Northwest Plume IRA (DOE 2009a):

> 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 plume, need to be evaluated for long-term protection.

The 2008 Five-Year Review contained the following recommendation:

> Evaluate the extraction system to determine whether zones of capture of the EW fields can be optimized to control contaminant migration from the source area more effectively. Examples of follow-up actions resulting from this evaluation may include preferential pumping of wells in high concentration areas, termination of the two extraction wells in the North EW Field, and MW/EW installation.

In response to recommendations contained in the 2008 CERCLA Five-Year Review, construction activities for the Northwest Plume IRA Optimization commenced in March 2010. The NWPGS initially consisted of two EW fields (north and south with each field having two EWs), for a total of four wells, underground pipeline, treatment facility, and MW network. In August 2010, two new EWs (EW232 and EW233) became operational near the original south wellfield, adjacent to the north security fence of PGDP. The north wellfield EWs (EW228 and EW229) were removed from service in August 2010. EW230 and EW231, located in the original south wellfield, are kept in standby mode and may be returned to service, if needed. The location of the new EWs was optimized to enhance mass capture of the Northwest Plume in the area of the north plant boundary through EW placement and increased extraction capacity. Each of the two new EWs can pump 220 gpm, if required, which is the throughput capacity of the C-612 treatment facility. This allows the optimized EWs to be operated separately or together as needed in response to potential changes in plume trajectory resulting from changes in site flow conditions.

DOE issued *Remedial Action Work Plan for the Northwest Plume Interim Remedial Action Optimization at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-0339&D1 (DOE 2010b) in May 2010 to document the groundwater flow modeling used in the optimization approach and revisions to wellfield design and to establish a testing and monitoring program for the new EW field. Major construction for the optimization of the Northwest Plume Treatment System was completed on August 13, 2010. Following completion of construction, the system underwent testing and was commissioned on August 27, 2010, transferring the system to routine operation and maintenance.

Revision of *Operations 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 2010a) was completed in September 2010 and a hydraulics test of the new EW field was performed in October 2010. DOE issued *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, (DOE 2010c) in December 2010 to describe the response action optimization that is expected to result in more effective control of contaminant migration from the source area. DOE followed with the *Postconstruction Report for the Northwest Plume Optimization at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-0359&D1, (DOE 2011b) in January 2011.

The October 2010 hydraulics test and the follow-on computer modeling evaluation of the new EWs demonstrate that the NWPGS zone of capture better intercepts the width of the Northwest Plume at the north security fence. 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. The long-term benefit of the optimization of the IRA will require additional time to become apparent.

5.5 SITE INSPECTION

On January 17, 2013, the Northwest Plume Pump-and-Treat Facility was inspected by a member of the Five-Year Review Team for this Five-Year Review. The facility includes the C-612 Treatment Facility and the south wellfield (EW232/EW233). The treatment facility is located just outside the northwest corner of the perimeter fence of PGDP, but within the security buffer zone around the plant. The EW232/EW233 field is located east of the treatment facility (just north of the PGDP 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 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. Groundwater treatment equipment inside includes a sand filter unit, an air stripper and carbon filtration unit, and four ion exchange columns. The interior of the building is clean, free of clutter and debris, and maintained well. Access-controlled areas within the building 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 were 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 PGDP Fire Services Department.

Well vaults for both the currently operating EWs and the original south wellfield EWs (in standby mode) are maintained properly. The new EWs are operating as intended, with minimal maintenance required.

5.6 TECHNICAL ASSESSMENT

The primary objective of the Northwest Plume IRA is to initiate an action to mitigate the spread of the high concentration zone of TCE and Tc-99 contamination of the Northwest Plume. Monitoring data indicate that this remedial action 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 maximum contaminant levels (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.

Figure 5.3 shows contaminant level trends in each of the south EWs. Targets for the average levels of TCE and Tc-99 in effluent continue to be met as indicated from the latest semiannual reporting period of January 2012 to June 30, 2012 (Table 5.1). The target concentrations for these contaminants are 5 µg/L EW230 and EW231, the EWs of the original south wellfield, are kept in standby mode and will be returned to service, if needed.

Groundwater flow modeling for the optimization study predicted 99.99% capture of the mass of TCE flux in the Northwest Plume at the PGDP security fence using the two new EWs that were installed in 2010. Groundwater analyses for TCE and Tc-99 from the MW systems for the original south EW Field (EW230 and EW231) and for the new south EW field (EW232 and EW233) demonstrate that the EWs have reduced contaminant levels in the RGA and that these reduced levels persist.[1] Table 5.2 summarizes contaminant analyses for late 1995, when groundwater extraction began at EW230 and EW231, compared with 2012 levels. Figure 5.4 shows the trends in TCE and Tc-99 in the two wells of the original south wellfield with highest contaminant levels (MW243 and MW248).

For the years 1998 through 2012, MW261, MW339, and MW340, located in the core of the Northwest Plume and far upgradient of both the original and new south EW fields, EW230/231 and EW232/233 (see Figure 5.1), have continued to yield water with elevated levels of TCE (as much as 10,000 to 40,000 µg/L) and Tc-99 (as much as 1,500 to 6,000 pCi/L) (see Figure 5.5). Marked trends of declining contaminant levels in MW261 and MW339 and increasing trends in MW340 (Figure 5.6) illustrate the eastward migration of the core of the upgradient plume. The rate of eastward migration may increase with continued operation of the new south EW232/233 wellfield. Downgradient MWs for the new south EW232/233 wellfield document reduced contaminant levels (Figures 5.7 and 5.8) and suggest that the new EW field is continuing to reduce contaminant levels in the core of the Northwest Plume, as intended by the ROD.

[1] Contaminant trends in MW242, specifically Tc-99 after late 2007, are less persuasive. Rising Tc-99 levels in MW242 after late 2007 may reflect an eastward migration of the Northwest Plume and the location of the core of Tc-99 contamination on the east side of the Northwest Plume.

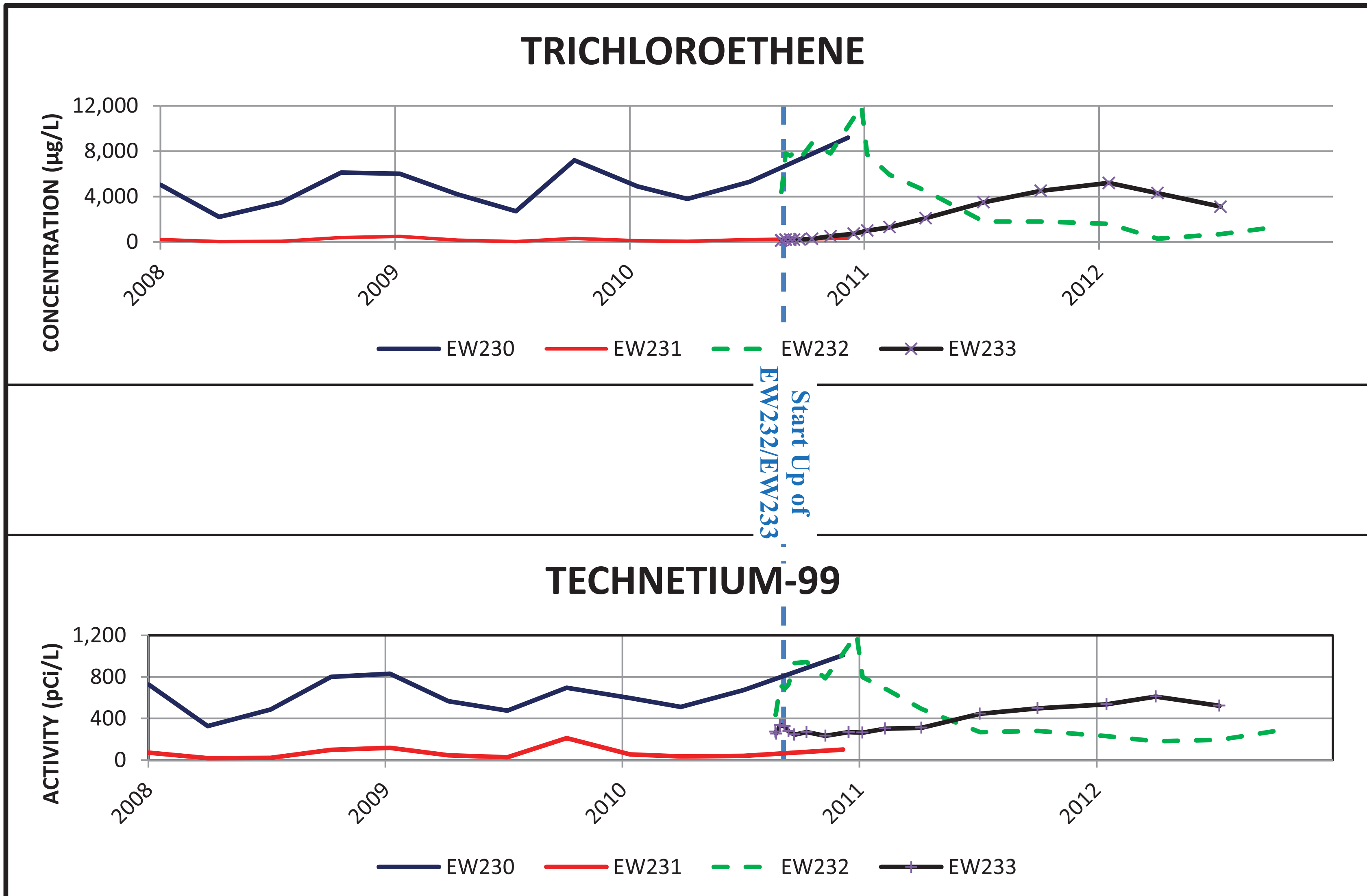


Figure 5.3. Contaminant Trends in the Original (EW230 and EW231) and New (EW232 and EW233) South Well Field EWs

Table 5.1. Northwest Plume Groundwater System Influent and Effluent Concentrations

	TCE (µg/L)			Tc-99 (pCi/L)		
	High	**Low**	**Average**[a]	**High**	**Low**	**Average**[a]
Influent	2,700	2,100	2,422	412	342	365
Effluent	6.6	2.5	4.15	43.3	16.3	28.3

Data is taken from the DOE PGDP FFA Semiannual Progress Report for Fiscal Year 2012 (DOE 2012a).
[a] Average is calculated as an arithmetic average, using the laboratory reporting limit for nondetects.

Table 5.2. Summary of Contaminant Levels at the Original South EW Field (EW230 and EW231)

	TCE Concentration (µg/L)		Reduction in	Tc-99 Activity (pCi/L)		Reduction in
Well	**Late 1995**	**2012**	**Concentration**	**Late 1995**	**2012**	**Activity**
MW242	530	120-160	Yes	247	197-218	Yes[a]
MW243	13,500	30-53	Yes	3,781	ND[b]-38	Yes
MW244	3,600	3-10	Yes	1,048	ND	Yes
MW248	14,000	9-28	Yes	3,488	ND-33	Yes
MW250	13,300	4-21	Yes	3,358	ND	Yes
MW245[c]	28	89-130	No	24	ND	Yes

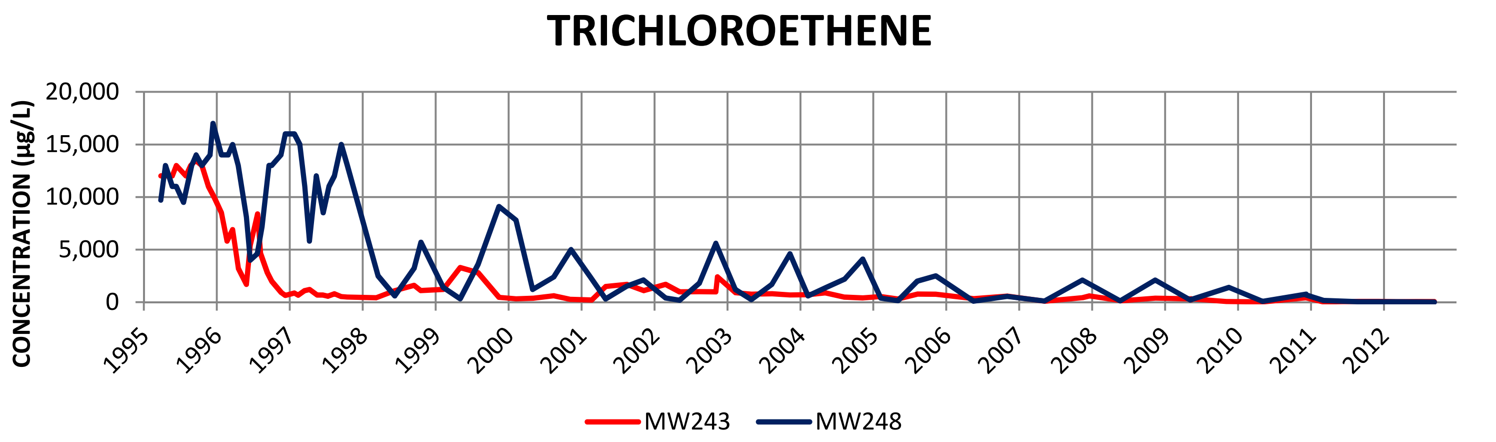
[a] Tc-99 levels have declined through 2007, but have increased over the period 2008 through 2012.
[b] Nondetect
[c] Upgradient well

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 EW228/EW229, north wellfield. RGA MW cluster MW489/MW490 was placed in the centroid of the Northwest Plume and MW cluster MW493/MW494 was placed to the east of the centroid. 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.

In general, contaminant levels in the core of the Northwest Plume in the area of the north wellfield have continued to decline: in 2012, contaminant levels were 200 µg/L or less TCE and 102 pCi/L or less Tc-99. Contaminant levels declined in MW489 and MW490 during 2011 and rose in MW491 and MW492. Further monitoring is required to determine the significance of these trends. Table 5.3 and Figure 5.9 document the contaminant trends in the area of the north wellfield.

The thick interval of relatively low-permeability silt that overlies the Northwest Plume should reduce the potential for transport of VOC vapors from the Northwest Plume to the surface. Moreover, the NWPGS has significantly reduced VOC levels in the off-site plume and is anticipated to further reduce off-site contaminant levels 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 PGDP actions (notably the Water Policy, discussed in Chapter 8).

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. There are no 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.



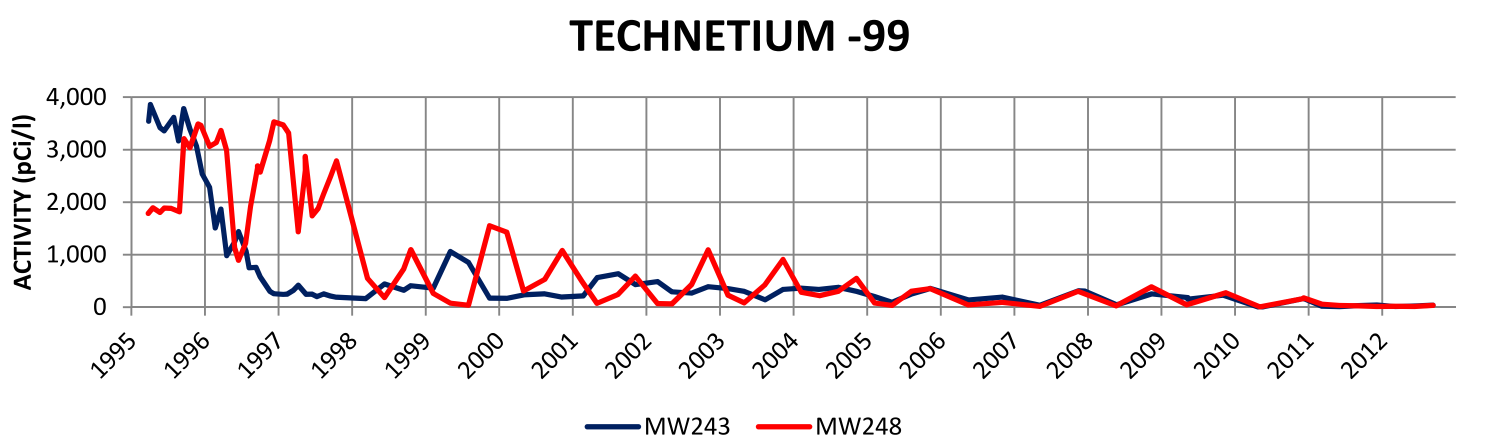


Figure 5.4. Contaminant Trends in MW243 and MW248 of the Original South Wellfield (EW230/EW231)

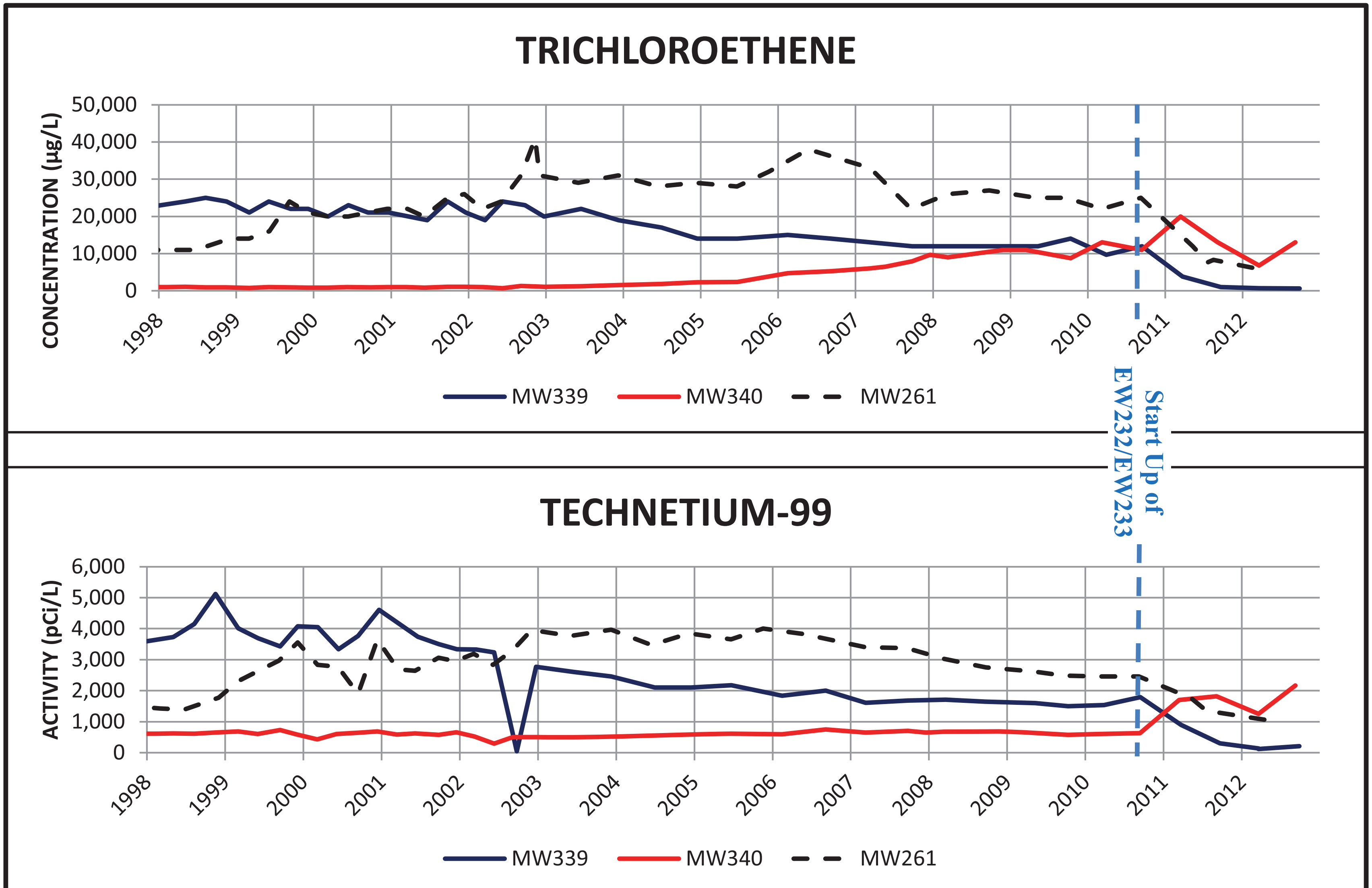


Figure 5.5. Contaminant Trends in MWs Located in the Upgradient NW Plume

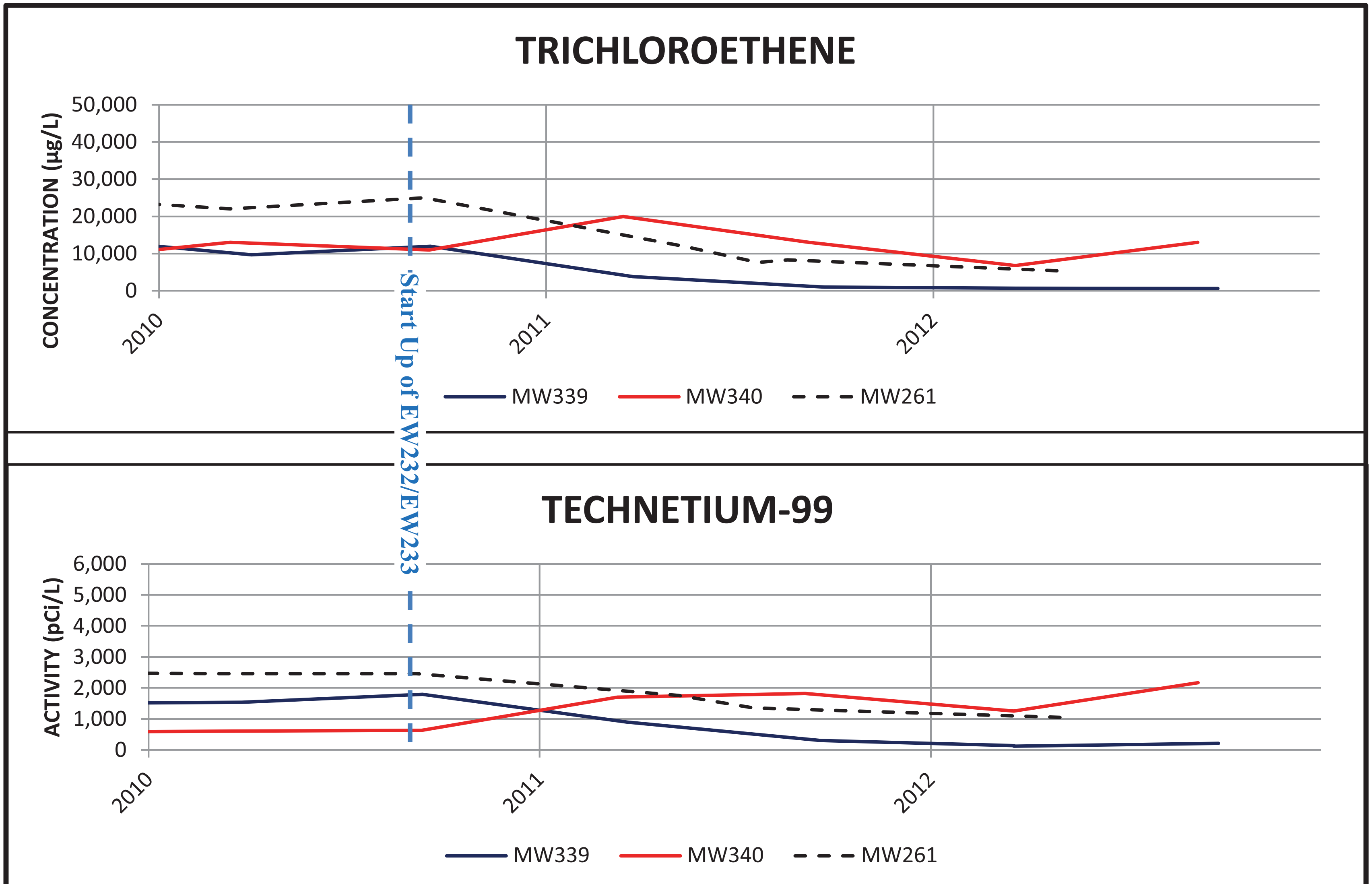


Figure 5.6. Trends in MWs Located in the Upgradient Northwest Plume since Start-Up of EW232/EW233

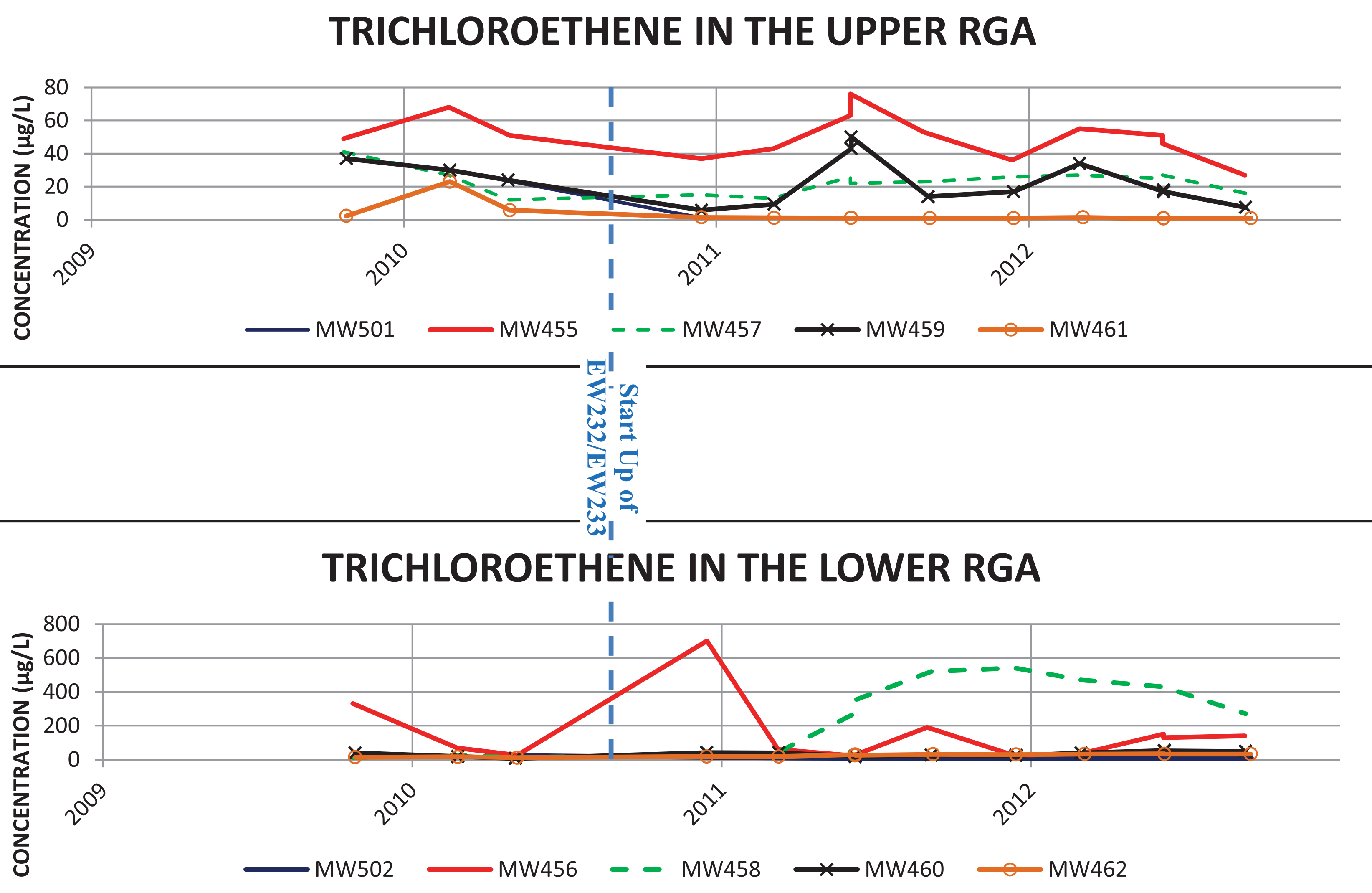


Figure 5.7. Trichloroethene Trends in MWs Located Downgradient of EW232 and EW233

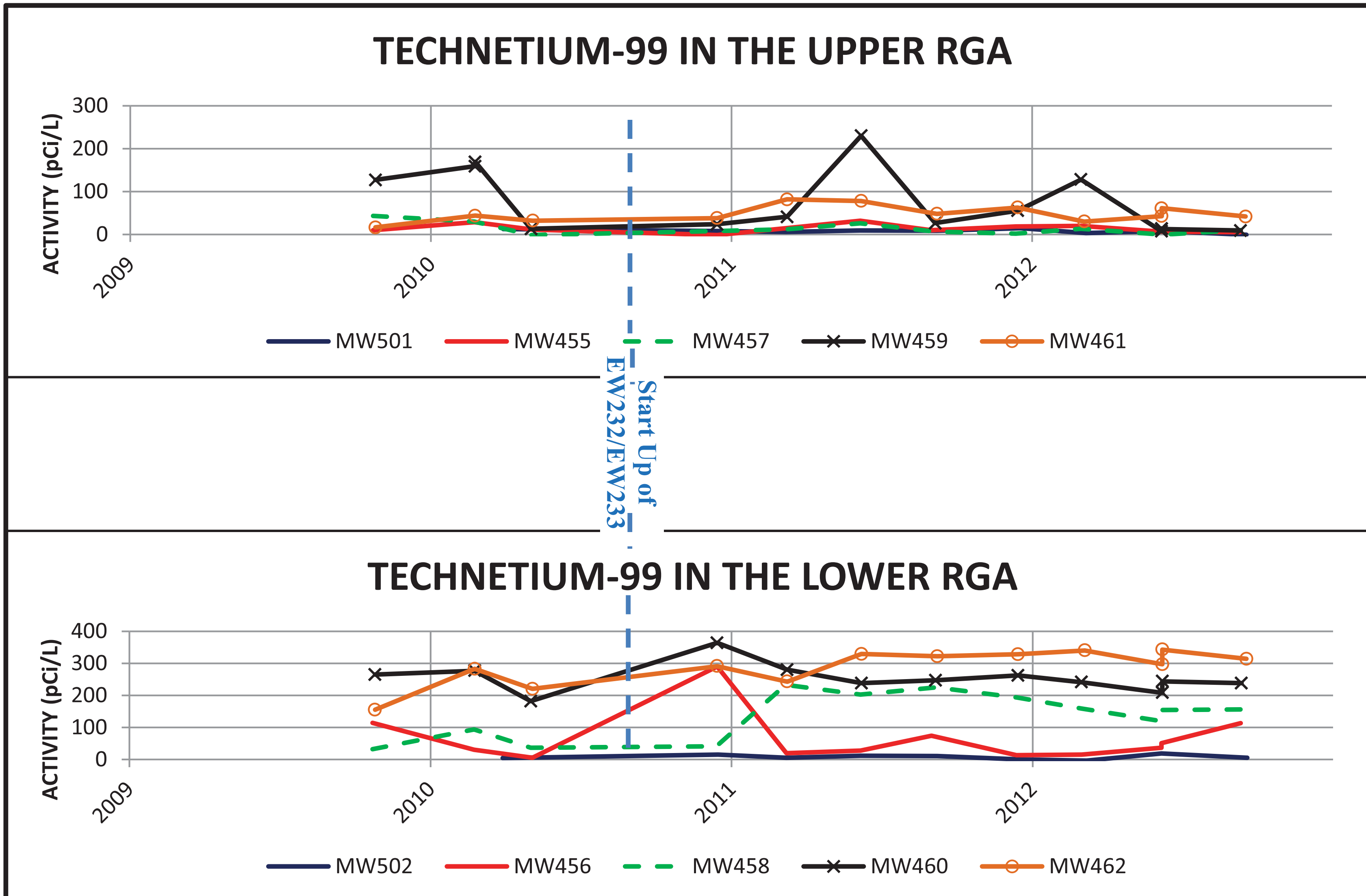


Figure 5.8. Technetium-99 Trends in MWs Located Downgradient of EW232 and EW233

Table 5.3. Summary of Contaminant Levels in the Area of the North EW Field (EW2228 and EW229)

Well	Screen Interval	TCE Concentration (μg/L) 2010	2011	2012	Tc-99 Activity (pCi/L) 2010	2011	2012
MW236	lower RGA	27	12	N/A[a]	28	ND[b]	N/A
MW381	middle RGA	46	N/A	N/A	27	N/A	N/A
MW489	upper RGA	200–310	220–310	150–200	95–111	76–111	57–61
MW490	lower RGA	320–530	170–320	150–200	141–153	62–122	63–71
MW491	upper RGA	13–20	3–160	100–110	91–110	81–99	87–99
MW492	lower RGA	28–47	8–130	130–140	91–103	84–109	98–102
MW493	upper RGA	4	3-4	2-3	11-30	10-30	14-32
MW494	middle RGA	6	4	ND-3	ND-15	20-46	25-42

[a] Data not available—no sample collected.
[b] Nondetect

Remedial actions are being implemented or planned to minimize further migration from sources. 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 following:

The EW Fields are functioning by 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, 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 the ARARs 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).

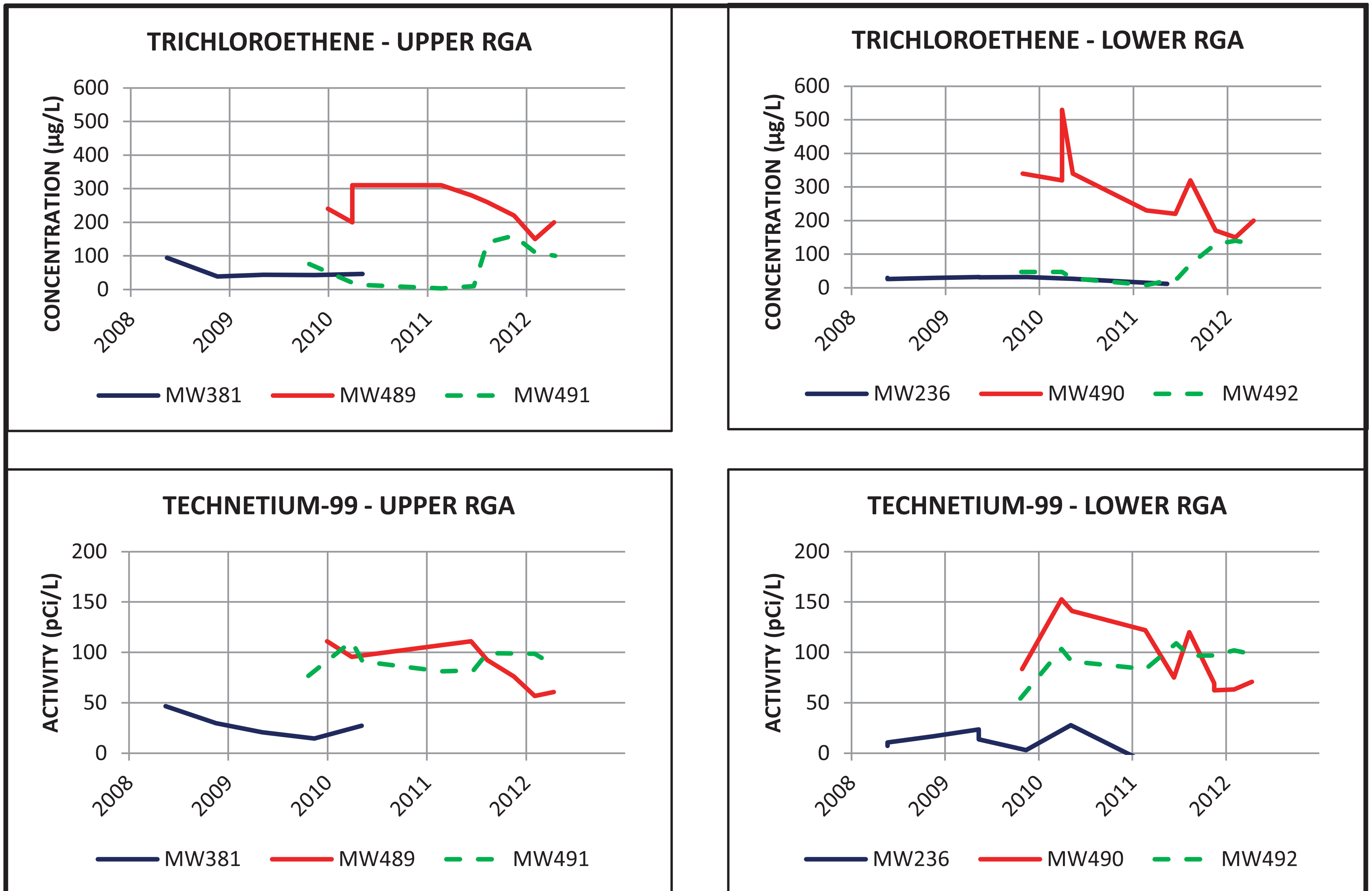


Figure 5.9. Contaminant Trends in MWs Located Proximal to the EW228/EW229 Wellfield

PGDP's 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 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.

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. 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 PGDP industrial area. This EW field is intended to control the source of groundwater contamination to the Northwest Plume immediately north of the PGDP main plant boundary. Contaminant levels in the area of the previous north EW field (EW228/EW229) have significantly decreased since the initiation of the Northwest Plume IRA and are continuing to decline with the operation of the new EW field (EW232/EW233). The remedy remains protective.

5.7 ISSUES

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.

6. NORTHEAST PLUME

After the initial discovery of contamination at PGDP 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 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* delineated numerous plumes within the RGA that coalesce to form the Northeast Plume (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 plant and extends off DOE property. Figure 6.1 depicts the aerial extent of the Northwest and Northeast Plumes based on the latest approved plume map from 2012 (LATA Kentucky 2014).

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 major components of the selected RA included the following:

- Installation of extraction wells and 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 PGDP 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 goal as follows:

> 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 plant security fence.

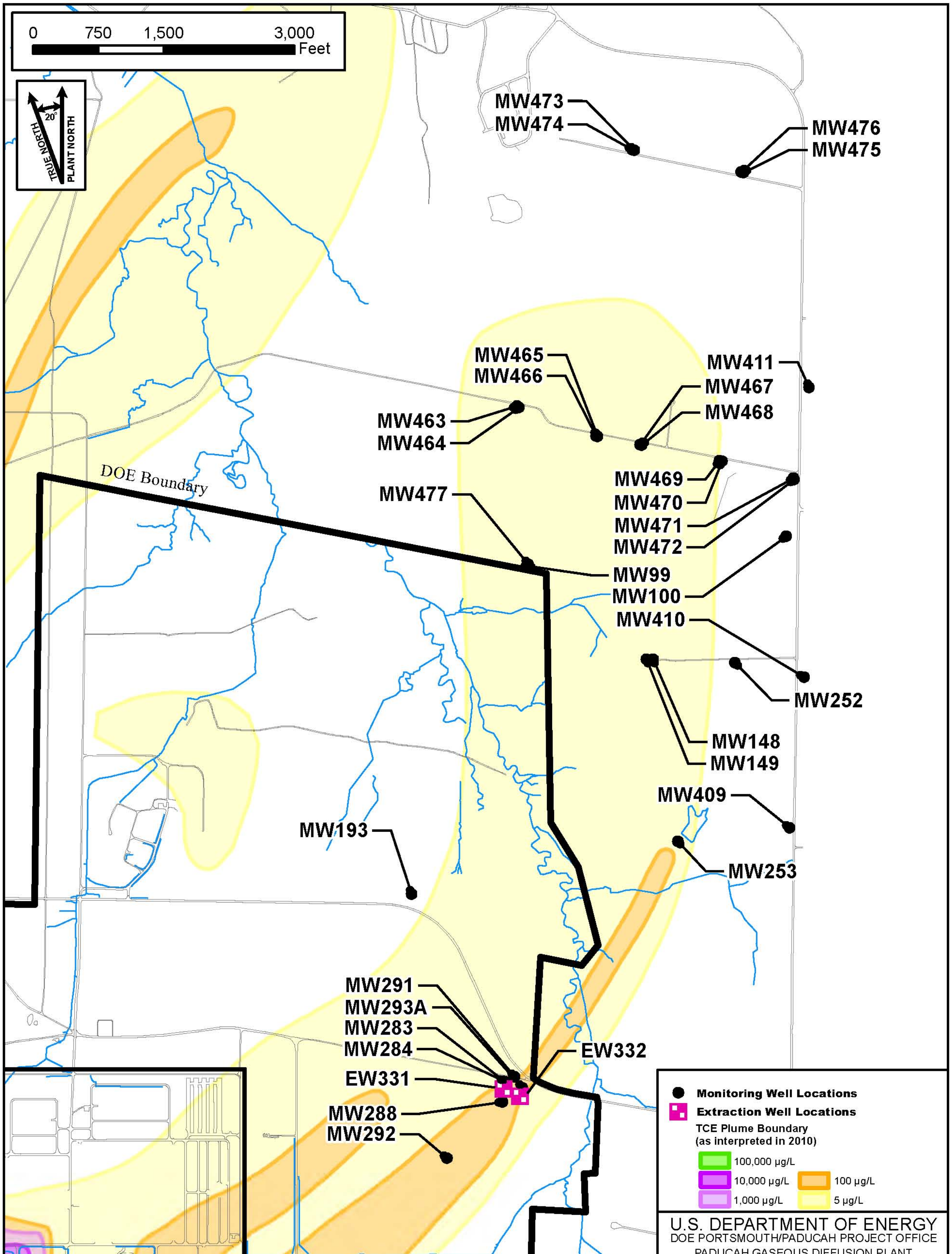


Figure 6.1. NE Plume EW Field with 2010 TCE Plume Map

LATA Environmental Services of Kentucky, LLC

FIGURE No. NE Plume\NEPlume_EW_Field_R1.mxd
DATE 05-30-2013

The ROD was supported by a PHEA. In the PHEA, TCE is listed as the primary PGDP-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 are identified in the ROD.

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 remedial action 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. Currently, the average pumping rate for the Northeast Plume EWs is approximately 200 gpm.

DOE issued a Notice to Proceed with construction 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, and was issued February 7, 1997 (DOE 1997a). The postconstruction report presents the summary of the construction activities for the RA. Operation of the Northeast Plume IRA began February 28, 1997.

In February and March 2006, DOE Headquarters conducted a Sitewide Remedy Review at PGDP. The Sitewide Remedy Review report recommended optimization of the Northeast Plume and Northwest Plume IRAs. 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 PGDP during October 2006. 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 Northeast Plume IRA 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.

6.3 SYSTEMS OPERATIONS/OPERATIONS AND MAINTENANCE

O&M activities for the Northeast Plume Containment System (NEPCS) are 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 2002b). 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 1,303,955,106 gal of water as of December 31, 2012. The treatment system has removed approximately 3,320 lb (274 gal) of TCE.

The costs associated with the O&M of the NEPCS and the NWPGS (which was 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 $3.42M, or an average of $684K per year. This average annual O&M cost of $684K 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 $28.6M at the end of December 2012. The Northeast Plume IRA treatment system has continued to operate as intended during the 2008–2012 period.

6.4 PROGRESS SINCE LAST FIVE-YEAR REVIEW

The 2008 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.

The previous Five-Year Review noted that the MW network may need to be enhanced to monitor the advancement of the plume toward the north and northwest, specifically by placing a lower RGA well in the northeast corner of the DOE property and placing RGA wells farther to the north along Anderson Road. These wells and others were installed in late 2009 as part of an MW system upgrade project.

The 2008 Five-Year Review reiterated the recommendation previously identified by the Remediation Systems Evaluation Team, that the IRA be placed in standby mode following the development of decision criteria, which specify the conditions under which the system would be restarted. In 2010, DOE initiated development of draft criteria for standby assessment in accordance with a recommendation in the 2008 Five-Year Review (DOE 2009a).

In 2011, the FFA managers identified optimization of the NEPCS as a priority, consistent with the sitewide strategy that includes a series of sequenced activities consisting of source actions and control of off-site groundwater migration followed by a final action for the overall dissolved-phased plume. Optimization activities are ongoing and will be documented in the CERCLA Explanation of Significant Difference.

The results of sampling in the additional Northeast Plume MWs have changed the site’s definition of the Northeast Plume. Recent monitoring data define two cores of higher contamination migrating from the east PGDP security fence, previously thought to be one larger core of contamination, and extend the end of the plume to north of Anderson Road. Relocation of EWs for the NEPCS is planned to address each of the plume cores.

6.5 SITE INSPECTION

A site inspection of the NEPCS facilities was made on January 31, 2013. Participants included the Facility Manager, a member of the Five-Year Review team, and the Facility Operator. This facility is located south and west of the intersection of Ogden Landing Road (KY Hwy 358) and Little Bayou

Creek, northeast of PGDP. The facility 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.

The main access road into the area is secured by a chain-link gate located just south of its intersection with Ogden Landing Road. Operators indicated 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 in good condition.

The two EWs are located approximately 200 ft apart. Each well is located in an underground concrete vault with a hinged aluminum lid. Each well also is surrounded by a chain-link security fence 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 appears to be maintained well. During this inspection, both wells were pumping with no apparent problems.

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 completely enclosed 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 is in good condition and functional. During this inspection, the pumps were running and no operating problems were observed. The electrical power and control panels are in good condition and properly labeled.

The Facility Operator was interviewed regarding system operations and system performance. The VOCs are stripped from the water in the C-637 cooling towers. Groundwater and plant process cooling water are collected in the basins of the cooling towers and recirculated through the cooling tower. After recirculation, water eventually is discharged to the C-616 Lagoons and then through the permitted Outfall 001.

Only minor repairs and routine maintenance have been performed. Shutdowns for repairs have been infrequent; no shutdowns have been long-term during the period of this Five-Year Review. A summary of both routine and nonroutine maintenance is reported in the DOE PGDP FFA Semiannual Progress Report. In accordance with the substantive requirements of the ARARs cited in the ROD, a tank tightness test and leak tests were successfully conducted in 2007 on the Northeast Plume EQ tank and high density polyethylene transfer lines, respectively. No leaks were identified during the tests. Per discussions with the FFA managers in March 2012, the tank tightness and leak tests scheduled for 2012 were rescheduled for May 2013 to allow for testing of newly constructed pipelines. These pipelines were installed as part of a new water treatment unit that will work in conjunction with the existing EQ tank and pipelines; however, the EQ tank and transfer lines are ancillary equipment that is connected to the cooling tower which has been determined to meet the definition of an exempt wastewater treatment unit.

For the 2008 through 2012 period, the EWs have operated as intended with minimal maintenance required.

6.6 TECHNICAL ASSESSMENT

The NEPCS is an IRA to control the high concentration area of the Northeast Plume that extends outside the plant security fence and to track contaminant migration to assess the IRA's performance. Monitoring data indicate that this remedial action 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 EWs of the Northeast Plume EW Field (EW331 and EW332) began operation on February 28, 1997 (Figure 6.1). Trends of TCE concentrations in groundwater of the Northeast Plume EW field monitoring system clearly show that TCE levels have been 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**	
Well	**Early 1997**	**Low of 2003**	**2012**	**Through 2003**	**2004–2012**
MW283	1,300	120	52–65	Reduction	Near steady reduction
MW291	1,400	100	38–59	Reduction	Near steady reduction
MW294/293A	2,000	280	200–230	Reduction	Near-steady reduction
MW288*	1,600	240	130–210	Reduction	Near steady reduction
MW292*	800	430	200–280	Rise to 1,400 µg/L, then decline to 440 µg/L	Near steady reduction
MW284**	1,500	140	See footnote	Reduction	See footnote, ranged 110–150 µg/L in 2004 and 2005

*MW288 and MW292 are upgradient wells.
**MW284 data for 2012 is not available because the well was last sampled for TCE in August 2005. All results obtained from January 2001, until the last sampling activity, were below 250 µg/L, with steady reduction shown throughout the sampling period.

1,1-DCE, is presented as the only other COC in the ROD. Since the ROD was signed, laboratory reporting limits for 1,1-DCE have 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 Northeast Plume EQ tank (12 and 25 µg/L) in 2007; since February 2009, 1,1-DCE concentrations have ranged from 5 to 10 µg/L. The 1,1-DCE present in the plume is being captured by the Northeast Plume EW Field.

As with the previous EW fields of the Northwest Plume IRA, a primary concern of the NEPCS is the extent of the zone of capture of the EW field. To ensure that an adequate zone of capture remains during periods when only one of the two well pumps has been idled by power supply failure to the pump or due to maintenance, the system operators have increased the pumping rate of the working well.

Operational efficiency (actual run time compared to 100% run time) typically exceeds the operational goal of 85%, often averaging better than 95% over a three-month period. For the period 2003 through 2012, TCE concentration levels from the EWs have remained near steady, declining to approximately 100-200 µg/L (Figures 6.2 and 6.3). Tc-99 levels have risen to approximately 30 pCi/L[2] in EW233 because continued operation of the EWs has pulled Tc-99-contaminated groundwater from the area of the plant.

TCE levels in all MWs and EWs associated with the Northeast Plume Groundwater System exhibit declining trends. The data indicate that the EWs are effective at controlling the high-concentration core of the Northeast Plume and that the TCE levels within the upgradient Northeast Plume are declining.

DOE installed 28 MWs near the east PGDP security fence and in downgradient reaches of the Northeast Plume as part of the recent monitoring well upgrade project (October 2009 through February 2010). A MIP was used to characterize the location of the centroids of the Northeast Plume near the east PGDP security fence to optimize the location of these wells. Results from these MWs were incorporated into the latest update of maps of the PGDP plumes (for calendar year 2010) (see Figure 6.1).

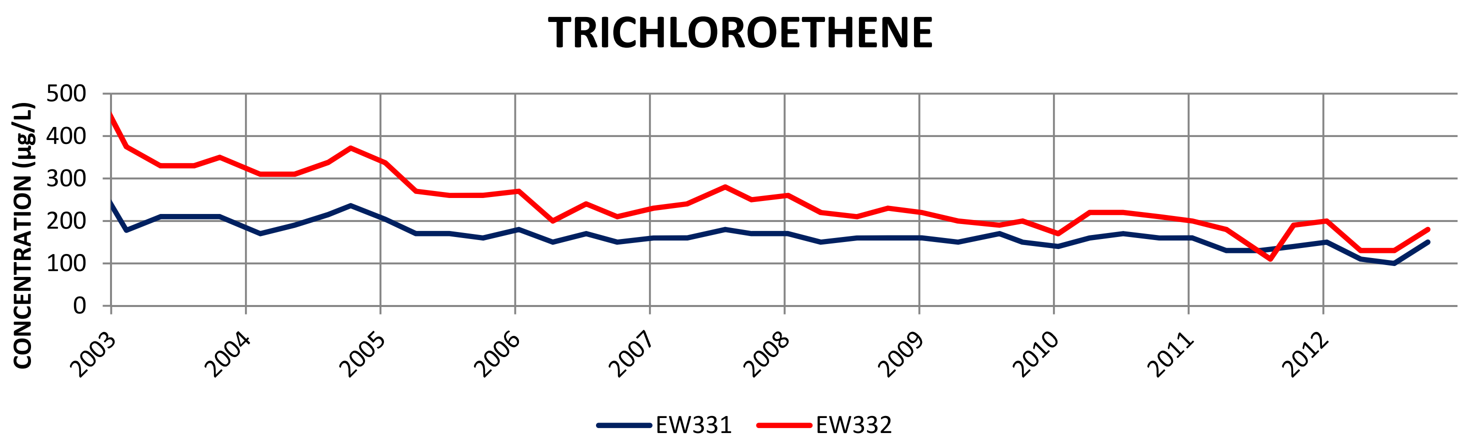
The IRA is intended to control the north end of the high concentration core of the Northeast Plume (1,000 µg/L and greater TCE). Monitoring data from throughout the plume document that the Northeast Plume TCE concentrations have diminished and are significantly less than 1,000 µg/L. Consistent with the sitewide strategy, which includes control of the migration of groundwater contamination from the site, DOE continues to operate the NEPCS. The TCE concentrations in the treatment system effluent continue to meet the target levels. TCE concentrations are less than 5 ppb, as indicated in the latest FFA semiannual reporting period of January–June 2012 (see Table 6.2).

Table 6.2. Northeast Plume Groundwater System Influent and Effluent Concentrations

	TCE (µg/L)		
	High	**Low**	**Average*[a]***
Influent	170	120	153
Effluent	< 1	< 1	< 1

Data is taken from the DOE PGDP FFA Second Semiannual Progress Report for Fiscal Year 2012, Paducah, Kentucky (DOE 2012a).
[a] Average is calculated as an arithmetic average.

[2] The current 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 ICRP Publication 107 (ICRP 2008) were also 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.



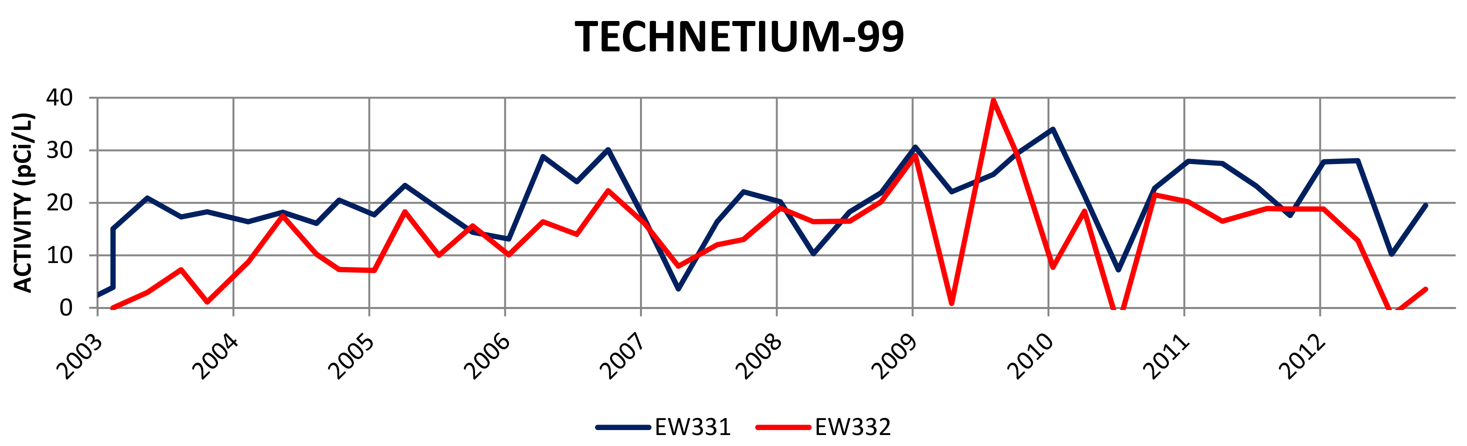
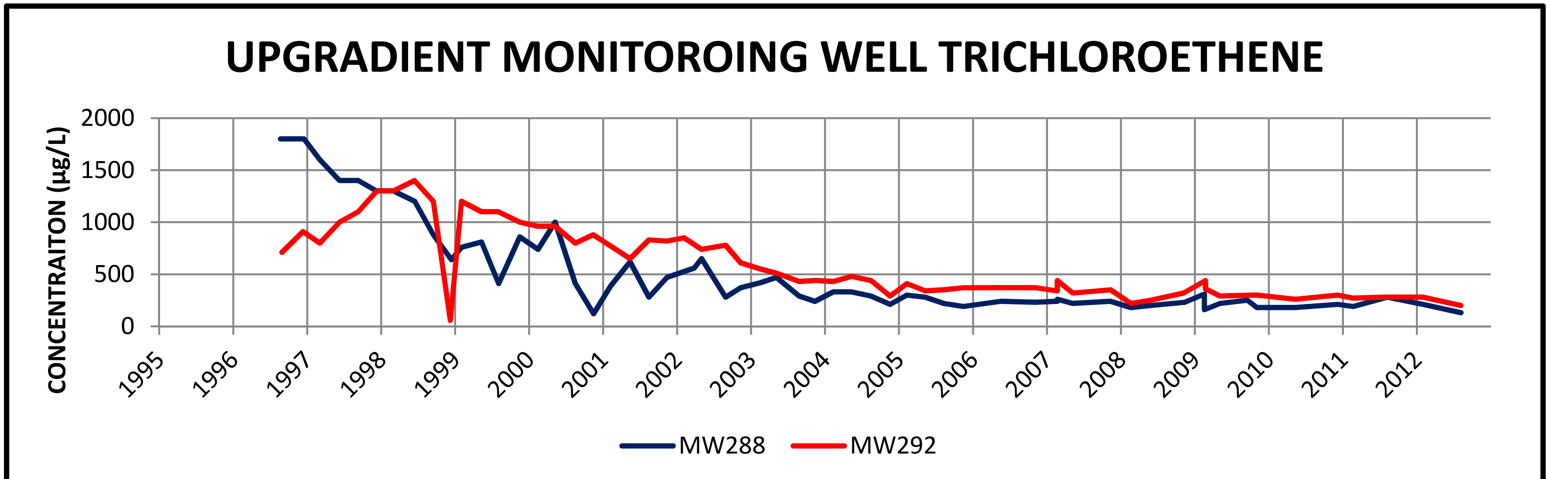


Figure 6.2. Contaminant Trends in EW332 and EW333



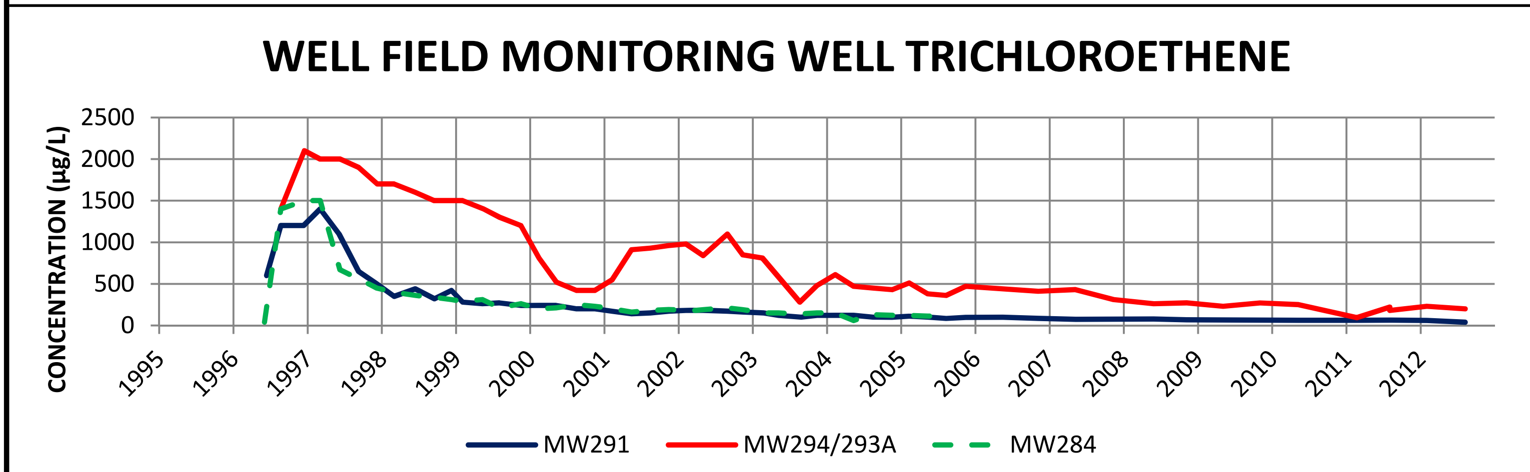


Figure 6.3. Trichloroethene Trends in the Northeast Plume

This review of data and the site inspection indicate that the remedy is functioning as described in the ROD and objectives have been met. DOE continues to operate the NEPCS to control off-site migration of contaminated groundwater, consistent with the sitewide strategy. There have been no changes in the physical conditions of the site 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 is functioning as designed. The planned optimization of the NEPCS includes relocation of the EWs to increase the rate of contaminant mass removal of 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 only to control 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 single goal identified for the Northeast Plume ROD, to initiate hydraulic control of the high concentration area that extends outside the plant security fence, remains 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 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:

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

- 401 *KAR* 63:022 was replaced with 401 *KAR* 63:020; however, guidance from 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.

PGDP's Northeast Plume underlies land controlled by DOE and sparsely populated areas northeast of the PGDP 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 Northeast Plume IRA consists of groundwater extraction from two EWs located near Ogden Landing Road at Little Bayou Creek. This EW field is intended to control migration of the high-concentration core of TCE contamination off the DOE property. Contaminant levels in the area 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. While operation of the NEPCS is an interim action, it is effectively protective in conjunction with other PGDP programs (notably the Water Policy).

Moreover, DOE is performing an optimization of the NEPCS in response to the recommendation of the 2008 Five-Year Review. DOE has performed groundwater modeling to optimize the configuration of groundwater extraction near the eastern fenceline for the Northeast Plume and is currently in the process of designing two new EWs (with air stripper treatment systems) to be placed near the east PGDP security fence. The new EWs to be constructed near the east PGDP security fence are expected to provide an interim, optimized approach to capture dissolved contamination derived from the sources of the Northeast Plume.

6.7 ISSUES

The Northeast Plume remedial action 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 Northeast Plume is an IRA designed to initiate hydraulic control of the high TCE concentration area within the Northeast Plume and does not achieve final cleanup of the groundwater contamination. A follow-up evaluation is needed to ensure long-term protection.

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7. CYLINDER DROP TEST AREA OR LASAGNA^{TM} TECHNOLOGY DEMONSTRATION

The Cylinder Drop Test Area (SWMU 91) encompasses approximately 1.7 acres and is located in the extreme west-central area of PGDP 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 pit. After the cylinders were chilled, a crane lifted 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* (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* (LMES 1996a).

Results of the initial investigations conducted at SWMU 91 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 into the UCRS, but had not fully penetrated the aquitard above the RGA at the unit. 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 electro-osmosis to move shallow groundwater and contaminants 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* (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 cleanup effectiveness of Lasagna^{TM} would achieve the cleanup goals. The results of the Phase IIA are discussed further in the *Lasagna^{TM} Soil Remediation: Innovative Technology Summary Report* (LMES 1996b).

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 for the remedy selection. The remedy consisted of treatment of contaminated soil pore water by the Lasagna^{TM} electro-osmosis

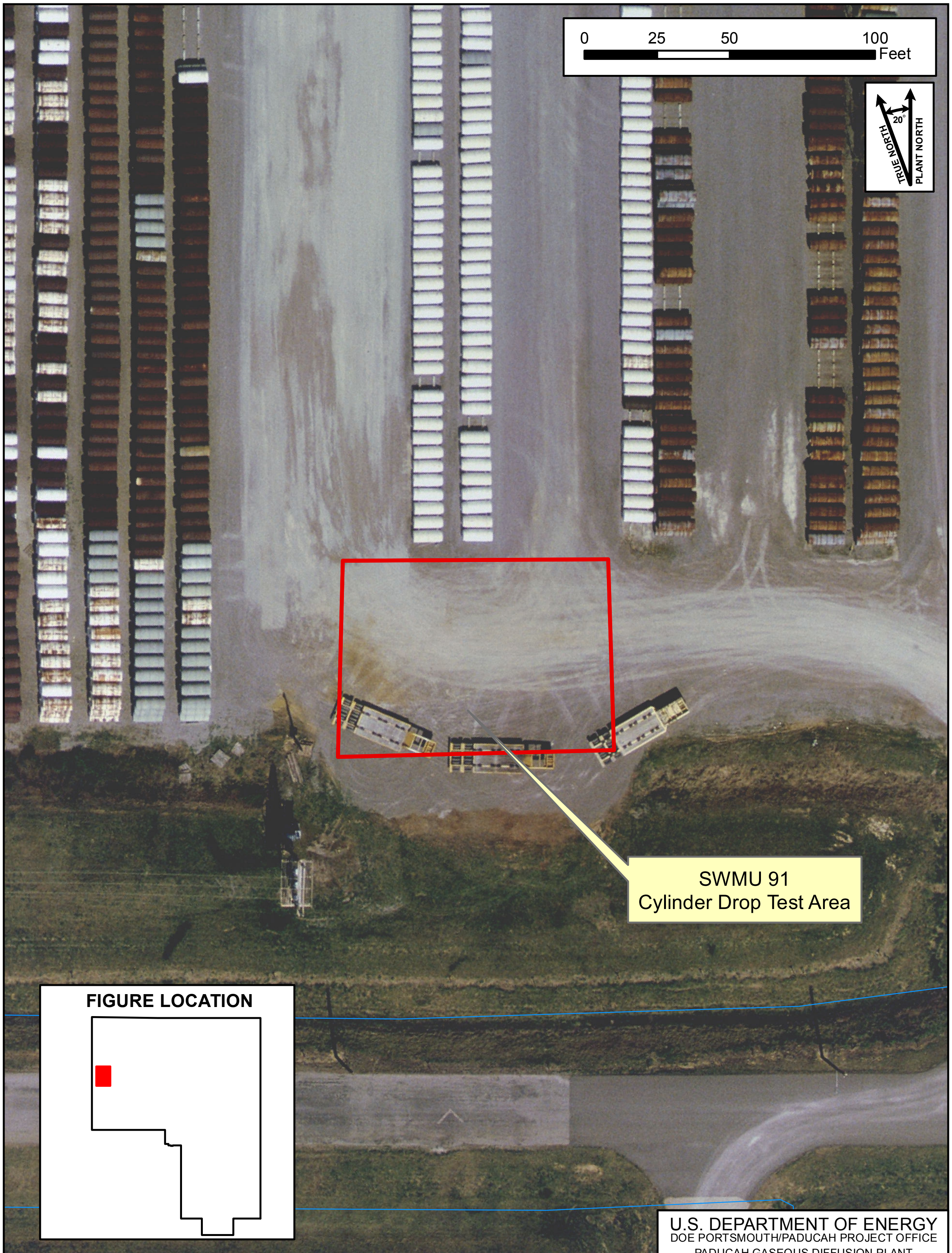

Figure 7.1. Location of Cylinder Drop Test Area

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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.

- Treatment zones containing reagents that either decompose the TCE to nontoxic products or adsorb the TCE and make it immobile (DOE 1998a).

- Electrodes (a cathode and an anode) that, when energized, moved contaminants (i.e., TCE) into or through the treatment zones and heat the soil. The contaminated water in the soil pores flowed from the anode through treatment zones toward the cathode (DOE 1998a).

- A water management system that recycles and returns the water that accumulates at the cathode back to the anode for acid-base neutralization (DOE 1998a).

The ROD specified that the Lasagna™ system operate for two years, but, if necessary to meet the clean-up objectives, the operation may 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 SWMU 91 (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 the 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 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 90°C, 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 2002c). The Commonwealth of Kentucky and EPA approved the final remedial action report on October 31, 2002.

Lasagna™ verification sampling and analysis were conducted in April 2003 and confirmed that the remediation objective was met. Details of the Lasagna™ verification sampling and analysis are included in the *Addendum to 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 2003a).

The Lasagna™ equipment and site was demobilized on September 30, 2002. The remediation site has been returned to its original condition. The total cost of the implementation of the Lasagna™ 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 summation of the 2008 Five-Year Review protectiveness statement follows: The remedy for the Cylinder Drop Test Area is protective of human health and the environment. Exposure pathways that could result in unacceptable risk are being controlled (DOE 2009a).

There have been no previous issues or recommendations for the Cylinder Drop Test Area. The site remains unchanged as described in the 2008 Five-Year Review, and no new actions have occurred.

7.5 SITE INSPECTION

A site inspection was conducted on February 4, 2013, by a member of the Five-Year Review Team. The site includes a grassy area south of the C-745-B cylinder yard and part of the area underlying 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.

7.6 TECHNICAL ASSESSMENT

The remedy was designed to be protective of future groundwater use at the fence line of PGDP by meeting the TCE MCL value of 5 µg/L. The MCL for TCE remains at 5 µg/L, and the average residual soil level of TCE at the SWMU is less than one-tenth of the original level calculated to be protective of groundwater in the ROD; therefore, the remedy employed is as protective as it was when the ROD was implemented.

The residual concentrations of TCE in soil (post-remediation) are an average 0.38 mg/kg and a maximum of 4 mg/kg.

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

Yes. The remedy is functioning as designed by being protective of future groundwater use at the fence line by the reduction of TCE concentrations in soil.

In 2011, EPA revised the cancer slope factors and toxicity data for TCE. The 2011 PGDP no-further-action level was based on a more conservative KDEP cancer slop factor and had an industrial screening value of 0.0619 mg/kg for the excavation worker at 1×10^{-6} (DOE 2011b). Using these screening levels, the mean concentration corresponds to 6×10^{-6} risk using the PGDP/KDEP value. The maximum value at the SWMU corresponds to 6.5 $\times 10^{-5}$ risk using this same value. Based on a comparison with draft 2012 PGDP screening values (i.e., 2.35 mg/kg for toxicity and 6.21 for cancer using the EPA slope factor), the effectiveness of the remedy for soil remains protective for future use of the SWMU based on the measured concentrations of TCE in soil after the remediation was completed.

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 SWMU 91 encompasses, and the land use remains industrial with no groundwater use on DOE property. The plant'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. 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.

Based on a comparison with draft 2012 PGDP screening values (i.e., 2.35 mg/kg for toxicity and 6.21 for cancer using the EPA slope factor), the effectiveness of the remedy for soil remains protective for the excavation worker, and future groundwater use at the fenceline of the facility based on the measured concentrations of TCE in soil after the remediation was completed.

The soil cleanup levels (Table 7.1) established in the ROD to be protective of groundwater at the POE were met and still are protective based on no groundwater use on DOE property.

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

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

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?

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 PGDP in August 1988, DOE immediately placed 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 PGDP Water Policy in accordance with the *Engineering Evaluation/Cost Analysis for the Water Policy at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (EE/CA) (DOE 1993b), and the *Action Memorandum for the Water Policy at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 1994b).

The actions associated with the remedy selections of the Northwest and Northeast Plumes mitigate the continued migration of the higher concentration portion of the plumes. The Water Policy response action mitigates risk that could be posed through use of the contaminated groundwater by residents. The 2008 Five-Year Review did not identify any issues or recommendations. No significant changes have occurred during the previous five-year period.

8.1 REMEDY SELECTION

The PGDP 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 Paducah Gaseous Diffusion Plant (affected area)." With the adoption of the Water Policy, DOE focused its groundwater monitoring program on the Water Policy Box and adjacent areas that might be affected if and when the plume migrates or expands. Figure 8.1 is a map of the groundwater contaminant plume boundaries and the Water Policy boundary as of 2007.

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.[3]

The AM included the following conditions:

- DOE offered to provide municipal water to all existing residences and businesses within the affected area surrounding PGDP. They also offered to pay for installation of water supply mains and connection of those residences 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.

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[3] It should be noted that signing of the agreement is voluntary and that 60% 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.

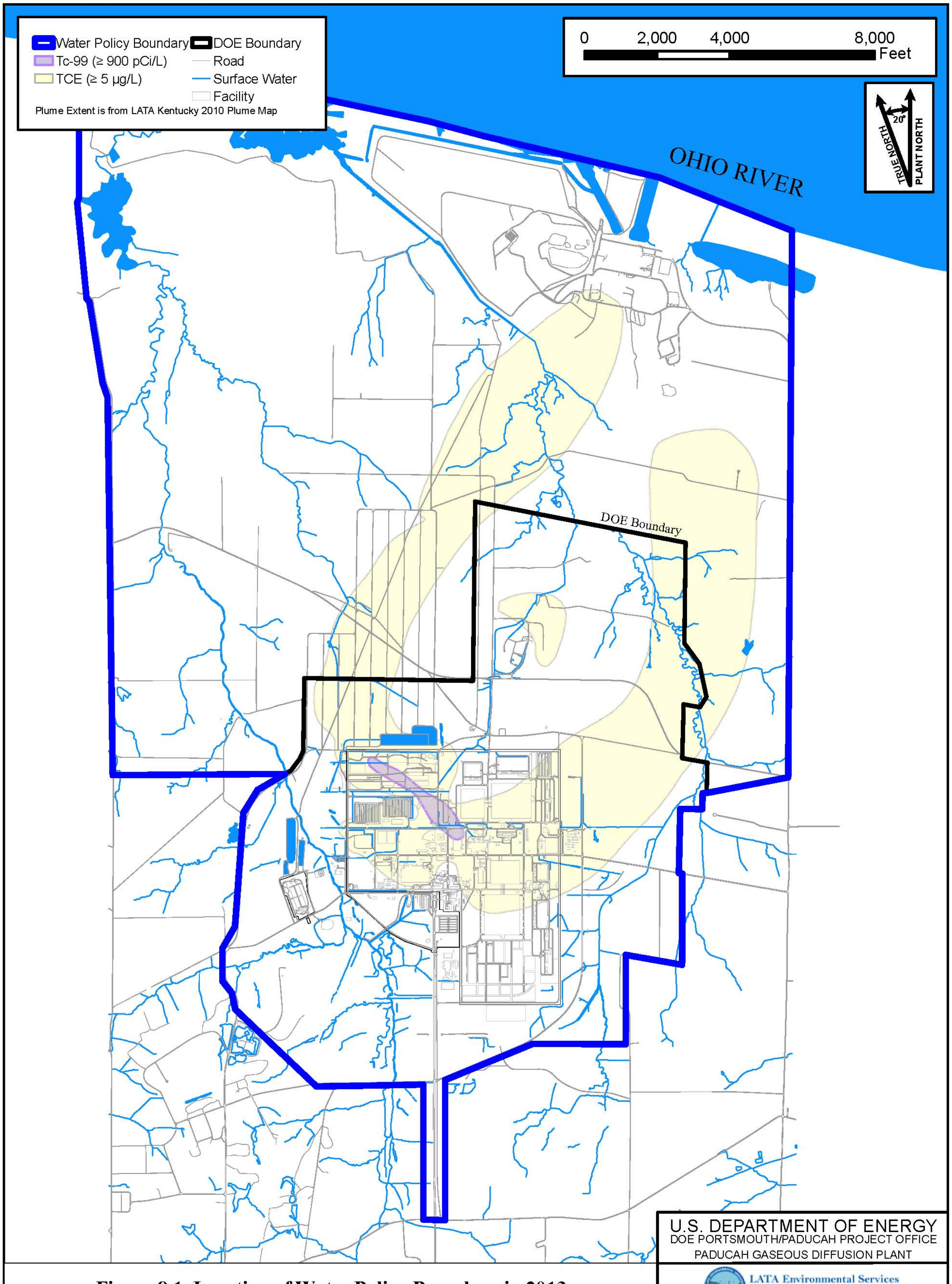

Figure 8.1. Location of Water Policy Boundary in 2013

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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 owners' 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 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 PGDP personnel are permitted access to the property for sampling purposes. PGDP 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 60% 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.

As noted in the 2008 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 either 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.

DOE regularly collects groundwater samples from the area in the Water Policy Box and recently has 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 monitoring wells, are sampled quarterly (LATA Kentucky 2013). 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 2008 review stated the following protectiveness statement.

> The remedy for the Water Policy Box currently protects human health and the environment by institutional controls; however, additional actions under the dissolved-phase plume need to be evaluated for long-term protection.

There have been no previous issues or recommendations for the Water Policy.

8.5 SITE INSPECTION

The site inspection by a member of the Five-Year Review Team included review of license agreements and review of the water bills. A periodic inspection program checks numerous residential wells to ensure that they remain nonoperational.

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.

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 55 of 91 landowners within the area affected by the Water Policy. Thirty four 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 land owners who have requested this, were informed of the risk associated with consuming the groundwater. An inspection program checks numerous residential wells to ensure that they remain nonoperational.

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 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 Action Memorandum 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.

It is recommended that DOE optimize the remedy to ensure that all landowners are educated about the potential contamination in their groundwater and that land ownership be reviewed at the McCracken County Property Valuation Assessment office annually to search for new owners of land parcels within the Water Policy Box.

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 PGDP that could be affected by migration of groundwater contamination originating from the plant. 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 60% of residents located within the Water Policy Boundary that prohibit use of groundwater; therefore, the potential exists that current and possibly new landowners could use their 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 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

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.

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9. C-400 ELECTRICAL RESISTANCE HEATING

The C-400 ERH project currently is underway. This project is included in this Five-Year Review with summaries of activities consistent with the progress of the project up to the date of the review; therefore, the entire five-year evaluation is not included.

The C-400 Cleaning Building is located near the center of the industrial section of PGDP. 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 of machinery parts, decontaminating the interiors of used UF_6 cylinders, disassembling and testing of cascade components, and laundering of plant 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. After the initial discovery of contamination, four borings were installed to better define the extent of the soil contamination. SWMU 11 and the C-400 Building area have 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 hydrostratigraphic 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 with a thickness range of approximately 25 ft to 36 ft.

Two previous actions have remediated some of the soil contamination near the southeast corner of C-400 Building. 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 310 ft^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 (5,378 yd^3 of contaminated soil and subsurface aquifer) in the southeast corner of the area near the C-400 Building.

9.1 REMEDY SELECTION

Following the RI (DOE 1999a) and the 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 because DNAPL is present, TCE in the source zone in the UCRS and the RGA at the C-400 Cleaning Building area can be considered principal threat source material. The ROD also documented the selection of ERH as the technology to address the source area contaminated with TCE and other VOCs.

In 2007, DOE commissioned an independent technical review (ITR) of a draft of the C-400 90% RDR (ITR 2007). The 2007 ITR team consisted of subject matter experts from DOE, the environmental remediation field, and the U.S. Environmental Protection Agency. The ITR team published their report in

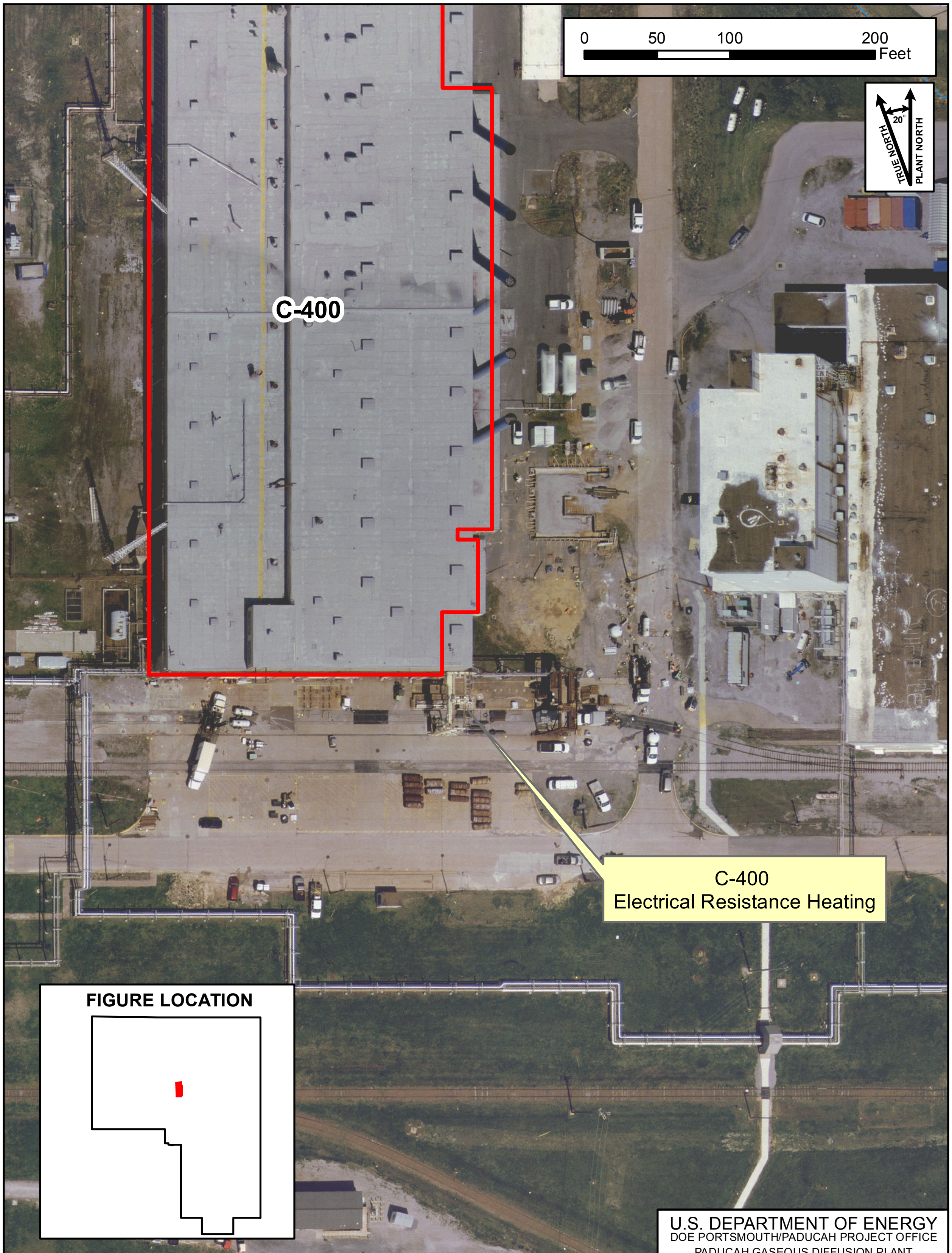

Figure 9.1. Location of C-400 Electrical Resistance Heating

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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.

The C-400 ERH actions (Phase I and Phase II) include 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), is to operate the ERH system until monitoring indicates that heating has stabilized in the subsurface and that recovery of TCE, as measured in the recovered vapor, diminishes to a point at which the recovery rate is constant (i.e., recovery is asymptotic).

The following are 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 has stabilized in the subsurface and when recovery diminishes to a point at which the rate of removal of TCE, as measured in the recovered vapor, becomes asymptotic;

- Implementation, maintenance, enforcing, 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 will remain in place following the IRAs.

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

The ROD stipulates 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 will be filed at the McCracken County Clerk's Office, in accordance with state law, within 120 days of regulatory approval of the Land Use Control Implementation Plan (LUCIP);

- Deed Restrictions to limit use of the property to industrial activities, to prevent exposure of groundwater to industrial workers, and 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 are to be recorded at the McCracken County Clerk's Office 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 remedial action.

The RAOs in the ROD are 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.

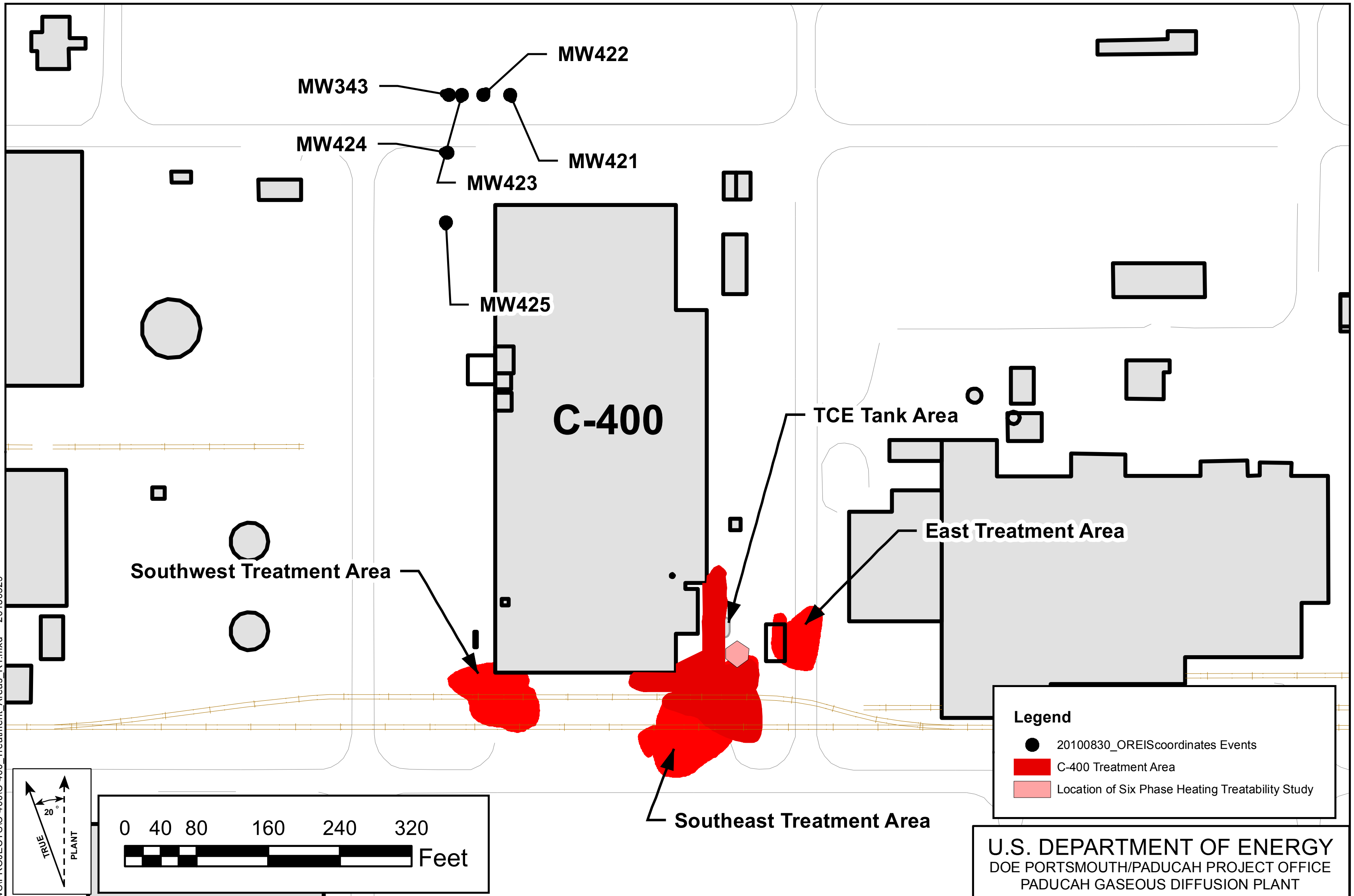
9.2 REMEDY IMPLEMENTATION

The RDSI, conducted in accordance *with Remedial Design Support Investigation Characterization Plan for the Interim Remedial Action for the Volatile Organic Compound Contamination at the C-400 Cleaning Building at the Paducah Gaseous Diffusion Plant, Paducah Kentucky* (DOE 2005b), was completed in August 2006. The DNAPL source zone was delineated during the RDSI and, coupled with data from previous investigations, was assessed to delineate 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.

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). The design incorporated two phases to mitigate the risks and uncertainties associated with large scale deployment of ERH in the highly permeable RGA.

Phase I heated and treated subsurface soils in the southwest and east treatment areas (see Figure 9.2). In addition to removing VOCs, another important objective of Phase I was to evaluate the heating performance of the base design in the lower RGA to the McNairy Formation interface in the southwest treatment area. ERH treatment in the east area involved only the UCRS. Phase I operations also provided an opportunity to evaluate the performance of the vapor recovery system, assess hydraulic containment, and optimize the aboveground vapor/liquid treatment system.

Phase I construction began in December 2008 and was substantially complete in December 2009; at that time, start up and shakedown testing began. Testing was completed and operations commenced at the end of March 2010. Heating operations ceased (soil vapor extraction continued) at the end of October 2010, and all system operations ended on December 4, 2010.



LATA Environmental Services of Kentucky, LLC

Figure 9.2. C-400 Treatment Areas

A second ITR team, chartered by DOE in September 2010, *Independent Technical Review of the C-400 Interim Remedial Project Phase I Results, Paducah, Kentucky*, SRNL-STI-2010-00681, evaluated Phase I performance and results of preliminary Phase II thermal design modeling (ITR 2010). Observations by the 2010 ITR were included in *Technical Performance Evaluation for Phase I of the C-400 Interim Remedial Action at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-1260&D1, (DOE 2011c), issued in August 2011. This report provides descriptions and details of the construction and implementation of the Phase I remedial action, as well as the results of operational and monitoring data collected during and subsequent to Phase I implementation. These data form the basis for evaluation of Phase I performance.

DOE began construction of an ERH system for the Phase II UCRS target zone (Phase IIa) in September 2012, with completion of underground components (electrodes, vapor extraction wells, etc.) scheduled in April 2013. The second ITR team determined that ERH did not reach target temperatures in the lower RGA despite implementation of contingency measures intended to assist in attaining temperature goals. As a result, it was recommended that ERH not be used for the lower RGA as part of Phase II. DOE, with the participation of the other FFA parties, currently is evaluating alternative remedies for the lower RGA (Phase IIb) and the need to implement treatability studies.

Groundwater monitoring in the area of the Phase I and II source zones is provided by six RGA MWs installed during the WAG 6 RI and the Six-Phase Heating Treatability Study: MW155, MW156, MW405 Port 5, MW406 Port 5, MW407 Port 4, and MW408 Port 5. Phase I activities interrupted sampling in these wells during 2009, 2010, and 2011. Quarterly sampling of these wells resumed in 2012.

DOE installed five MW nests, with screens in the middle and lower RGA, across the northwest corner of C-400 in June 2009 to monitor dissolved contaminant trends near the C-400 source(s) better. These wells were sampled monthly for the period July 2009 through October 2011. The sampling schedule for these wells switched to quarterly collection during 2012, from the basal RGA screen only in each MW nest. (The highest TCE levels were present routinely in the basal RGA screens.)

The C-400 LUCIP was issued in February 2008 and was attached as an appendix to the C-400 Remedial Design Report (DOE 2008a). Each of the LUCs under the ROD was implemented, as appropriate, during the review period. The C-400 area property record notice was filed in the McCracken County Clerk's Office in 2009. DOE did not transfer any of the property covered by the C-400 ROD during the review period so deed restrictions were not applicable. The plant's excavation/penetration permit program required formal authorization prior to performance of all excavations and other intrusive activities. Access controls were maintained during and following each phase of the remedial action, where needed, to ensure protection of plant workers.

9.3 SYSTEMS OPERATIONS/OPERATIONS AND MAINTENANCE

For Phase I, drilling and subsurface completion of ERH components (electrodes, multiphase extraction wells, temperature monitoring strings, vacuum piezometers, and water-level monitoring instruments) was completed in June 2009. System testing concluded in March 2010 and normal operations began. Normal operations continued through September 2010 when TCE concentrations in recovered vapor had dropped to asymptotic levels. Pulsed operations then were initiated as detailed in the Paducah C-400 Project pulsed operations plan. The strategy for the pulsing operations was intended to maximize removal of the remaining contaminants from the 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 was then repeated for two cycles. Pulsed operations ended in October 2010 and power to the electrodes was turned off at the end of October 2010. Vapor extraction continued for approximately five weeks to facilitate subsurface cooling.

O&M activities for Phase I were conducted in accordance with the *Operations and Maintenance Plan for the Interim Remedial Action for the Volatile Organic Compound Contamination at the C-400 Cleaning Building at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-0187&D2 (DOE 2009b). Phase I treatment system removed approximately 6,548 lb (535 gal) of TCE. The cost of Phase I was approximately $32.5M.

Phase I heating began on March 27, 2010 and continued over a 164-day period prior to the commencement of pulsed operations on September 7, 2010. During that time, operation of the electrodes was interrupted (power failures and other system problems) for approximately 48 days (29% of the time). Temperature plots in the treatment areas document that the two most significant downtime events in May 2010 and July 2010 had an impact on heating and extended the time needed to reach target temperatures.

9.4 PROGRESS SINCE LAST FIVE-YEAR REVIEW

The 2008 review stated the following protectiveness statement.

> The remedy at C-400 involving ERH is expected to be protective of human health and the environment upon completion, and, in the interim, exposure pathways that could result in unacceptable risks are being controlled.

During the period addressed by this Five-Year Review, DOE has continued to implement the C-400 remedy, completing the Phase I remedial action and beginning construction to implement the Phase II remedial action in the UCRS and upper RGA. Because Phase I showed that ERH may be unable to reach target temperatures in the lower RGA, DOE, with the participation of the other FFA parties, currently is evaluating alternative remedies for the lower RGA (Phase IIb) and the need to implement treatability studies.

9.5 SITE INSPECTION

A site inspection of the area of the C-400 remedial action was made on May 21, 2013, by a member of the Five-Year Review Team, using the C-400 Area Land Use Controls Checklist from the C-400 LUCIP. The inspection revealed no evidence of land use changes or prohibited activity (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). Access controls were in place to prevent unauthorized entry into the remedial action construction zone, and the warning sign prescribed by the LUCIP was present. Documentation was available to verify that the Property Record Notice was on file in the McCracken County Clerk's Office.

9.6 TECHNICAL ASSESSMENT

The C-400 ROD is an IRA to reduce the concentration of TCE and other VOCs in the source soils in the UCRS and RGA at the C-400 area. Monitoring data indicate that this remedial action has reduced the contaminant concentrations in the Phase I area by implementation of ERH in the UCRS and upper RGA. However, Phase I data suggest that ERH may be ineffective in the lower RGA.

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

In August 2011, DOE transmitted a *Technical Performance Evaluation for the C-400 Interim Remedial Action at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-1260&D1, to EPA and KDEP, which provided the results of the Phase I implementation and identified lessons learned and recommendations for Phase II design and implementation (DOE 2011c).

Phase I ERH removed approximately 6,830 lb of TCE (560 gal), which was a small fraction of the original estimate of TCE in the combined east and southwest treatment areas (285,781 lb/23,350 gal). The original estimate of TCE for the southwest treatment area was based on a faulty conceptual model and grossly overestimated the amount of TCE that was present. Collocated baseline (collected before heating) and postoperation (collected after heating) soil samples document 95% and greater reduction in TCE contamination in the treatment zones.

Soil samples obtained from borings used to install ERH equipment were used to determine the concentrations of TCE and TCE degradation products in the soil prior to the operation of the ERH electrodes. Postoperational samples from collocated borings were obtained for comparison to baseline soil sample analyses to determine the residual TCE concentrations subsequent to the operation of Phase I. The paired baseline and postoperational sample results were compared to assess the reduction in concentrations.

Baseline and postoperational soil samples were collected from 12 locations in the east area (Table 9.1 and Figure 9.3). For the east treatment area, there are 25 paired sampling sets for comparison. Comparing the baseline to the postoperational shows a 95% reduction in concentration, shifting the average concentration of 584 μg/kg to 29 μg/kg. These data demonstrate significant mass reduction within the UCRS in the East Area. Postoperational soil sampling results indicate that the RAOs were achieved in the east treatment area in accordance with the second RAO.

Baseline and postoperational soil samples were collected from 15 locations in the southwest area (Table 9.2 and Figure 9.4). For the southwest treatment area, there are 63 paired sampling sets for comparison. Comparing the baseline to the postoperational shows a 99% reduction in concentration, shifting the average concentration of 1,046 μg/kg to 15 μg/kg. These data demonstrate significant mass reduction in the southwest area. Postoperational soil sampling results indicate that the RAOs were achieved in the treatment areas (UCRS) in the southwest locations in accordance with the second RAO. The data from 60 to 80 ft intervals demonstrate a reduction in concentrations in the upper RGA in accordance with the third RAO.

Target temperatures were attained in treatment areas and depths targeted for VOC removal, indicating that the ERH design was adequate for thermal treatment of UCRS soils; however, target temperatures were not attained in the deep RGA. Key factors that affected attainment of target temperature in the deep RGA include groundwater flow velocity, formation resistivity, and heat loss due to convective flow.

Observed maximum formation temperatures attained during Phase I operations in the lower RGA fell short of target temperature by over 100°F. Contingency thermal engineering techniques identified in the RAWP to boost formation heating were implemented during Phase I in attempts to attain target temperatures. These techniques included injection of saline solutions and maximizing the delivery of electrical power to the electrodes in the lower RGA. Phase I operating experience in the southwest treatment area and subsequent modeling results using a groundwater velocity of 3.0 ft per day indicate

Table 9.1. East Area Baseline and Postoperational Soil TCE Results

Location	Depth (ft bgs)	Baseline Result (µg/kg)	Post Op Result (µg/kg)	Baseline—Post Op[1] (µg/kg)	Reduction[2] (%)
E095	20	10.9	5.5	5.4	49.5
	35	6.91	9.28	-2.37	-34.3
	52	1,880	< 5	1,875	99.7
	60	5.46	75	-69.54	-1,273.6
	80	8.08	20.2	-12.12	-150.0
E097	35	< 4.98	36	-31.02	-622.9
E098	20	< 5.03	< 4.99	0.04	0.8
	35	< 5.02	< 5.01	0.01	0.2
E099	35	6.37	< 5.02	1.35	21.2
E100	20	7,820	< 5	7,815	99.9
	35	1,860	< 5.02	1,854.98	99.7
E102	20	27.9	< 4.99	22.91	82.1
	35	30.5	7.73	22.77	74.7
E103	20	< 4.99	< 5	-0.01	-0.2
	35	< 5.01	< 5.02	-0.01	-0.2
	52	< 5.02	< 5.01	0.01	0.2
E104	20	< 4.97	< 5.01	-0.04	-0.8
	35	196	9.4	186.6	95.2
E105	35	< 5	< 5	0	0
E106	20	20	315	-295	-1,475
	35	< 5	9.15	-4.15	-83
E107	35	60.2	118	-57.8	-96
E110	20	8.46	< 5.03	3.43	40.5
	35	10.6	46.1	-35.5	-334.9
	52	2,610	5.23	2,604.77	99.8
Count		25	25		
Average (µg/kg)		584	29		95
Minimum (µg/kg)		4.97	4.99		
Maximum (µg/kg)		7,820	315		
Count < 70 µg/kg		20	22		
Count nondetectable		9	16		

[1] Difference of baseline and postoperational samples
[2] Reduction Percentage = (Baseline Result - Post Op Result)/Baseline Result*100

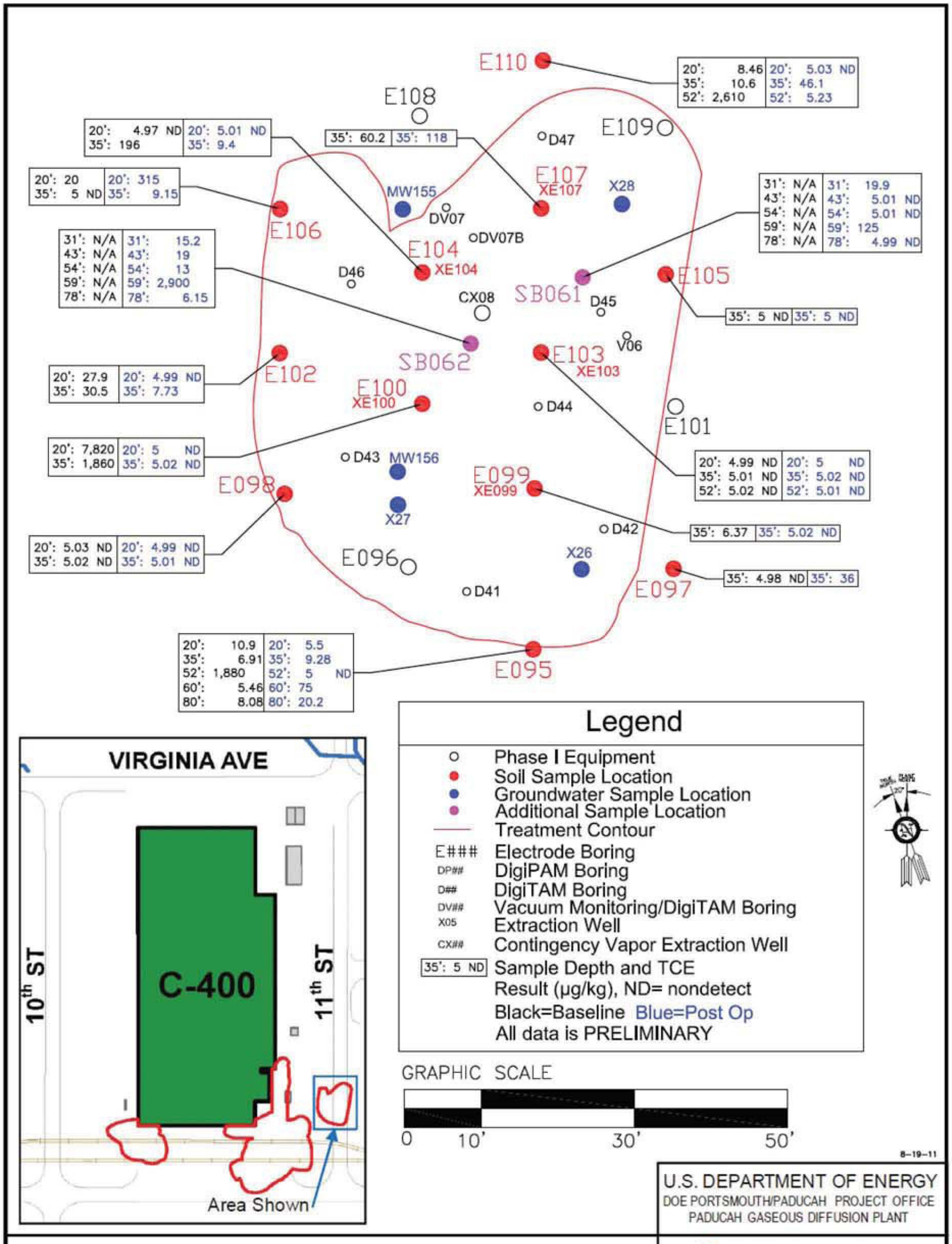


Figure 9.3. East Area Sample Locations and Soil Data

Table 9.2. Southwest Area Baseline and Postoperational Soil TCE Results

Location	Depth (ft bgs)	Baseline Result (µg/kg)	Post Op Result (µg/kg)	Baseline—Post Op[1] (µg/kg)	Reduction[2] (%)
E003	20	< 5.01	< 5.01	0	0
E003	35	< 4.97	< 4.97	0	0
E006	20	6.31	< 5.02	1.29	20.4
E006	35	176	< 5.01	170.99	97.2
E006	52	373	< 4.98	368.02	98.7
E006	60	< 5.03	< 5	0.03	0.6
E006	80	< 5.01	13.2	-8.19	-163.5
E006	103	< 4.99	< 5.02	-0.03	-0.6
E007	20	< 5.02	< 5.04	-0.02	-0.4
E007	35	< 4.97	< 5.02	-0.05	-1
E007	52	124	< 5.03	118.97	95.9
E007	60	21.2	< 5.01	16.19	76.4
E007	80	< 5	< 4.98	0.02	0.4
E007	103	8.94	< 5	3.94	44.1
E009	20	12.3	< 4.98	7.32	59.5
E009	35	8,670	< 5.03	8,664.97	99.9
E010	20	1,010	< 5.03	1,004.97	99.5
E010	35	3,590	< 5.03	3,584.97	99.9
E010	52	873	< 5.01	867.99	99.4
E010	60	15	5.31	9.69	64.6
E010	80	< 5.01	< 5.03	-0.02	-0.4
E010	103	< 4.98	14.5	-9.52	-191.2
E011	20	5,720	< 5.02	5,714.98	99.9
E011	35	1,230	< 5.04	1,224.96	99.6
E011	52	5,240	5.01	5,234.99	99.9
E011	60	7,860	11	7,849	99.9
E011	80	14	8.14	5.86	41.9
E011	103	17.3	< 5.04	12.26	70.9
E012	20	99.5	< 5.03	94.47	94.9
E012	35	6,590	< 5.01	6,584.99	99.9
E012	52	14,500	< 5	14,495	100
E012	60	469	< 5.02	463.98	98.9
E012	80	195	38.1	156.9	80.5
E012	103	< 5.03	< 5.01	0.02	0.4
E013	20	7.09	< 5.02	2.07	29.2
E013	35	50.1	34	16.1	32.1
E016	20	< 5.03	18.8	-13.77	-273.8

Table 9.2. Southwest Area Baseline and Postoperational Soil TCE Results (Continued)

Location	Depth (ft bgs)	Baseline Result (µg/kg)	Post Op Result (µg/kg)	Baseline—Post Op[1] (µg/kg)	Reduction[2] (%)
E016	35	28.9	< 5.03	23.87	82.6
E017	20	607	< 5.02	601.98	99.2
E017	35	3,770	< 5.02	3,764.98	99.9
E017	52	55.7	< 5.03	50.67	91
E017	60	< 46.3	< 4.99	41.31	89.2
E017	80	< 49.3	< 5.04	44.26	89.8
E017	103	< 4.97	< 5.01	-0.04	-0.8
E018	20	676	92.6	583.40	86.3
E018	35	522	14.3	507.70	97.3
E018	52	323	< 5.02	317.98	98.4
E018	60	706	228	478	67.7
E018	80	< 5.01	< 5.01	0	0
E018	103	6.57	< 5	1.57	23.9
E019	20	11.9	68.9	-57	-479
E019	35	69.7	< 4.98	64.72	92.9
E019	52	1,900	13.8	1,886.2	99.3
E020	20	120	< 5.04	114.96	95.8
E020	35	< 5.04	9.93	-4.89	-97
E026	20	26.7	< 4.99	21.71	81.3
E026	35	< 5	27.2	-22.2	-444
X06	20	< 5.02	< 5.03	-0.01	-0.2
X06	35	< 5.03	< 4.99	0.04	0.8
X06	52	< 5.03	88	-82.97	-1,649.5
X06	60	14.5	7.88	6.62	45.7
X06	80	< 5.03	24.6	-19.57	-389.1
X06	103	< 4.99	12.7	-7.71	-154.5
Count		63	63		
Average (µg/kg)		1,046	15		99
Minimum (µg/kg)		4.97	4.97		
Maximum (µg/kg)		14,500	228		
Count <70 µg/kg		39	60		
Count nondetectable		23	43		

[1] Difference of baseline and post operational samples

[2] Reduction Percentage = (Baseline Result - Post Op Result)/Baseline Result*100

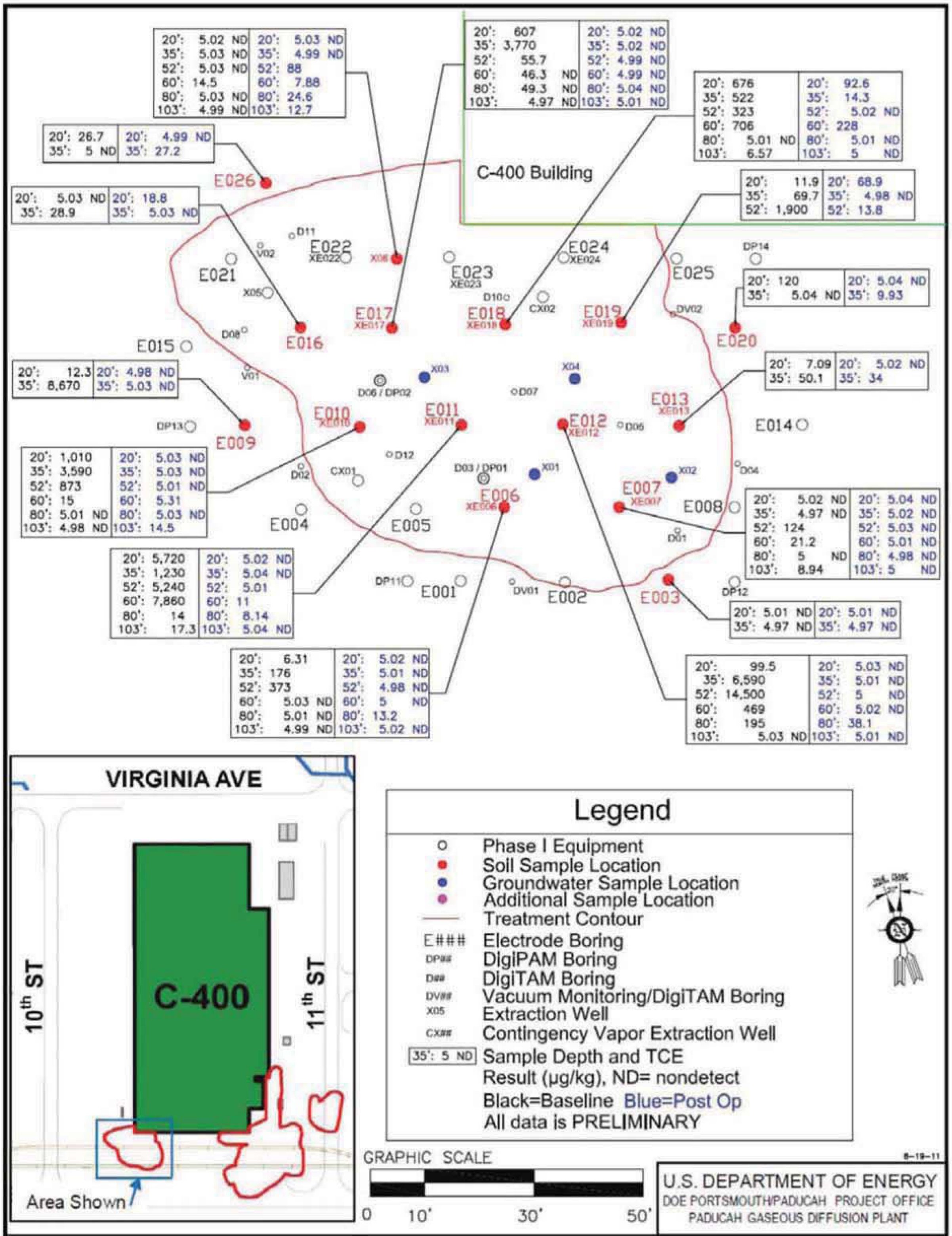


Figure 9.4. Southwest Area Sample Locations and Soil Data

that, in order to achieve target temperatures in the RGA, the ERH configuration developed for Phase I would require significant scale up (e.g., additional electrodes, with hot water injection within the target zone, upgradient electrodes for preheating, and upgradient groundwater extraction to reduce the flux of groundwater through the target volume). A 2010 ITR assessment of Phase I (ITR 2010) concluded that Phase II should implement ERH for the UCRS, but noted that, based on the Phase I results, ERH (or any of the other thermally enhanced removal technologies) is poorly matched to the RGA conditions in the vicinity of the C-400 Building. As an interim action, the ITR recommended modification of the existing water treatment infrastructure for Phase II support (to reduce unnecessary costs) and implementation of pump-and-treat of contaminated groundwater from the RGA in the Phase II RGA target zone.[4] The ITR recommended that heating technology be eliminated from Phase II for the RGA. Instead, the ITR recommended using a technology that is better matched to the RGA, such as oxidation using chemical reagents or solubilization using cosolvents or surfactants.

Six RGA groundwater MWs provide characterization of TCE levels in the area of the Phase I source zones: MW155, MW156, MW405 Port 5, MW406 Port 5, MW407 Port 4, and MW408 Port 5 (see Figure 9.5). TCE levels are markedly highest in MW408 Port 5 (typically greater than 250,000 ppb). Prior to Phase I, TCE levels were generally below 40,000 ppb in the other area wells. Subsequent to Phase I, TCE levels decreased in MW155 (from 14,000 to 3,700 ppb), MW406 Port 5 (from 5,200 to as low as 1,200 ppb), and MW407 Port 4 (from 29,000 to as low as 4,900 ppb). TCE levels were markedly increased in MW156 (from 34,000 to as high as 65,000 ppb), MW405 Port 5 (from 23,000 to as high as 97,000 ppb), and MW408 Port 5 (from 520,000 to as high as 1,400,000 ppb). During 2012, TCE levels declined in MW156 (to as low as 1,700 ppb) and MW405 Port 5 (to as low as 41,000 ppb). Further sampling will be required to assess the trend of TCE levels in MW408 Port 5 and the overall impact of Phase I upon TCE levels in the source zone.

DOE installed five MW nests, with screens in the middle and lower RGA, across the northwest corner of C-400 in June 2009 to monitor better dissolved contaminant trends near the C-400 source(s). In general, the level of dissolved TCE (see Figure 9.6) increases eastward across the well transect on the north side of C-400 (from MW423 to MW424 to MW421) and 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. Through 2012, the C-400 remedial actions have not resulted in any significant decline of contaminant levels in the Northwest Plume at the north side of C-400.

9.6.2 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 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 only to extent practicable, and no specific risk-based level or MCL was established as a cleanup criteria for the project.

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

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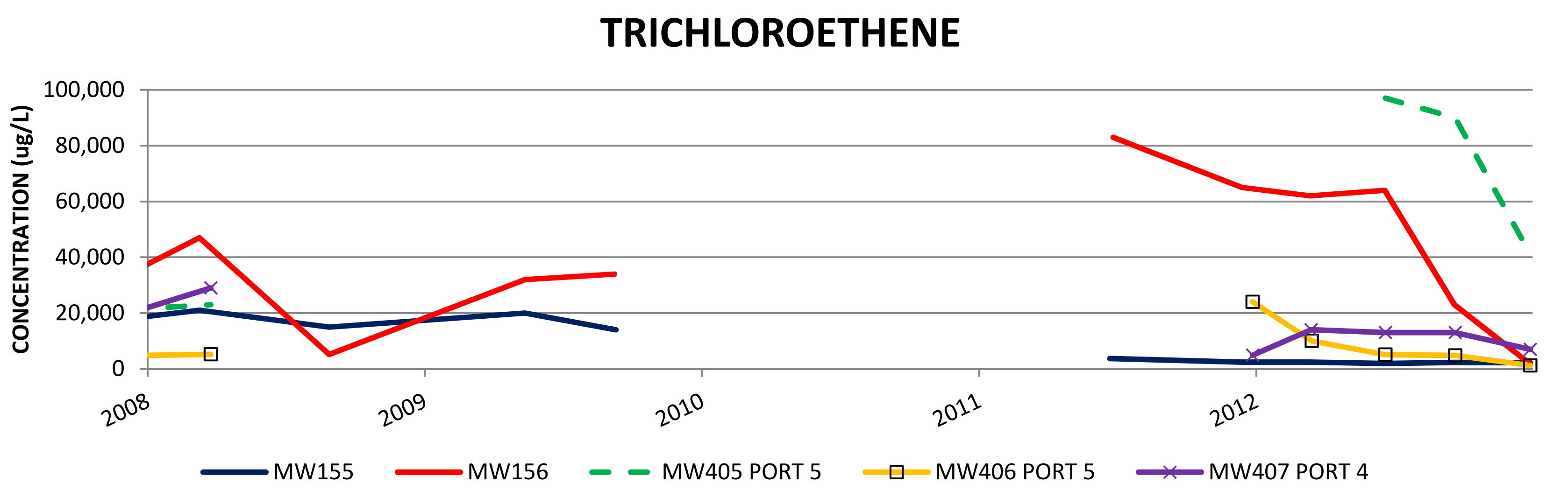
[4] Preliminary ITR calculations indicate that pump--and-treat in the Phase II RGA target zone would remove contamination at rates that are on par with the Phase I RGA system, while substantially reducing the potential for adverse impacts.



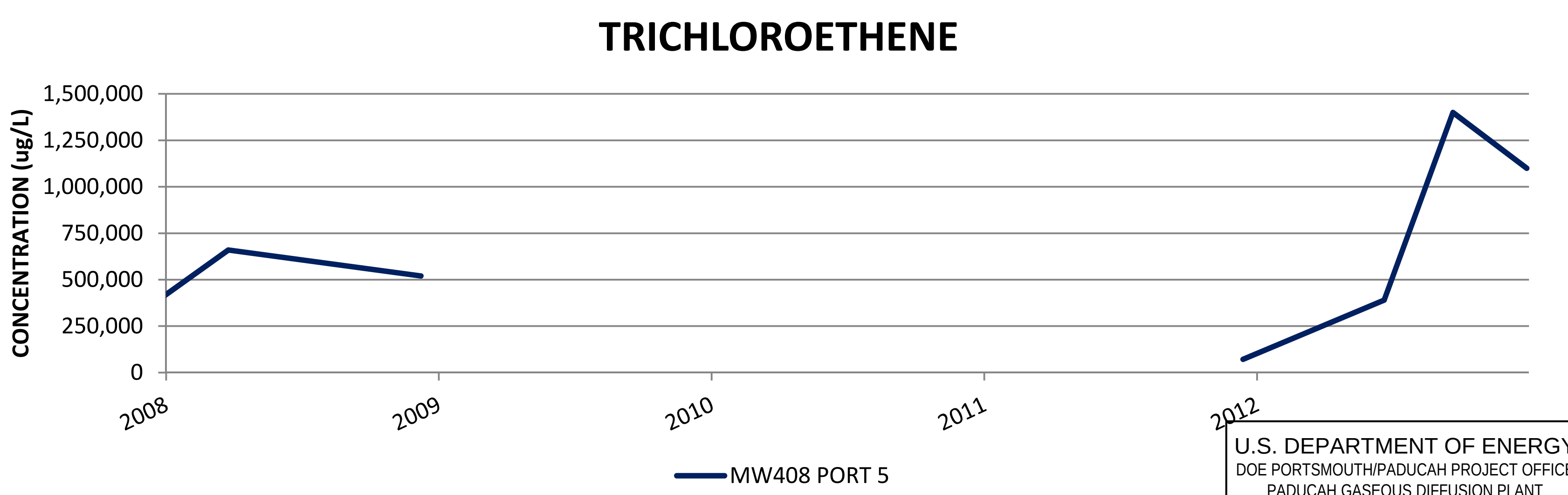


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Figure 9.5. Contaminant Trends in MWs Located Near the C-400 Phase I Source Zones

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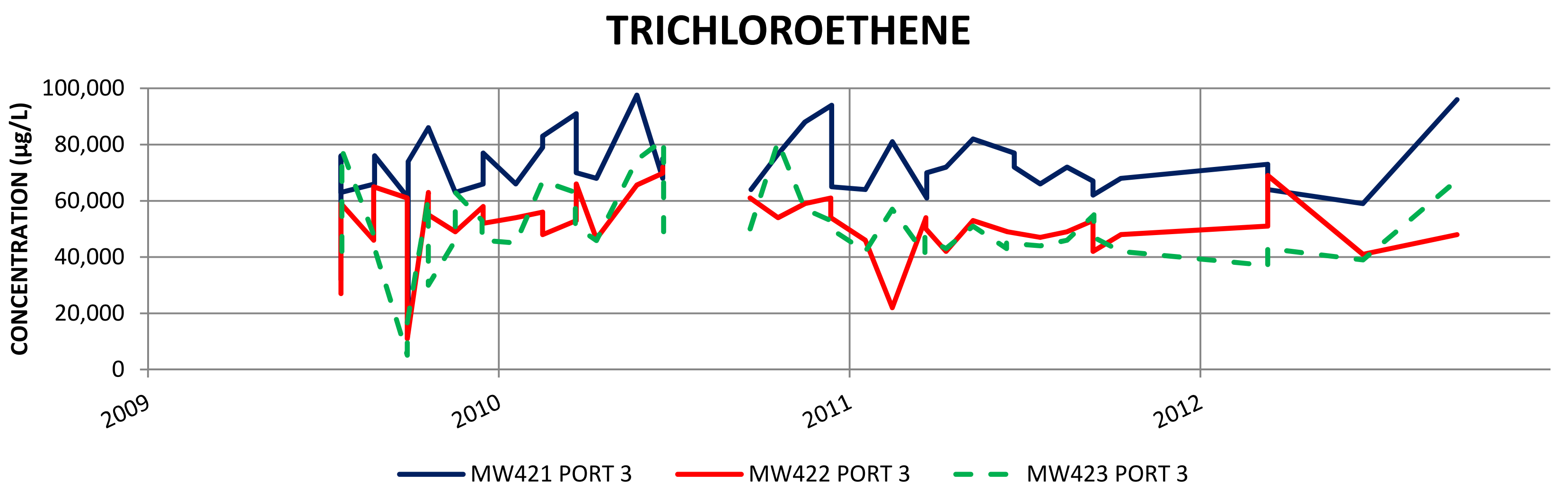

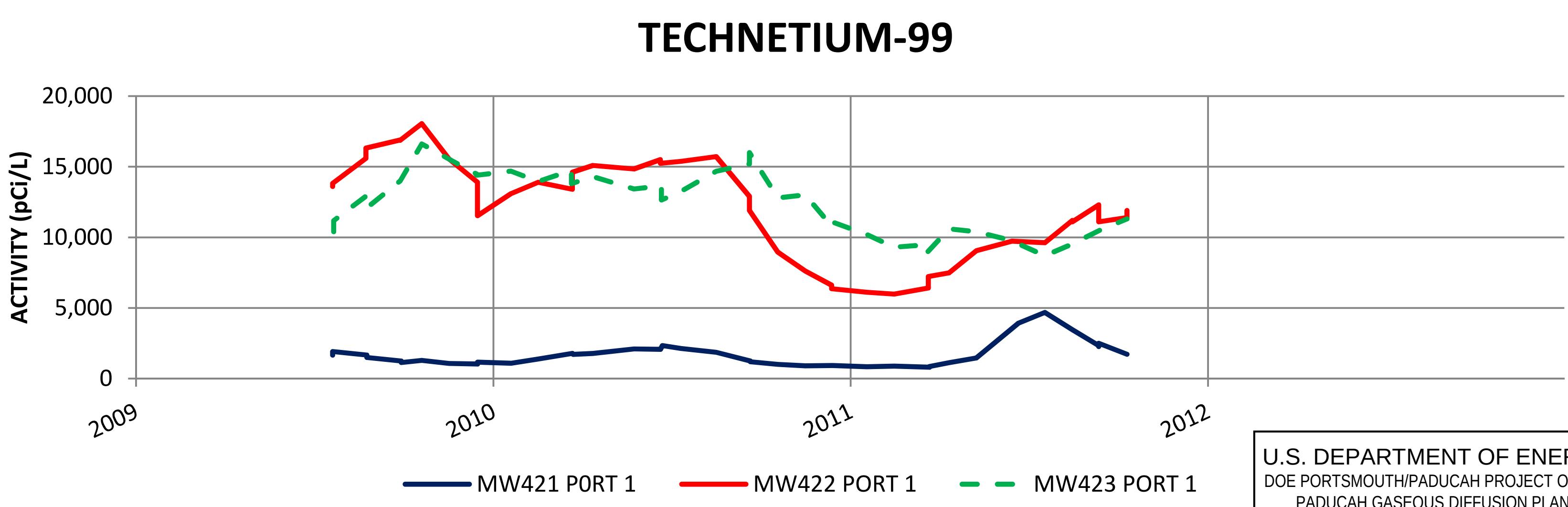

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Figure 9.6. Contaminant Trends in MWs Located on the North Side of C-400

LATA Environmental Services of Kentucky, LLC

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:

- 401 *KAR* 5:029(2) references have been moved 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 PGDP, within security 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.

9.6.3 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.

9.6.4 Technical Assessment Summary

The Phase I ERH action effectively removed UCRS contamination associated with a former break in a sewer pipe to the east of C-400 and associated with an unknown source at the southwest corner of C-400. The upcoming Phase II ERH action is anticipated to reduce effectively the remaining VOC contamination in the UCRS to the south and southeast of C-400. This IRA will be protective of the site worker.

DOE, with the participation of the other FFA parties, currently is evaluating alternative remedies for the lower RGA (Phase IIb) and the need to implement treatability studies.

9.7 ISSUES

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 the RAOs in the Upper Continental Recharge System 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.

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. A follow-up evaluation is needed to ensure long-term protection.

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 and, therefore, 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.

10. SOUTHWEST PLUME

The Southwest Plume project currently is underway. The scope of this project is to implement selected remedies for some of the known VOC sources to the Southwest Plume. This project is included in this 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, less than a year time frame is included in this evaluation.

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 2007)]. Then a Focused Feasibility Study for the Southwest Groundwater Plume VOC Sources (Oil Landfarm and C-720 Northeast and Southeast Sites) was conducted (DOE 2012b).

The Southwest Plume consists of groundwater in the RGA contaminated primarily with TCE, a VOC, and is located within the DOE property, west of the C-400 Building and south of the larger groundwater contamination area identified as the Northwest Plume. Sources to the Southwest Plume included in this action are the SWMU 1 Oil Landfarm, SWMU 211-A C-720 Building TCE Northeast Spill Site, and the SWMU 211-B C-720 Building TCE Southeast Spill Site.

10.1 REMEDY SELECTION

The ROD for these SWMUs implements *in situ* source treatment using deep soil mixing with interim LUCs at SWMU 1. The ROD requires field data collection followed by either enhanced *in situ* bioremediation with interim LUCs or long-term monitoring with interim LUCs, pending further investigation, for SWMUs 211-A and 211-B (DOE 2012c). These interim LUCs, for both SWMU 1 and SWMUs 211-A and 211-B, consist of the site's excavation-penetration permit program and warning signs.

The SWMU 1 remedial action includes an RDSI to determine the extent and distribution of VOCs in the UCRS, implementation of deep soil mixing with injection of steam and zero-valent iron, confirmatory sampling, site restoration, and groundwater monitoring. The remediation goal for TCE (the primary VOC) and other COCs for this action, as documented in the ROD (DOE 2012c), is 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

DOE will refine the design, based on the TCE mass at SWMU 1, as determined from the RDSI, to meet the remedial action goals. Implementation of deep soil mixing is planned for calendar year 2014.

The SWMUs 211-A and 211-B remedial actions began with a final characterization (FC)/RDSI for each site. Based on the results of the FC/RDSI, the FFA parties will determine if treatment (*in situ* source treatment using enhanced *in situ* bioremediation) is appropriate for each of the SWMUs or if long-term monitoring alone is sufficient for each SWMU. The alternative actions contain the following components.

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

The selection of the remedial action for the C-720 sites will be based upon the results on the FC, 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 SWMUs 211-A and 211-B is to reduce average VOC levels in the UCRS soil to below the following 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

The response actions selected in this ROD provide for timely remediation of VOCs at the Southwest Plume sources. Deep soil mixing at SWMU 1 will volatilize contaminants in the groundwater and soil. The volatilized contaminants are captured by vacuum in a shroud that extends over the auger zone and leads to aboveground equipment for processing and later disposal as hazardous waste. Enhanced *in situ* bioremediation destroys the contaminants in place.

This ROD designates the high-concentration-TCE soils and residual TCE DNAPL as principal threat waste. The RAOs in the ROD are as follows:

- Treat and/or remove the principal threat waste consistent with the National Oil and Hazardous Substances Pollution Contingency Plan.

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

- Prevent exposure to non-VOC contamination and residual VOC contamination through interim LUCs within the Southwest Plume source areas (i.e., SWMU 1, SWMU 211-A, and SWMU 211-B) pending final remedy selection as part of a subsequent OU that addresses the relevant media.

- Reduce VOC migration from contaminated subsurface soils in the treatment areas at the Oil Landfarm and the C-720 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.

10.2 REMEDY IMPLEMENTATION

The SWMU 1 RDSI was conducted in accordance with the RDSI Characterization Plan found in *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*, DOE/LX/07-1268&D2/R2, during July and August 2012 using direct push technology (DPT) sampling (DOE 2012d). DPT provides a continuous soil core while minimizing the generation of investigation-derived waste. The RDSI sampled 24 DPT soil borings (with preliminary next-day VOC results) to a depth of 60 to 65 ft (top of the RGA gravel member or depth of refusal) to determine the extent of the VOC source zone at SWMU 1 (see Figure 10.1). The DPT soil cores provided for sampling in each 5-ft depth interval for VOCs, sampling for geotechnical testing, and logging of soil texture. The extent of the VOC source zone delineated during the RDSI is being used by the design team to optimize the placement and spacing of the deep soil mixing borings. The 30% and 60% RDRs, DOE/LX/07-1276&D1, were issued in June and September 2012, respectively.

Well installation and soil sampling for the SWMU 211-A and 211-B FC/RDSI began in August 2012 in accordance with the RDSI Characterization Plan (DOE 2012e). The project crew completed DPT sampling, as done at SWMU 1, and well testing at SWMU 211-B in October 2012. The characterization of extent at SWMU 211-B required 19 DPT soil borings (Figure 10.2). Sampling activities at SWMU 211-A are continuing into 2013. Through 2012, the characterization of extent at SWMU 211-A had required 34 DPT soil borings (Figure 10.3). Additional characterization is required to define the extent of VOC-contaminated UCRS soil to the west of the existing SWMU boundary. Results from the FC/RDSI will be reported in a Field Characterization Report in 2013.

As required by the ROD, the ROD was made available to the organization responsible for implementing the Excavation/Penetration Permit Program within 30 days of the ROD signatures. Warning signs also were posted for the Southwest Plume source areas before beginning RDSI field activities. Signs were removed once RDSI fieldwork was completed. Subsequently, DOE has reposted the areas to warn site workers of potential exposure to contaminated groundwater or soil.

10.3 SYSTEMS OPERATIONS/OPERATIONS AND MAINTENANCE

O&M cannot be assessed at this time.

10.4 PROGRESS SINCE LAST FIVE-YEAR REVIEW

The remedial action for Southwest Plume VOC sources was not included in the 2008 Five-Year Review. The only site remedial activity during the period of this Five-Year Review at each of the SWMUs has been performance of the FC/RDSI. The draft RDSI report was submitted to the regulatory agencies in February 2012, and the final RDSI report was issued in December 2013. A decision regarding the selection of remedy for SWMUs 211-A and 211-B awaits review of the RDSI report.

10.5 SITE INSPECTION

Site inspections of the areas of the Southwest Plume source zone remedial actions were made on August 14, 2013, by a member of the Five-Year Review Team. The inspection revealed no changes to physical site conditions or changes to land use or expected land use at any of the three SWMUs. Interim LUCs consisting of placement of warning signs and the sites' excavation/penetration permit program are in place to prevent exposure to the site contaminants.

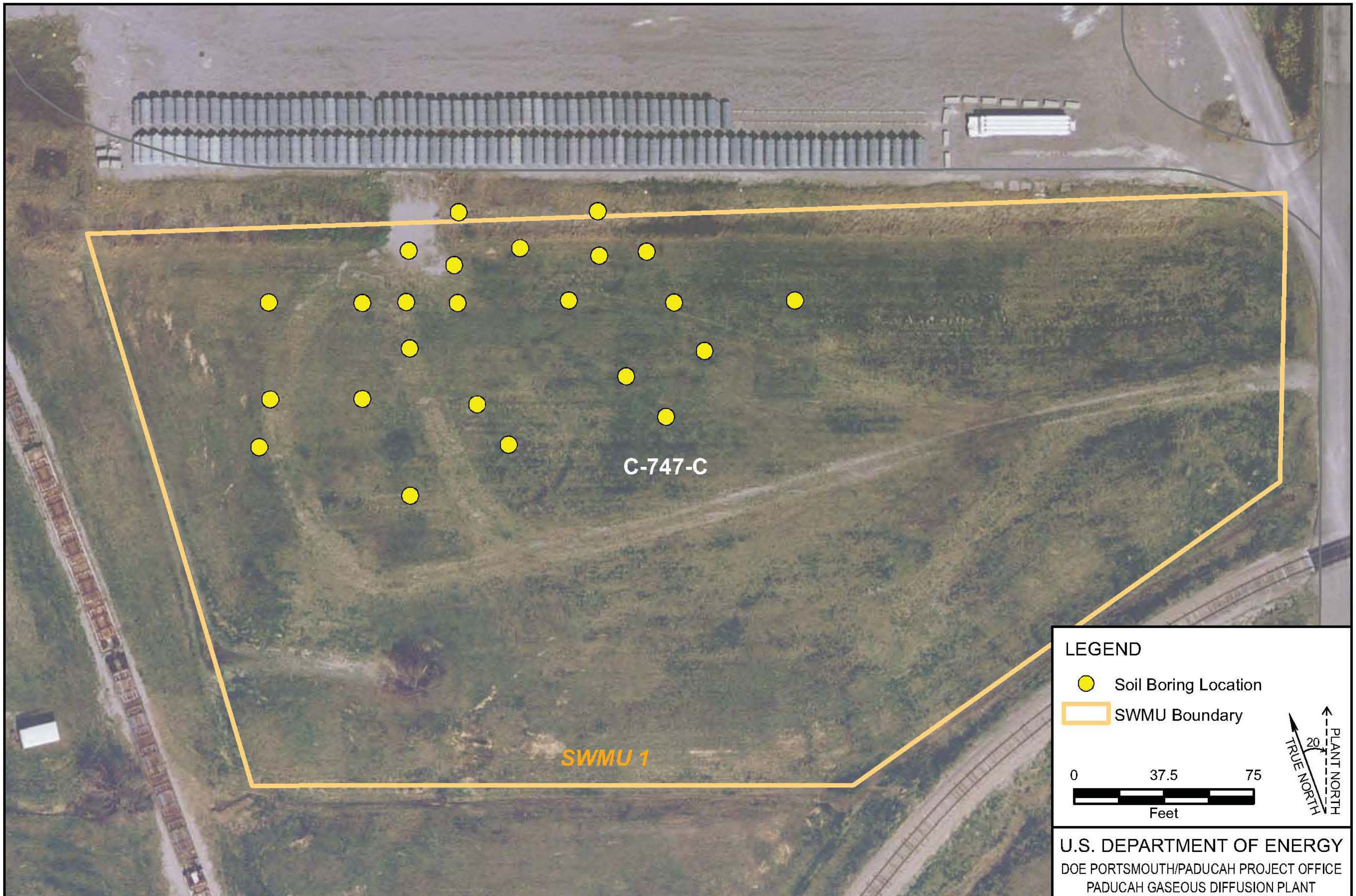

Figure 10.1. 2012 RDSI Sample Locations at the C-747-C Oil Landfarm

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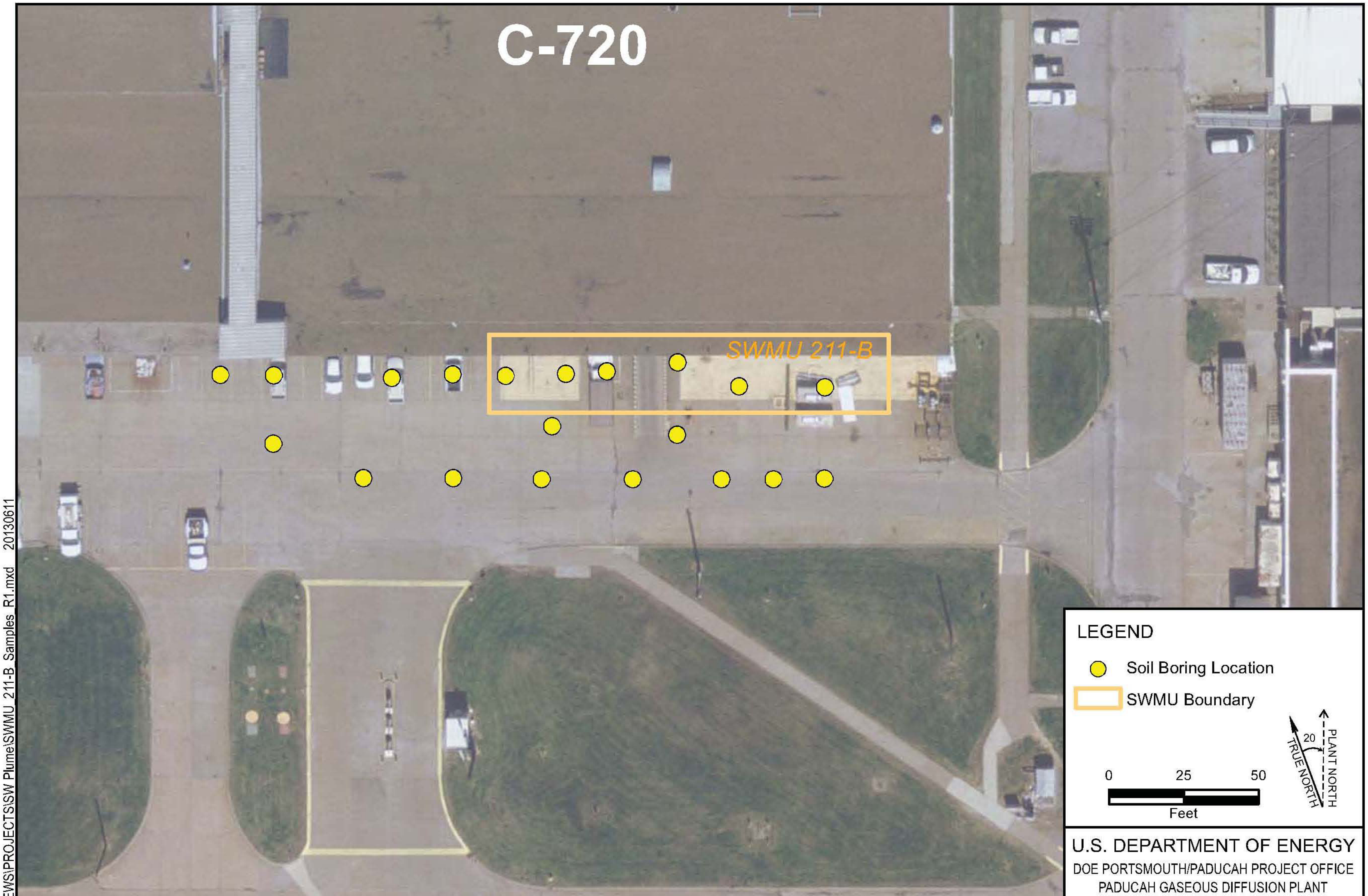

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Figure 10.2. 2012 RDSI Sample Locations at SWMU 211-B

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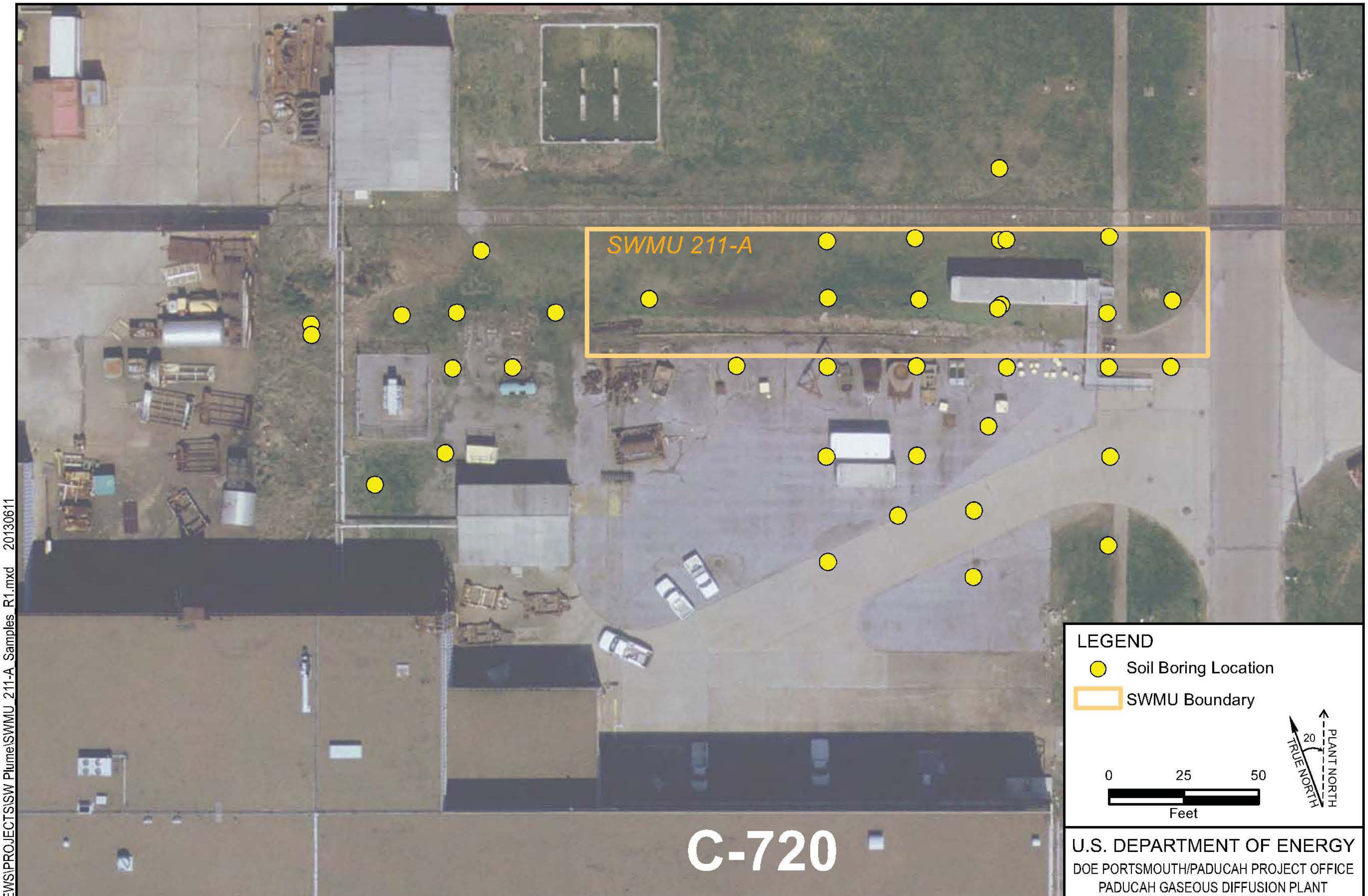

Figure 10.3. 2012 RDSI Sample Locations at SWMU 211-A

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10.6 TECHNICAL ASSESSMENT

The only site remedial activity during the period of this Five-Year Review at each of the SWMUs has been performance of the FC/RDSI.

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

The remedial action for the Southwest Plume VOC sources is under construction. The function of the remedies cannot be assessed at this time.

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?

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 they were during the original remedy selection. The basis and the numerical cleanup levels established in the Southwest Plume ROD are included in Table 10.1.

Table 10.1. Changes in Chemical-Specific Standards for the Southwest Plume

Contaminant*	Media	Cleanup Level-SWMU 1	Cleanup Level-SWMUs 211-A and B	Basis
Trichloroethene	Soil	73 µg/kg	75 µg/kg	Calculated soil cleanup levels protective of GW at the POE
1,1-Dichloroethene	Soil	130 µg/kg	137 µg/kg	Calculated soil cleanup levels protective of GW at the POE
cis-1,2-Dichloroethene	Soil	600 µg/kg	619 µg/kg	Calculated soil cleanup levels protective of GW at the POE
trans-1,2-Dichloroethene	Soil	1,080 µg/kg	5,290 µg/kg	Calculated soil cleanup levels protective of GW at the POE
Vinyl chloride	Soil	34 µg/kg	570 µg/kg	Calculated soil cleanup levels protective of GW at the POE

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

The goals identified for the Southwest Plume VOC sources ROD remain valid:

- To treat and/or remove principal threat waste;
- To prevent unacceptable exposure to VOCs by the excavation worker and to non-VOC contamination; and
- To reduce VOC migration from the source zones such that contaminants migrating from the treatment areas do not result in an 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 PGDP, within security, 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. There have been no new contaminants or new understanding of geologic conditions identified.

10.6.3 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.

10.6.4 Technical Assessment Summary

The area of UCRS soil contamination at the C-720 Building Southeast Site is near the outlet to one of the storm drains for the east end of the C-720 Building. There also is a storm sewer inlet for the southeast parking lot in the vicinity. The northern edge of the this parking lot where the contamination occurs, also is the location of one of the loading docks for the C-720 Building, an area where chemicals, including solvents, may have been loaded or unloaded. The VOCs associated with this site, which are beneath the southeast parking lot, may be the result of activities within the building that resulted in VOCs entering the storm drains for the southeast corner of the building or from spills or leaks of activities on the loading dock or in the southeast parking lot. The subsurface soil contamination found to the northeast of the C-720 Building is believed to have been a result of routine equipment cleaning and rinsing with solvents.

The C-747-C Oil Landfarm was used for landfarming of waste oils contaminated with TCE, uranium, PCBs, and 1,1,1-trichlorethane between 1973 and 1979. These waste oils are believed to have been derived from a variety of plant processes. The Landfarm consisted of two 1,125 ft^2 plots that were plowed to a depth of 1 to 2 ft. Waste oils were spread on the surface every 3 to 4 months, then the area was limed and fertilized. The VOC contamination in the soils at C-747-C is thought to be the residual of the waste oils.

These activities, or other unknown spills, have resulted in VOC-contamination. PGDP's contractor excavation/penetration permit program and the DOE Water Policy limit the exposure pathways to the SWMU 1 and C-720 area source zones.

It is anticipated that the upcoming Southwest Plume source actions will be protective.

10.7 ISSUES

The Southwest Plume project is a remedial action under construction. The remedial action is designed to address VOC releases to groundwater. A follow-up evaluation is needed to ensure long-term protection.

11. NSDD SOURCE CONTROL

The NSDD originates within the north central portion of PGDP and joins with Little Bayou Creek to the north of the plant. Figure 11.1 illustrates the location of the NSDD Source Control. 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 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 at PGDP 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 (i.e., outside the existing security fence) migration of on-site contaminant sources (CH2M HILL 1992). The PHEA also recommended action to eliminate the off-site (i.e., outside the existing security fence) migration of these contaminants to the outside of the Paducah Gaseous Diffusion Plant's boundaries (i.e., outside the existing security fence) and recommended remedial action to eliminate this off-site (i.e., outside the existing security fence) movement. The NSDD ROD also stated there was potential for exposure of plant maintenance personnel to the contaminants within the ditch through routine maintenance activities. The personnel were potentially 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 remedial action, discussed in this section, and the response actions for Sections 1 and 2, 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 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.

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;

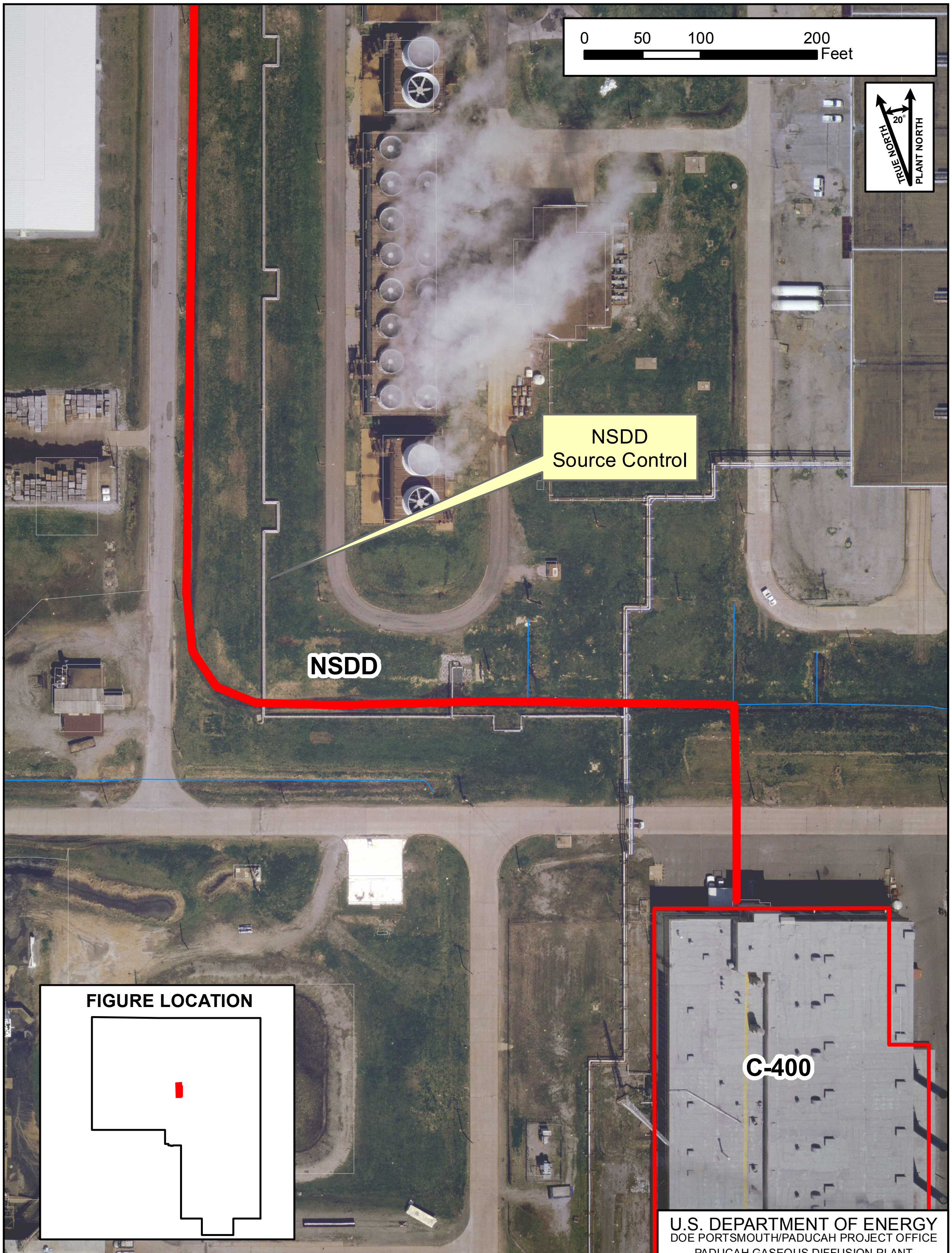

Figure 11.1. Location of NSDD Source Control

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- 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-616-H Lift Station;

- Removing fly ash from the C-600 Steam Plant ash pile runoff by constructing settling lagoons 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 (i.e., outside the existing security fence) 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). Once construction was completed, two components of the actions, the C-400 Ion Exchange and C-600 Fly Ash Lagoons, were incorporated into the daily operations of PGDP by USEC. 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 stormwater 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 stormwater drain. The discharge water will be transferred through the stormwater drainage system to Outfall 008.[5]

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

The 1994 NSDD ROD identified ARARs pertinent to the remedial action (DOE 1994a). The 1998 Five-Year Review found that jurisdictional wetlands have been identified in the NSDD after the ROD had been signed. The 1994 ROD for the NSDD was signed prior to DOE's Secretarial Policy requiring that National Environmental Policy Act values be incorporated in CERCLA documents (DOE 1994a). DOE

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

complied with all requirements during implementation of the remedial action and continues to comply with identified requirements during operation of the action. Because the wetlands were not identified prior to signing the 1994 ROD, ARARs for the protection of wetlands were not identified. They were added in 2003 during the five-year review period and are being complied with.

11.3 SYSTEMS OPERATIONS/OPERATIONS AND MAINTENANCE

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

The operations of the C-400 Ion Exchange unit and discharges from it are conducted according to a memorandum of understanding between USEC and DOE.

The C-400-L Lift Station is located on the north side of the NSDD near its upper reach near 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 were some cattails and 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 2009, extensive re-wiring was completed for the lift station to accommodate new level probes and relays that were installed. The previous level probes had begun to malfunction, which resulted in the occasional need for manual pumping of the lift station.

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 is under the control and operation of USEC. 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-C 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; however, several small pieces of covering were damaged, partially attached, or missing.

A gabion with a nonwoven, geotextile filter was installed at the existing C-616-H 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 plantwide, long-term surveillance and maintenance, and environmental monitoring programs.

11.4 PROGRESS SINCE LAST FIVE-YEAR REVIEW

The 2008 Five-Year Review determined that the exposure pathways for the NSDD Control Source that could result in unacceptable risk are being controlled and therefore are protective of human health and the environment. The following is from the 2008 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 was not a final action and was not designed to return the area to unrestricted use (DOE 2009a).

There have been no previous issues or recommendations for the NSDD Source Control. The site remains unchanged as described in the 2008 Five-Year Review, and no new actions have occurred.

11.5 SITE INSPECTION

On February 19, 2013, a site inspection by the SWOU Project Manager of the following facilities associated with the NSDD IRA was conducted: (1) the C-400-L Lift Station and associated piping, (2) the C-616-L Lift Station and associated piping, and (3) the gabion installed at the C-616-H Lift Station. Additionally, 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; however, several small pieces of the covering were damaged, partially attached, or missing. The lift stations appear to be functioning properly. After the site inspection, maintenance on the aboveground pipeline metal jacket covering was completed. The facility manager and the site inspector also were consulted concerning this facility and did not have any concerns.

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 is routed to the USEC-operated C-400 Cleaning Building collection tank, where it is stored until the treatment levels are assessed. The wastewater is repeatedly processed through the uranium precipitation and ion exchange systems until a point of diminishing return is reached (i.e., until the percentage of reduction becomes insignificant with subsequent treatments). The final concentration in the treated water is contingent upon the initial concentrations. After treatment, the water either is recycled in C-400 Building processes or is discharged via Outfall 008. Because the effluent discharge from the C-400 Building is treated until a point of diminishing return is reached and was rerouted to Outfall 008 during the design phase, the introduction of contaminants into the NSDD from the C-400 Building has been eliminated completely.

The discharges of Outfall 008 are the responsibility of USEC. The wastewater from the C-400 Building is treated and DOE monitors surface water at Outfall 008 quarterly as a part of its Environmental Monitoring Program. From 2005 to 2010, this location was monitored for volatiles, PCBs, metals, anions/cations, and radionuclides. Since 2011, this location has been monitored for volatiles and PCBs. The maximum Tc-99 detection during this review period is 20.1 pCi/L, which is considerably less than the accepted standards.

Two concrete settling lagoons were constructed to reduce fly ash from the C-600 Steam Plant ash pile runoff prior to discharge. The C-600 Fly Ash Lagoons continue to be used to keep coal-pile water runoff out of the NSDD, thereby lowering the levels of sediment being deposited in the NSDD. With the installation of the two lift stations, C-400-L and C-616-L, and associated aboveground and underground pipelines to bypass coal-pile water runoff and fly ash settling basin water to the NSDD, the introduction of contaminants into the NSDD from the C-600 Steam Plant has been eliminated completely.

To minimize sediment transport off-site (i.e., outside the existing security fence) from the NSDD, a gabion with a nonwoven, geotextile filter was installed. 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 at a minimum of twice 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 remains valid.

Changes in risk assessment methodology subsequent to approval of the ROD have been significant; these changes, however, 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.

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, 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.
- 401 *KAR* 5:029(2) and 401 *KAR* 5:031(4) were moved 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 to ensure that the screen of the Ditch 001 lift station remains 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 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. The interim action is functioning as designed and therefore is protective of human health and the environment.

11.7 ISSUES

None.

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12. NSDD SECTIONS 1 AND 2

The NSDD originates within the north central portion of PGDP and joins with Little Bayou Creek to the north of the plant. 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 at PGDP.

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 remedial action (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 plant 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).

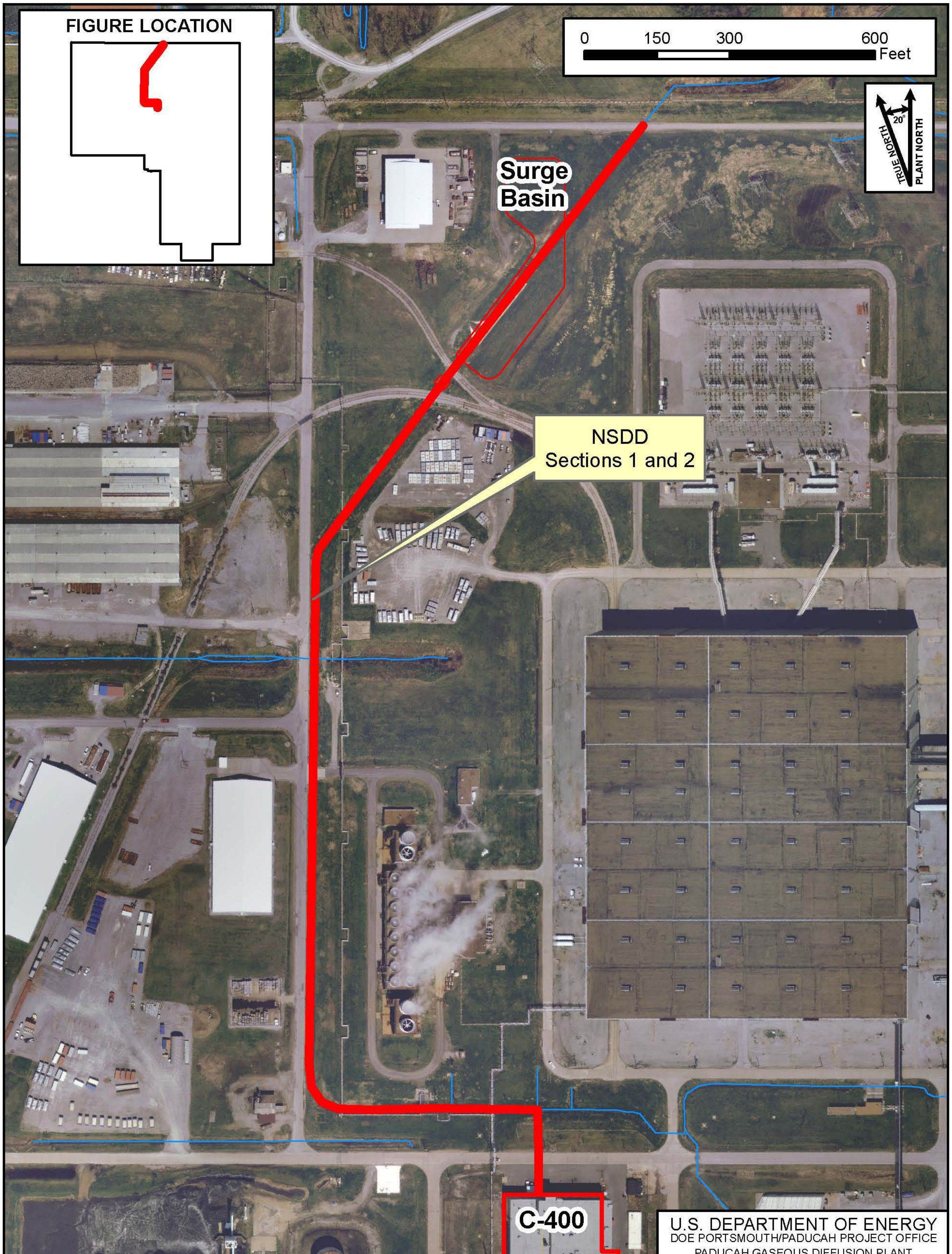

Figure 12.1. Location of NSDD Sections 1 and 2

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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 Kentucky Division of Waste Management (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 for the C-746-U Landfill.

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

The C-746-U Landfill is a contained landfill as defined in Kentucky regulations of 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 remediation contractor has procedures in place to ensure that no wastes are disposed of in the landfill that do not meet the waste acceptance criteria for this facility. This includes soil waste from the NSDD and other areas of PGDP. One aspect of the waste acceptance criteria are 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 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 (TSCA)-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 Paducah/Portsmouth project health physicist. This is done through documentation prepared for all waste disposed 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 is 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 the maximally exposed individual. 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 disposing 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 2005d).

Figure 12.2. NSDD Sections 1 and 2 before Remedial Action

Figure 12.3. NSDD Sections 1 and 2 after Remedial Action

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 can be optimized (e.g., risks are at a level that would support modification of institutional controls and/or cessation of five-year reviews). This evaluation shows 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 newly excavated and lined ditch is maintained as part of PGDP's ongoing grounds maintenance program, and the cost is not tracked separately.

12.4 PROGRESS SINCE LAST FIVE-YEAR REVIEW

The summation of the 2008 Five-Year Review protectiveness statement follows: The remedy for the NSDD Sections 1 and 2 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 (DOE 2009a).

The 2008 Five-Year Review had the following recommendation:

> Perform a residual risk calculation to determine if the remedy can be optimized (e.g., risks are at a level that would support modification of institutional controls and/or cessation of five-year reviews).

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 EPA risk range (EPA 1999); therefore, monitoring of LUCs can be reduced to once every five years in conjunction with the Five-Year Reviews to ensure that the assumption of industrial land use continues until a final remedy is selected. A request for modification of the NSDD LUCIP for reduced monitoring of institutional controls is recommended. The residual risk evaluation is provided in Appendix B.

The site remains unchanged as described in the 2008 Five-Year Review, and no new actions have occurred.

12.5 SITE INSPECTION

The NSDD site inspection was conducted on February 19, 2013, by the SWOU Project Manager, as part of this Five-Year Review. 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, although there were some cattails in the concrete lining of the basin entry point. There was no standing water in the surge basin. The grass cover is well established and was mowed. There were no visible signs of erosion along the banks of the surge basin. NSDD inspections are ongoing as part of the current remediation contractor’s scope. The facility manager and the site inspector also were consulted concerning this facility and did not have any concerns.

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, TSCA-regulated, or greater than authorized limits for the on-site C-746-U Landfill. The waste acceptance criteria 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. The plugged culverts and detention basin prevent rainfall from inside the plant from flowing beyond the 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 2012b). Current exposure assumptions and toxicity data were used to prepare the residual risk evaluation.

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 EPA risk range (EPA 1999); therefore, monitoring of LUCs can be reduced to once every five years in conjunction with the Five-Year Reviews to ensure that the assumption of industrial land use continues to be the current and reasonably anticipated future land use until a final remedy is selected.

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 clean-up 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 a new standard using similar risk-based exposures and current risk methodology (DOE 2002d; DOE 2013). For technetium-99, thorium-230, and uranium-234, the new standards 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 standard (i.e., an ELCR of 1E-04). The cleanup levels still are protective. Verification sampling showed the results for these contaminants were well below both the cleanup level and the new standard. 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, but do not impact the protectiveness of the remedy:

- DOE O 5400.5—has been superseded by DOE O 458.1.
- 401 *KAR* 5:029(2) and 5:031 references 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.

12.6.4 Technical Assessment Summary

The remedial action 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.

Table 12.1. Changes in Chemical-Specific Standards for the NSDD Sections 1 and 2

Contaminant	Media	Cleanup Level[a]	Standard[b]	Citation/Year
Aluminum	Sediment	139,200 mg/kg		DOE 2002d
			100,000 mg/kg	DOE 2013
Antimony	Sediment	11.37 mg/kg		DOE 2002d
			2,450 mg/kg	DOE 2013
Arsenic	Sediment	52.3 mg/kg		DOE 2002d
			381 mg/kg	DOE 2013
Barium	Sediment	6,870 mg/kg		DOE 2002d
			100,000 mg/kg	DOE 2013
Beryllium	Sediment	28.44 mg/kg		DOE 2002d
			11,900 mg/kg	DOE 2013
Cadmium	Sediment	639 mg/kg		DOE 2002d
			5,940 mg/kg	DOE 2013
Chromium	Sediment	85.2 mg/kg		DOE 2002d
			19,800 mg/kg	DOE 2013
Copper	Sediment	14,790 mg/kg		DOE 2002d
			100,000 mg/kg	DOE 2013
Iron	Sediment	62,100 mg/kg		DOE 2002d
			100,000 mg/kg	DOE 2013
Lead	Sediment	50 mg/kg		DOE 2002d
			800 mg/kg	DOE 2013
Manganese	Sediment	2,598 mg/kg		DOE 2002d
			100,000 mg/kg	DOE 2013
Mercury	Sediment	29.46 mg/kg		DOE 2002d
			1,840 mg/kg	DOE 2013
Nickel	Sediment	7,260 mg/kg		DOE 2002d
			100,000 mg/kg	DOE 2013
Selenium	Sediment	2,847 mg/kg		DOE 2002d
			30,600 mg/kg	DOE 2013
Silver	Sediment	1,233 mg/kg		DOE 2002d
			30,600 mg/kg	DOE 2013
Thallium	Sediment	2.2 mg/kg		DOE 2002d
			61.2 mg/kg	DOE 2013
Uranium	Sediment	3,030 mg/kg		DOE 2002d
			17,900 mg/kg	DOE 2013
Vanadium	Sediment	99.6 mg/kg		DOE 2002d
			30,900 mg/kg	DOE 2013
Total PCBs	Sediment	19.9 mg/kg		DOE 2002d
			286 mg/kg	DOE 2013
Total PAHs	Sediment	2.12 mg/kg		DOE 2002d
			78.4 mg/kg	DOE 2013
Americium-241	Sediment	467 pCi/g		DOE 2002d
			1,550 pCi/g	DOE 2013
Cesium-137	Sediment	13.3 pCi/g		DOE 2002d
			40.5 pCi/g	DOE 2013
Neptunium-237	Sediment	45.4 pCi/g		DOE 2002d
			121 pCi/g	DOE 2013

Table 12.1. Changes in Chemical-Specific Standards for the NSDD Sections 1 and 2 (Continued)

Contaminant	Media	Cleanup Level[a]	Standard[b]	Citation/Year
Plutonium-239	Sediment	563 pCi/g		DOE 2002d
			2,140 pCi/g	DOE 2013
Technetium-99	Sediment	227,000 pCi/g		DOE 2002d
			100,000 pCi/g	DOE 2013
Thorium-230	Sediment	3,510 pCi/g		DOE 2002d
			2,510 pCi/g	DOE 2013
Uranium-234	Sediment	6,880 pCi/g		DOE 2002d
			6,110 pCi/g	DOE 2013
Uranium-235	Sediment	81.6 pCi/g		DOE 2002d
			161 pCi/g	DOE 2013
Uranium-238	Sediment	313 pCi/g		DOE 2002d
			748 pCi/g	DOE 2013

[a] Previous standards 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 standards 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 2013 Risk Methods Document (DOE 2013).

The maintenance of the clay cover to prevent exposure is not required because the samples collected from the open excavation indicated that the clean-up criteria 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 PGDP. Based on the recommendation of the 2008 Five-Year Review, a residual risk evaluation was performed. The evaluation showed that the residual risk to the outdoor and industrial worker falls within EPA risk range (EPA 1999). Based on the residual risk evaluation, a modification to the LUCIP is recommended that calls for the monitoring of 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 NSDD Sections 1 and 2.

12.7 ISSUES

The 2008 Five-Year Review recommended that a residual risk evaluation be performed to determine if the remedy could be optimized, leading to the removal of institutional controls and/or cessation of the five-year reviews. 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.

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13. C-746-K LANDFILL

The C-746-K Sanitary Landfill, SWMU 8, is located southwest of the PGDP fenced security area and approximately 200 m (656 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 C-746-K.

Records indicate that PGDP used the landfill between 1951 and 1981 for disposal of fly ash from the plant's coal combustion boilers, uncontaminated combustible plant waste, and potential radiologically contaminated plant 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 indicates that up to 28 ft of fly ash and trash was 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, PGDP 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. The 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 (KDOW) 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 the 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 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. Location of C-746-K Landfill

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13.2 REMEDY IMPLEMENTATION

The ROD defined and identified the following components of the remedial action for the C-746-K 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 PGDP MOA and LUCAP, there is no LUCIP for the LUCs at the C-746-K 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*, documents the remedial actions taken at the C-746-K Landfill ROD (DOE 1999b). The O&M requirements were then revised in the document, *Operation and Maintenance Plan for the Surface Water Operable Unit at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 2000c).

The action implemented at the C-746-K 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 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* and developed the monitoring program that was used until October 1998 (DOE 1992). Four stations made up the surface water monitoring network. Two stations, 746KTB1 and 746KTB2 (Figure 13.2), located on the adjacent unnamed tributary and Bayou Creek, respectively, 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 746K3A was impacted by the leachate from the C-746-K Sanitary Landfill, while monitoring station 746K-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).

As stipulated in the ROD, the surface water monitoring requirements for C-746-K 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 effective date of December 1, 2009 for PGDP. The 2009 KPDES permit allowed for the 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 requires only that surface

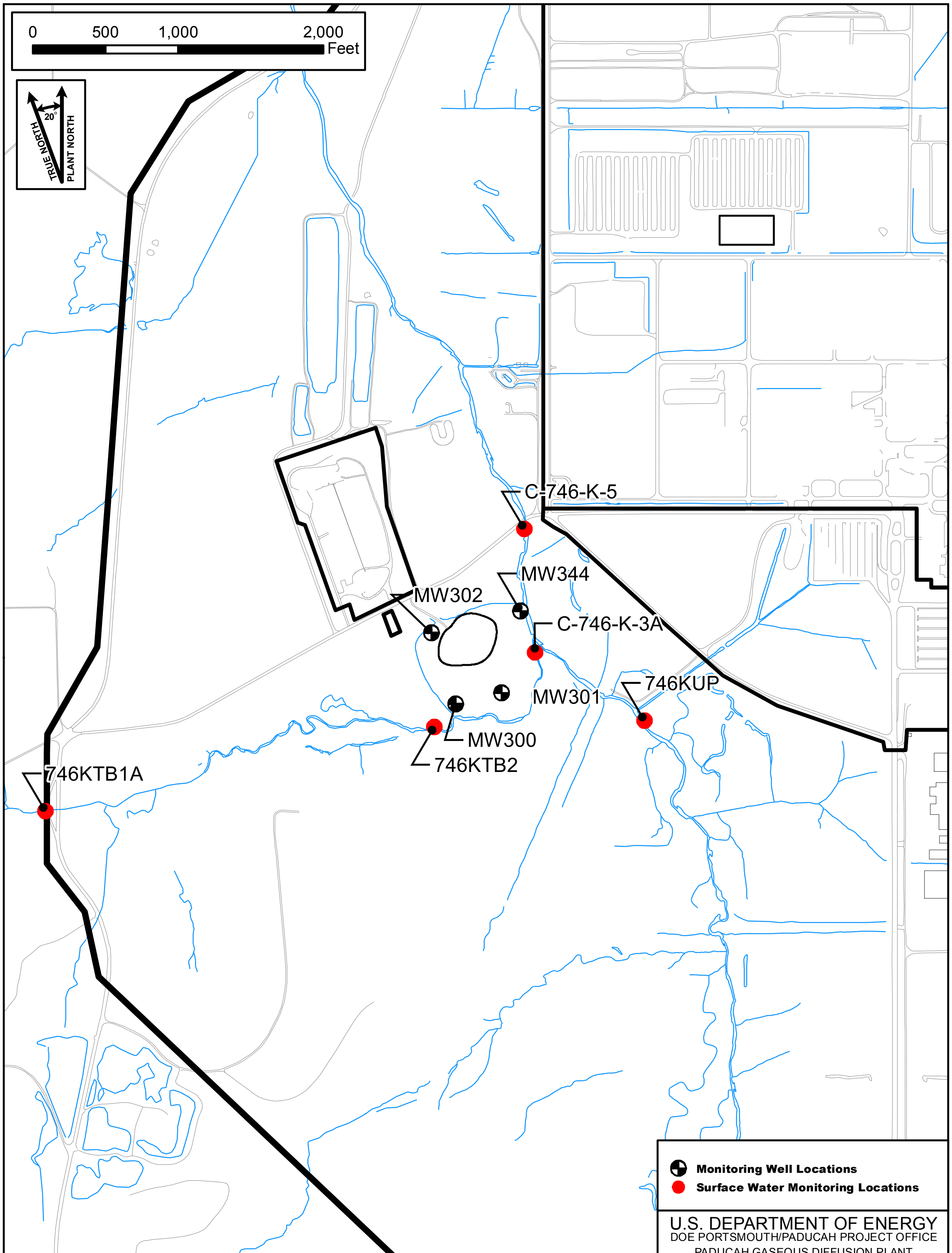

Figure 13.2. Sampling Locations at C-746-K Landfill

water be sampled quarterly for PCBs and TCE in Bayou Creek. After additional evaluations of the plan and historical data sets, the metals analysis and aquatic organism sampling was removed from the plan in a revised Watershed Monitoring Plan, which was submitted to KDOW on September 27, 2011. Water was last 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 was last collected for chemical analyses from these stations in 1999.

The remedy identified in the C-746-K Landfill ROD included the placement of riprap on visible leachate seep locations to prevent direct 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 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. Three leachate seep sites were covered to minimize the potential for human and animal exposure. 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.

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 Court Clerk.

13.3 SYSTEMS OPERATIONS/OPERATIONS AND MAINTENANCE

Two locations in the unnamed tributary and Bayou Creek in the vicinity of SWMU 8 are sampled quarterly.

Figure 13.2 shows the four monitoring well locations and the two surface water monitoring locations. The 2011 through the current CY 2013 Environmental Monitoring Plan (EMP) analytical suite for surface water monitoring includes PCBs, TCE, pH, and other field measurements at these two locations. Of note, the shaft of MW301 has buckled so that pump repair/replacement would not be possible. MW301 is installed in a position comparable to MW300, which typically has higher concentrations. The data from MW300 would represent the worst case scenario for monitoring purposes, which makes the abandonment of MW301 acceptable. Both MW300 and MW301 are Terrace Gravel wells and both are downgradient of the C-746-K Landfill according to the interpreted southeast groundwater flow through the Terrace Gravel. Based on the location and sampling results of MW301, it is recommended that this well be abandoned.

Table 13.1 summarizes relevant data for COCs since the last Five-Year Review. The surface water monitoring requirements at the C-746-K Landfill have been incorporated into the Watershed Monitoring Plan required by the KPDES permit of December 1, 2009. The modification of the Groundwater

Table 13.1. Summary of Surface Water Quality Analyses for the C-746-K Landfill COCs–2008 through 2012

Analyte	Unit	Bayou Creek (surface water) C-746-K-5 (downstream)	Unnamed Tributary (surface water) 746KTB1A (upstream)
Aluminum [a]	mg/L	ND-2.67	ND-1.04
Iron [a]	mg/L	0.22-1.82	ND-0.805
Manganese [a]	mg/L	0.024-0.121	0.0245-0.0425
Zinc [a]	mg/L	ND	ND
TCE[b]	µg/L	ND	ND

[a] For years 2008–2010
[b] For years 2008–2012
ND = nondetect

Monitoring Program in support of the remedy implementation was to generate groundwater data that could be used for future decision-making purposes involving groundwater remediation. Groundwater monitoring continues under the PGDP Groundwater Monitoring Program and is included in the FFA semiannual reports.

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

13.4 PROGRESS SINCE LAST FIVE-YEAR REVIEW

The summation of the 2008 Five-Year Review protectiveness statement follows: The remedy for the C-746-K 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 2009a).

There have been no previous issues or recommendations for the C-746-K Landfill. The site remains unchanged as described in the 2008 Five-Year Review, and no new actions have occurred. Surface water is monitored in accordance with the KPDES Permit.

13.5 SITE INSPECTION

The C-746-K Sanitary Landfill and its immediate surroundings were inspected on February 4, 2013, by a member of the Five-Year Review team, to determine if the required remedial actions for the C-746-K Landfill ROD are being met (DOE 1998b). The facility manager also was consulted concerning this facility and did not have any concerns.

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 C-746-K Landfill and along the north bank of the unnamed tributary to the south of C-746-K Landfill. The signs are in good condition and clearly legible. Additionally, the C-746-K Landfill falls within the boundaries of an extended security buffer zone around PGDP that was established by DOE immediately following September 11, 2001. This buffer zone severely restricts access to the area by the general public.

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 were 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

The overall objectives of this project were to control the release of COCs from the unit, reducing the ecological risks, and limiting human contact. The risk assessment for the C-746-K Landfill determined that the unit posed unacceptable risk to industrial workers and animals via direct contact with leachate and contaminated sediments.

The current remedy for the C-746-K area includes institutional controls (LUCs and engineering barriers to prevent exposure), along with groundwater monitoring for potential migration of contaminants off-site. The concentrations of metals detected in surface water that are listed in Table 13.1 were compared to the surface water preliminary remediation goals (PRGs) (i.e., cleanup goals) generated for the PGDP human health Risk Methods Document (DOE 2011d). For metals, the lowest PRGs associated with surface water are for the child swimming scenario. The PRGs for that scenario are 82.8 mg/L for aluminum, 58 mg/L for iron, 0.529 mg/L for manganese, and 26 mg/L for zinc, and are current for exposure assumptions and toxicity data. All detections in Table 13.1 are below the corresponding lowest PRG for surface water. The results in Table 13.1 were also compared to the Kentucky surface water standards in 401 *KAR* 10:031. The chronic warm water aquatic habitat criteria are 1 mg/L for iron and a function of hardness for zinc; there are no criteria for aluminum and manganese (KY 2013). Results from surface water are below these Kentucky standards, with the exception of the maximum result for iron downstream. The 2010 PGDP ecological risk methods document provides surface water screening levels for aluminum, iron, manganese, and zinc as 0.087 mg/L, 1 mg/L, 0.12 mg/L, and 0.05971 mg/L, respectively (DOE 2010d). Maximum results exceed ecological surface water screening values for aluminum both upstream and downstream and iron and manganese downstream. Results are shown graphically in Figures 13.3–13.5 for iron, aluminum, and manganese.

These comparisons indicate that the remedy continues to be protective of human health and the environment due to restricted direct exposure and because surface water contaminants are near or below applicable surface water standards and screening levels.

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 systems operation or maintenance.

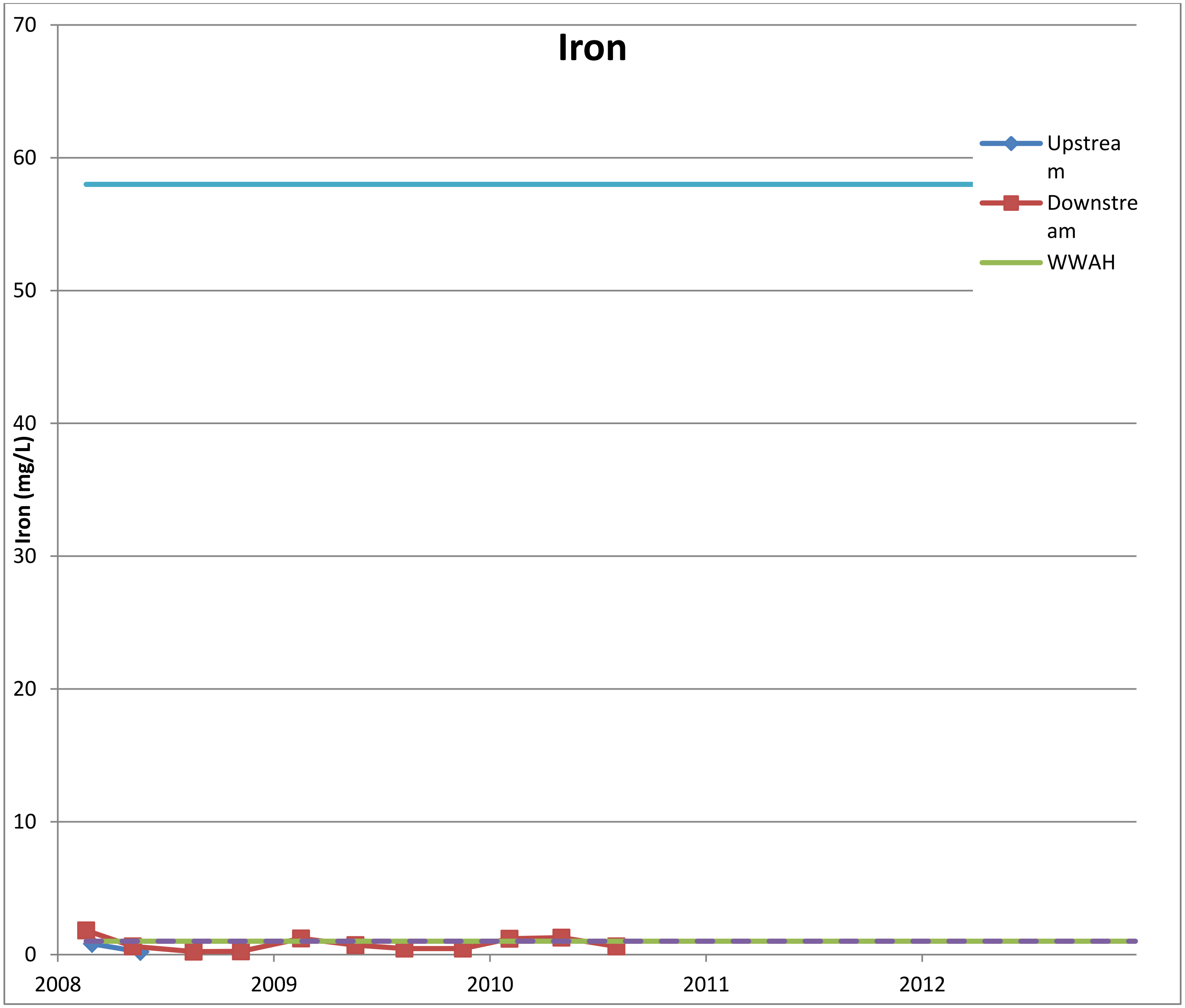

Figure 13.3. Surface Water Results for Iron at C-746-K Landfill

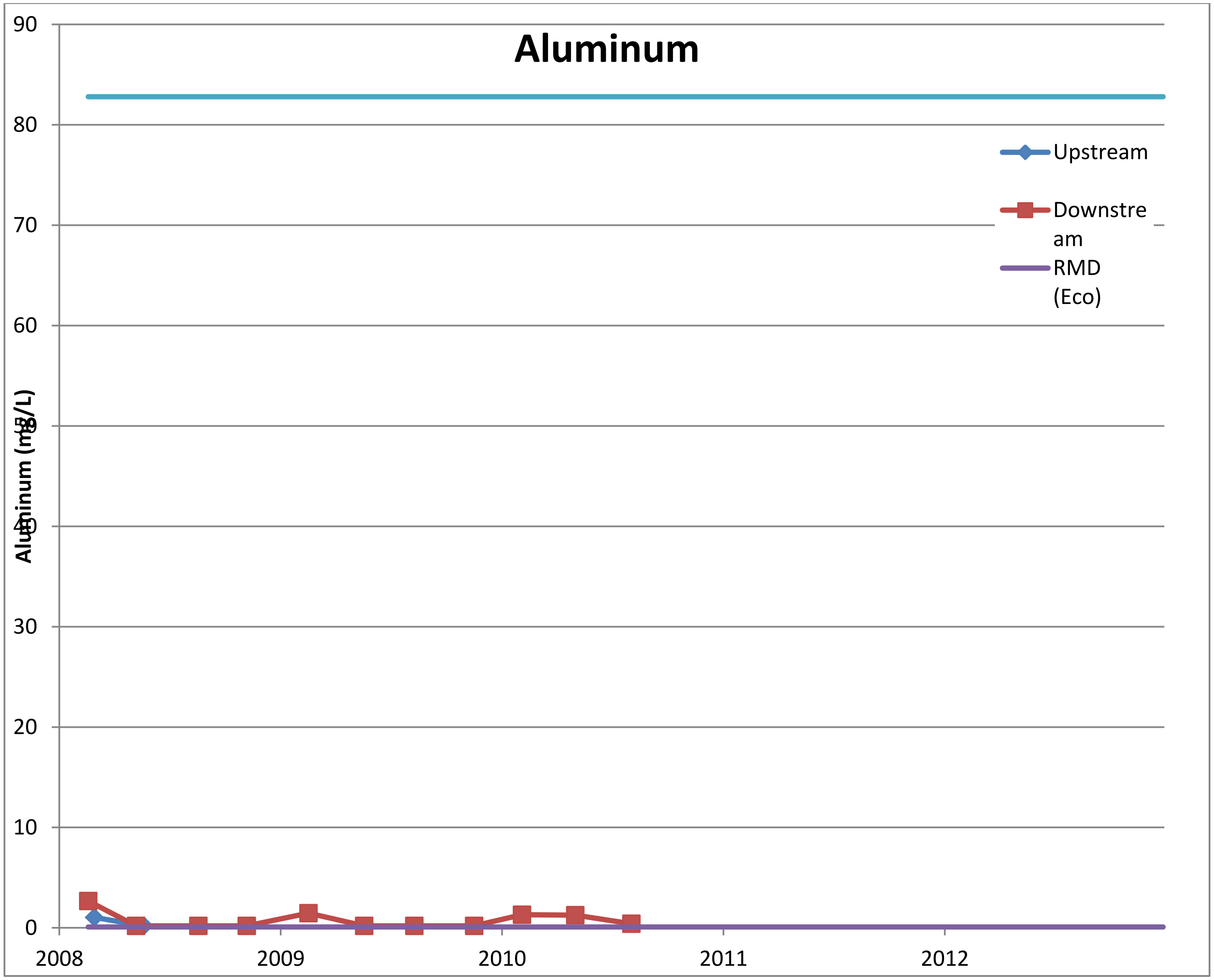

Figure 13.4 Surface Water Results for Aluminum at C-746-K Landfill

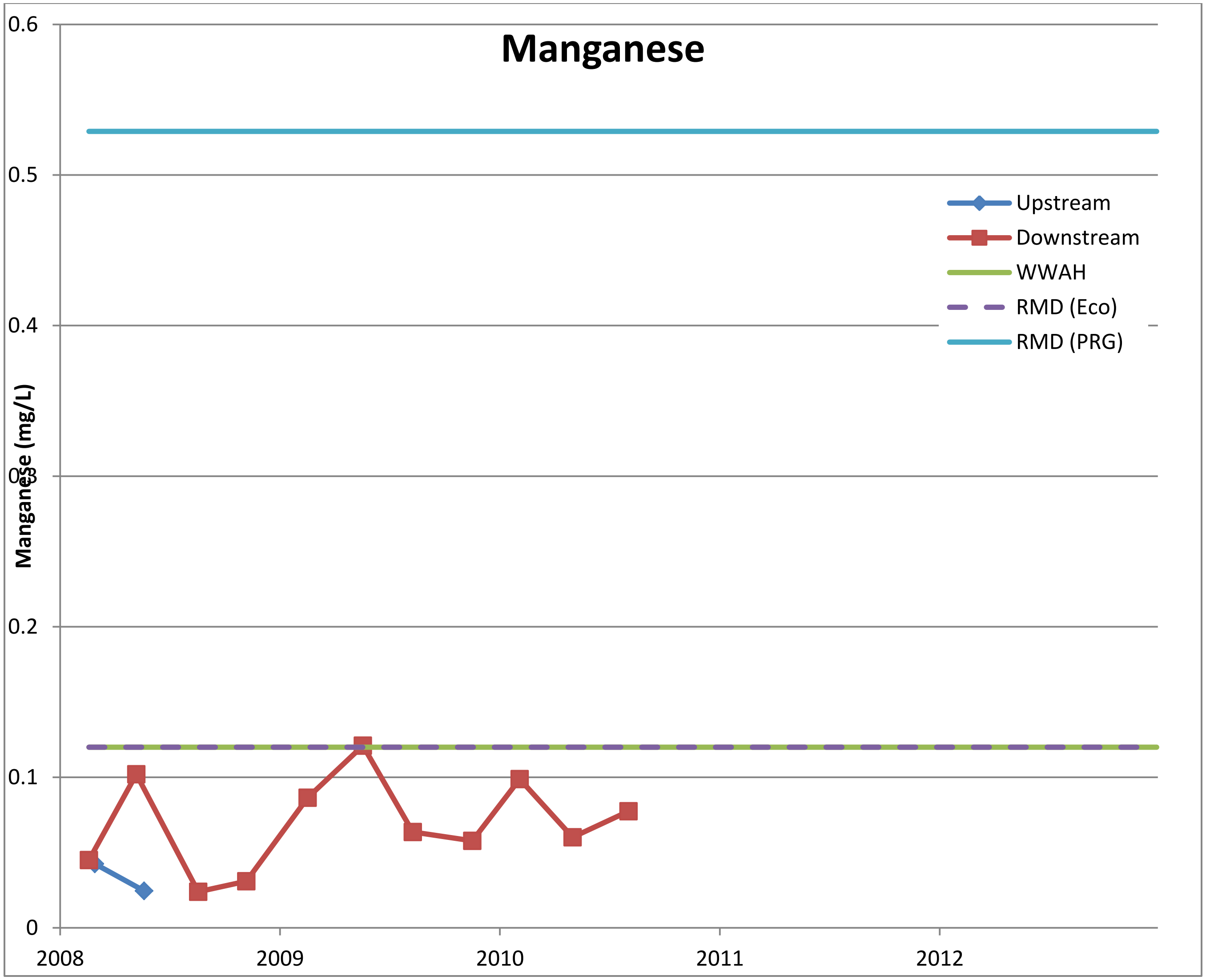

Figure 13.5. Surface Water Results for Manganese at C-746-K Landfill

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 SWMU 8 encompasses and the land use remains industrial. The plant'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, 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 2008- 2012 review period, the remedial action at the C-746-K 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 (DOE 1998b). The potential for direct human contact also is reduced by the placement of riprap along the seeps and by deed notice and restrictions recorded for the C-746-K Landfill, which restrict use of the property.

13.7 ISSUES

The shaft of MW301 has buckled so any repair/replacement of the pump would not be possible.

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14. FIRE TRAINING AREA

The Fire Training Area, SWMU 100, is located in the southwest corner of PGDP. 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 are no longer used. Figure 14.1 illustrates the location of the Fire Training Area.

14.1 REMEDY SELECTION

The selected remedy, which depends on the area remaining industrial, for the Fire Training Area, SWMU 100, was No Further Action (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 SWMU 100 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 plantwide, long-term surveillance and maintenance and environmental monitoring programs.

14.4 PROGRESS SINCE LAST FIVE-YEAR REVIEW

The summation of the 2008 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 2008 Five-Year Review, and no new actions have occurred.

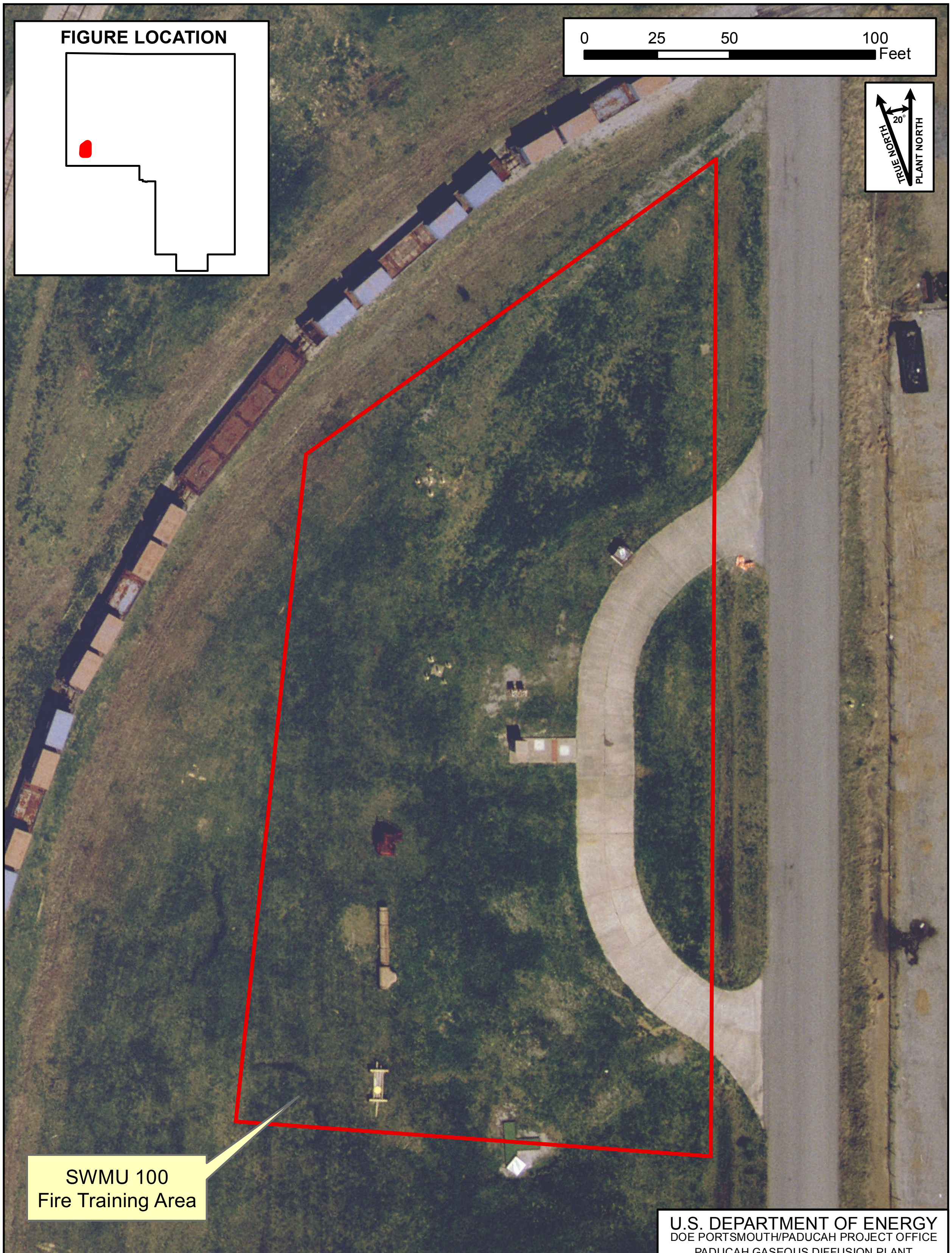

Figure 14.1. Location of Fire Training Area

LATA Environmental Services of Kentucky, LLC

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14.5 SITE INSPECTION

A site inspection of the Fire Training Area was conducted on February 4, 2013, by a member of the Five-Year Review team. Although it is apparent that the concrete area is used for fire fighters' training, the ground surface features described in the first paragraph of this chapter no longer are apparent. 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.

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. NFA is necessary to protect PGDP 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 SWMU 100 encompasses, and the land use remains industrial. The plant'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 SWMU 100, the WAGs 1 and 7 RI report states that the primary pathway contributing to both the total hazard index (HI) and the total excess lifetime cancer risk (ELCR) is dermal contact with sediment (DOE 1996b).

Updates have been made to dermal toxicity to correct the overly conservative estimation of risk that used dermal absorption factors that exceed oral absorption values (DOE 2013). These updates do not adversely impact the remedy selected. 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, 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 site investigations at PGDP indicated that various units were contributing to off-site surface water contamination. The *Results of the Site Investigation, Phase I* (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* (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 site investigation identified 21 SWMUs which 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 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 PGDP 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 PGDP. 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 1992). 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 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*, 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

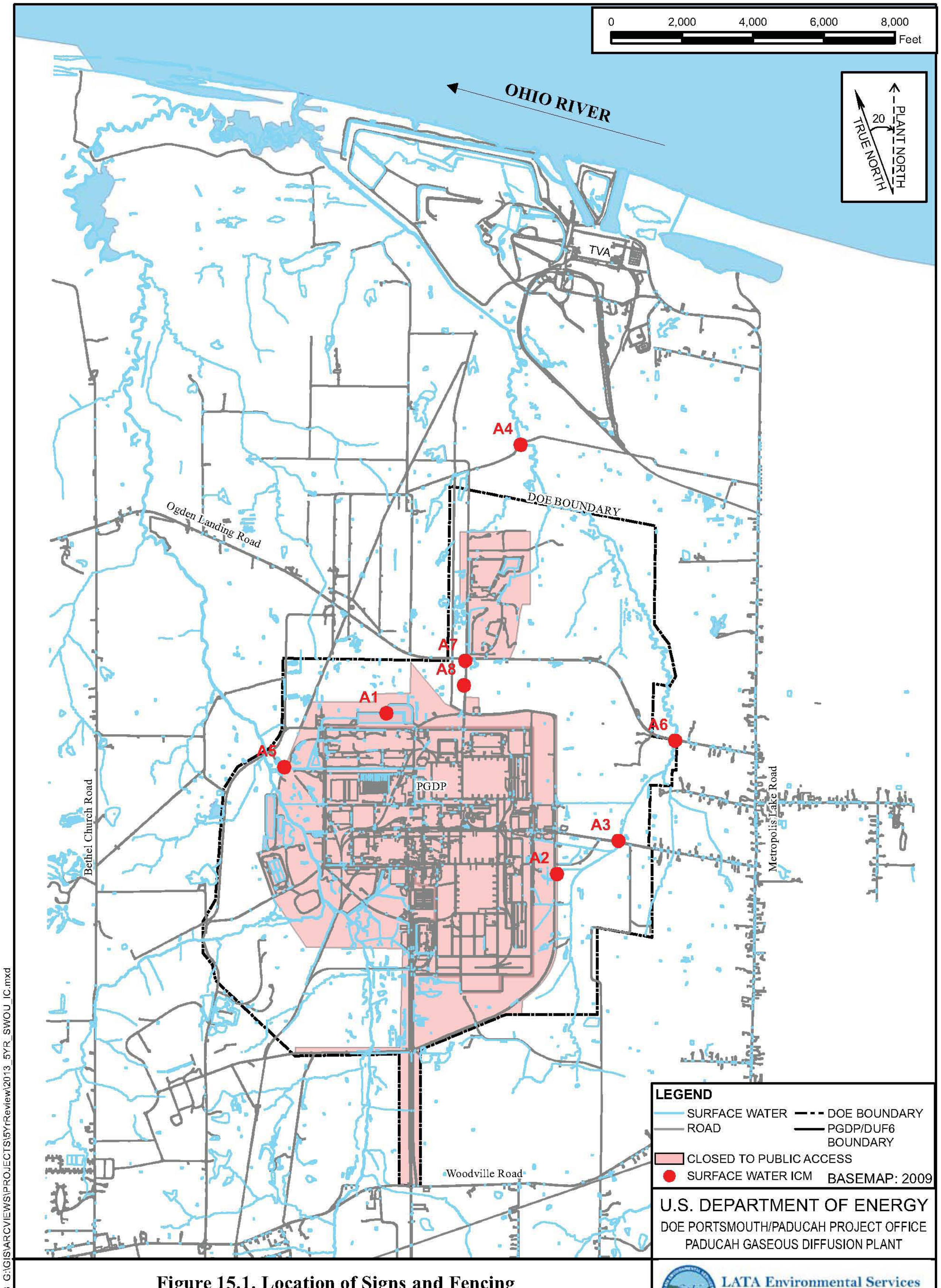

Figure 15.1. Location of Signs and Fencing Installed for the Surface Water ICM

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*, (MMES 1993) 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 2000c). The signs read as follows:

> This waterway is contaminated. Use of this waterway for drinking, fishing, swimming, or other forms of recreation may expose you to unnecessary health risks. Do not eat fish caught in this body of water. Do not cross posted boundaries. Cross only in designated areas. For information, call (270) 441-5023.

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 document *Operation and Maintenance Plan for the Surface Water Operable Unit at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 2000c). Signs are inspected monthly and repaired or replaced, as needed.

Although the sampling and assessment of surface water and sediment data is part of the PGDP 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 PGDP 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 (discussed in Chapter 16) removed areas of contaminated sediment both inside and outside the PGDP fence. After September 11, 2001, PGDP 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.

Following the erection of the fencing and signs in support of the Surface Water ICM Work Plan, another sign program was implemented in 2008. It was implemented through the Government Performance and Results Act (GPRA). The GPRA holds federal agencies accountable for using resources wisely and achieving program results. EPA, under direction from Congress, established two environmental indicators (EIs): (1) groundwater contaminant migration under control and (2) human exposure under control. KDEP had the responsibility for making this determination. The three determination choices were as follows: (1) Yes, contamination under control; (2) No, contamination not under control; or (3) Insufficient information.

In order to help achieve a “Yes” with regard to the GPRA milestone of having Human Health Exposures Under Control, DOE placed EI signs in nine locations along the Bayou and Little Bayou Creeks, as well as in off-site (i.e., outside the existing security fence) portions of Section 5 of the NSDD in the spring of

2008. The placement of these EI signs, along with flowcharts that demonstrated decision making processes that would reduce uncertainty for nonworker exposure associated with PGDP, aided KDEP in achieving a "Yes." Although these signs were not erected through an FFA party agreement, these EI signs were placed in areas that are managed by FFA decision documents (i.e., *ICM Work Plan*); therefore, after the EI signs were erected, the site was managing signs in the surface water areas using two sign programs: EI signs and the Surface Water ICM signs.

The issue of the management of two sign programs was captured in the following CERCLA Five-Year Review report. The *Five-Year Review for Remedial Actions at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/0117&D2, (DOE 2009a) evaluated the SWOU and identified the following issue: "Signs were erected under the scope of another project. Although the message content between the signs does not conflict with one other, an evaluation of the sign program is needed." This issue denotes that the EI signs were located in the same areas where the Surface Water ICM signs were located. Though the intent of the signs is the same, subtle differences existed in the wording between the two types of signs, and contact information was inconsistent (i.e., phone numbers). The 2008 Five-Year Review document provided the following recommended action for the issue: "Evaluate whether interim corrective measures signs should be removed or replaced with new signs with language approved for the Environmental Indicator signs."

An evaluation of both sign programs was finalized in 2010, and a recommendation was made to replace the Surface Water ICM signs with the more current language of the EI signs. This action will remove all Surface Water ICM signs and increase the overall number of EI signs within the program. Implementation of these actions will result in only one sign program. Each sign will be assigned a unique number thereby allowing the ICM locations to be identified separately for the next Five-Year Review. A recommendation also has been made for the fencing to remain down in Section 3 (defined as ICM area number A7 and A8) of the NSDD based on the SWOU On-Site Removal Action Report (RAR) residual risk evaluation (DOE 2011a). The former fencing in areas A7 and A8 add no real value since the areas can be entered from various access points. Table 15.1 is a summary of both recommendations.

Table 15.1. ICM/EI Sign Evaluation Recommendations

ICM Area Number	Description of Area	Is Fencing Present?	Posting Recommendation
A1	C-616 Lagoons	**Yes**	**Remove** ICM signs but leave fencing—area is not readily accessible by the public
A2	KPDES Outfall 011 and Dyke Road	**Yes**	**Remove** ICM signs—**Add** EI signs
A3	Little Bayou Creek and McCaw Road	**Yes**	**Remove** ICM signs—**Leave existing** EI signs
A4	Little Bayou Creek and Anderson Road	**Yes**	**Remove** ICM signs—**Leave existing** EI signs
A5	KPDES Outfall 001 and New Water Line Road	**Yes**	**Remove** ICM signs—**Add** EI signs
A6	Little Bayou Creek and Ogden Landing Road	**Yes**	**Remove** ICM signs—**Leave existing** EI signs
A7	NSDD and Ogden Landing Road	**Yes**	**Remove** ICM signs and fencing—**Add** EI signs
A8	NSDD-PGDP to Ogden Landing Road	**Yes**	**Remove** ICM signs and fencing—**Add** EI signs

Specifically, the evaluation proposes that, where the signs are co-located, 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. Also recommended is that remaining fencing located at areas A7 and A8 be removed, and signs located at A1 will be removed (see Figure 15.1).

15.4 PROGRESS SINCE LAST FIVE-YEAR REVIEW

The 2008 review contained the following protectiveness statement:

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

The 2008 Five-Year Review contained the following Issue and associated Recommendation:

> Signs were erected under the scope of another project. Although the message content between the signs does not conflict with one other, an evaluation of the sign program is needed.
>
> Evaluate whether ICM signs should be removed or replaced with new signs with language approved for the Environmental Indicator signs.

The results of this evaluation made a decision to replace the Surface Water ICM signs with EI signs. Specifically, where the signs are co-located, 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. These actions will remove all Surface Water ICM signs and increase the overall number of EI signs within the program. Implementation of these actions will result in only one sign program. 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 (see Figure ES.1).

Inspections of signs and fences continue along with the monitoring of sediments and surface water per the KPDES permit. The Surface Water On-site Sediment Removal (discussed in Chapter 16) removed areas of contaminated sediment both inside and outside the PGDP fence. This action prevents transport of contaminated sediment off-site (i.e., outside the existing security fence and off DOE property),

15.5 SITE INSPECTION

The locations of the signs and fences were inspected on February 20, 2013, by a member of the Five-Year Review team and the site inspector. The ICM signs were in good condition. 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, with the exception of some of the fencing along the NSDD Section 3 which was subject to the SWOU Removal Action discussed in Chapter 16. A recommendation has been made for the fencing to remain down based on the residual risk evaluation, which was prepared as part of the SWOU On-Site Removal Action Report, and is discussed later in this Chapter and Chapter 16 (DOE 2011a).

15.6 TECHNICAL ASSESSMENT

Outfalls 002, 010, 011, 012, 013, 019, and 020 drain the eastern boundary of PGDP and flow eastward toward Little Bayou Creek. The areas included in the drainage networks for these outfalls are comprised mostly of USEC process equipment 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 PGDP 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 PGDP 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 (Chapter 12), have eliminated this outfall. The stormwater that drained through NSDD to Outfall 003 when the Surface Water ICM was implemented was diverted to the C-616 treatment facility and then 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 PGDP security fence are warned that contact with contaminated water and sediment may pose potential dangers, as detailed in the Section 15.5, Site Inspection. Sediments and water continue to be monitored through the EMP in accordance with the KPDES permit and results are made available through the Annual Site Environmental Report. Since 2008, the KPDES outfalls associated with DOE's permit have exceeded their permit limits a few times, but overall remain compliant. The majority of the exceedances are for zinc and toxicity due to operations at the DUF_6 Conversion Plant. A corrective action plan for these exceedances has been developed. The following summarizes these permit exceedances:

- October 2008, Outfall 017 (oil and grease).
- March 2009, Outfall 015 [total suspended solids (TSS)];
- February 2009, Outfall 017 (zinc);
- January 2010, Outfall 020 (TSS);
- August 2010, Outfall 017 (zinc);
- December 2010, Outfall 017 (zinc);
- January 2011, Outfall 017 (zinc);
- February 2011, Outfall 017 (zinc and toxicity) and Outfall 001 (TSS);
- March 2011, Outfall 001 (TSS);
- April 2011, Outfall 017 (zinc);
- October 2011, Outfall 001 (pH);
- November 2011, Outfall 017 (zinc);
- December 2011, Outfall 017 (toxicity);
- April 2012, Outfall 017 (zinc, 3 exceedances)
- May 2012, Outfall 001 (TSS, 3 exceedances)
- January 2012, Outfall 017 (acute toxicity)

- February 2012, Outfall 017 (chronic toxicity)
- March 2012, Outfall 017 (acute toxicity, 2 exceedances)
- July 2012, Outfall 017 (acute toxicity)
- November 2012, Outfall 017 (acute and chronic toxicity)
- December 2012, Outfall 017 (acute and chronic toxicity)

A recommendation to optimize the sign program has been made. Based on the evaluation, removing of all Surface Water ICM signs and increasing the overall number of EI signs will result in only one sign program. Each sign will be assigned a unique number, thereby allowing the ICM locations to be identified separately for the next Five-Year Review. A recommendation also has been made for the fencing to remain down in Section 3 (defined as ICM area number A7 and A8) of the NSDD based on the SWOU On-Site RAR residual risk evaluation (DOE 2011a). The previous fencing in areas A7 and A8 adds no real value because the areas can be entered from various access points. Table 15.1 is a summary of both recommendations.

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 and 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 1992).

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. As previously stated, some sign locations are now in a restricted access security buffer zone due to responses after September 11, 2001, which prevents most human contact with contaminants in the streams. The access changes have led to greater protectiveness for these areas.

The NSDD, Sections 3, 4, and 5, are part of the Surface Water ICMs. As part of the SWOU On-Site RAR, a residual risk evaluation was prepared (DOE 2011a) that included these sections of the NSDD. 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 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.

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. The remedy protects human health and the environment because the fences prevent recreational users from contacting contaminated sediment and water. This action was not intended to restore the area in which it was implemented to unrestricted use.

15.7 ISSUES

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.

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-PCB Spill
- SWMU 97-C-601 Diesel Spill

The identified contamination was derived from surface water runoff and wastewater from various plant activities conducted at PGDP facilities and 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 SW 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 PGDP and discharges into Little Bayou Creek to the north of the plant.

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 plant ditches that discharge to NSDD and the outfalls were trenched when PGDP was built and became fully operational when the plant 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.

SWMU 92 was designated as a SWMU due to placement of PCB-contaminated soils as fill from a transformer rupture in 1967. SWMU 97 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 SWMUs 92 and 97) 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 remedial investigations, 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 PGDP (DOE 2008b). The investigation involved the 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 having the greatest potential for contaminant discharge to creeks surrounding PGDP.

16.1 REMEDY SELECTION

The Surface Water On-site Sediment Removal was performed as a non-time-critical removal action under the Paducah Federal Facility Agreement. The *Action Memorandum for Contaminated Sediment*

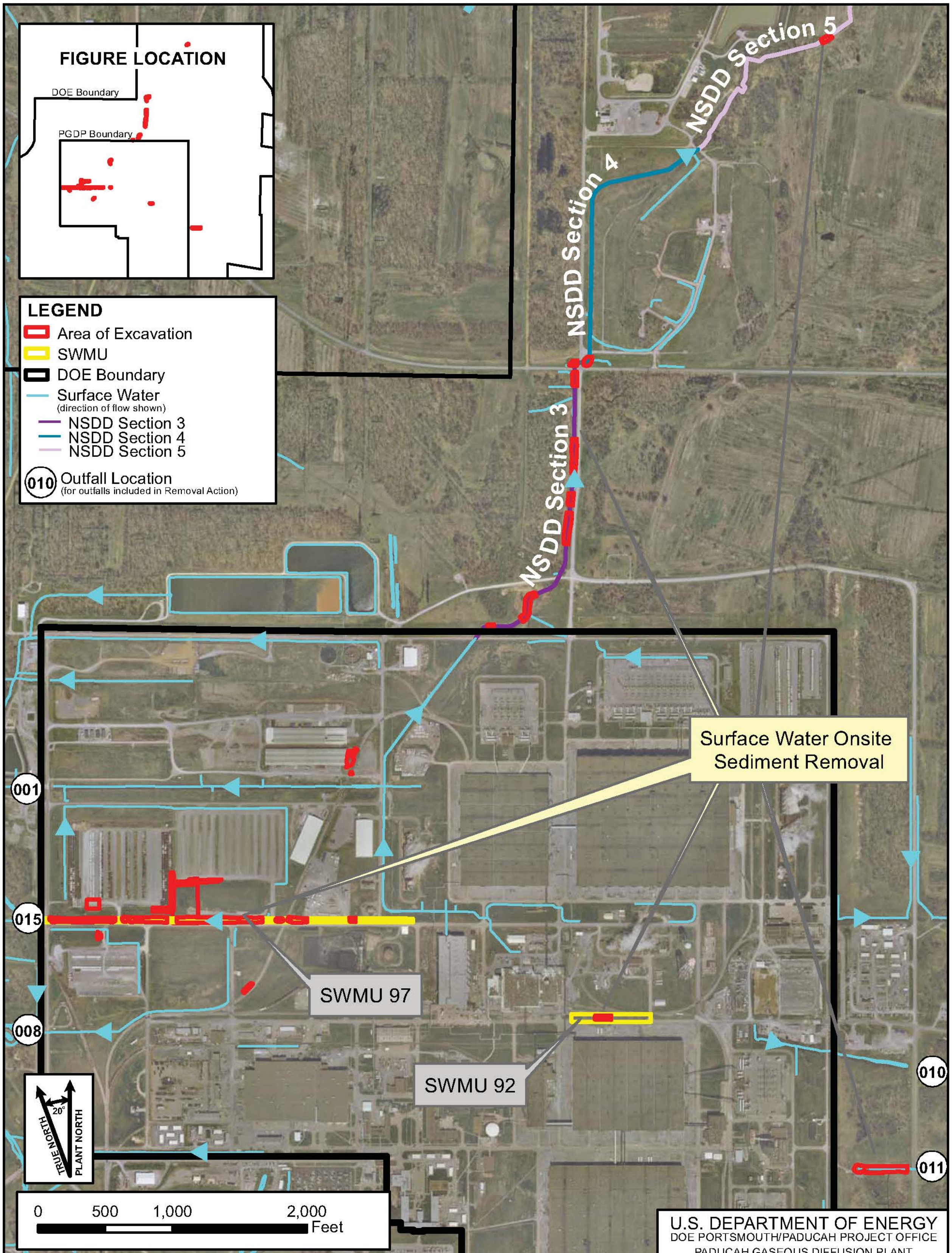

Figure 16.1. Location of Surface Water On-Site Sediment Removal

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1/30/2014

Associated with the SWOU (On-Site) (DOE 2009c) documents the non-time-critical removal action in specific areas or defined exposure units (EUs) located within PGDP 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 2008c); *Action Memorandum for Contaminated Sediment Associated with the SWOU (On-Site)* (DOE 2009c); 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 2009d).

The RAOs were consistent with the overall RAOs for the SWOU and include the following:

- 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 SWMUs 92 and 97).

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.

- Consistent with the results of the risk-based cost-benefit analysis, verification of 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.

- Methods to validate the achievement of the chemical-specific cleanup levels were implemented similar to the NSDD Sections 1 and 2 remediation.

- Installation of temporary localized engineering controls a small stormwater 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, and until the excavated/restored area was stable.

Figures 16.2 through 16.33 show "before and after" views of NSDD Sections 3 and 5 and KPDES Outfalls 001, 008, 010, 011, 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 2011a).

The RAOs were attained through the 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.

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

A residual risk evaluation was prepared as part of the RAR. 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 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 non-time-critical removal action 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.

16.4 PROGRESS SINCE LAST FIVE-YEAR REVIEW

Actions for the Surface Water On-site Sediment Removal had not begun at the time of the 2008 Five-Year Review; therefore, no previous protectiveness statement is available. Since the 2008 Five-Year Review, the Surface Water On-Site Sediment Removal was initiated and completed.

16.5 SITE INSPECTION

A site inspection was conducted on February 4, 2013, by the SWOU Project Manager and a member of the Five-Year Review team. All areas were grass covered or riprap covered and in good condition. Section 3 of the NSDD did show some signs of erosion on the steep slopes.

16.6 TECHNICAL ASSESSMENT

The remedial action for NSDD Sections 3 and 5 and KPDES Outfalls 001, 008, 010, 011, and 015 and their associated internal ditches and areas (including SWMUs 92 and 97) 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 clean-up 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.

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 standards, compared to the cleanup level established in the AM are lower because the exposure factors are higher for the new standards (Table 16.2). The cleanup levels were based on a current industrial worker accessing the ditches 14 days per year. For simplicity and conformance with the Risk Methods Document, the default industrial worker scenario for which the new standards were derived is based on accessing the ditches 250 days per year (DOE 2013). When comparing the maximum exposure concentration results from verification sampling to the new standards, only one contaminant, uranium-238, is greater. The new standard for uranium-238 is within an order of magnitude of the cleanup level, so the cleanup level would fall within the same risk range as the new standard (i.e., an ELCR of 1E-05). The cleanup levels are protective.

Table 16.2. Changes in Chemical-Specific Standards for the Surface Water On-Site Sediment Removal

Contaminant	Media	Cleanup Level[a]	Standard[b]	Citation/Year
Arsenic	Sediment	27 mg/kg		DOE 2009c
			19.05 mg/kg	DOE 2013
Beryllium	Sediment	50,000 mg/kg		DOE 2009c
			34,750 mg/kg	DOE 2013
Total PCB	Sediment	16 mg/kg		DOE 2009c
			14.3 mg/kg	DOE 2013
Americium-241	Sediment	115 pCi/g		DOE 2009c
			89.5 pCi/g	DOE 2013
Cesium-137	Sediment	8 pCi/g		DOE 2009c
			2.54 pCi/g	DOE 2013
Neptunium-237	Sediment	22 pCi/g		DOE 2009c
			6.05 pCi/g	DOE 2013
Plutonium-239/240	Sediment	108 pCi/g		DOE 2009c
			130 pCi g	DOE 2013
Technetium-99	Sediment	3,825 pCi/g		DOE 2009c
			10,100 pCi/g	DOE 2013
Thorium-230	Sediment	147 pCi/g		DOE 2009c
			197.5 pCi/g	DOE 2013
Thorium-232	Sediment	129 pCi/g		DOE 2009c
			183 pCi/g[c]	DOE 2014
Uranium-234	Sediment	188 pCi/g		DOE 2009c
			305.5 pCi/g	DOE 2013
Uranium-235	Sediment	30 pCi/g		DOE 2009c
			9.2 pCi/g	DOE 2013
Uranium-238	Sediment	94 pCi/g		DOE 2009c
			37.4 pCi/g	DOE 2013
Uranium	Sediment	227 mg/kg		DOE 2009c
			5,980 mg/kg	DOE 2013

[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 for uranium (metal) to achieve cleanup of a cumulative ELCR of 1E-05 and a cumulative HI of 1, see Section 3 and Table 1 of the Action Memorandum (DOE 2009c).
[b] New standards are based on the default industrial worker action levels (Table A.1) presented in the 2013 Risk Methods Document (DOE 2013), calculated to the risk-based set at a target of ELCR = 5E-06 for most COCs and a target of HI = 1 for uranium (metal).
[c] Thorium-232 is not a COPC for PGDP and was not included in the 2013 Risk Methods Document. The new standard was calculated using http://rais.ornl.gov/cgi-bin/prg/PRG_search (accessed January 2014).

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.

Figure 16.2. Outfall 001 11-12-09 (Before)

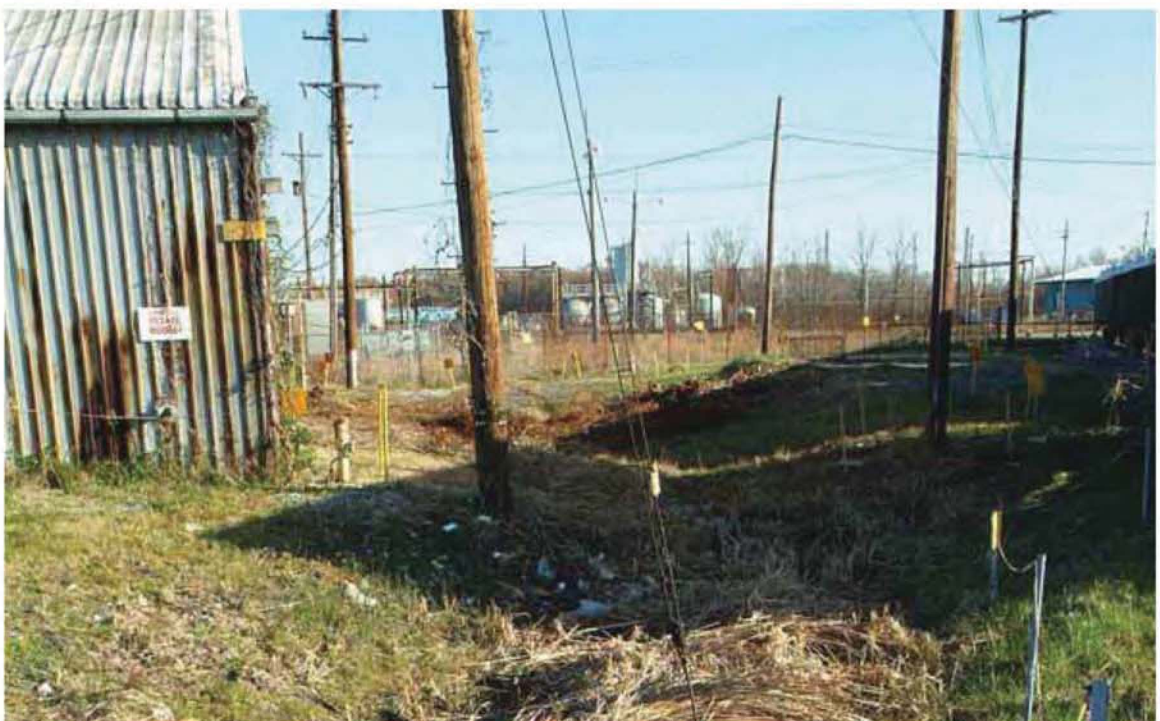

Figure 16.3. Outfall 001 11-12-09 (Before)

Figure 16.4. Outfall 001 07-22-10 (After)

Figure 16.5. Outfall 001 07-22-10 (After)

Figure 16.6. Outfall 010 11-12-09 (Before)

Figure 16.7. Outfall 010 07-12-10 (After)

Figure 16.8. Outfall 011 11-12-09 (Before)

Figure 16.9. Outfall 011 07-12-10 (After)

Figure 16.10. Outfall 015, EU02 11-12-09 (Before)

Figure 16.11. Outfall 015, EU02 11-12-09 (Before)

Figure 16.12. Outfall 015 EU03 11-12-09 (Before)

Figure 16.13. Outfall 015 EU03 11-12-09 (Before)

Figure 16.14. Outfall 015 EU04 11-12-09 (Before)

Figure 16.15. Outfall 015 EU04 11-12-09 (Before)

Figure 16.16. Outfall 015 EU04 11-12-09 (Before)

Figure 16.17. Outfall 015 EU07 1112-09 (Before)

Figure 16.18. Outfall 015 EU08 11-12-09 (Before)

Figure 16.19. Outfall 015, EU 02 07-12-10 (After)

Figure 16.20. Outfall 015, EU 02/03 07-12-10 (After)

Figure 16.21. Outfall 015, EU 03 07-12-10 (After)

Figure 16.22. Outfall 015, Eu 04 07-12-10 (After)

Figure 16.23. North South Diversion Ditch Section 3, EU 01 11-12-09 (Before)

Figure 16.24. North South Diversion Ditch Section 3, E U01 11-12-09 (Before)

Figure 16.25. North South Diversion Ditch Section 3, EU 02 11-12-09 (Before)

Figure 16.26. North South Diversion Ditch Section 3, EU 03 11-12-09 (Before)

Figure 16.27. North South Diversion Ditch Section 3, EU 03 11-12-09 (Before)

Figure 16.28. North South Diversion Ditch Section 3, EU 03 11-12-09 (Before)

Figure 16.29. North South Diversion Ditch Section 5 11-12-09 (Before)

Figure 16.30. North South Diversion Ditch Section 3 EU 01 07-13-10 (After)

Figure 16.31. North South Diversion Ditch Section 3 EU 02 07-13-10 (After)

Figure 16.32. North South Diversion Ditch Section 3 EU 03 07-13-10 (After)

Figure 16.33. North South Diversion Ditch Section 5 07-13-10 (After)

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17. C-749 URANIUM BURIAL GROUND

The C-749 Uranium Burial Ground (SWMU 2) is located in the west-central portion of the plant north of Virginia Avenue and on the western edge of the C-404 Low-Level Radioactive/Hazardous Waste Burial Ground (Figure 17.1). 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*, was signed in 1995 (DOE 1995d). Because SWMU 3, the C-404 Contaminated Burial Ground, is closed with a RCRA cap and is being addressed by RCRA postclosure permit requirements, the 1995 ROD required NFA for it. For SWMU 2, 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. Through agreement by the parties, an impermeable cap was not constructed [WAG 22 Post-ROD Change, October 23, 1996 (Hodges 1996)]. Fieldwork to collect data for the final actions for the BGOU RI was performed in 2007 and the RI report was completed in 2010 (DOE 2010e). An FS is underway to evaluate final remedial actions for SWMUs 2 and 3. Figure 17.1 illustrates the location of SWMU 2.

This IRA in the 1995 ROD leaves waste in place that requires restricted access; therefore, SWMU 2 will be reviewed no less than once every five years. 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 November 2012 report contains a map depicting the SWMU 2 groundwater MWs and a summary of the SWMU 2 trends for TCE and Tc-99 for reporting dates 1996 through July 2012 (DOE 2012a).

DOE conducted an investigation at SWMU 2 to provide information needed before the selected interim action was fully implemented and to provide additional data to evaluate a final remedial action for SWMU 2 (DOE 1997b). One of the goals of this investigation was to determine if the waste within SWMU 2 was saturated with groundwater. The results of the investigation indicated that the waste within SWMU 2 was saturated; therefore, placement of a cap on SWMU 2 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 PGDP boundary in concentrations that exceed both human health risk-based and regulatory (i.e., MCL) PRGs; 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.

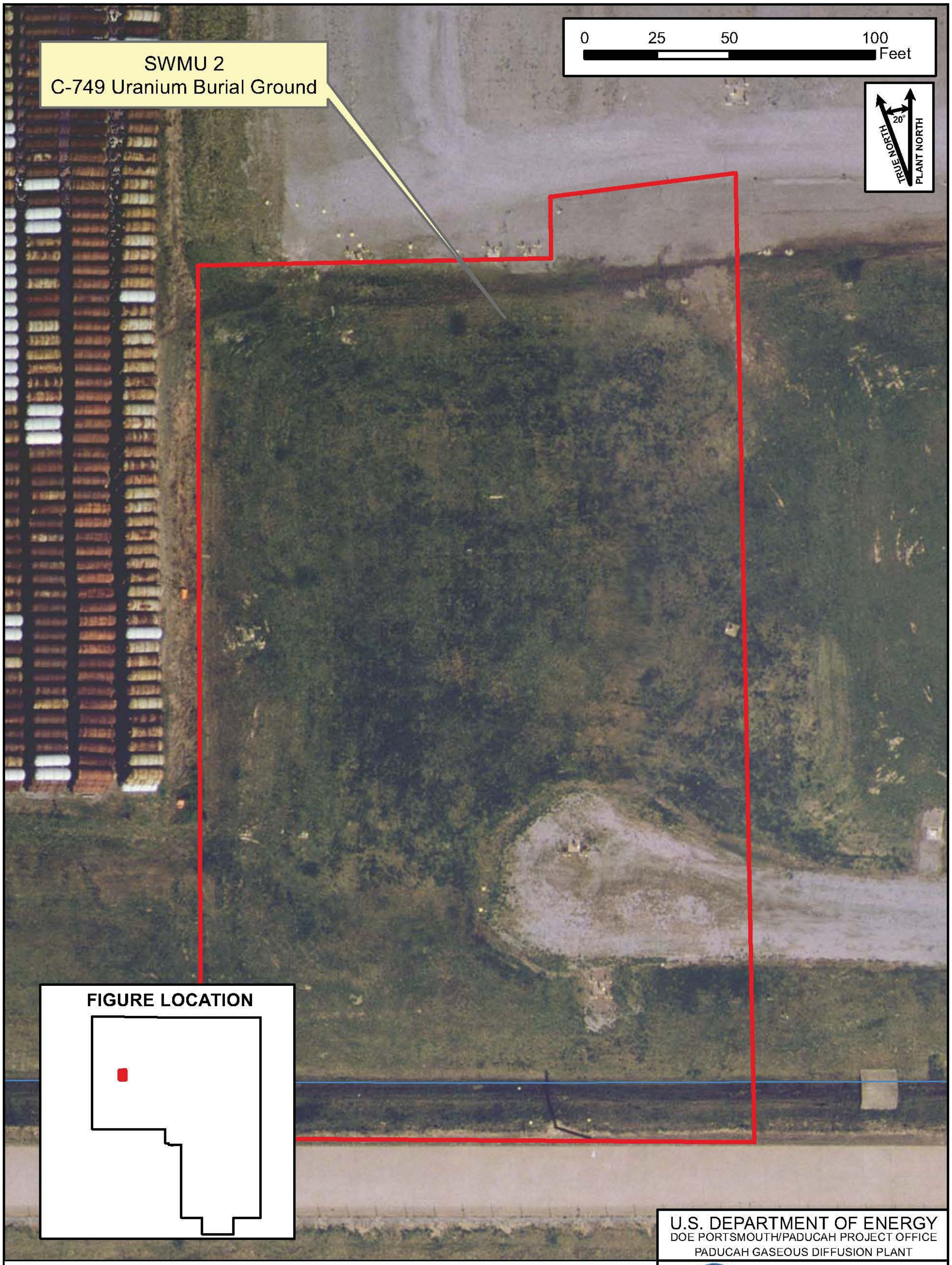

Figure 17.1. Location of C-749 Uranium Burial Ground

LATA Environmental Services of Kentucky, LLC

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3/12/2013

The RAOs for the interim action were to mitigate migration of uranium and TCE from SWMU 2 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 ground water interaction with the buried wastes, a low permeability, multilayered cap may be placed on SWMU 2, the C-749 Uranium Burial Ground, to reduce infiltration of surface water from precipitation events into and through buried wastes. This will also reduce potential leaching of contaminants to ground water. The cap will also 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;

- A ground water monitoring program will be implemented in the uppermost aquifer, the Regional Gravel Aquifer, to detect any release of contaminants from SWMU 2; and

- Institutional controls will be implemented to prevent transferal of the SWMU 2 property and prevent to future intrusive activities at the unit (DOE 1995d).

The low-permeability, multilayered cap would be constructed over SWMU 2 to reduce significantly the infiltration of surface water from precipitation events into the unit.

A groundwater monitoring program would be established in the RGA to detect potential contaminants released from SWMU 2. A monitoring program also would evaluate the cap's effect(s) on the shallow groundwater level in the UCRS and fill data gaps.

Institutional controls would be implemented to further prevent access to SWMU 2. These institutional controls may include a deed restriction to ensure that DOE retains ownership of the property, which SWMU 2 encompasses. Institutional controls also may prevent inappropriate use of the property and any intrusive activities that could expose buried waste materials.

Additionally, DOE would conduct reviews of the action no less than once every five years.

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 SWMU 2. 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 SWMU 2. MW337 and MW338 were installed downgradient of SWMU 2, and MW333 was installed upgradient of SWMU 2. The wells currently are sampled as part of the PGDP Groundwater Monitoring Program as specified in the EMP (LATA Kentucky 2013).

Since the ROD for this IRA was signed prior to the effective date of the PGDP MOA and LUCAP, a LUCIP does not exist for the institutional controls at SWMU 2.

DOE remains in control of the property that SWMU 2 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 2008 Five-Year Review protectiveness statement follows: The remedy for the C-749 Uranium Burial Ground 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 (DOE 2009a).

There have been no previous issues or recommendations for the C-749 Uranium Burial Ground. The site remains unchanged as described in the 2008 Five-Year Review, and no new actions have occurred.

17.5 SITE INSPECTION

On February 12, 2013, a site inspection of the SWMU 2 was performed by the BGOU Project Manager, and BGOU Project Engineer. This area is located north and west of the C-600 Building within the boundaries of the controlled access area of PGDP. There were no indications of erosion or standing water in the area. An access road is located on the south side of the area outside the radiological boundary. 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 was 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 SWMU 2 to groundwater and to prevent disturbance or contact with the buried waste materials.

The SWMU 2 low-permeability, multilayered cap was intended to mitigate migration of uranium and TCE from SWMU 2 to groundwater; however, this action was cancelled after it was determined that it would be ineffective because of the shallow groundwater found at SWMU 2.

The maximum detected concentrations of TCE in the one upgradient well and the three downgradient RGA wells located at SWMU 2 currently exceed the National Primary Drinking Water Standards and applicable state standards. Tc-99 activity has remained below the MCL, but appears to be rising in SWMU 2 downgradient well, MW337.

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 17.1 and 17.2 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 SWMU 2, based on groundwater sampling conducted between 1996 and 2012. The maximum detected

Table 17.1. Comparison of Initial and Current Contaminant Concentrations in RGA Groundwater, Downgradient of SWMU 2

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	2.3 2.3	MW337 MW67	5/11/2009 8/5/2009	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 17.1. Comparison of Initial and Current Contaminant Concentrations in RGA Groundwater, Downgradient of SWMU 2 (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[h]	pCi/L
U-235/U-236	ND	N/A	ALL	0.11	MW337	10/4/1996	0.3[g]	0.466[h]	pCi/L
U-238	3.3	MW67	3/11/1991	0.67	MW338	10/4/1996	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 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] Background value for U-235.
[h] 2013 Update of the Human Health Risk Methods Document (DOE 2013).

Table 17.2. Comparison of Initial and Current Contaminant Concentrations in RGA Groundwater, Upgradient of SWMU 2

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	7.1	MW333	5/7/2009	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	0.770	MW333	5/7/2009 3/8/2010	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 17.2. Comparison of Initial and Current Contaminant Concentrations in RGA Groundwater, Upgradient of SWMU 2 (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[h]	N/A	ALL	0.03	No Value	pCi/L
Tc-99	33	MW48	8/1/1989	39.9	MW333	5/7/2009	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[i]	pCi/L
U-235/U-236	ND	N/A	ALL	0.35	MW333	10/14/1996	0.3[g]	0.466[i]	pCi/L
U-238	1.3	MW48	4/3/1991	0.14	MW333	10/14/1996	0.7	9.99[i]	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] Background value for U-235.
[h] Value reported below laboratory detection limit, but was not laboratory qualified as a nondetect.
[i] 2013 Update of the Human Health Risk Methods Document (DOE 2013).

concentrations of TCE in the one upgradient well and the three downgradient RGA wells (MW337, MW338, and MW67) located at SWMU 2 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;[6] 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 17.2 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 the downgradient wells. These data indicate that TCE contamination in the RGA at SWMU 2 is coming from an upgradient source and that the net groundwater flow direction is northward. See Figure 17.3 for RGA well locations.

Figure 17.2 illustrates the potentiometric surface in the vicinity of SWMU 3 and SWMU 2 on July 17, 2012. There is a northerly gradient (compare 324.82 ft elevation at upgradient MW333 with 324.45 ft elevation downgradient MW338). The slight easterly vector of groundwater gradient likely is related to the fact that SWMU 3 has an impermeable (RCRA-equivalent) cap that limits infiltration in the vicinity of the unit. This will slightly depress the water table in the vicinity of SWMU 3 and induce some flow to the east, as shown on Figure 17.3, especially during periods of higher infiltration. A review of the shape of the TCE plume 100 µg/L implied contour (See Figure 17.4) supports the finding that the net groundwater flow is to the north, with some seasonal flow to the northwest and some to the northeast.

Because SWMU 2 is located inside the plant secured area and under DOE ownership and control, deed restrictions have not been necessary. SWMU 2 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.

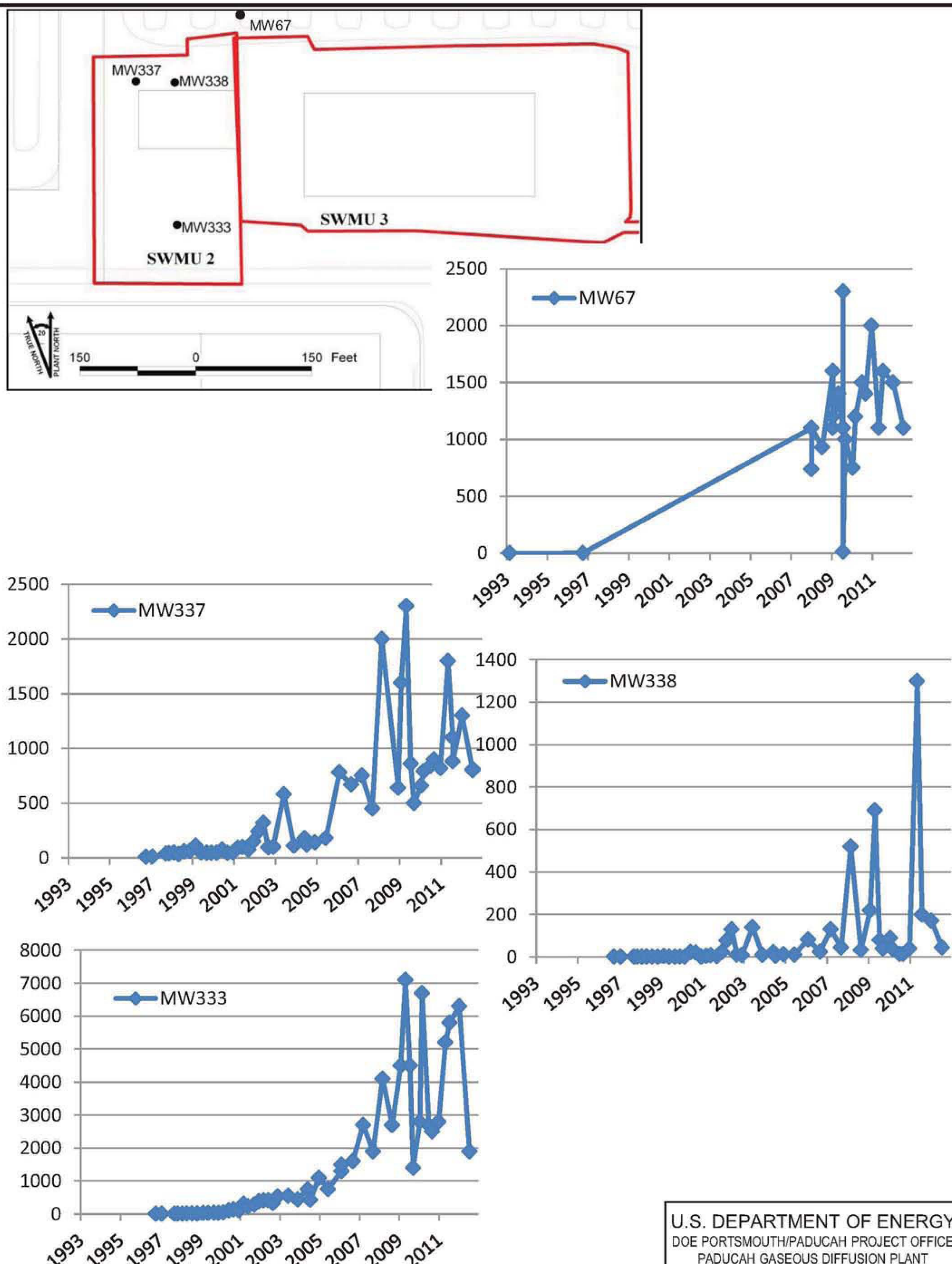
17.6.1 Question A: Is the Remedy Functioning as Intended by the Decision Documents?

The components of the remedy that were implemented are functioning as intended. Groundwater MWs constructed for SWMU 2, consisting of two downgradient wells (MW337 and MW338) and one upgradient well (MW333), are located to monitor the facility. Furthermore, a previously existing RGA well (MW67) provides additional downgradient monitoring.

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?

DOE remains in control of the property that SWMU 2 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.

[6] The laboratory reporting limit for uranium typically is 1 µg/L or less.



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

Figure 17.2. TCE Trends in the Upper RGA for SWMU 2

LATA Environmental Services of Kentucky, LLC

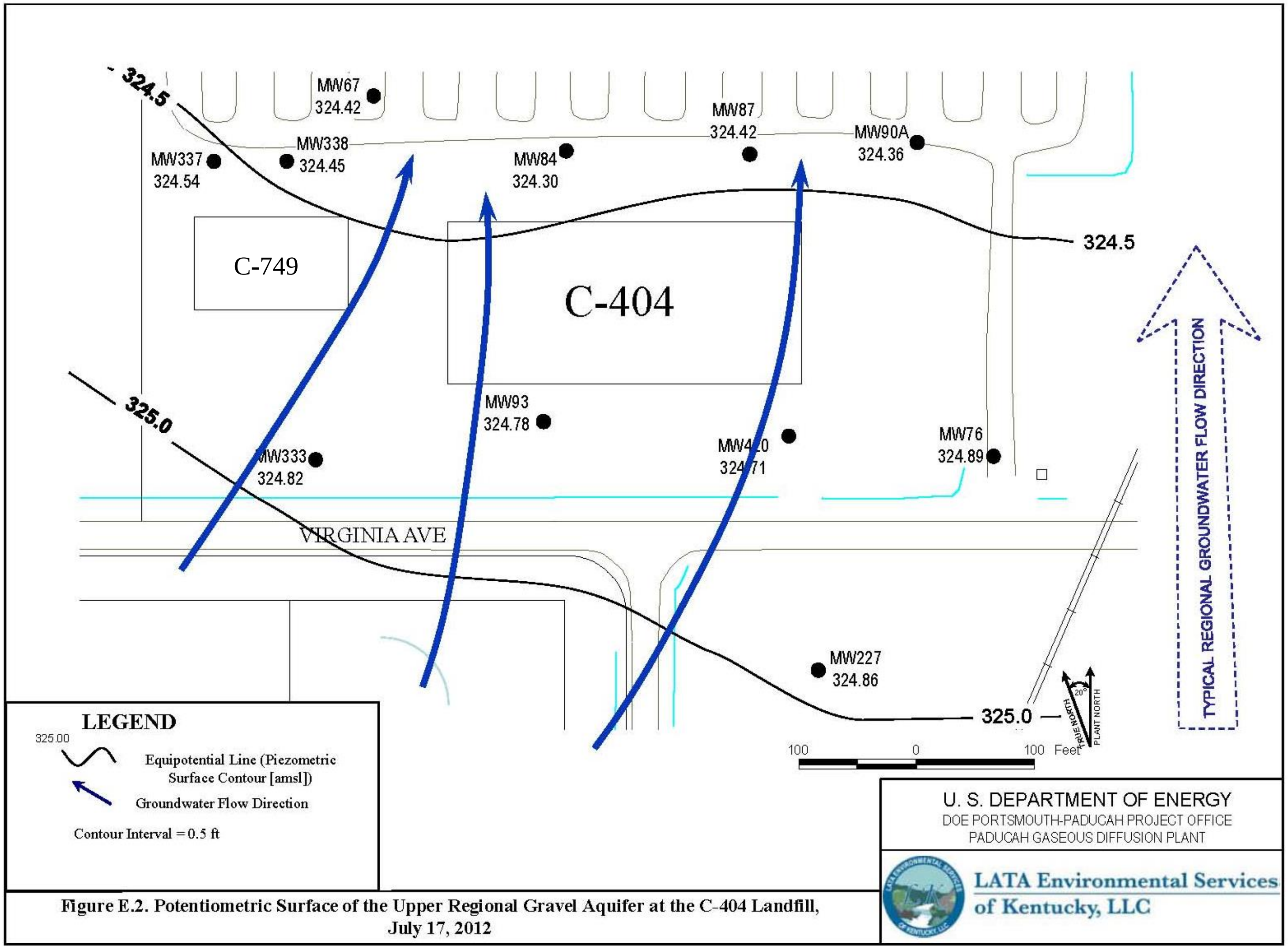


Figure E.2. Potentiometric Surface of the Upper Regional Gravel Aquifer at the C-404 Landfill, July 17, 2012

Figure from LATA Kentucky 2012d

Figure 17.3. Potentiometric Surface of the Upper Regional Gravel Aquifer at the C-404 (SWMU 3) and C-749 (SWMU 2) Landfills, July 17, 2012

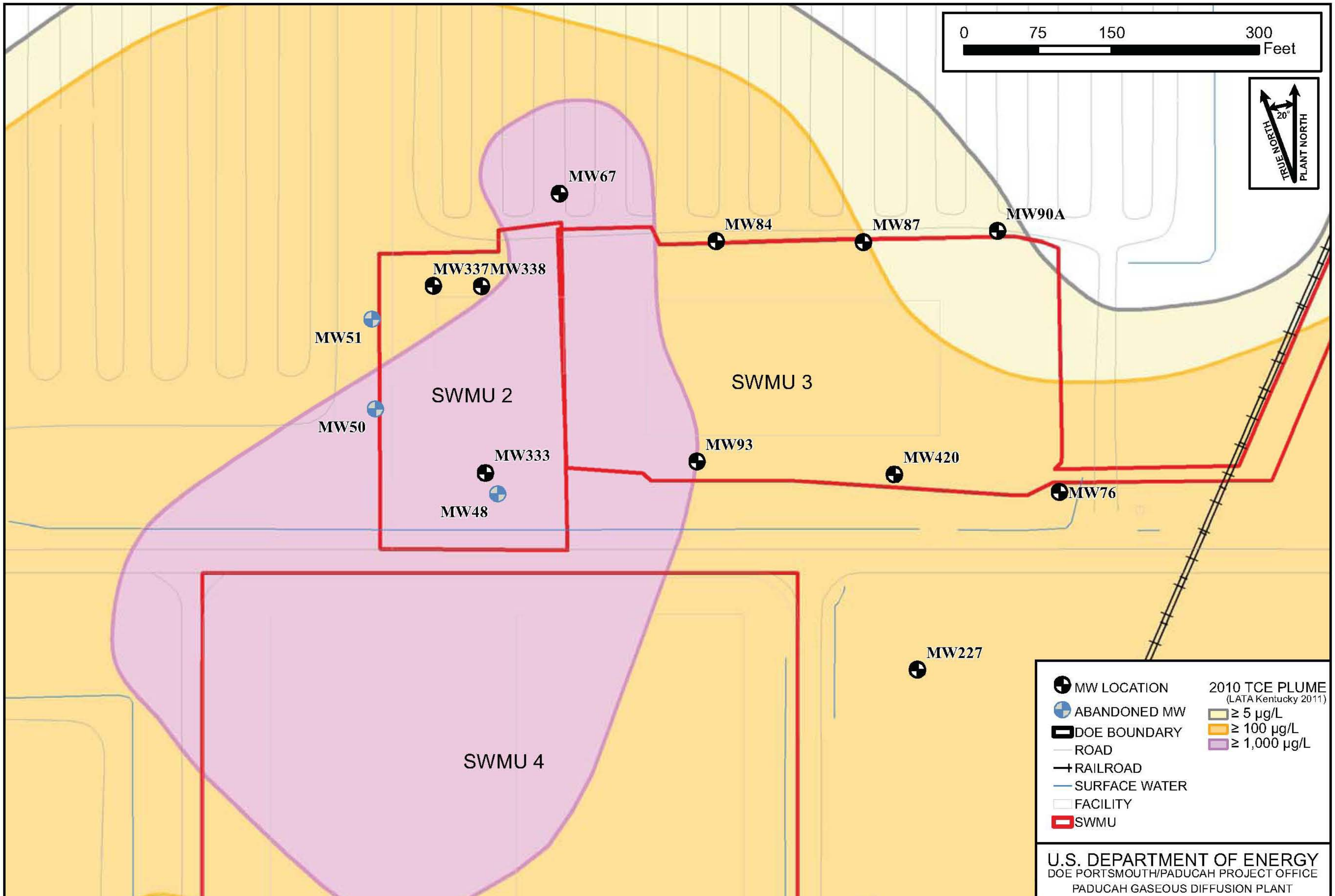


Figure 17.4. Location of C-749 (SWMU 2) and Trichloroethene Groundwater Plume

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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 UCRS water levels in the waste were predominately 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 original remedy was based on the assumption that there is no exposure pathway because institutional controls prevent access to the groundwater at the unit. The changes to the parameters for risk evaluation of TCE, therefore, have no effect on the protectiveness of the remedy because the exposure assumption (no exposure) is still valid. The recent data also indicate that contaminants in groundwater from this unit do 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 changes were identified, but do 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.

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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	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.	DOE	EPA and the Commonwealth of Kentucky	Additional action, if necessary, for long-term protection should be evaluated and documented in the final decision document for the Dissolved-Phase Plume.	09/30/2029	N	Y
Groundwater, Northeast Plume	The Northeast Plume remedial action 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.	DOE	EPA and the Commonwealth of Kentucky	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 PGDP 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.	12/30/2017	N	Y
Groundwater, Northeast Plume	The Northeast Plume is an IRA designed to initiate hydraulic control of the high TCE concentration area within the Northeast Plume and does not achieve final cleanup of the groundwater contamination. A follow-up evaluation is needed to ensure long-term protection.	DOE	EPA and the Commonwealth of Kentucky	Additional action, if necessary, for long-term protection should be evaluated and documented in the final decision document for the Dissolved-Phase Plume.	09/30/2029	N	Y

Operable Unit	Issue	Party Responsible	Oversight Agency	Recommendations and Follow-up Actions	Completion Date	Affects Protectiveness (Y/N)	
						Current	Future
Groundwater, Water Policy	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	EPA and the Commonwealth of Kentucky	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.	12/30/2014	N	Y
Groundwater, C-400 Electrical Resistance Heating (ERH)	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 Upper Continental Recharge System 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.	DOE	EPA and the Commonwealth of Kentucky	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.	TBD	N	Y

Operable Unit	Issue	Party Responsible	Oversight Agency	Recommendations and Follow-up Actions	Completion Date	Affects Protectiveness (Y/N)	
						Current	Future
Groundwater, C-400 Electrical Resistance Heating (ERH)	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. A follow-up evaluation is needed to ensure long-term protection.	DOE	EPA and the Commonwealth of Kentucky	Additional action, if necessary, for long-term protection should be evaluated and documented in the final decision document for the GDP Groundwater Sources OU and the CSOU.	TBD	N	Y
Groundwater, C-400 Electrical Resistance Heating (ERH)	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 and, therefore, 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.	DOE	EPA and the Commonwealth of Kentucky	To ensure that the remedy is protective for vapor intrusion, it is recommended that a vapor intrusion analysis be performed consistent with the PGDP Risk Methods Document as part of any subsequent follow-up C-400 actions (e.g., GDP Groundwater Sources OU, Dissolved-Phase Plume project).	09/30/2029	N	Y
Groundwater, Southwest Plume	The Southwest Plume project is a remedial action under construction. The remedial action is designed to address VOC releases to groundwater. A follow-up evaluation is needed to ensure long-term protection.	DOE	EPA and the Commonwealth of Kentucky	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 Plume project).	09/30/2029	N	Y

Operable Unit	Issue	Party Responsible	Oversight Agency	Recommendations and Follow-up Actions	Completion Date	Affects Protectiveness (Y/N)	
						Current	Future
Surface Water, NSDD Sections 1 and 2	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.	DOE	EPA and the Commonwealth of Kentucky	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 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. In the event there is a major change in land use for the Fire Training Area, an evaluation will be conducted to ensure the remedy is protective consistent with the PGDP LUCAP. Finally, DOE must comply with the requirements of CERCLA Section 120(h) if the property is transferred.	12/30/2014	N	N
Surface Water, C-746-K Landfill	The shaft of MW301 has buckled so that any repair/replacement of the pump would not be possible.	DOE	EPA and the Commonwealth of Kentucky	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.	12/30/2015	N	N
Surface Water, Surface Water Interim Corrective Measures (ICMs)	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.	DOE	EPA and the Commonwealth of Kentucky	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 (see Figure ES.1).	12/30/2014	N	N

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.

19. PROGRESS SINCE THE LAST FIVE-YEAR REVIEW

2008 Issue	2008 Recommendations/ Follow-up Actions	Party Responsible	Milestone Date	Results	Date of Action
Northwest Plume (GWOU)					
Although the remedy remains protective, the action could be optimized by ascertaining whether the high-concentration core of TCE of the Northwest Plume at the North Extraction Wellfield has migrated eastward of the capture zone of the wellfield.	Evaluate the extraction system to determine whether zones of capture of the EW fields can be optimized to control contaminant migration from the source area more effectively. Examples of follow-up actions resulting from this evaluation may include preferential pumping of wells in high concentration areas, termination of the two extraction wells in the North EW Field, and MW/EW installation.	DOE	12/30/2013	In response to recommendations contained in the 2008 CERCLA Five-Year Review, construction activities for the Northwest Plume IRA Optimization commenced in March 2010. The NWPGS previously consisted of two EW fields (north and south with each field having two EWs), for a total of four wells, underground pipeline, treatment facility, and MW network. In August 2010, two new EWs (EW232 and EW233) became operational near the original south wellfield, adjacent to the north security fence of PGDP. The north wellfield EWs (EW228 and EW229) were removed from service in August 2010. EW230 and EW231, located in the original south wellfield, are kept in standby mode and will be returned to service, if needed. The location of the new EWs was optimized to capture the core and the lateral extent of the Northwest Plume in the area of the north plant boundary.	03/18/2010
Northeast Plume (GWOU)					
The objectives of the interim ROD are being met by the IRAs.	Place the system in standby mode following the development of decision criteria that specify the conditions under which the system would be restarted.	DOE	12/30/2013	In 2011, the FFA managers identified optimization of the NEPCS as a priority, consistent with the sitewide strategy that includes a series of sequenced activities consisting of source actions and control of groundwater migration off DOE property followed by a final action for the overall dissolved-phased plume. Optimization activities are ongoing.	4/13/2011

2008 Issue	2008 Recommendations/ Follow-up Actions	Party Responsible	Milestone Date	Results	Date of Action
NSDD Section 1 and 2					
Not Applicable.	Perform a residual risk calculation to determine if the remedy can be optimized (e.g., risks are at a level that would support modification of ICs and/or cessation of five-year reviews).	DOE	12/30/2013	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 EPA risk range (EPA 1999); therefore, monitoring of LUCs can be reduced to once every five years in conjunction with the Five-Year Reviews to ensure that the assumption of industrial land use continues to be the current and reasonably anticipated future land use until a final remedy is selected. A request for modification of the NSDD LUCIP for reduced monitoring of institutional controls is recommended.	12/03/2012
Surface Water Interim Corrective Measures					
Signs were erected under the scope of another project. Although the message content between the signs does not conflict with one other, an evaluation of the sign program is needed.	Evaluate whether ICM signs should be removed or replaced with new signs with language approved for the EI signs.	DOE	12/30/2013	An evaluation of both sign programs was conducted, and a decision was made to replace the Surface Water ICM signs with EI 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. These actions will remove all Surface Water ICM signs and increase the overall number of EI signs within the program. Implementation of these actions will result in only one sign program. 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 (see Figure ES.1).	3/22/2013

20. 2013 PROTECTIVENESS STATEMENTS

Overall, the selected remedies implemented thus far are protective, but PGDP cleanup activities are still ongoing with additional future actions planned. The groundwater exposure pathways for PGDP are being controlled by providing 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 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, 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.

20.1.2 Northeast Plume

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, 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 plant security fence. Optimization of the Northeast Plume is being pursued by the FFA parties. 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 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 remedial action shall be selected and implemented…" as part of the CSOU.

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 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, need to be evaluated for long-term protection.

The objective of this removal action 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 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. However, in order to establish long-term protectiveness, additional remedial actions will be evaluated and selected, as necessary, under the GDP Groundwater Sources OU.

20.1.6 Southwest Plume

The remedial action for VOC sources at Southwest Plume 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.), has addressed adequately known exposure pathways that could result in unacceptable risks originating from the Southwest Plume.

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 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 SWMU 59. 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 Landfill

The remedy for the C-747-K Landfill 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 the reduction of human risks by posting warning signs and other institutional controls, through the 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 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 remedial action shall be selected and implemented…" as part of the CSOU.

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. However, in order to establish long-term protectiveness, additional remedial actions 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 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 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 remedial action 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 currently is being 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 [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)], groundwater monitoring, and institutional controls. 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.

21. NEXT REVIEW

The next Five-Year Review for PGDP is required to be approved by the FFA parties by December 30, 2017. Note: These schedules are estimates for planning and are included for informational purposes only 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. All remedial actions 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 environmental remediation subcontractor performed this Five-Year Review. The reviews were conducted during January through April 2013. 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

22.2 COMMUNITY NOTIFICATION AND INVOLVEMENT

Community involvement at PGDP is handled primarily in conjunction with the CAB. The CAB meets monthly to discuss many aspects of environmental restoration efforts at PGDP. Copies of AR decision documents are kept at the Environmental Information Center (EIC). The EIC is open to the public during regular business hours. DOE published a public notice in the local newspaper on March 17, 2013, announcing the Five-Year Review had been initiated and requested that any suggestions, issues, questions, or concerns regarding this review be provided from March 18 through March 22, 2013. No comments were received.

22.3 DOCUMENT REVIEW

This activity consisted of a review of relevant documents to the remedial action of each of the units and the previous Five-Year Reviews. This was conducted during January through April 2013. These documents are included as references in Chapter 23.

22.4 DATA REVIEW

Groundwater, surface water, and sediment samples are collected routinely at PGDP to assess environmental conditions. These data are stored in Paducah's Oak Ridge Environmental Information System (Paducah OREIS). Data were downloaded for review from Paducah OREIS throughout the review process.

22.5 SITE INSPECTIONS

Inspections were conducted at each of the response action sites during January and February 2013. The DOE 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 February, March, and April 2013 with various personnel connected to some of the response actions. Specifically, the operating engineer 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, CAB, LATA Kentucky subcontractor, and local residents concerning the overall DOE project.

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APPENDIX A

GENERAL PGDP INTERVIEWS

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Name: **Gaye Brewer**
Affiliation: **KDWM, local resident**
Date: **March 12, 2013**

1. What is your overall impression of the project?

Response: I am glad the site is dealing with the tough issues like Burial Grounds and Groundwater and glad to see cleanup efforts moving forward.

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 the purpose and results.

Response: Yes, Bill Clark (KDWM) does oversight of field activities and reports to the KY project manager what he has observed. These are brief write-ups and are mostly positive.

1. 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.

Response: They have received some complaints but whenever they receive one, it is investigated. None have been confirmed, to-date.

2. Do you feel well informed about the site's activities and progress?

Response: Yes.

3. Do you have any comments, suggestions, or recommendations regarding the site's management or operation?

Response: The program is professionally run and is doing a good job. One suggestion is to make sure decisions are made considering the long-term.

4. What effects have site operations had on the surrounding community?

Response: Biggest effects on the community are jobs and an increase in the standard of living. There have been minimal effects environmentally.

5. Are you aware of any community concerns regarding the surrounding community?

Response: Current community concerns are jobs. There also is interest in the Waste Disposal Options (CERCLA Cell) and where it will be located and how it will look.

6. Are you aware of any events, incidents, or activities at the site such as vandalism, trespassing, or emergency responses from local authorities?

Response: No.

Name: **Tim Kreher**
Affiliation: **WKWMA Manager, local resident**
Date: **April 2, 2013**

1. What is your overall impression of the project?

Response: Sometimes it is hard to see where the project is going. For example, on-site disposal facility was investigated and discussed over 10 years ago. Today we are now discussing potential sites for an on-site disposal facility. A large amount of time and money was spent in the past, why are we doing it again now?

1. Have there been routine communications or activities (site visits, inspections, reporting activities, etc.) conducted by your office regarding the site? If so, please give the purpose and results.

Response: No.

2. 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.

Response: Not to my recollection.

3. Do you feel well informed about the site's activities and progress?

Response: Yes on some issues, no on others.

4. Do you have any comments, suggestions, or recommendations regarding the site's management or operation?

Response: I believe that some of the people and entities involved in potential land transfer activities may not be aware of ongoing CERCLA issues with portions of the DOE property. Also, some of the sites that are being suggested for the on-site disposal facility are within the boundaries of the Environmental Assessment for DOE to transfer property to other entities. This makes little sense to me – sites need to be chosen or rejected for potential CERCLA activities before they can be giving away.

5. What effects have site operations had on the surrounding community?

Response: Many of the surrounding residents seem to have lost faith in DOE's ability to accurately convey the importance of cleanup issues at the site. I have heard neighbors say that they have begun throwing away notices of meetings, etc., because the announcements don't make sense to them.

6. Are you aware of any community concerns regarding the surrounding community?

Response: Some people seem to be concerned that cleanup activities will be affected by decreased budget and/or USEC closure. (In effect, close the doors and leave everything like it is.) Others are concerned that the potential re-industrialization of portions of the site may not be well planned out, for example, tracts of land re-industrialized in a disorganized fashion. Many recreational users of the surrounding wildlife management area would choose to see reindustrialization performed in a fashion to minimize impacts on wildlife habitat and historical recreational activities.

7. Are you aware of any events, incidents, or activities at the site such as vandalism, trespassing, or emergency responses from local authorities?

Response: Fish and Wildlife personnel have found evidence of illegal off-road driving taking place on DOE-owned property at the site. These infractions have been investigated and prosecuted by state and county law enforcement agencies, when applicable.

Name: **James Tortorelli**
Affiliation: **Local resident, subcontractor to LATA Kentucky**
Date: **April 8, 2013**

1. What is your overall impression of the project?

Response: I expect for DOE to do the right thing. I feel safe living in the area. I do not believe it is reasonable to expect free release of entire DOE site.

2. Do you feel well informed about the site's activities and progress?

Response: No. I think an email distribution list or website would help keep the community informed of any community meetings and updates as to what is being done.

3. Do you have any comments, suggestions, or recommendations regarding the site's management or operation?

Response: Not really. Every organization needs more discipline in long-term planning. DOE is doing OK.

4. What effects have site operations had on the surrounding community?

Response: Mostly psychological – lots of uncertainty in the economic future, and uncertainty in the level of hazard that exists. This causes fear. It would be nice if DOE would do a workshop on relative risk for the community and the community would attend.

5. Are you aware of any community concerns regarding the surrounding community?

Response: The plume is the biggest health concern. Then there are the economic concerns.

6. Are you aware of any events, incidents, or activities at the site such as vandalism, trespassing, or emergency responses from local authorities?

Response: Not first hand. I have heard that the solar cells installed may have been vandalized but this is not confirmed.

Name: **Mike Kemp**
Affiliation: **Citizen's Advisory Board member**
Date: **April 8, 2013**

1. What is your overall impression of the project?

Response: Complicated and slow.

2. Do you feel well informed about the site's activities and progress?

Response: Yes.

3. Do you have any comments, suggestions, or recommendations regarding the site's management or operation?

Response: The perspective we have in regard to remedial activities is that all is being done. There has been a shift from remedial activities to re-use of the site over the last year. DOE leadership changes to frequently so that we do not know who is in charge from meeting to meeting. There needs to be some consistency in who is doing what.

4. What effects have site operations had on the surrounding community?

Response: Five years ago, no one cared but now, the community is energized. They are concerned about what the condition of the site is going to be left in and how it will be re-developed.

5. Are you aware of any community concerns regarding the surrounding community?

Response: Same as previously stated (Response to question #4). USEC shutting down is of concern.

6. Are you aware of any events, incidents, or activities at the site such as vandalism, trespassing, or emergency responses from local authorities?

Response: No.

Name: **Resident**
Affiliation: **Resident**
Date: **April 9, 2013**

1. What is your overall impression of the project?

Response: It appears that DOE has spent a lot of money and I am not sure they have gotten their money's worth.

2. Do you feel well informed about the site's activities and progress?

Response: Maybe, I feel like DOE is trying but I have little interest as it is not a priority in my life.

3. Do you have any comments, suggestions, or recommendations regarding the site's management or operation?

Response: No.

4. What effects have site operations had on the surrounding community?

Response: I have heard that some people feel that their land has lost value due to the groundwater contamination. For me, it is a personal inconvenience that I cannot water my lawn or garden with my well.

5. Are you aware of any community concerns regarding the surrounding community?

Response: No.

6. Are you aware of any events, incidents, or activities at the site such as vandalism, trespassing, or emergency responses from local authorities?

Response: No.

APPENDIX B

NSDD RESIDUAL RISK ASSESSMENT

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APPENDIX B

NSDD RESIDUAL RISK ASSESSMENT (CD)

Appendix B presents a residual risk assessment performed in response to a recommendation in the 2008 Five-Year Review. This residual risk assessment is presented in the 2013 Five-Year Review to support a recommendation presented in Chapter 18 regarding LUCs for Sections 1 and 2 of the NSDD. Discussions of the need for LUCs presented in this residual risk assessment were made in the context of current DOE ownership of PGDP.

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APPENDIX C

WATER POLICY ADDITIONAL ACTIONS

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WATER POLICY ADDITIONAL ACTIONS

This addendum was prepared to document the additional information that has been collected to support the protectiveness determination of the Water Policy Removal Action (Section 8 of the main text), as requested by the U.S. Environmental Protection Agency (EPA) in letter dated September 30, 2014. 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.

The U.S. Department of Energy (DOE) has completed the following actions:

- The annual Water Policy Educational Fact Sheet, Attachment C1, 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/Kentucky Department for Environmental Protection (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 calendar year, unless another time is agreed to by the Federal Facility Agreement (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 2015. No new landowners were identified. Using this review to supplement current records, the educational mailer was sent in January 2016 to all known addresses (residential and business) within the Water Policy Area; each was addressed to "Current Resident."

DOE intends to repeat this procedure annually and also will include absentee landowners in future mailings.

- The Water Policy Vapor Intrusion Screening Study Report, Attachment C2, was submitted as a secondary document under the FFA to EPA/KDEP on October 21, 2015. Comments were received and a revised report was submitted on February 22, 2016. This addendum contains the revised report that was approved previously by Kentucky on March 8, 2016, but not approved previously by EPA per letter dated March 2, 2016.

- The demonstration that residents located over the 5 µg/L or greater trichloroethene (TCE) plume, which is the Safe Drinking Water Act maximum contaminant level (MCL) for TCE, are not using groundwater is included as Attachment C3 of this Addendum.

Based upon these completed actions, the protectiveness determination for the Water Policy Removal Action is determined to be Short-term Protective as follows:

> 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.

ATTACHMENT C1

WATER POLICY EDUCATIONAL MAILER

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INFORMATIONAL BROCHURE - DOE WATER POLICY RESIDENT

Water Policy Area

Upon discovering residential well contamination in 1988, DOE committed to eliminate residents' exposure to trichloroethene (TCE) and technetium-99 (Tc-99) contamination by providing alternate drinking water to potentially affected residents. This action became known as the DOE Water Policy. To achieve the goal of eliminating residents' exposure to contamination, DOE paid for extending the West McCracken public water supply to the potentially affected area. The potentially affected area is bounded by the Ohio River to the north, DOE property boundary on the south, Metropolis Lake Road to the east, and Bethel Church Road to the west.

DOE also asked property owners in the area to sign a license agreement, in which DOE agreed to pay residents' water bills, allowed DOE representatives access to residential properties to collect samples, and prohibited the property owner from drilling new water supply wells or using existing water supply wells.

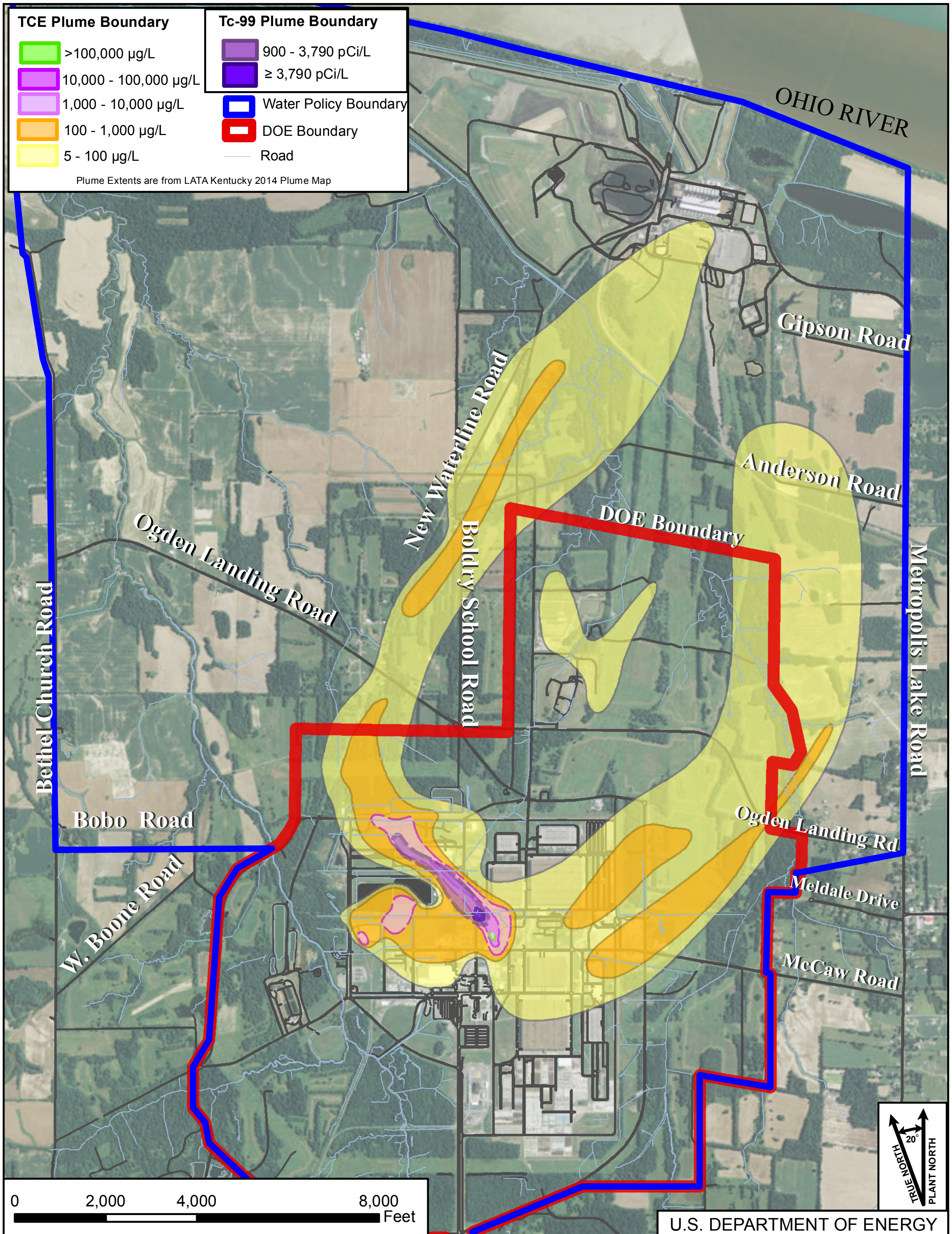
DOE continues to implement the Water Policy by renewing license agreements with property owners within the potentially affected area. The protectiveness of the Water Policy is required by law to be reviewed every five years. As a result of the most recent review, DOE with agreement from the U.S. Environmental Protection Agency (EPA) and the Kentucky Department for Environmental Protection (KDEP) decided to send this fact sheet to all Water Policy residents to ensure they are educated about the potential contamination in underlying groundwater.

Since discovering the residential well contamination in 1988, DOE has taken actions that have reduced the groundwater concentrations of TCE and Tc-99 in the potentially affected area, including implementing groundwater remedial actions in the northeast and northwest contaminant plumes, which underlie the potentially affected area, and reducing contaminants at the source of those plumes. DOE continues these actions under the oversight of EPA and KDEP.

Resident Need to Know

All residents are asked to not drill a new water supply well or use any existing water wells.

For more information about the Water Policy, please contact: Buz Smith at 270-441-6000



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

Location of Water Policy Boundary

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ATTACHMENT C2

WATER POLICY VAPOR INTRUSION SCREENING STUDY

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Secondary Document

Water Policy Area Vapor Intrusion Screening Study Report for the Five-Year Review of Remedial Actions Paducah, Kentucky

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DOE/LX/07-1289&D2/R1/A1/R2
Secondary Document

Water Policy Area Vapor Intrusion Screening Study Report for the Five-Year Review of Remedial Actions Paducah, Kentucky

Date Issued—October 2017

U.S. DEPARTMENT OF ENERGY
Office of Environmental Management

Prepared by
FLUOR FEDERAL SERVICES, INC.,
Paducah Deactivation Project
managing the
Deactivation Project at the
Paducah Gaseous Diffusion Plant
under Task Order DE-DT0007774

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PREFACE

This *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/R2, has been prepared as a Secondary Document under the *Federal Facility Agreement for the Paducah Gaseous Diffusion Plant* (EPA 1998). This report has been developed to supplement the *Five-Year Review for Remedial Actions at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/LX/07-1289&D2/R1 (DOE 2014a).

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ACRONYMS

bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
DOE	U.S. Department of Energy
DPT	Direct Push Technology (boring)
EPA	U.S. Environmental Protection Agency
FFA	Federal Facility Agreement
KDFWR	Kentucky Department of Fish and Wildlife Resources
PGDP	Paducah Gaseous Diffusion Plant
Pot	potentiometric surface
RGA	Regional Gravel Aquifer
SAP	sampling and analysis plan
TIC	top of inner casing
TOC	top of casing
UCRS	Upper Continental Recharge System
VISL	Vapor Intrusion Screening Level
VOC	volatile organic compound
WKWMA	West Kentucky Wildlife Management Area
WWR	Well Wizard riser

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EXECUTIVE SUMMARY

This report presents the results of a vapor intrusion screening study performed as an additional action based on determinations made in the *Five-Year Review for Remedial Actions at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/LX/07-1289&D2/R1 (Five-Year Review) (DOE 2014a). The vapor intrusion screening study was conducted at four locations within the Water Policy Area to determine whether volatile organic compound (VOC) [primarily trichloroethene (TCE)] concentrations in groundwater warrant a detailed vapor intrusion study.

This study meets the sampling requirements in *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, as modified by field conditions. During the study, first available water samples were collected, as available, from locations within the Water Policy Area near the residences located near/above the TCE plumes. The Federal Facility Agreement parties agreed that the sampling results provide quality data sufficient to address the study's decision rules.

Direct push technology borings were advanced into the Upper Continental Recharge System (UCRS) matrix in the vicinity of four residences located near/above the Regional Gravel Aquifer (RGA) TCE plumes. Although groundwater was encountered at all four boring locations, only two sets of the borings had sufficient water to allow collection of a water sample. The dearth of water for sample collection at the residences is consistent with the conceptual site model (CSM) for the UCRS and earlier UCRS sampling efforts. The CSM for the UCRS shows the upper UCRS matrix consists of silt and clay that limits water migration and the upward migration of vapor phase VOCs.

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.

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1. INTRODUCTION

This report presents the results of the vapor intrusion screening study performed in accordance with the approved *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&D2 [Sampling and Analysis Plan (SAP)] (DOE 2015a), which was conducted as an additional action subsequent to the *Five-Year Review for Remedial Actions at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-1289&D2/R1 (Five-Year Review) (DOE 2014a). The vapor intrusion screening study was performed to determine whether volatile organic compound (VOC) [primarily trichloroethene (TCE)] concentrations in Upper Continental Recharge System (UCRS) groundwater warrant a detailed vapor intrusion study within the Water Policy Area. TCE plumes in the Regional Gravel Aquifer (RGA) underlie the Water Policy Area, and TCE vapor released from these plumes has the potential to migrate upward. To evaluate this potential for upward migration, a vapor intrusion screening study was designed and a SAP was prepared that described how to collect first-available water samples from locations within the Water Policy Area near the residences located near/above the TCE plumes. The Federal Facility Agreement (FFA) parties agreed that this sampling approach would provide a sufficient basis on which to determine whether a detailed vapor intrusion study is warranted, and the SAP was approved by the U.S. Environmental Protection Agency (EPA) on May 21, 2015, (EPA 2015a) and by the Kentucky Division of Waste Management on May 22, 2015 (KDWM 2015).

1.1 PROJECT SCOPE

The Five-Year Review (DOE 2014a) presented the results of a 2013 review of the Water Policy Removal Action. In a letter dated September 30, 2014, (EPA 2014a) EPA noted the following project-related uncertainty:

> 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.

Three meetings were held to scope the vapor intrusion concern raised by EPA and develop an approach to collecting groundwater data. The meetings were held on August 8, 2014; February 24, 2015; and April 22, 2015. As a result of these meetings, the FFA parties agreed to undertake a vapor intrusion screening study to determine whether a detailed vapor intrusion study is warranted. This study was performed under the provisions of Section XXX, Five-Year Review, of the FFA, as documented in the Record of Conversation letter dated August 1, 2014 (DOE 2014b).

1.2 PROJECT OBJECTIVES

The objective of the field work was to collect first-available water samples from locations within the Water Policy Area near residences located near/above the TCE plumes. Figures 1 and 2 present maps of the RGA TCE plumes and the four boring locations (NW1, NW2, NE1, and NE2) sampled to complete this study. The water samples would be analyzed for selected VOCs per the SAP. Analytical results were compared to the respective default Vapor Intrusion Screening Level (VISL) for groundwater from the VISL Calculator (VISL values) (EPA 2014b). If groundwater data for selected VOCs are less than the

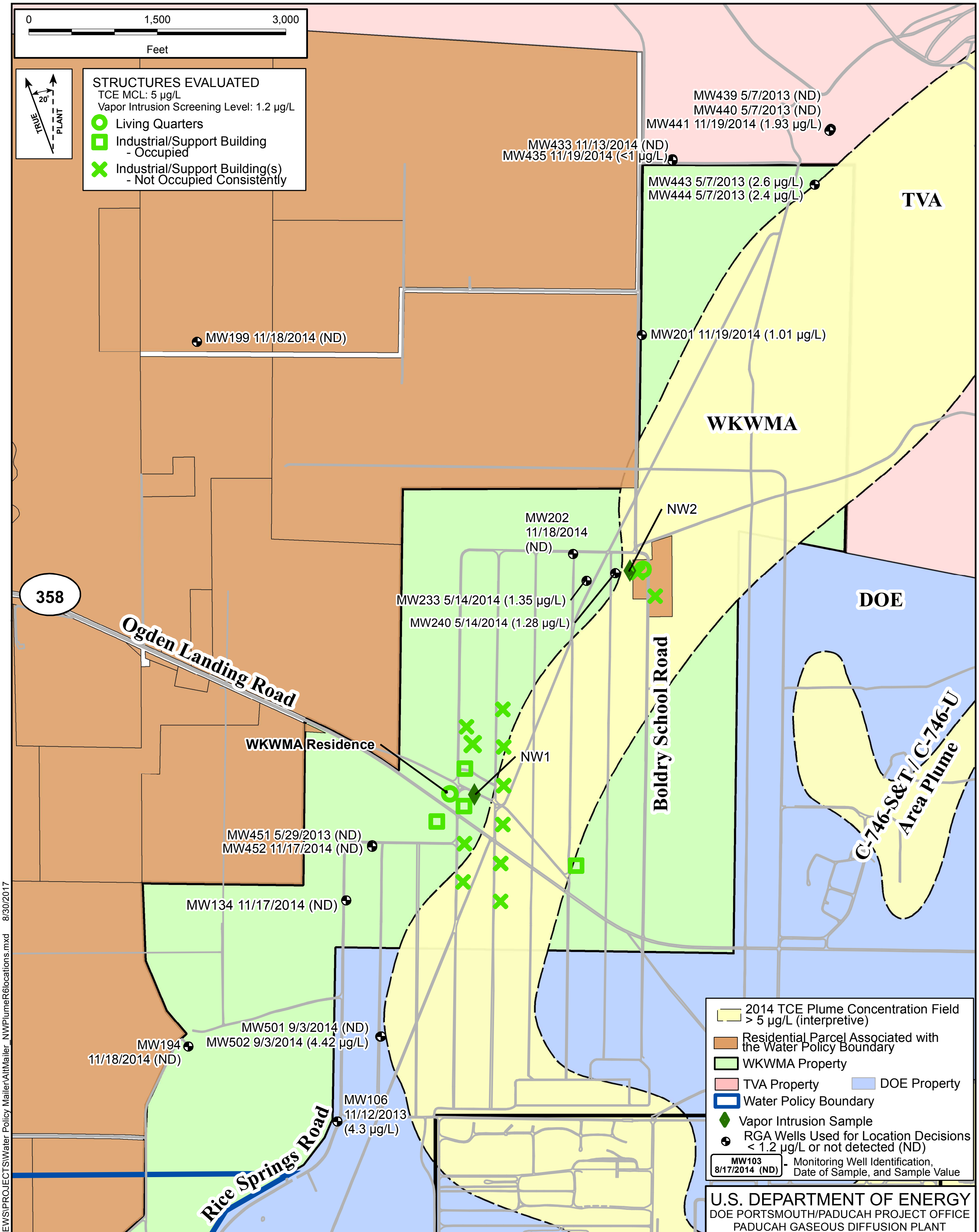

Figure 1. Northwest Plume Water Policy Area - Vapor Intrusion Screening Sampling Locations

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VISL or nondetect, then no additional groundwater sampling is needed and the vapor intrusion pathway does not pose a concern for the residence.

1.3 PROJECT APPROACH

The approach agreed to by the FFA parties to meet the project objective of this vapor intrusion screening study was as follows.

- Advance Direct Push Technology (DPT) rods into the UCRS to allow collection of water from the first-available UCRS depth.

- Sample groundwater from the first available UCRS depth and analyze for VOCs.

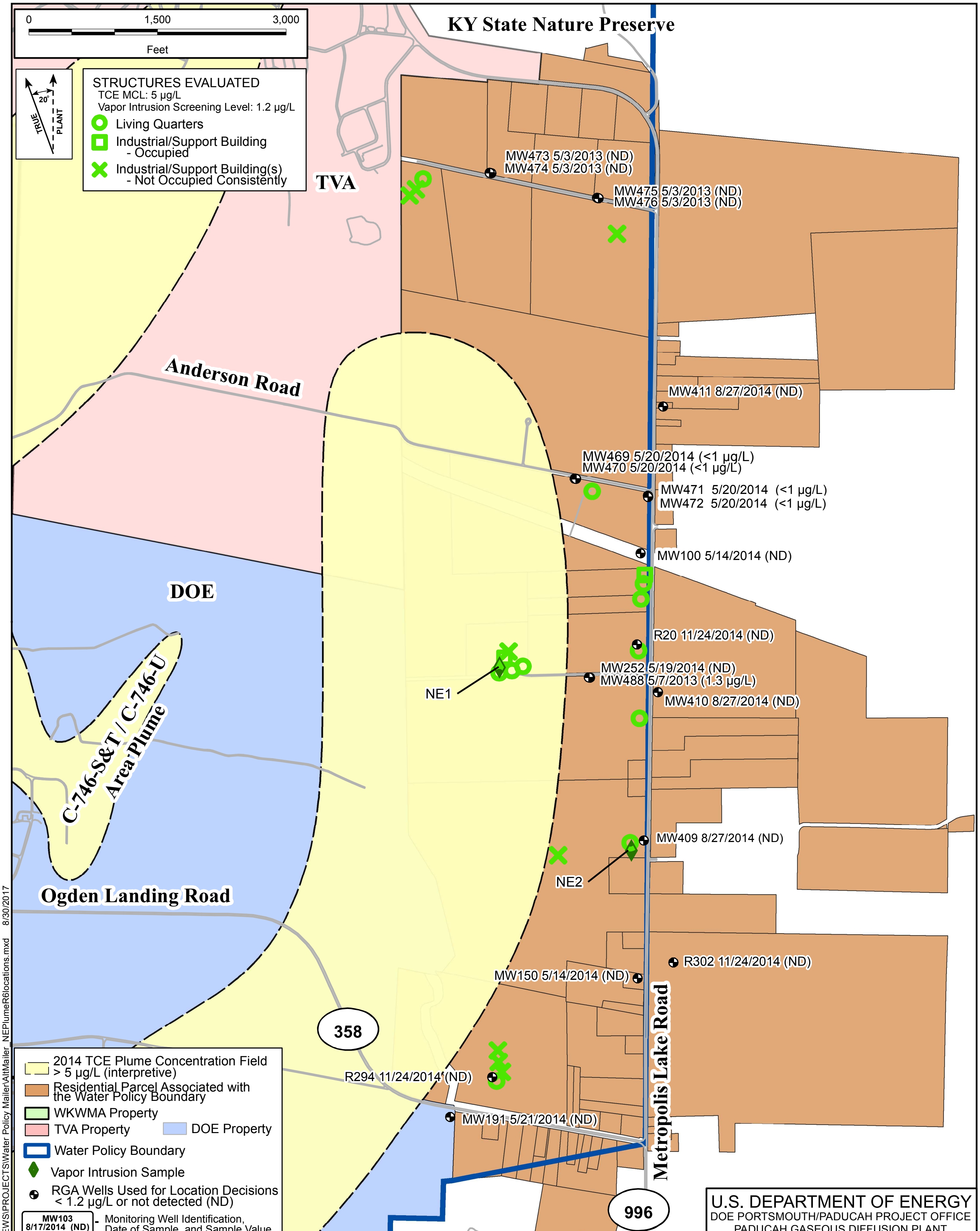
- Compare groundwater analytical results to the respective default VISL for groundwater calculated using the VISL Calculator (EPA 2014b).

- Groundwater samples were to be collected from first-available water from four locations within the Water Policy Area near the residences located near/above the TCE Plume. Samples were to be taken within 100 ft. laterally, where possible, and not further than 300 ft. from the residence for the study.

Figure 1 presents a map of the privately-owned parcels located near/above the TCE contamination in groundwater on the west side of the Water Policy Area. A review of the privately-owned parcels indicated there were three parcels located near/over the TCE contamination area and only one of those included a structure with living quarters. Additionally, there was one structure with living quarters on the West Kentucky Wildlife Management Area owned by the Commonwealth of Kentucky over the TCE contamination area. These two structures with living quarters were chosen for locating the two boring locations (NW1 and NW2).

Figure 2 presents a map of the privately-owned parcels located near/above the TCE contamination in groundwater on the east side of the Water Policy Area. A review of the privately-owned parcels indicated there were thirteen parcels (10 owners) located near/over the TCE contamination area. The parcel overlying the TCE contamination contained three structures with living quarters in close proximity to each other. One boring location was utilized to represent all three structures (NE1). A second parcel chosen for evaluation contained one structure with living quarters and a boring was sampled near the structure (NE2). There were seven other parcels with living quarters identified; however, previous groundwater data indicated the contamination was less than the VISL screening level of 1.2 μg/L for groundwater from the VISL values (EPA 2014b). In accordance with the sampling plan, further screening of these properties for vapor intrusion was not necessary. The NE2 boring represented similar conditions for all the other parcels with living quarters.

Consistent with EPA guidance, parcels with TCE trend data below the residential VISL of 1.2 ug/L were not included in the screening study. Figures 1 and 2 include 2014 groundwater sample collection points where results for TCE showed less than 1.2 μg/L and less than 5 ug/L. The figures also illustrate the location of the TCE plume in 2014 based on data above the Maximum Contaminant Level of 5 μg/L for drinking water. Properties with structures located at or beyond the selected vapor intrusion sampling locations (NW1 and NW2 on the west and NE1 and NE2 on the east sides of the Water Policy Area, representing the potential “worse case” scenario for vapor mitigation from groundwater to structures) would not likely overlie areas of the TCE plume that exceed the TCE VISL screening level of 1.2 μg/L; which supports the rationale for not sampling other properties within the Water Policy Area.



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

Figure 2. Northeast Plume Water Policy Area - Vapor Intrusion Screening Sampling Locations

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The *Trichloroethene and Technetium-99 Groundwater Contamination in the Regional Gravel Aquifer for Calendar Year 2014 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* PAD-ENR-0146, states that all data for the 2014 TCE Plume map were extracted from the Paducah Oak Ridge Environmental Information System database. The map for calendar year 2014 is based on analytical results from the most recent sampling event (primarily January–December 2014). Where collocated monitoring wells (i.e., clustered wells or multiport wells) provide analytical results for the calendar year from screened intervals at multiple elevations within the RGA (e.g., upper, middle, and/or lower RGA), the maps use the value from the interval that has the highest concentration. Data from sampling in 2013 have been used, as necessary, to supplement the 2014 information and aid in plume delineation. This data set, as described, is the source of the TCE data shown on Figures 1 and 2.

1.4 AREA DESCRIPTION

Paducah Gaseous Diffusion Plant (PGDP), located within the Jackson Purchase region of western Kentucky, is an inactive uranium enrichment facility owned by the U.S. Department of Energy (DOE). PGDP first was owned and managed by the Atomic Energy Commission and the Energy Research and Development Administration, DOE’s predecessors; DOE then managed PGDP until 1993. On July 1, 1993, the United States Enrichment Corporation assumed management and operation of the PGDP enrichment facility under a lease agreement with DOE that continued until October 2014 when the facility was returned to DOE. DOE retains ownership of the enrichment complex.

Of the 3,556 acres owned by DOE, approximately 650 acres of this parcel are inside the PGDP fenced area. Most of the facilities used to support enrichment operations are located inside the PGDP fenced area. Outside the fenced area, several support facilities for DOE projects can be found. The support facilities include landfills (both active and closed), modular office complexes, a water treatment facility, groundwater remediation systems, decontamination facilities, storage areas, a storm water retention basin, and liquid effluent treatment facilities. Of the remaining DOE land, approximately 1,986 acres is licensed to the Commonwealth of Kentucky Department of Fish and Wildlife Resources (KDFWR) and serves as a portion of the West Kentucky Wildlife Management Area (WKWMA). The licensed portion of the WKWMA is used by the public for hunting and horse and dog field trials. KDFWR staff work in the licensed area performing wildlife management activities.

The topography of DOE property is level to slightly rolling. It is rural and predominantly open grasslands with scattered wooded areas of mature hardwoods and brush. Approximately 60% of the total area outside PGDP but on DOE-owned property is grasslands; much of this nonwooded area is right-of-way for electrical power lines.

1.5 GEOLOGY AND SOILS

The Jackson Purchase region of western Kentucky, where PGDP is located, represents the northern tip of the Mississippi Embayment portion of the Coastal Plain. The Jackson Purchase region is an area of land that includes all of Kentucky west of the Tennessee River. The stratigraphic sequence in the region consists of Cretaceous, Tertiary, and Quaternary sediments unconformably overlying Paleozoic bedrock. Relative to the shallow groundwater flow system in the vicinity of PGDP, the continental deposits and the overlying loess and alluvium are of key importance. The continental deposits locally consist of an upper silt member, with lesser sand and gravel interbeds, and a thick, basal sand and gravel member, which fills a buried river valley. A subcrop of the Porters Creek Clay, located beneath and immediately south of PGDP marks the southern extent of the buried river valley. Fine sand and clay of the McNairy Formation

directly underlie the continental deposits in the buried river valley. These continental deposits are continuous from beneath PGDP northward beyond the present course of the Ohio River.

The general soil map for Ballard and McCracken Counties indicates that three soil associations are found within the vicinity of PGDP (USDA 1976): the Rosebloom-Wheeling-Dubbs association, the Grenada-Calloway association, and the Calloway-Henry association. The predominant soil association in the vicinity of PGDP is the Calloway-Henry association, which consists of nearly level, somewhat poorly drained, medium-textured soils on upland positions. Many of the characteristics of the original soil have been lost due to industrial activity that has occurred over the past 50-plus years. Activities that have disrupted the original soil classifications include filling, mixing, and grading. The soil type present in these disturbed areas is characterized as urban.

1.6 HYDROGEOLOGY

PGDP is located in the western portion of the Ohio River drainage 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, PGDP is within the drainage areas of the Ohio River, Bayou Creek, and Little Bayou Creek.

PGDP is situated on the divide between the two creeks. Bayou Creek is a perennial stream on the western boundary of the plant that flows generally northward, from approximately 2.5 miles south of the plant site to the Ohio River. Little Bayou Creek becomes a perennial stream at the east outfalls of PGDP. The Little Bayou Creek drainage originates within WKWMA and extends northward and joins Bayou Creek near the Ohio River. The drainage basins for both creeks are located in rural areas; however, they receive surface drainage from numerous swales that drain residential and commercial properties, including WKWMA, PGDP, and Tennessee Valley Authority Shawnee Fossil Plant. The confluence of the two creeks is approximately 3 miles north of the plant site, just upstream of the location at which the combined flow of the creeks discharges into the Ohio River (DOE 2008).

During uranium enrichment operations (1952–2013) and continuing into 2014, most of the flow within Bayou and Little Bayou Creeks was from process effluents or surface water runoff from PGDP. Contributions from PGDP comprised approximately 85% of flow within Bayou Creek and near 100% of flow within Little Bayou Creek. (Process effluents have been significantly reduced during 2015.) A network of ditches discharges effluent and surface water runoff from PGDP to the creeks. Plant discharges are monitored at the Kentucky Pollutant Discharge Elimination System outfalls prior to discharge into the creeks.

The local groundwater flow system at PGDP occurs within the sands of the Cretaceous McNairy Formation, Pliocene Terrace Gravel, Plio-Pleistocene lower continental gravel deposits and upper continental deposits, and Holocene alluvium. The primary local aquifer is the RGA. The RGA consists of the Quaternary sand and gravel facies of the lower continental deposits and Holocene alluvium found adjacent to the Ohio River and is of sufficient thickness and saturation to constitute an aquifer. These deposits have an average thickness of 30 ft. Groundwater flow is predominantly north toward the Ohio River (DOE 2008).

The primary source of groundwater recharge to the RGA derives as downward percolation of infiltrating rainwater and seepage from streams and ponds, through the shallow silt and fine sand units (and lesser clayey units) overlying the RGA. This flow system is termed the UCRS. The top of the saturated zone within the UCRS is the water table, which is poorly known within the Water Policy Area overlying the

TCE plumes. These sediments have low hydraulic conductivity (10^{-7} to 10^{-6} cm/sec); hydraulic gradients often approach -1 ft/ft within the saturated UCRS in response to the downward groundwater flow.

1.7 PROJECT CONCEPTUAL SITE MODEL

There are TCE plumes in RGA groundwater that have migrated off of the DOE property and into the vicinity of four residences (see Figures 1 and 2); therefore, a theoretical potential exists for the TCE to migrate upward from the RGA, through the UCRS groundwater and the UCRS vadose zone (as a vapor) and to the surface. Figure 3, reproduced from the scoping presentations and the SAP, presents an EPA figure (EPA 2013; EPA 2015b) adapted to PGDP conditions to present the conceptual model for how VOCs have the potential to migrate.

The SAP presented the results of historical investigations that indicate that the UCRS soils in the vicinity of PGDP have very low permeability and do not show evidence of vapor migration. Figures 4 and 5, reproduced from the scoping presentations, document trends of soil texture with depth along transects of the two off-site TCE plumes. Figure 6 shows the projected location of the cross sections. Low permeability soils (silts and clays) are continuous to depths of approximately 30 to 50 ft throughout the transects, with the exception of the incised stream valley of Little Bayou Creek. This vapor intrusion screening study was designed to sample UCRS groundwater and confirm that shallow groundwater concentrations do not exceed default VISL values.

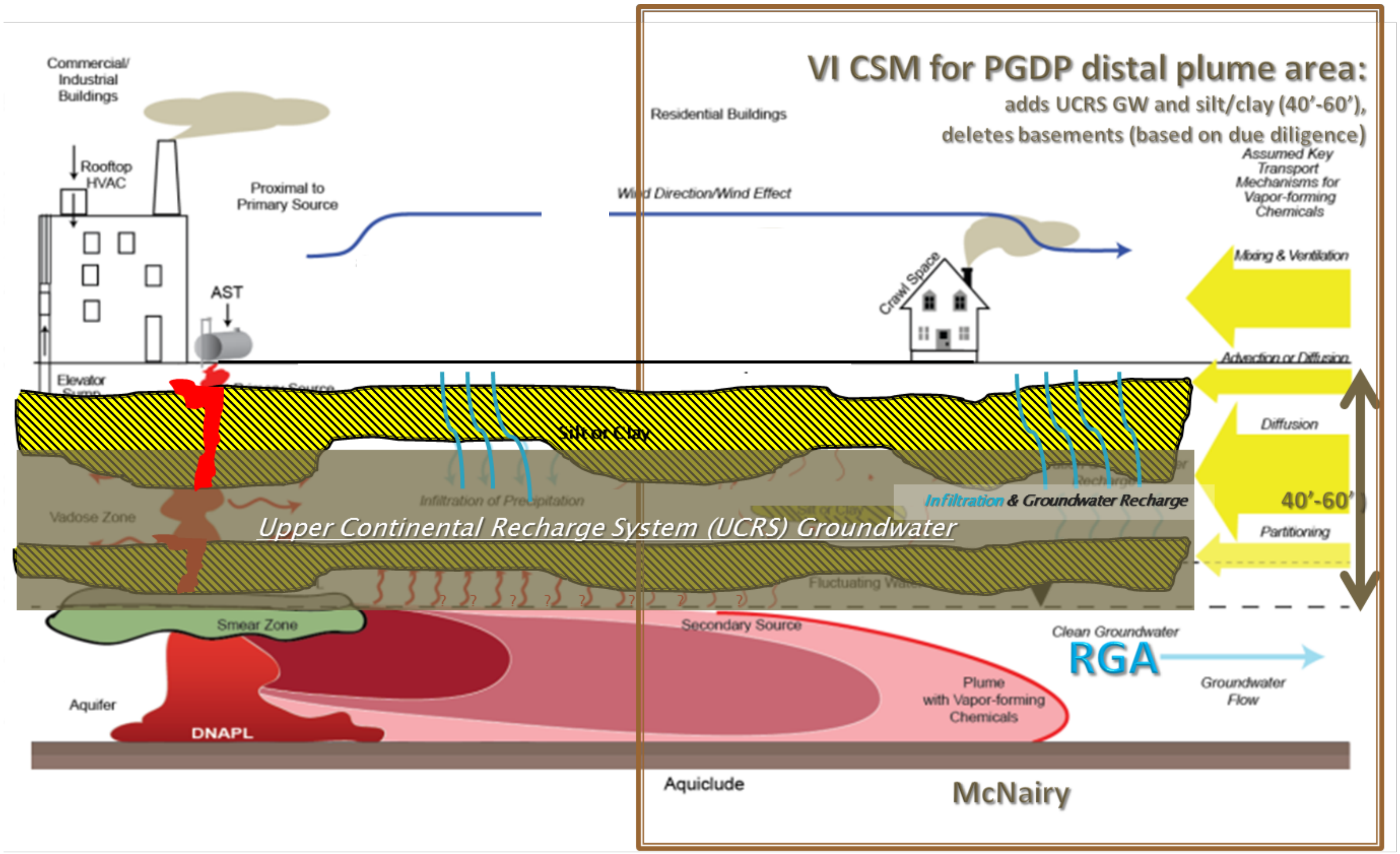

Figure 3. Conceptual Site Model: EPA Figure Adapted to PGDP Conditions

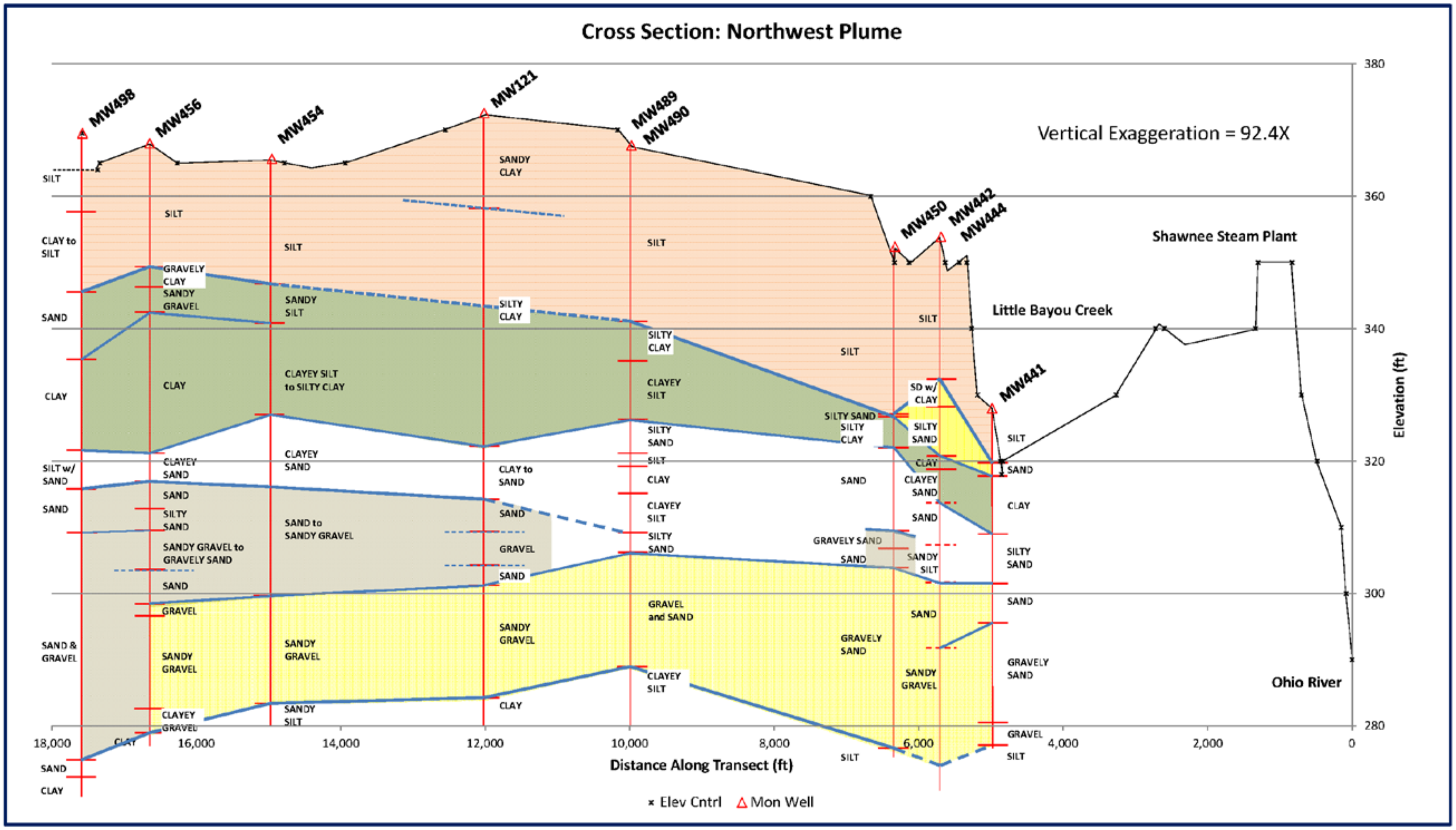

Figure 4. Northwest Plume Cross Section

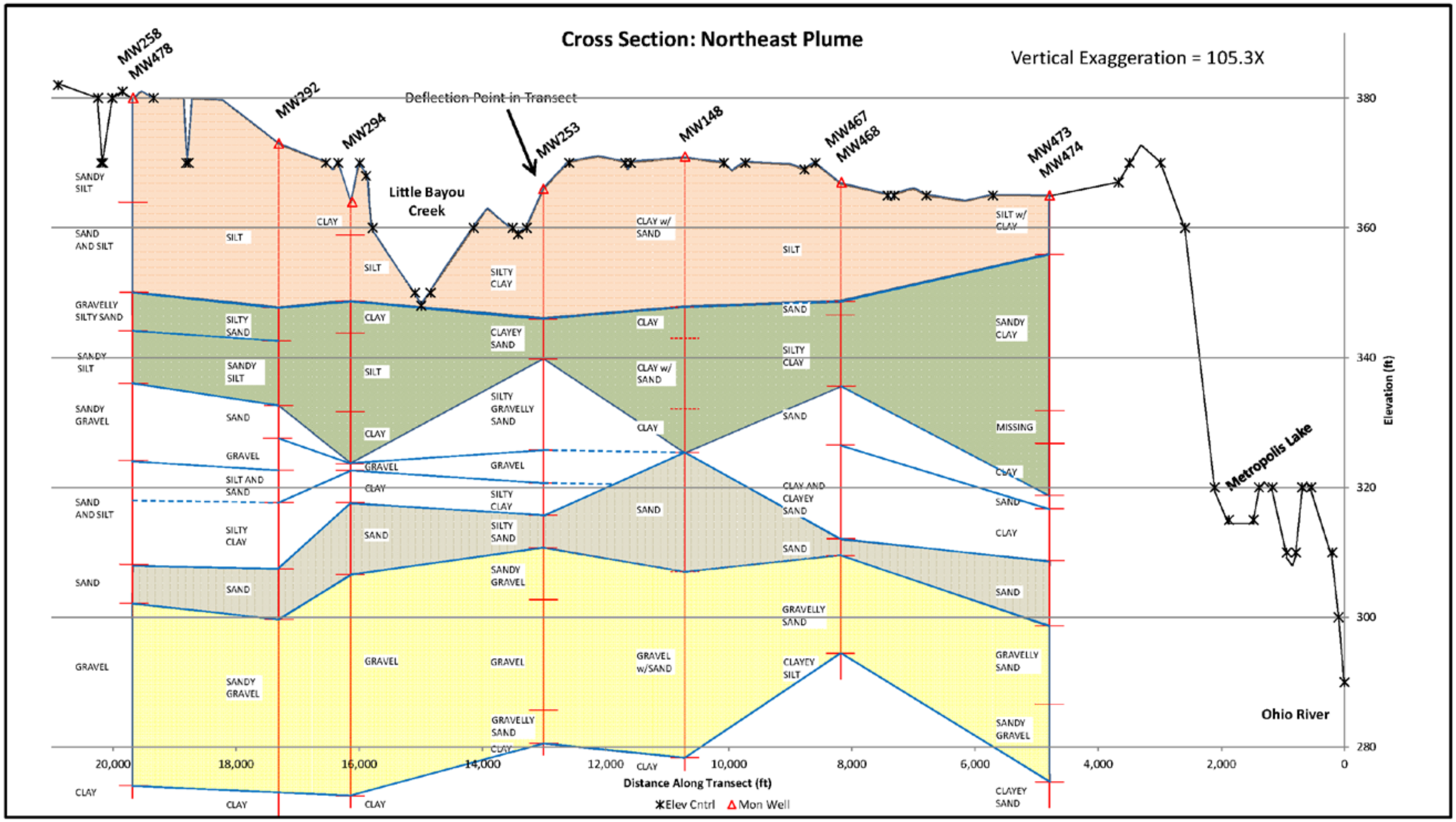

Figure 5. Northeast Plume Cross Section

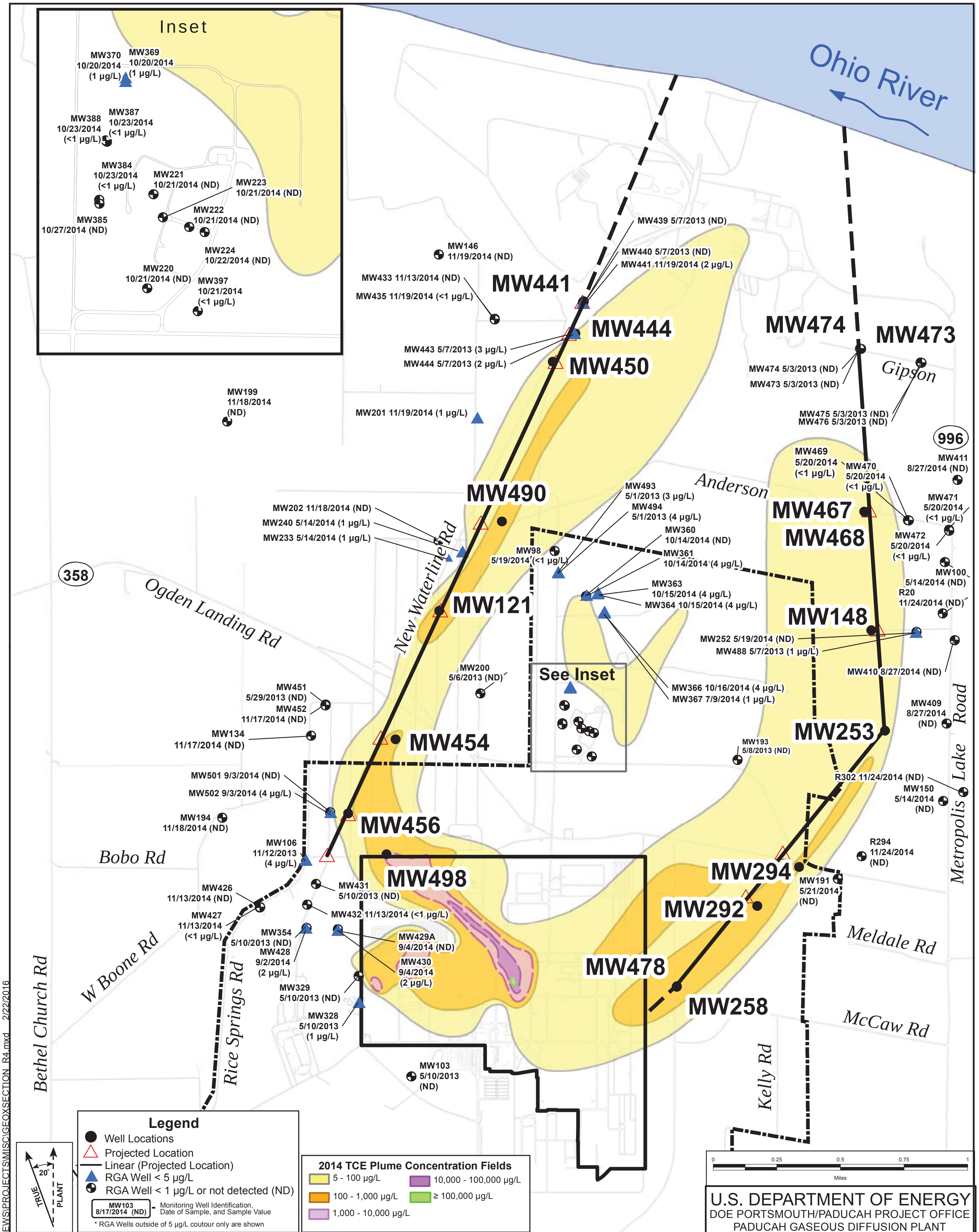

Figure 6. Northeast and Northwest Plumes Geologic Cross Sections Locations

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2. VAPOR INTRUSION SCREENING STUDY APPROACH

At each of four locations, DPT rods were advanced to three depths [nominally 12 ft below ground surface (bgs), 22 ft bgs, and 32 ft bgs]. The borings were advanced in accordance with the SAP at locations summarized in Table 1 and shown on Figures 7, 8, 9, and 10. When target depth had been reached at each boring, the DPT rod was retracted 0.5 ft to allow for groundwater to enter. The rods remained in that position overnight. The groundwater from the shallowest DPT was sampled the following morning.

The methods used to install the DPTs matched the SAP, except for increasing the sampling depth at one location; however, the groundwater sampling approach was modified from what had been planned in the SAP, after consultation with the FFA parties, due to field conditions. On June 11, 2015, the FFA parties met and discussed the results of NE1 and NE2 borings being found dry. For the NE locations, the FFA parties agreed to the following, which was documented in a record of conversation (DOE 2015b):

- Should no water be available or should the amount of water be insufficient to collect a groundwater sample, water levels will be verified up to three subsequent days, as necessary, in an effort to obtain a groundwater sample.

- Abandon NE1 12 ft and NE2 12 ft and 22 ft borings.

- NE1 22 ft DPT boring will be increased in depth to 5 ft minimum distance of the measured water level in the paired RGA monitoring well, MW148.

If a groundwater sample cannot be obtained from the DPT borings at NE2, then the sample collected at NE1 will be used to extrapolate the conditions at NE2. On June 29, 2015, the FFA parties met and discussed the results of NW1 and NW2 borings having insufficient water to sample. For the NW locations, the FFA parties agreed to the following, which is documented in a record of conversation (DOE 2015c):

- Fieldwork should be considered finished and the borings abandoned.
- The one sample collected from NW2 can be used to extrapolate the condition for NW1.
- The soils have been demonstrated to be sufficiently tight such that water movement is inhibited.

Table 1. Five-Year Review Vapor Intrusion Screening Study DPT Sample Borings Locations

Sample Boring Group	Approximate Location of Boring from Residence	DPT Depths (bgs) Paired RGA well	Approx. Plant Coordinates	
			East	North
NW1	~ 264 ft east (Figure 2)[a]	12 ft, 22 ft, 32 ft MW451	-6837	4808
NW2	~ 117 ft west (Figure 3)	12 ft, 22 ft, 32 ft MW236	-5025	7417
NE1 (three residences—one boring location)	Left Residence ~ 102 ft northeast Middle Residence ~ 54 ft north Right Residence ~ 255 ft west (Figure 4)	12 ft, 22 ft and 42 ft[b], 32 ft MW148	3173	5832
NE2	~ 65 ft south (Figure 5)	12 ft, 22 ft, 32 ft MW253	4707	3708

[a] Location changed from SAP based on resident's request.
[b] NE1 22 ft boring extended to 42 ft in attempt to secure UCRS groundwater sample.

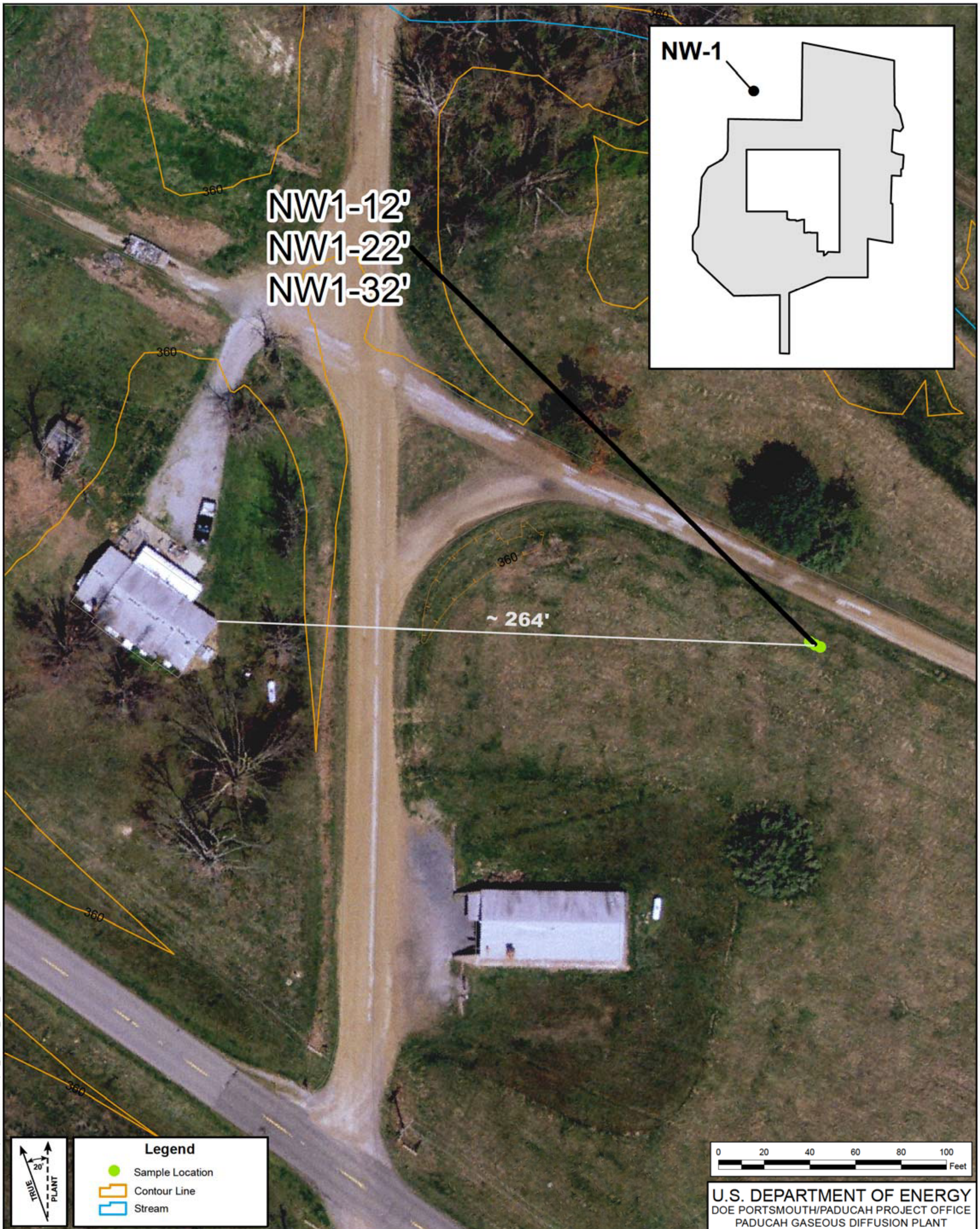

Figure 7. NW1 DPT Sample Boring Locations

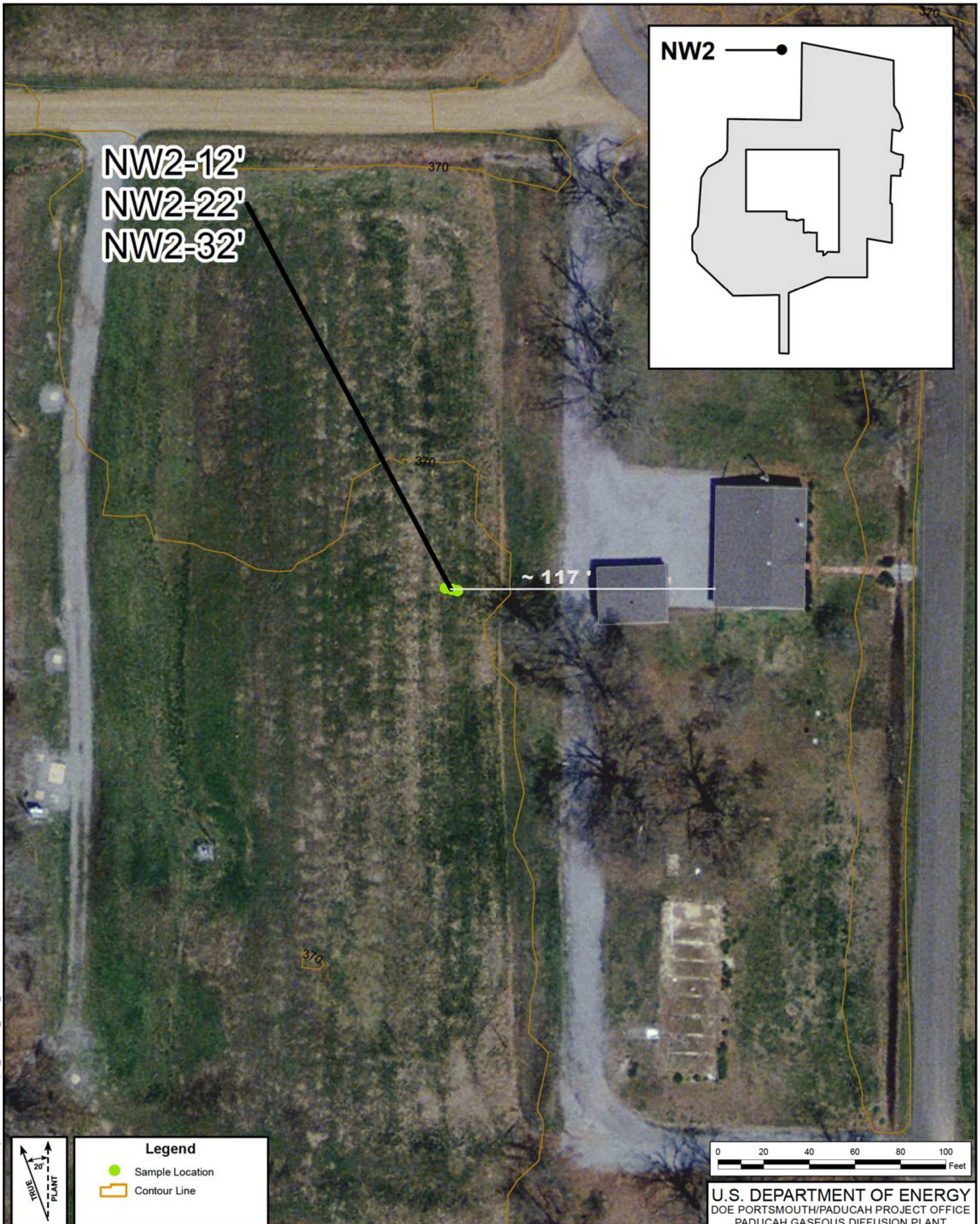

Figure 8. NW2 DPT Sample Boring Locations

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Figure 9. NE1 DPT Sample Boring Locations

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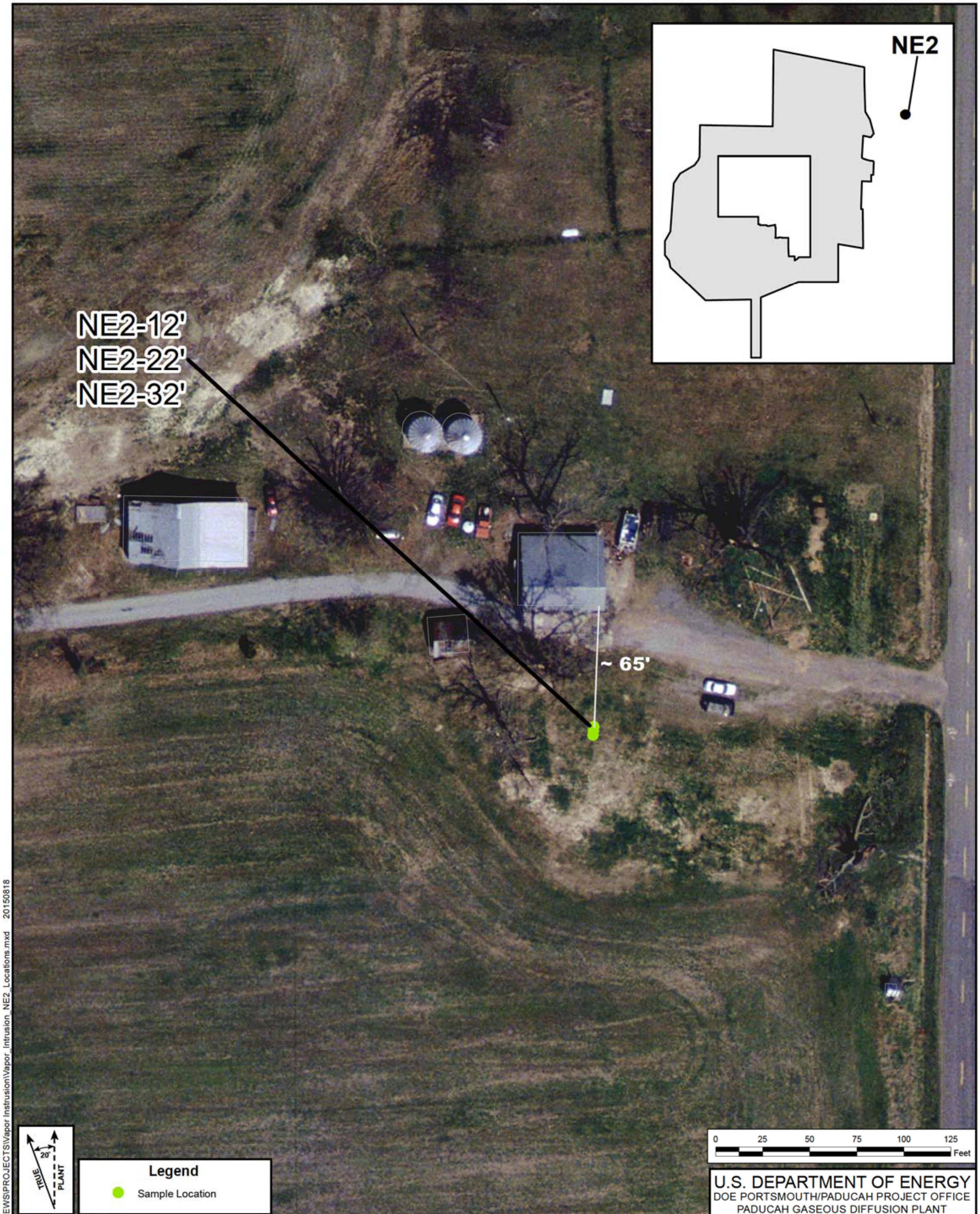

Figure 10. NE2 DPT Sample Boring Locations

2.1 DRILLING METHOD

This vapor intrusion screening study used a DPT rig and dual tube sampling system. The drill crew advanced the sample system with a center rod and drive point assembly to 5 ft short of the target depth (see Section 6) and withdrew the drive point for the bottom 5 ft, allowing the sampler to fill with soil over the bottom 5 ft. This approach was used to minimize the compaction of soils over the bottom 5 ft. Compaction by the DPT rods in the overlying soils provided an effective temporary seal for the DPT rods.

The drill crew extracted the soil core from the bottom of the hole and pulled the outer rods up 0.5 ft to expose the soils and allow groundwater to flow into the interior of the DPT rods. Upon completion of sampling, the DPT boreholes were abandoned by pulling the DPT rods from the ground and filling the boreholes to within 2 ft of ground surface with 3/8-inch particle size bentonite, hydrating the bentonite in 3-ft lifts. The top 2 ft of the borehole was filled with materials consistent with the surrounding ground surface.

2.2 SAMPLING

Three DPT borings were installed at each location, to assure that samples were collected above the potentiometric surface of the underlying RGA (i.e., ~ 32 ft bgs sample above ~ 37 ft bgs RGA potentiometric surface).[1]

Table 2 summarizes the information on each sample boring group including the identification of an RGA monitoring well closest to the boring location. The depth to water in each of these wells was measured to ensure that the greatest boring depth was still nominally 5 ft above the RGA potentiometric surface.

Table 2. RGA Paired Well Information

Sample Boring Group	Paired RGA MW	Approx. Plant Coordinates for Paired RGA Well		Reference Point	Reference Elevation (ft)	Ground Elev. (ft)	Depth to RGA (ft)	~ RGA Pot. Elev.
		X	Y					
NW1	MW451	-8,031.59	4,211.78	TOC	367.22	364.68	42.69	324.53
NW2	MW236	-5,090.64	7,919.36	WWR	369.05	369.28	38.92	330.13
NE1	MW148	3,289.83	5,755.06	TOC	374.00	371.08	47.20	326.80
NE2	MW253	3,572.22	3,669.88	TIC	370.86	368.90	38.52	332.34

TOC = top of casing reference elevation
WWR = Well Wizard riser top reference elevation
TIC = Top Inner Casing
Pot = Potentiometric Surface

When the target depth was reached at each boring, the DPT rod was retracted 0.5 ft to allow groundwater to enter. The rods remained in that position overnight. The next day water levels were measured in each of the DPTs to identify the shallowest DPT with water.

[1] The potentiometric surface of the RGA occurs within the UCRS, above the top of the RGA. The RGA potentiometric surface provides a measurable and reliable reference to assure that the deepest sample depth represents the UCRS and is approximately 10 ft above the top of the RGA.

Table 3 presents a summary timeline of boring installation, sample attempts, and field adjustments to the vapor intrusion screening study.

Table 3. Vapor Intrusion Screening Study Implementation Timeline

Date	Event	Notes
5/28/2015	Initial contact with residents to discuss vapor intrusion screening study borings.	Relocated NW1 borings based upon resident's request and in accordance with the SAP.
6/08/2015	Mobilized to northeast locations. Measured depth to water at MW253 and MW148. Installed NE1 and NE2 borings at 12 ft, 22 ft, and 32 ft bgs.	Groundwater in MW148 measured at 47.20 ft bgs. Groundwater in MW253 measured at 38.52 ft bgs.
6/09/2015	NE1 and NE2 borings found dry.	--
6/11/2015	FFA parties met via teleconference and agreed to path forward: • Abandon NE1 12 ft and NE2 12 ft and 22 ft borings. • NE1 22 ft DPT boring will be increased in depth to 5 ft minimum distance of the measured water level in the paired RGA monitoring well, MW148. • If a groundwater sample cannot be obtained from the DPT borings at NE2, then the sample collected at NE1 will be used to extrapolate the conditions at NE2. • Should no water be available or should the amount of water be insufficient to collect a groundwater sample, water levels will be verified up to three subsequent days, as necessary, in an effort to obtain a groundwater sample.	--
6/15/2015	Collected sample from NE1 32 ft boring. NE2 borings had insufficient water for a sample to be collected. NE1 12 ft boring abandoned per the SAP. NE1 22 ft boring advanced to 42 ft bgs. NE2 12 ft and 22 ft borings abandoned per SAP.	Sample collected at NE1 32 ft boring had heavy sediment; uncertain if enough water for lab to run analysis. Laboratory was able to analyze the sample.
6/16/2015	Collected sample from NE1 32 ft boring. Insufficient water in both NE1 42 ft and NE2 32 ft borings to allow sample to be collected.	Sample collected at NE1 32 ft had heavy sediment. Laboratory was able to analyze the sample.
6/17/2015	Water present in both NE1 32 ft and NE2 32 ft borings but too much sediment to allow sample to be collected. Insufficient water in the NE1 42 ft boring to collect a sample.	--
6/22/2015	DOE issued Record of Conversation for 6/11/2015 teleconference.	--

Table 3. Vapor Intrusion Screening Study Implementation Timeline (Continued)

Date	Event	Notes
6/23/2015	NE1 22 ft and 42 ft and NE2 32 ft borings abandoned per the SAP. Mobilized to northwest locations. Measured depth to water at MW 236 and MW451. Installed NW1 and NW2 borings at 12 ft, 22 ft, and 32 ft bgs.	Groundwater in MW236 measured at 42.69 ft bgs. Groundwater in MW451 measured at 38.92 ft bgs.
6/24/2015	Insufficient water to sample NW1 or NW2.	--
6/25/2015	Insufficient water to sample NW1 or NW2.	--
6/29/2015	Water sample collected from NW2 22 ft boring. Remaining borings were either dry or had insufficient water to collect a sample. FFA parties met via teleconference and agreed to the following: • Fieldwork should be considered finished and the borings abandoned. • The one sample collected from NW2 can be used to extrapolate the condition for NW1. • The soils have been demonstrated to be sufficiently tight that water movement is inhibited.	--
6/30/2015	NW1 and NW2 borings abandoned in accordance with approved work plan.	--
7/16/2015	DOE issued Record of Conversation for 6/29/2015 teleconference.	--

3. DATA EVALUATION

3.1 RESULTS

Three samples were submitted for laboratory analysis for VOCs, one sample from NW2 and two samples from NE1. The results of the analysis for TCE, *cis*-1,2-dichloroethene, *trans*-1,2-dichloroethene, and vinyl chloride were nondetect for each sample with a reporting limit of 1 µg/L. Table 4 presents a summary of the results including the recorded field temperature of the water sample.

Table 4. DPT Boring Water Sample Results

Boring Sampled	Date Sampled	*cis*-1,2-Dichloroethene[1]	*trans*-1,2-Dichloroethene[1]	Trichloroethene[1]	Vinyl Chloride[1]	Field Temperature (F)
NE1-32 ft	15-Jun-15	ND	ND	ND	ND	75.5
NE1-32 ft	16-Jun-15	ND	ND	ND	ND	81.2
NW2-22 ft	29-Jun-15	ND	ND	ND	ND	72.7

[1] Results were all nondetect at a reporting limit of 1µg/L.
ND = nondetect

Table 5 contains the default VISL values from EPA VISL Calculator, v3.4.2, September 3, 2015.

Table 5. Default VISL Values for Selected VOCs

Selected VOC	Default VISL Value[a]
cis-1,2-Dichloroethene	No Inhalation Toxicity Information
trans-1,2-Dichloroethene	No Inhalation Toxicity Information
Trichloroethene	1.2 µg/L
Vinyl Chloride	0.15 µg/L[b]

[a] http://www.epa.gov/oswer/vaporintrusion/documents/VISL-Calculator.xlsm.
[b] During scoping, the FFA parties agreed 1 µg/L detection limit was sufficient.

3.2 CONCLUSION

The intent of this vapor intrusion screening study was to compare TCE (and other selected chlorinated VOCs) concentrations in the first available water against VISLs developed using default parameter assumptions. VOCs of concern for this vapor intrusion screening study are TCE, *cis*-1,2-dichloroethene, *trans*-1,2-dichloroethene, and vinyl chloride. The Decision Rules presented in the SAP (DOE 2015a) are as follows:

- **IF** groundwater data for selected VOCs are less than the associated VISL or nondetect, **THEN** no additional groundwater sampling is needed and the vapor intrusion pathway does not pose a concern for the residence.

- **IF** groundwater data for selected VOCs are greater than or equal to the associated VISL, **THEN** reevaluate and scope the next step to address the potential for a vapor intrusion concern.

The groundwater data for all the selected VOCs was nondetect at a reporting limit of 1µg/L; therefore, according to the Decision Rules presented in the SAP (DOE 2015a), no additional groundwater sampling is needed, and the vapor intrusion pathway does not pose a concern for the residences. This study is consistent with historical investigations and the conceptual site model, which demonstrated limited potential for vapor intrusion. Based on the results of this vapor intrusion screening study (see Figures 11 and 12), historical information provided/referenced in the SAP, and the vapor intrusion guidance (EPA 2015b), an additional vapor intrusion study (i.e., a detailed investigation) is not warranted in the Water Policy Area at the time of this study. Because this study was designed to investigate the residences with the greatest potential for vapor intrusion, it is not likely that other residences in the water policy area currently have vapor intrusion concerns.

DOE will continue to evaluate groundwater conditions in the Water Policy Area in a manner consistent with five-year reviews for remedial actions required under Section 121(c) of Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and final remedial actions required under Section XXX of the FFA. Results of these periodic evaluations will be used to determine if a detailed vapor intrusion study is warranted.

4. REFERENCES

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DOE 2014b. J. Woodard letter to J. Tufts and T. Mullins, "Transmittal of the Record of Conversation Concerning the U.S. Environmental Protection Agency Recommendation for Modification and Additional Action to the Five-Year Review," Paducah, KY, August 1.

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DOE 2015c. J. Woodard letter to J. Corkran and A. Webb, "Transmittal of the Record of Conversation Concerning the Additional Action for the Five-Year Review Fieldwork," Paducah, KY, July 16.

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EPA 2013. *OSWER Final Guidance for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Sources to Indoor Air (External Review Draft*), U.S. Environmental Protection Agency, Washington, DC, April.

EPA 2014a. R. Chaffins letter to J. Woodard, Paducah, KY, September 30.

EPA 2014b. OSWER Vapor Intrusion Screening Level (VISL) Calculator, U.S. Environmental Protection Agency, accessed at http://www.epa.gov/oswer/vaporintrusion/documents/VISL-Calculator.xlsm.

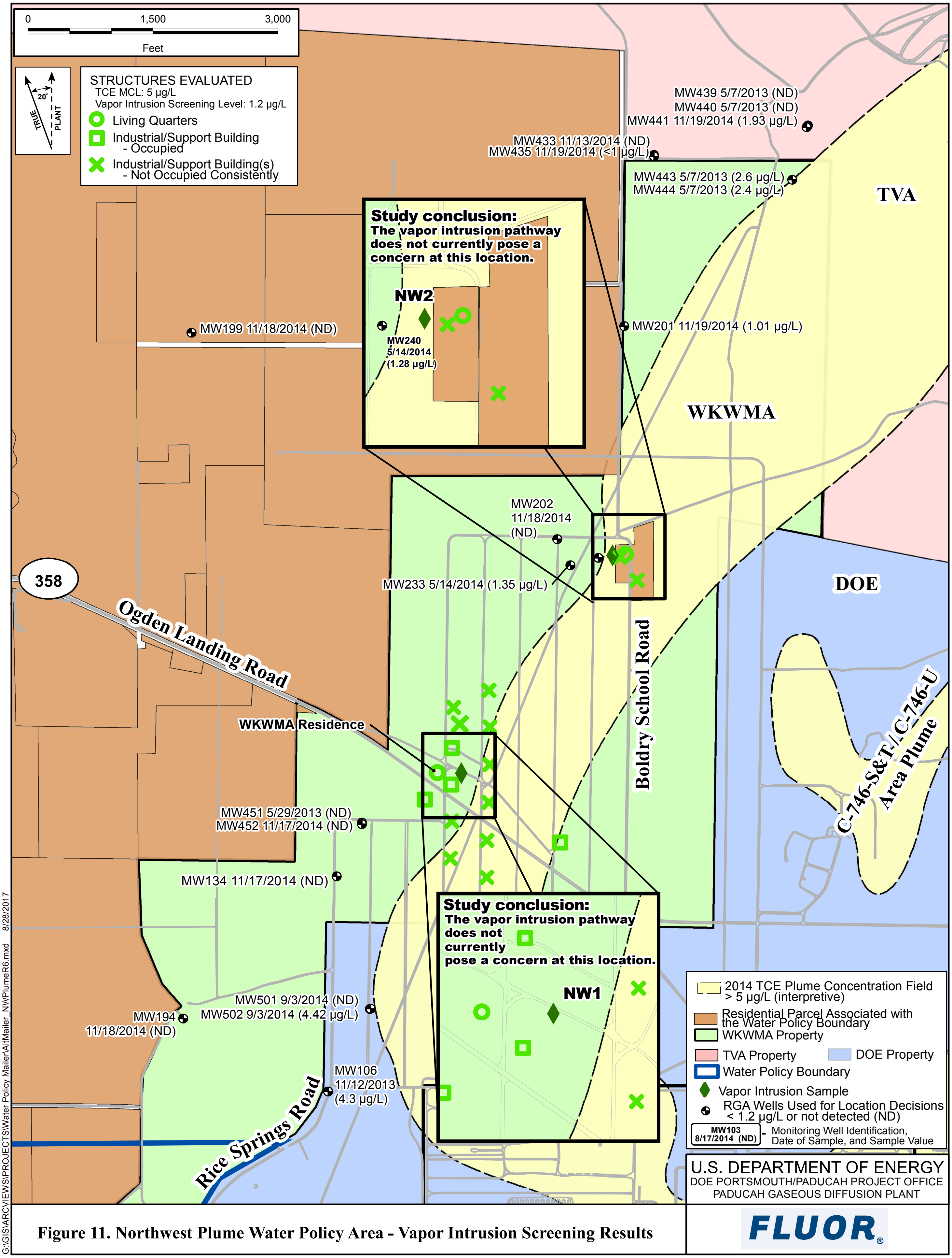

Figure 11. Northwest Plume Water Policy Area - Vapor Intrusion Screening Results

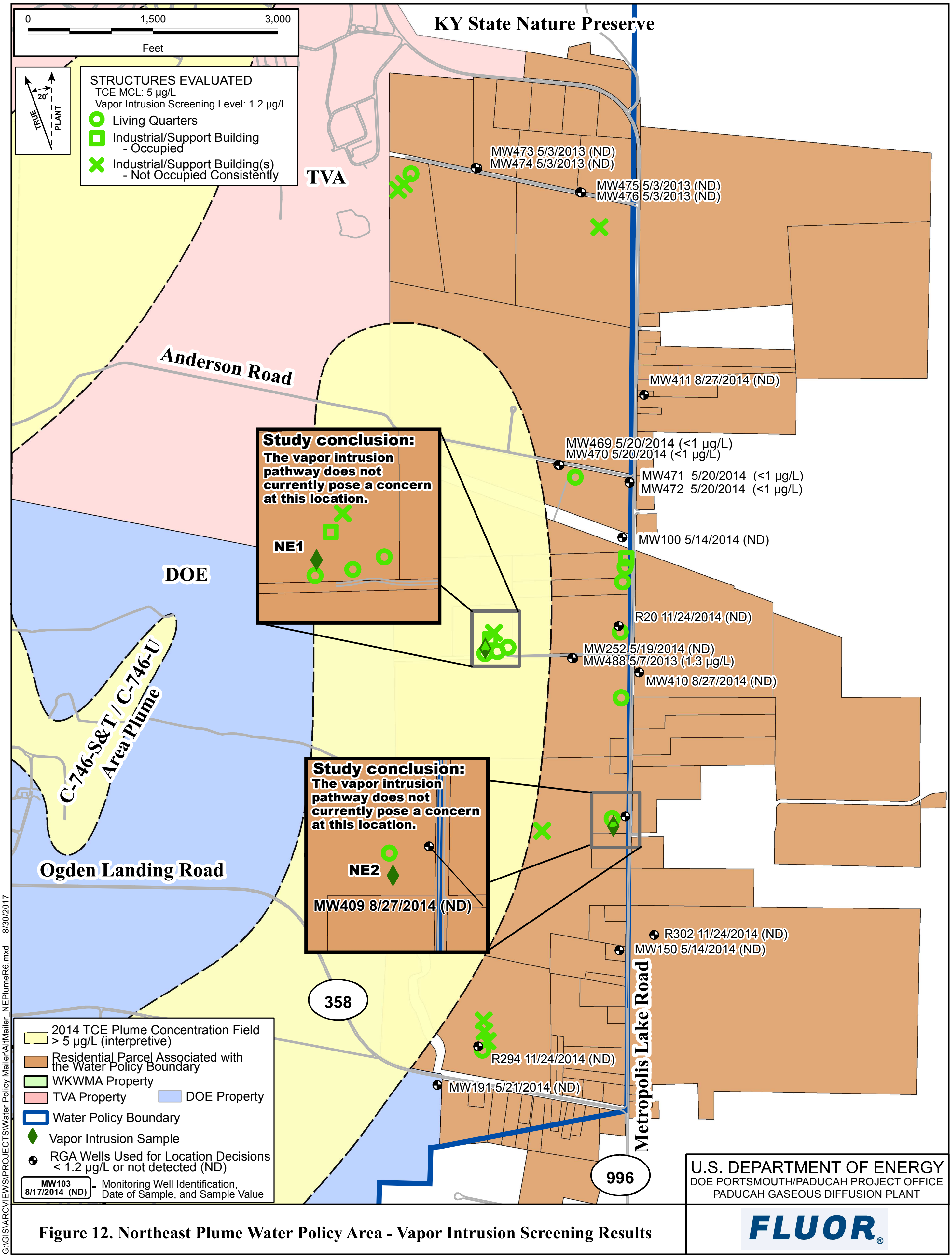

Figure 12. Northeast Plume Water Policy Area - Vapor Intrusion Screening Results

EPA 2015a. J. Corkran letter to J. Woodard, “EPA Concurrence: Replacement Pages for the *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&D2, U.S. Environmental Protection Agency, Atlanta GA, May.

EPA 2015b. *OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air*, OSWER Publication 9200.2-154, U.S. Environmental Protection Agency, Washington, DC, June.

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APPENDIX

RESIDENT CONTACT SUMMARY

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RESIDENT CONTACT SUMMARY

Called NE1 resident on May 28, 2015, and scheduled a visit for May 29, 2015. Met with resident and provided information about the needed sampling on May 29, 2015. Resident reviewed a map of the proposed sampling and agreed to the proposed location. The resident called and left a voice mail on June 1, 2015, regarding a buried fiber optic line in the area. Spoke to the resident on June 11, 2015, and discussed that a groundwater sample had not been obtained and would like to leave the rods in longer. Resident agreed.

Called NE2 resident on May 28, 2015, but no one answered and no answering machine picked up. On May 29, 2015, met with resident on their property and discussed the sampling project. The resident reviewed a map of proposed sampling location and agreed to the location. On June 4, 2015, utilities were scheduled to be marked, but the resident refused to let that be done. Resident stated that he would not allow this to happen and wanted a change to his license agreement. On June 5, 2015, met with resident and he agreed to the sampling event. The change he wants is to add a word to the license agreement. He was told that the requested change would be presented to DOE for their approval. He also wants two separate agreements: one for this water and the other for the monitoring wells. Spoke to the resident on June 11, 2015, and discussed that a groundwater sample had not been obtained and would like to leave the rods in longer. Resident agreed.

Called NW1 and NW2 resident/property owner and left a voice mail on May 28, 2015. Called again on June 1, 2015, and spoke to resident and scheduled a meeting to discuss the project on June 2, 2015. The resident reviewed a map of the proposed sampling location and agreed to the NW2 location on June 2, 2015. The resident requested a different location for the NW1 location. The resident did not want sampling that close to the home and wanted it to be at least 150 yards away. Resident stated that a previous sampling event had rattled objects on the walls of the club house and did not want that to happen to the home. With further discussion and a new map, the resident agreed to a location that was approximately 260 ft away from the house.

Called NW1 and NW2 resident/property owner on June 11, 2015, and left message on office phone. Called again on June 12, 2015, both cell and office phones, no answer. Called on June 15, 2015, and left voice mail on cell phone. Called office on June 16, 2015, and left message for resident to call. Sent e-mail on June 16, 2015, and received response e-mail on June 17, 2015, stating that sampling event could not happen on June 17, 2015. Spoke on phone with resident about the sampling event on June 17, 2015. Resident was having a meeting on the June 17, 2015, date and needed to reschedule because the resident wanted to be present for the sampling event. Sent e-mail, per the resident’s request, with new proposed date of June 23, 2015, for sampling event and received e-mail from resident stating that the sampling event could begin on that date.

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ATTACHMENT C3

DEMOSTRATE NO GROUNDWATER USAGE

**(The following has been reprinted in its original format.
Pagination and formatting from original document retained.)**

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Demonstration that Residents Located over the Contaminated Groundwater Plume Are Not Using Groundwater at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky

Demonstration that Residents Located over the Contaminated Groundwater Plume Are Not Using Groundwater at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky

Date Issued—October 2017

U.S. DEPARTMENT OF ENERGY
Office of Environmental Management

Prepared by
FLUOR FEDERAL SERVICES, INC.,
Paducah Deactivation Project
managing the
Deactivation Project at the
Paducah Gaseous Diffusion Plant
under Task Order DE-DT0007774

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CONTENTS

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FIGURES

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TABLES

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ACRONYMS

AKGWA	Assembled Kentucky Ground Water Database
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
ND	nondetectable
PGDP	Paducah Gaseous Diffusion Plant

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1. INTRODUCTION

This document describes actions taken by the U.S. Department of Energy (DOE) in response to comments on the *Five-Year Review for Remedial Actions at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-1289&D2/R1 (DOE 2014). In a letter dated September 30, 2014, (EPA 2014) the U.S. Environmental Protection Agency (EPA) stated the following:

> 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"…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…

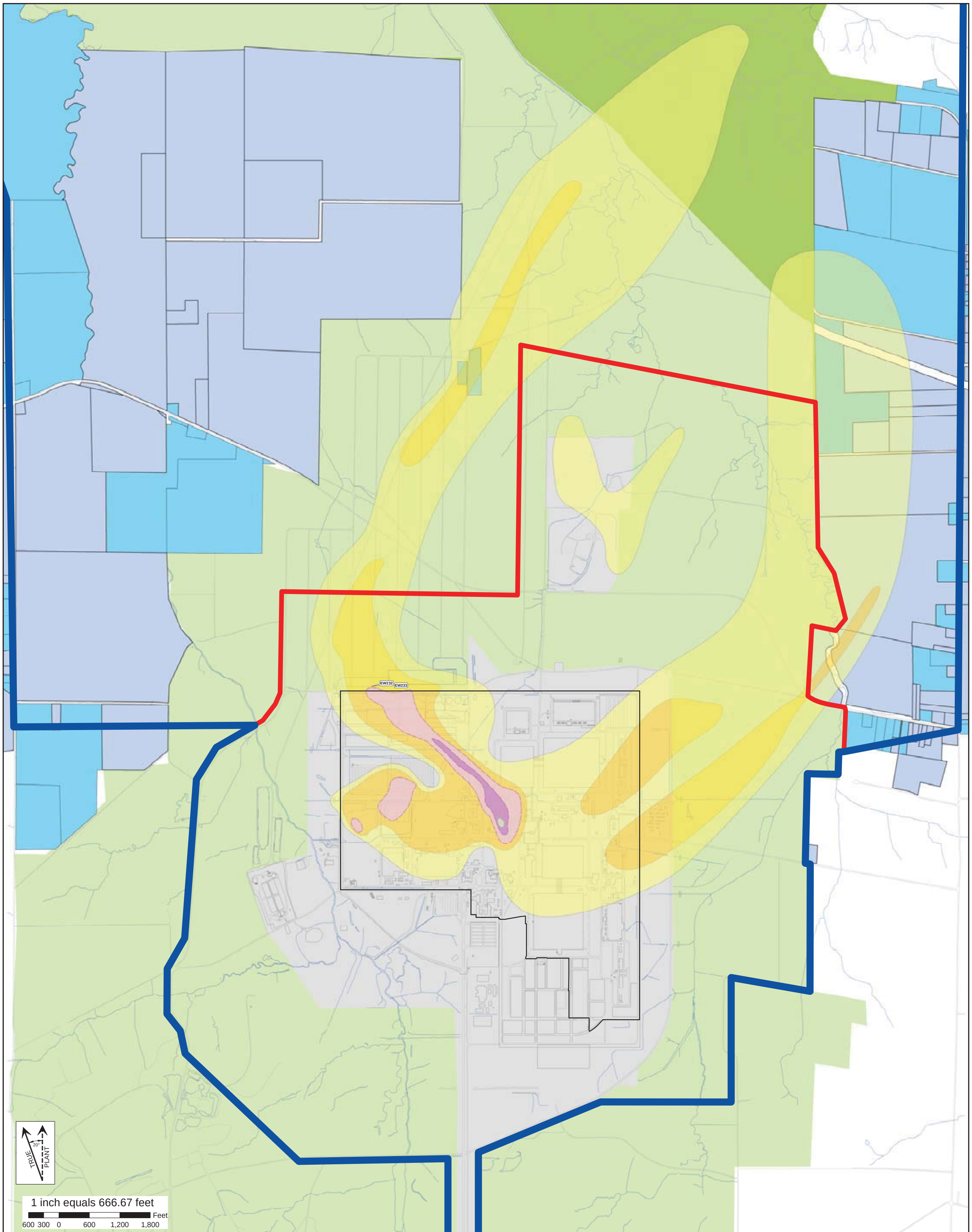
This document has been developed to address EPA's requirement that DOE demonstrate that all residents located above the contaminated groundwater plume are not using groundwater from their wells. To further protect the health of residents living north of the PGDP in the area commonly referred to as the "Water Policy Area" (Figure 1), DOE conducted a vapor intrusion screening study (DOE 2016) and determined that vapor intrusion is not occurring into residential properties.

DOE also developed and mailed an educational flyer to all residents within the Water Policy Area. This flyer was designed to educate landowners about the presence of groundwater contamination in the area.

To demonstrate that all residents located above the contaminated groundwater plume are not using groundwater from their wells, DOE has evaluated which parcels currently are located over the 5 µg/L or greater trichloroethene (TCE) plume. The 5 µg/L is the Safe Drinking Water Act maximum contaminant level (MCL) for TCE. DOE has identified 16 parcels overlying or immediately downgradient of the 5 µg/L or greater TCE-contaminant plume (Figure 2). Each of the 16 parcels was researched to identify the landowner(s), the presence of a residence, the presence of a license agreement, the presence of groundwater wells, and current integrity of DOE caps and locks. DOE then assessed the current uses of each parcel by reviewing applicable state groundwater well databases, examining aerial photographs for evidence of disturbances potentially related to wells, and physically assessing the conditions of the property, either by driving past the property where no license agreement was in place or through a sight check from the existing well location where license agreements were in place. Through these surveillance actions, DOE has examined all reasonably available lines of evidence and has concluded that no owners or occupants of any of the parcels located above the contaminated groundwater plume (i.e., overlying or immediately downgradient of the 5 µg/L or greater TCE plume) are using groundwater. As such, this study meets the requirements set forth in EPA's September 30, 2014, letter requesting that DOE demonstrate that all residents located above the contaminated groundwater plume are not using groundwater from their wells.

2. BACKGROUND

Upon detecting TCE and technetium-99 in private wells located north of Paducah Gaseous Diffusion Plant (PGDP) in August 1988, the U.S. Department of Energy (DOE) placed affected residences/businesses on alternate water supplies and began a monitoring and investigation program to define the extent and temporal variations of the groundwater contaminant plumes. DOE developed the current PGDP Water Policy in accordance with the *Engineering Evaluation/Cost Analysis for the Water Policy at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* (DOE 1993) and the *Action*



LEGEND

2014 TCE Plume Concentration Fields

- 5 - 100 µg/L
- 100 - 1,000 µg/L
- 1,000 - 10,000 µg/L
- 10,000 - 100,000 µg/L
- ≥ 100,000 µg/L

- Water Policy Area
- Parcels w/o Current Agreements
- Parcels w/Current Agreements
- Wildlife Management Area
- TVA Boundary
- DOE Boundary

- DOE Property Boundary
- Roadways
- Streams
- PGDP Boundary

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PADUCAH GASEOUS DIFFUSION PLANT

Figure 1. 2014 Plume Map with Parcels

FILE NAME:	PROJECT #:	SCALE:	DATE:
Fig 1 WP_2014Plumes_Parcels R2	EM	AS NOTED	3/3/2016

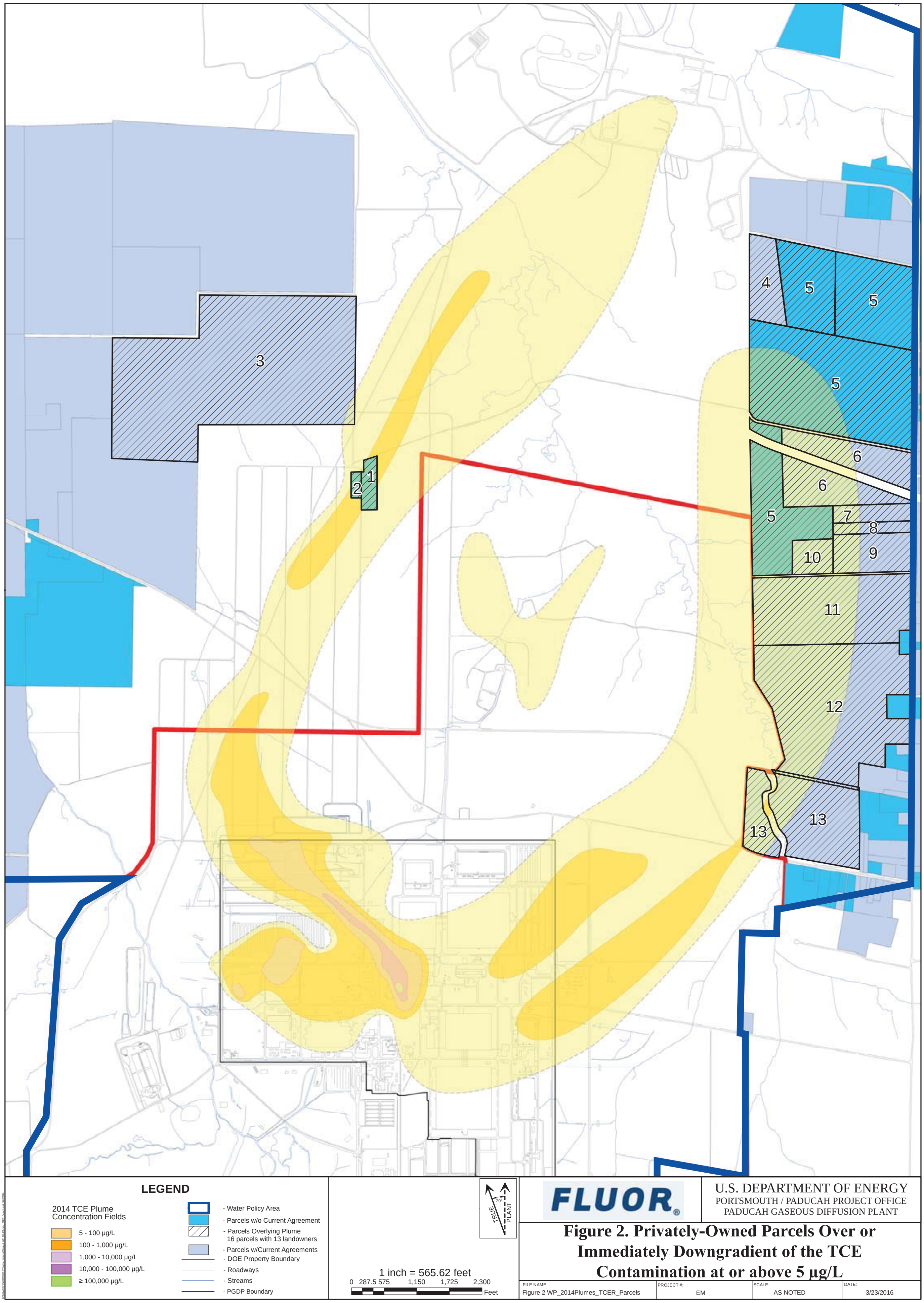

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Figure 2. Privately-Owned Parcels Over or Immediately Downgradient of the TCE Contamination at or above 5 µg/L

FILE NAME:	PROJECT #:	SCALE:	DATE:
Figure 2 WP_2014Plumes_TCER_Parcels	EM	AS NOTED	3/23/2016

Memorandum for the Water Policy at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, (DOE 1994) for the Water Policy removal action.

The PGDP 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 Paducah Gaseous Diffusion Plant (affected area).”

In June 1994, DOE signed the Action Memorandum for the Water Policy (DOE 1994). The Action Memorandum 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.

Management activities of the Water Policy include the following:

- Water bills are reviewed monthly looking for abnormal bills; residents whose bills are outside the range of historical usage are notified by mail and/or a site visit.
- A due diligence is conducted yearly at the McCracken County Property Valuation Office for new owners of land parcels within the Water Policy Box.
- As License Agreements are set to expire, property owners are contacted prior to the expiration date to request a renewal.
- Caps and locks installed on residential wells are inspected to verify the wells are nonoperational.

3. DEMONSTRATION OF NO WATER USAGE OVER THE GROUNDWATER PLUMES

3.1 EVALUATION PROCESS

The following approach was developed and implemented to evaluate groundwater usage above the 5 µg/L or greater TCE plume.

1. Determined locations of land parcels overlying or immediately downgradient of the 5 µg/L or greater TCE plume by overlaying property boundaries on the 2014 TCE Plume map.
2. Reaffirmed land ownership of land parcels overlying or immediately downgradient of the 5 µg/L or greater TCE plume by reviewing relevant records in the McCracken County Property Valuation office.
3. Reviewed records for land parcels situated overlying or immediately downgradient of the 5 µg/L or greater TCE plume to determine whether those parcels had residential wells, DOE caps and locks, and/or license agreements.

4. Reviewed the Kentucky water well database to ensure no additional groundwater wells have been installed overlying or immediately downgradient of the 5 µg/L or greater TCE plume.

5. Conducted visual assessment of properties overlying or immediately downgradient of the 5 µg/L or greater TCE plume. For properties with a current Water Policy license agreement, contacted the landowner, accessed the site, confirmed no residential well is being used, and checked well cap and lock, if applicable. For properties without a current Water Policy license agreement, conducted a drive-by assessment and documented any evidence of water well usage.

6. Examined aerial images of properties overlying or immediately downgradient of the 5 µg/L or greater TCE plume for signs of groundwater well usage.

There are 13 landowners associated with 16 parcels. Figure 2 groups the parcels by landowner and provides a unique identifier for each property owner and each individual parcel (1–13).

3.1.1 Property 1 Evaluation

Table 1 presents the evaluation results and additional comments concerning Property 1, and Figures 3 and 4 present the overall aerial view of the property along with an example of the aerial examination.

Table 1. Property 1 Evaluation

Evaluation Process	Evaluation Results	Comments
Property overlying or immediately downgradient of the 5 µg/L or greater TCE Plume?	Yes.	Northwest Plume.
Land ownership of property	No change from previous year.	--
Municipal water usage	Historically consistent.	--
Known existing wells (residential or monitoring)	No.	--
Historical capping and locking information	None.	--
License Agreement Status	No current agreement in place.	Last agreement expired September 30, 2015, attempts to contact for renewal have not been successful.
Property has a residence	No.	The structure (repurposed Kentucky Ordinance Works bunker) is used as a hunting club.
Review of the Kentucky Database for Water Wells	No new wells have been installed/reported to Kentucky.	The Water Well & Spring Records Database, Kentucky Groundwater Data Repository was reviewed in August 2015 and was current on the Web as of June 2014.
Visual assessment of property*	Visual was conducted by drive-by and aerial photograph and noted no visible sign of groundwater usage.	--

*See Appendix A for Assessment Forms

Figure 3. Property 1 Aerial View—Overall

Figure 4. Property 1 Street View—Club House

3.1.2 Property 2 Evaluation

Table 2 presents the evaluation results and additional comments concerning Property 2, and Figures 5, 6, and 7 present the overall aerial view of the property along with examples of the aerial examination.

Table 2. Property 2 Evaluation

Evaluation Process	Evaluation Results	Comments
Property overlying or immediately downgradient of the 5 µg/L or greater TCE Plume?	Yes.	Northwest Plume.
Land ownership of property	No change from previous year.	--
Municipal water usage	Historically consistent.	--
Known existing wells (residential or monitoring)	Record of residential well on-site that was abandoned by resident.	The Kentucky database for water wells (see Section 3.1.5) reports the status of the well as "Inactive" and lists the well as "unused" on a 1992 inspection record.
Historical capping and locking information	DOE capping and locking notes from 1994 state that the resident abandoned the well [Assembled Kentucky Ground Water Database (AKGWA) # 0003-0205] and capped it below grade.	--
License Agreement Status	No current agreement in place.	Original landowner and current landowner have both refused to sign a license agreement.
Property has a residence	Yes.	Modular home.
Review of the Kentucky Database for Water Wells	No new wells have been installed/reported to Kentucky.	The Water Well & Spring Records Database, Kentucky Groundwater Data Repository was reviewed and was current on the Web as of June 2014.
Visual assessment of property*	Visual conducted as drive-by and aerial photograph and noted no visible sign of groundwater usage.	--

*See Appendix A for Assessment Forms

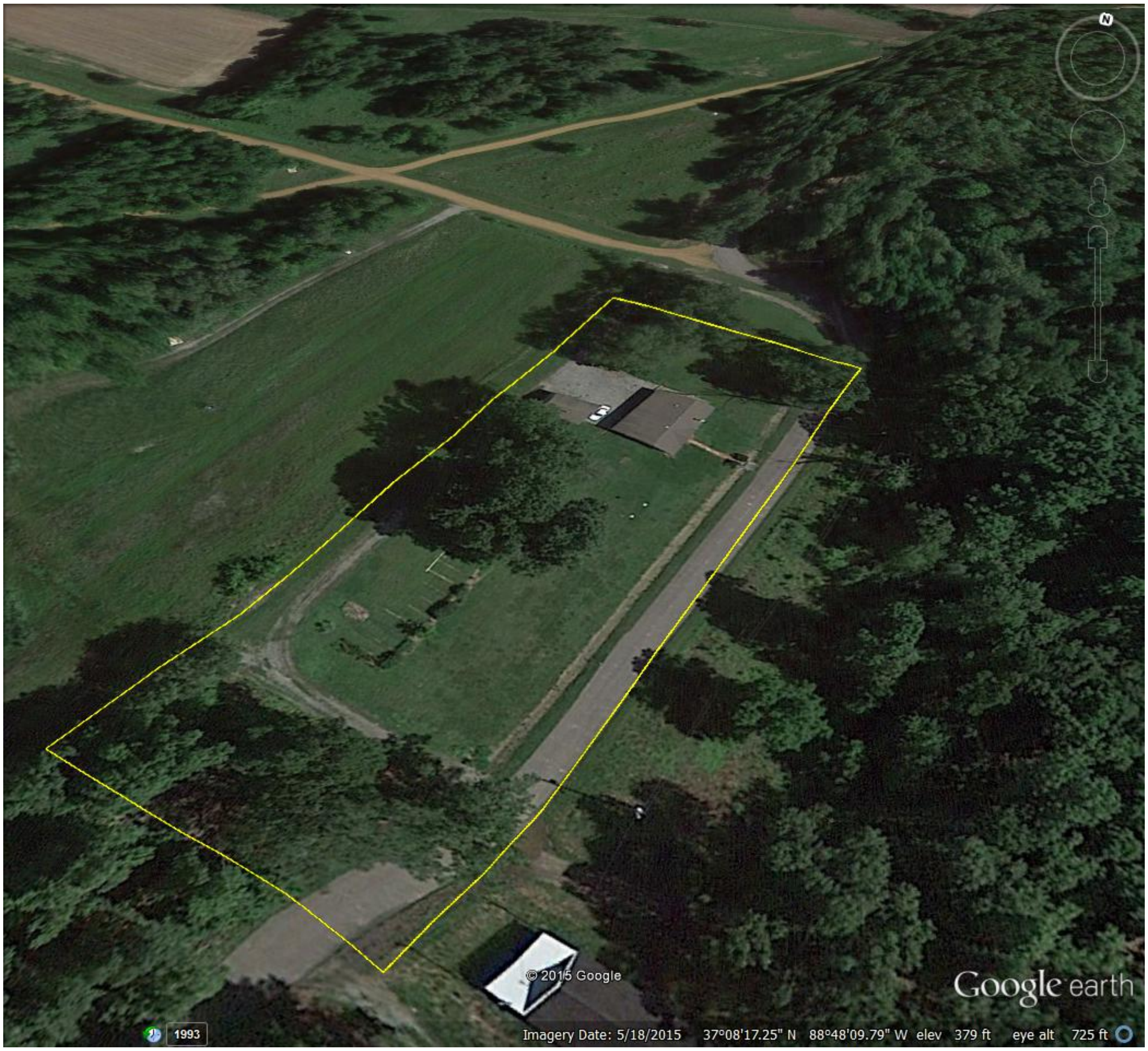

Figure 5. Property 2 Aerial View—Overall

Figure 6. Property 2 Street View—Residence

Figure 7. Property 2 Street View—Former Residence Footprint

3.1.3 Property 3 Evaluation

Table 3 presents the evaluation results and additional comments concerning Property 3, and Figures 8 and 9 present the overall aerial view of the property along with an example of the aerial examination.

Table 3. Property 3 Evaluation

Evaluation Process	Evaluation Results	Comments
Property overlying or immediately downgradient of the 5 µg/L or greater TCE Plume?	Yes.	Northwest Plume.
Land ownership of property	No change from previous year.	--
Municipal water usage	Historically consistent.	--
Known existing wells (residential or monitoring)	No.	Farmland with no known groundwater well on parcel. The adjoining property to the north, which is owned by the same landowner, has two capped and locked residential wells, R16 and R245, and a monitoring well, MW199.
Historical capping and locking information	None.	--
License Agreement Status	Current agreement in place.	--
Property has a residence	No.	Adjoining property to the north has a residence.
Review of the Kentucky Database for Water Wells	No new wells have been installed/reported to Kentucky.	The Water Well & Spring Records Database, Kentucky Groundwater Data Repository was reviewed and was current on the Web as of June 2014.
Visual assessment of property*	Visual from location of existing wells on adjoining parcels and drive-by and aerial photograph, noted no visible sign of groundwater usage.	Resident confirmed not using existing wells on adjoining parcels and has not drilled a new well. It was noted that the cap was broken and the lock missing on the R245. The resident was informed that the cap and lock would be replaced, but did not express any concern or ask any additional questions. Cap and lock were replaced as of March 3, 2016.

*See Appendix A for Assessment Forms

Figure 8. Property 3 Aerial View—Overall

Figure 9. Property 3 Aerial View—Monitoring Well on Adjoining Property

3.1.4 Property 4 Evaluation

Table 4 presents the evaluation results and additional comments concerning Property 4, and Figures 10, 11, 12, and 13 present the overall aerial view of the property along with an example of the aerial examination.

Table 4. Property 4 Evaluation

Evaluation Process	Evaluation Results	Comments
Property overlying or immediately downgradient of the 5 µg/L or greater TCE Plume?	Yes.	Northeast Plume.
Land ownership of property	No change from previous year.	--
Municipal water usage	Historically consistent.	--
Known existing wells (residential or monitoring)	No.	Farmland with no known groundwater well.
Historical capping and locking information	None.	--
License Agreement Status	Current agreement in place.	--
Property has a residence	Yes.	Residence was built in 1998.
Review of the Kentucky Database for Water Wells	No new wells have been installed/reported to Kentucky.	The Water Well & Spring Records Database, Kentucky Groundwater Data Repository was reviewed and was current on the Web as of June 2014.
Visual assessment of property*	Visual from driveway, drive-by, and aerial photograph noted no visible sign of groundwater usage.	Resident confirmed no new water well has been installed. Resident also indicated that there was a residential well on the property in the 1950s, but it was filled in many years ago.

*See Appendix A for Assessment Forms

Figure 10. Property 4 Aerial View—Overall

Figure 11. Property 4 Street View—Residence

Figure 12. Property 4 Street View—Barns

Figure 13. Property 4 Aerial View—Barns

3.1.5 Property 5 Evaluation

Table 5 presents the evaluation results and additional comments concerning Property 5, and Figures 14 and 15 present the overall aerial view of the property along with an example of the aerial examination.

Table 5. Property 5 Evaluation

Evaluation Process	Evaluation Results	Comments
Property overlying or immediately downgradient of the 5 µg/L or greater TCE Plume?	Yes.	Northeast Plume.
Land ownership of property	No change from previous year.	It should be noted that this property has been purchased by Tennessee Valley Authority since the D1 version was written.
Municipal water usage	N/A.	This property is farmland with no municipal hookup.
Known existing wells (residential or monitoring)	No.	--
Historical capping and locking information	None.	--
License Agreement Status	No current agreement in place.	Original landowner had refused to sign a license agreement.
Property has a residence	No.	Farmland with no known groundwater well.
Review of the Kentucky Database for Water Wells	No new wells have been installed/reported to Kentucky.	The Water Well & Spring Records Database, Kentucky Groundwater Data Repository was reviewed and was current on the Web as of June 2014.
Visual assessment of property*	Visual conducted as drive-by and aerial photograph and noted no visible sign of groundwater usage.	No indications were seen during drive-by or on aerial photograph of a new well.

*See Appendix A for Assessment Forms

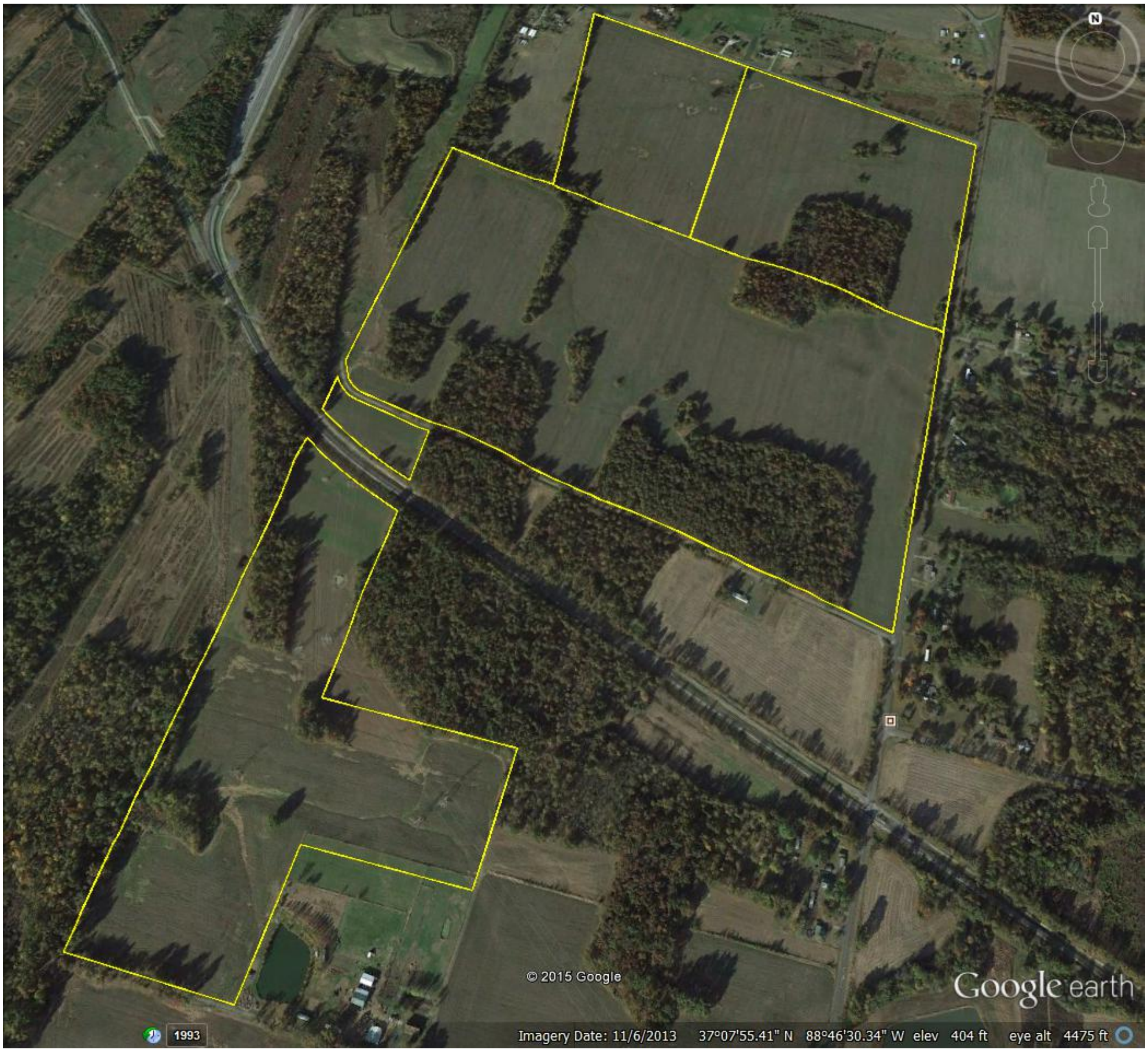

Figure 14. Property 5 Aerial View—Overall

Figure 15. Property 5 Aerial View—Old Barn

3.1.6 Property 6 Evaluation

Table 6 presents the evaluation results and additional comments concerning Property 6, and Figures 16 and 17 present the overall aerial view of the property along with an example of the aerial examination.

Table 6. Property 6 Evaluation

Evaluation Process	Evaluation Results	Comments
Property overlying or immediately downgradient of the 5 µg/L or greater TCE Plume?	Yes.	Northeast Plume.
Land ownership of property	No change from previous year.	Please note that Tennessee Valley Authority is in the process of purchasing this property.
Municipal water usage	Historically consistent.	
Known existing wells (residential or monitoring)	Yes, monitoring well.	Monitoring wells 465-472 are located on this property and are sampled annually with the exception of 468, 473, and 474, which are samples biennially. All monitoring wells are inspected annually.
Historical capping and locking information	None.	--
License Agreement Status	Current agreement in place.	--
Property has a residence	Yes.	Residence was built in approximately 2006. Owner of property lives out of state and the residence is rented.
Review of the Kentucky Database for Water Wells	No new wells have been installed/reported to Kentucky.	The Water Well & Spring Records Database, Kentucky Groundwater Data Repository was reviewed and was current on the Web as of June 2014.
Visual assessment of property*	Visual from driveway, drive-by, and aerial photograph noted no visible sign of groundwater usage.	Resident confirmed not using existing wells. Resident confirmed no new water well has been installed. Property is forested with areas used for row crops. Property also has the Tennessee Valley Authority railroad running diagonally through it.

*See Appendix A for Assessment Forms

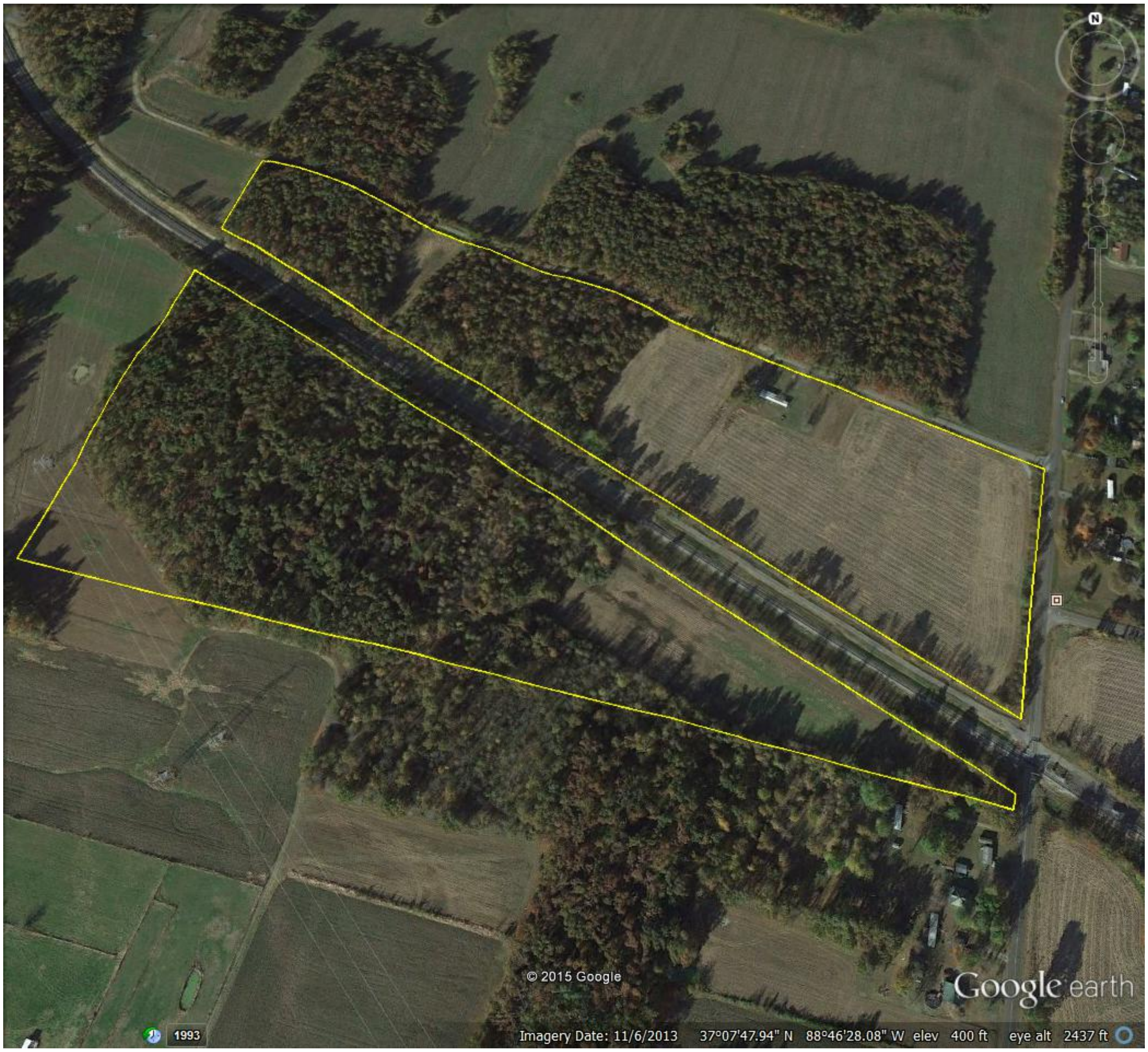

Figure 16. Property 6 Aerial View—Overall

Figure 17. Property 6 Aerial View—Flush Mounted Monitoring Wells

3.1.7 Property 7 Evaluation

Table 7 presents the evaluation results and additional comments concerning Property 7, and Figures 18 and 19 present the overall aerial view of the property along with an example of the aerial examination.

Table 7. Property 7 Evaluation

Evaluation Process	Evaluation Results	Comments
Property overlying or immediately downgradient of the 5 µg/L or greater TCE Plume?	Yes.	Northeast Plume.
Land ownership of property	No change.	--
Municipal water usage	Historically consistent.	--
Known existing wells (residential or monitoring)	Yes, residential well.	R530, AKGWA 0004-2844, is not inspected; please see comment below.
Historical capping and locking information	None.	Well is under residence, with no access to the well without removing flooring. It was removed from the capping and locking project.
License Agreement Status	Current agreement in place.	--
Property has a residence	Yes.	--
Review of the Kentucky Database for Water Wells	No new wells have been installed/reported to Kentucky.	The Water Well & Spring Records Database, Kentucky Groundwater Data Repository was reviewed and was current on the Web as of June 2014.
Visual assessment of property*	Visual from driveway, drive-by, and aerial photograph noted no visible sign of groundwater usage.	Resident confirmed they are not using existing wells. Resident confirmed no new water well has been installed. Resident confirmed the existing well is located under an addition to the house and is not accessible.

*See Appendix A for Assessment Forms

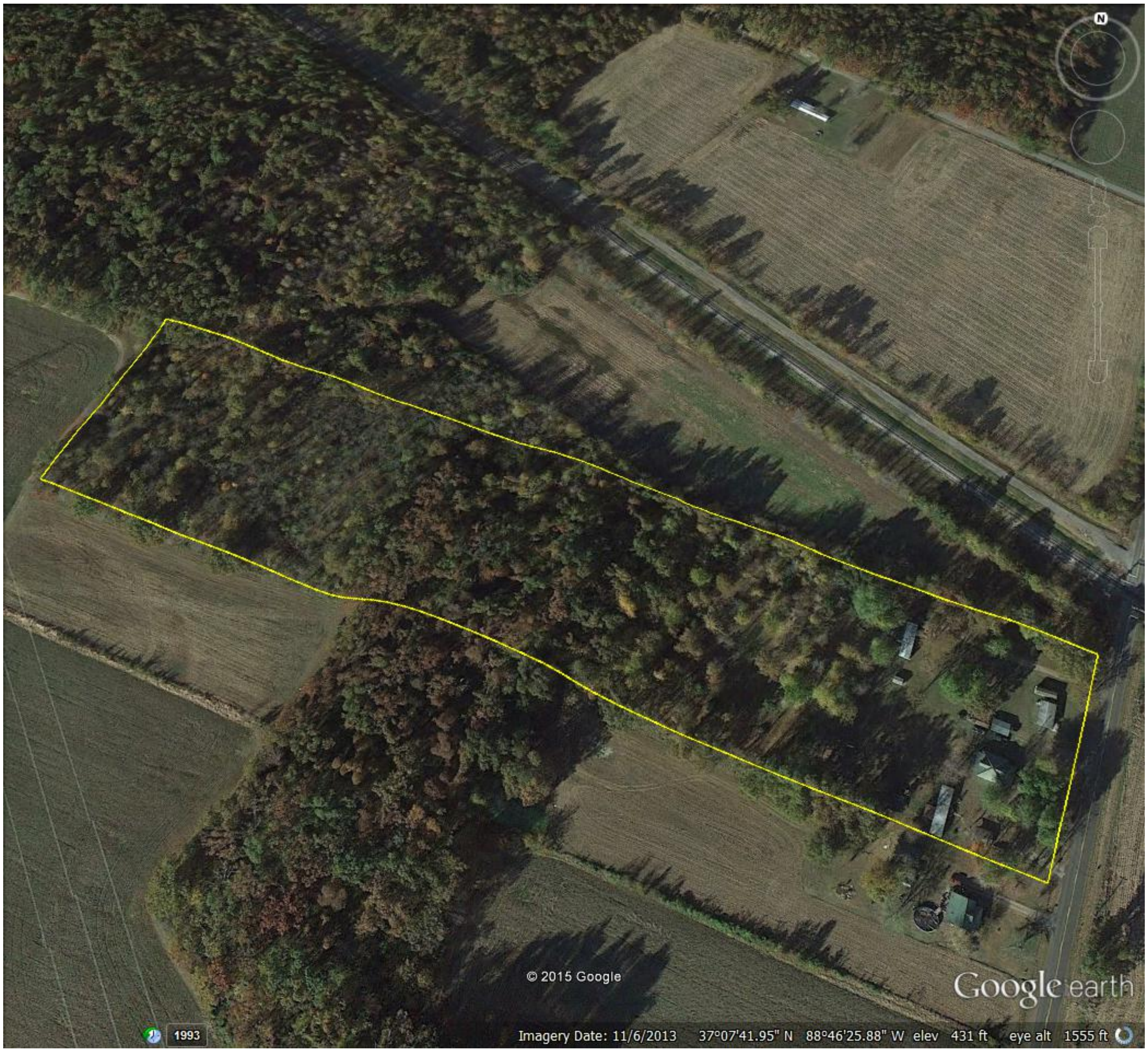

Figure 18. Property 7 Aerial View—Overall

Figure 19. Property 7 Street View—Business and Residence

3.1.8 Property 8 Evaluation

Table 8 presents the evaluation results and additional comments concerning Property 8, and Figures 20 and 21 present the overall aerial view of the property along with an example of the aerial examination.

Table 8. Property 8 Evaluation

Evaluation Process	Evaluation Results	Comments
Property overlying or immediately downgradient of the 5 µg/L or greater TCE Plume?	Yes.	Northeast Plume.
Land ownership of property	No change from previous year.	--
Municipal water usage	Historically consistent.	--
Known existing wells (residential or monitoring)	No.	--
Historical capping and locking information	None.	--
License Agreement Status	Current agreement in place.	--
Property has a residence	Yes.	--
Review of the Kentucky Database for Water Wells	No new wells have been installed/reported to Kentucky.	The Water Well & Spring Records Database, Kentucky Groundwater Data Repository was reviewed and was current on the Web as of June 2014.
Visual assessment of property*	Visual from driveway, drive-by, and aerial photograph noted no visible sign of groundwater usage.	--

*See Appendix A for Assessment Forms

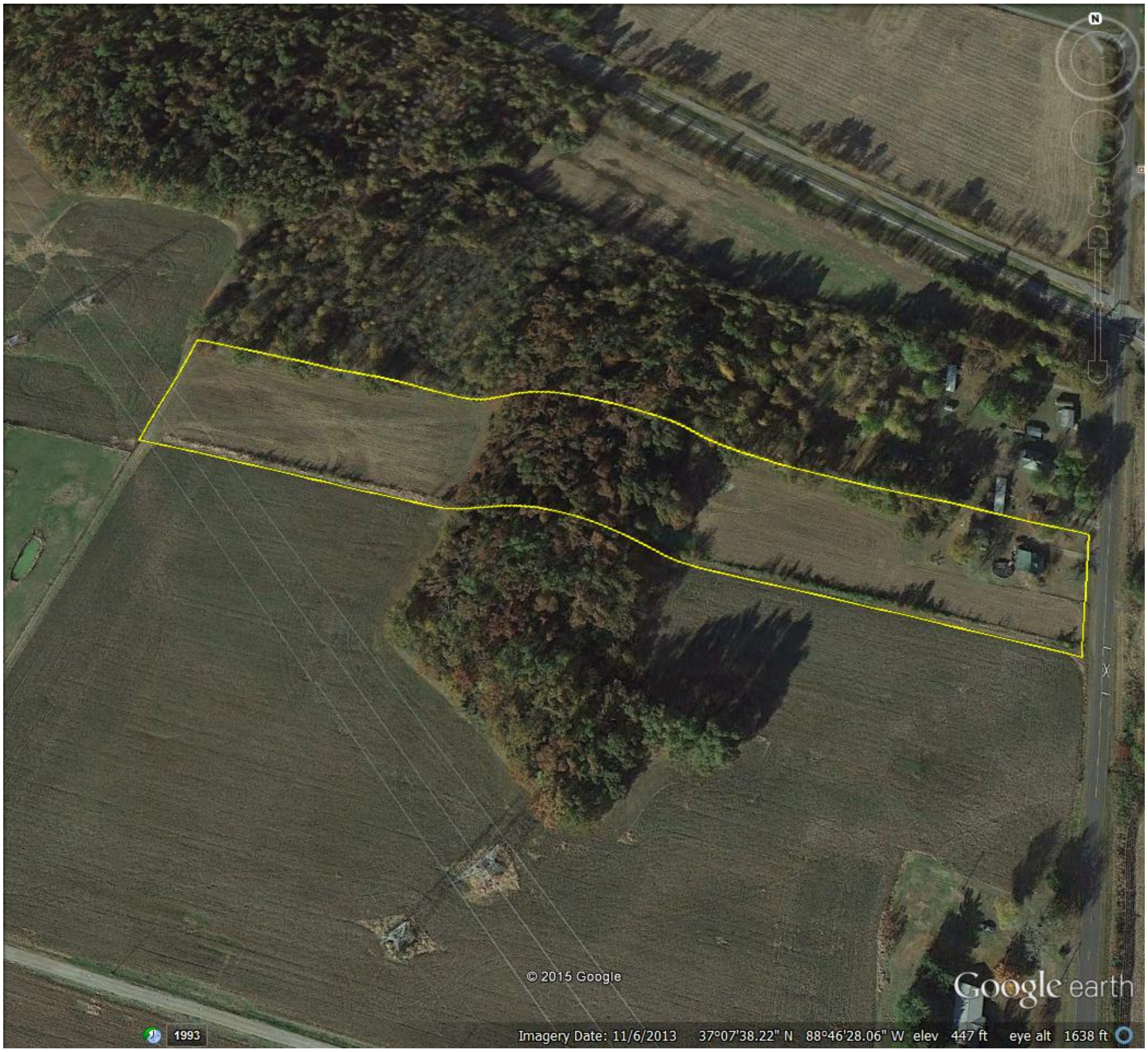

Figure 20. Property 8 Aerial View—Overall

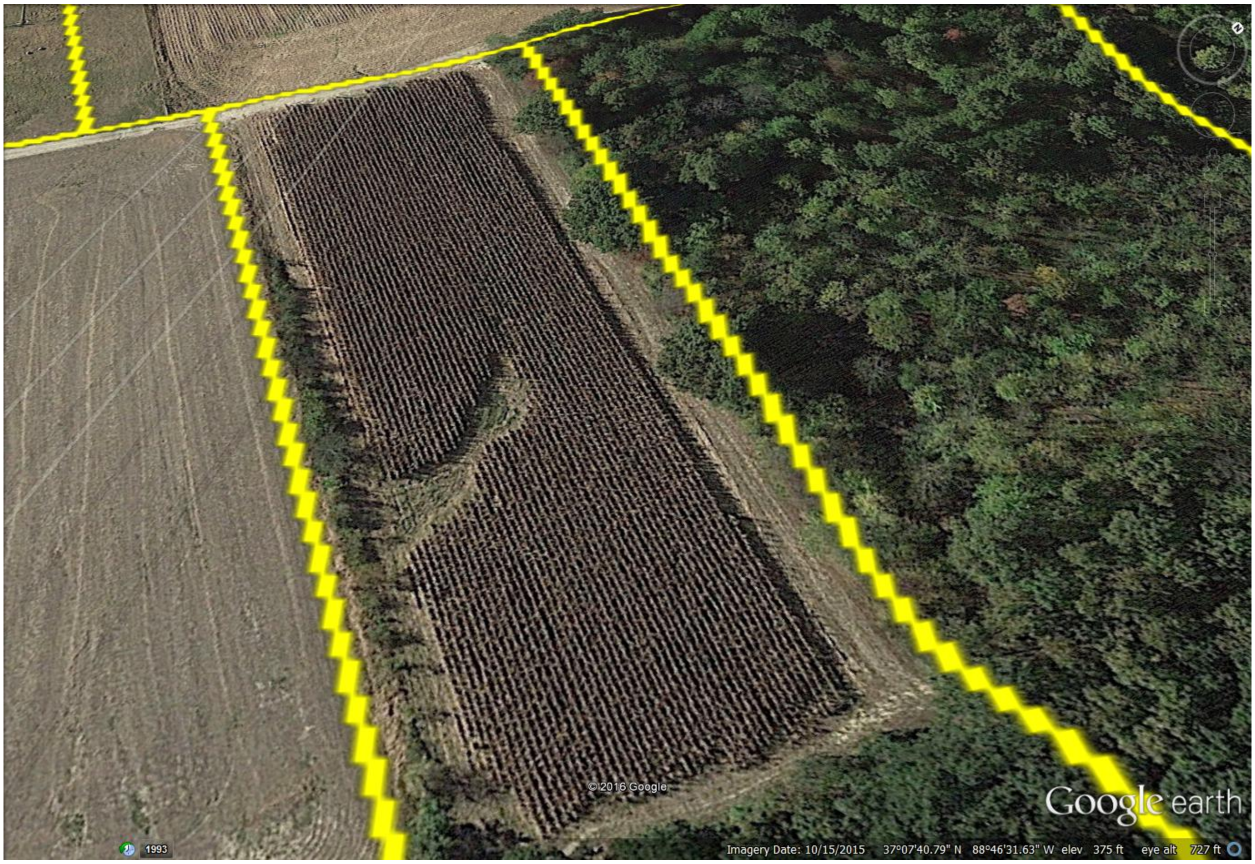

Figure 21. Property 8 Aerial View—Row Crop

3.1.9 Property 9 Evaluation

Table 9 presents the evaluation results and additional comments concerning Property 9, and Figures 22 and 23 present the overall aerial view of the property along with an example of the aerial examination.

Table 9. Property 9 Evaluation

Evaluation Process	Evaluation Results	Comments
Property overlying or immediately downgradient of the 5 µg/L or greater TCE Plume?	Yes.	Northeast Plume.
Land ownership of property	No change from previous year.	--
Municipal water usage	Historically consistent.	--
Known existing wells (residential or monitoring)	Yes, residential well.	R20, AKGWA 0003-5007, is sampled annually and is inspected in conjunction with the Five-Year Reviews.
Historical capping and locking information	Capped and Locked on June 22, 1995.	--
License Agreement Status	Current agreement in place.	--
Property has a residence	Yes.	--
Review of the Kentucky Database for Water Wells	No new wells have been installed/reported to Kentucky.	The Water Well & Spring Records Database, Kentucky Groundwater Data Repository was reviewed and was current on the Web as of June 2014.
Visual assessment of property*	Visual from well, drive-by, and aerial photograph noted no visible sign of groundwater usage.	Resident confirmed not using existing wells. Resident confirmed no new water well has been installed.

*See Appendix A for Assessment Forms

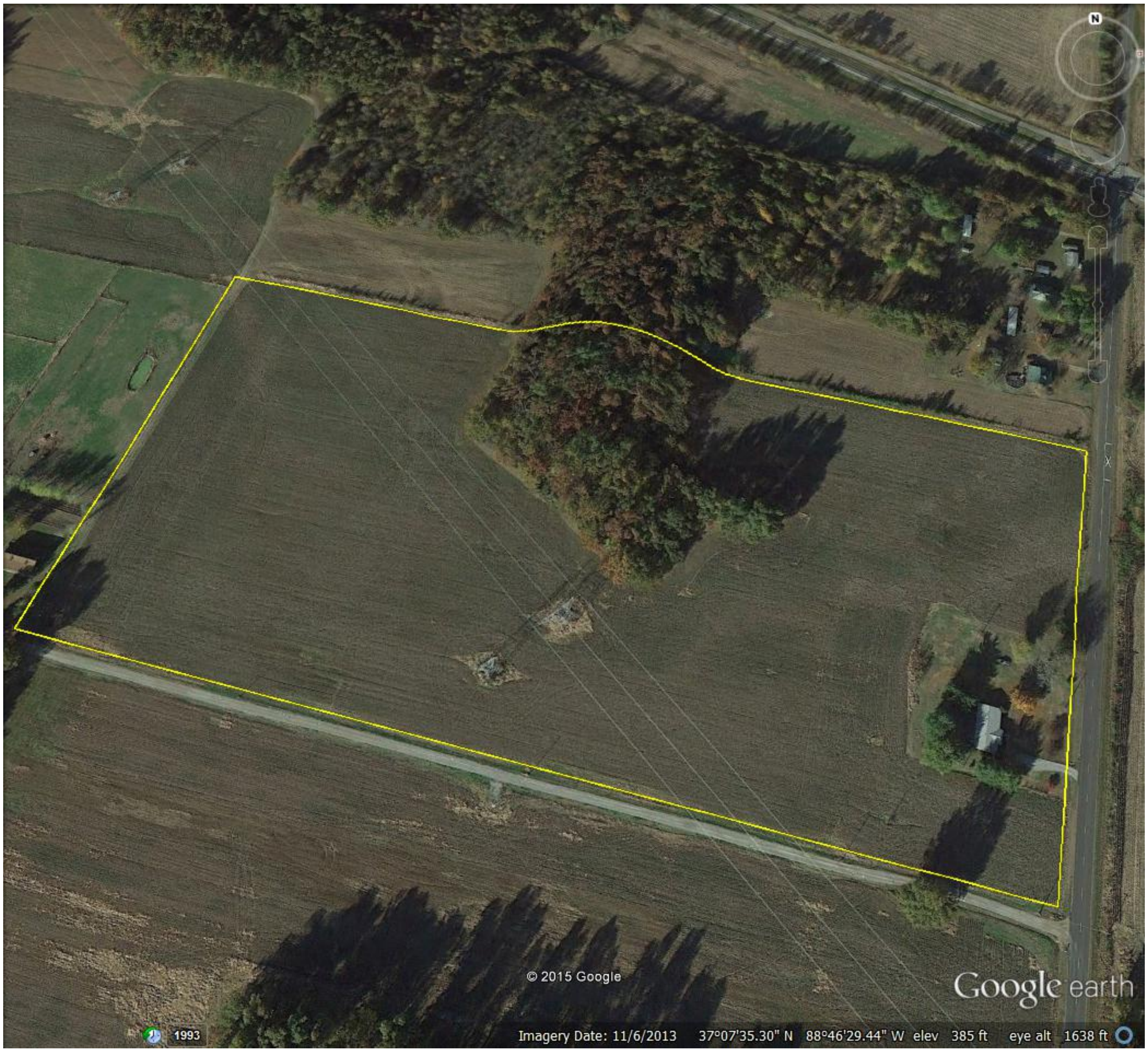

Figure 22. Property 9 Aerial View—Overall

Figure 23. Property 9 Street View—Drive Used for Sampling Residential Well

3.1.10 Property 10 Evaluation

Table 10 presents the evaluation results and additional comments concerning Property 10, and Figures 24 and 25 present the overall aerial view of the property along with an example of the aerial examination.

Table 10. Property 10 Evaluation

Evaluation Process	Evaluation Results	Comments
Property overlying or immediately downgradient of the 5 µg/L or greater TCE Plume?	Yes.	Northeast Plume.
Land ownership of property	No change from previous year.	--
Municipal water usage	Historically consistent.	--
Known existing wells (residential or monitoring)	Yes, residential and monitoring wells.	R31, AKGWA 0003-5008, is inspected in conjunction with the Five-Year Reviews. Two MWs are located on the property, MW148 and MW149, which are sampled biennially.
Historical capping and locking information	Capped and Locked on June 22, 1995.	--
License Agreement Status	Current agreement in place.	--
Property has a residence	Yes.	--
Review of the Kentucky Database for Water Wells	No new wells have been installed/reported to Kentucky.	The Water Well & Spring Records Database, Kentucky Groundwater Data Repository was reviewed and was current on the Web as of June 2014.
Visual assessment of property*	Visual from well, drive-by, and aerial photograph noted no visible sign of groundwater usage.	Resident confirmed not using existing wells. Resident confirmed no new water well has been installed. It was noted that the lock was missing on R31. The resident was informed that the lock would be replaced, but did not express any concern or asked any additional questions. Lock was replaced as of February 19, 2016.

*See Appendix A for Assessment Forms

Figure 24. Property 10 Aerial View—Overall

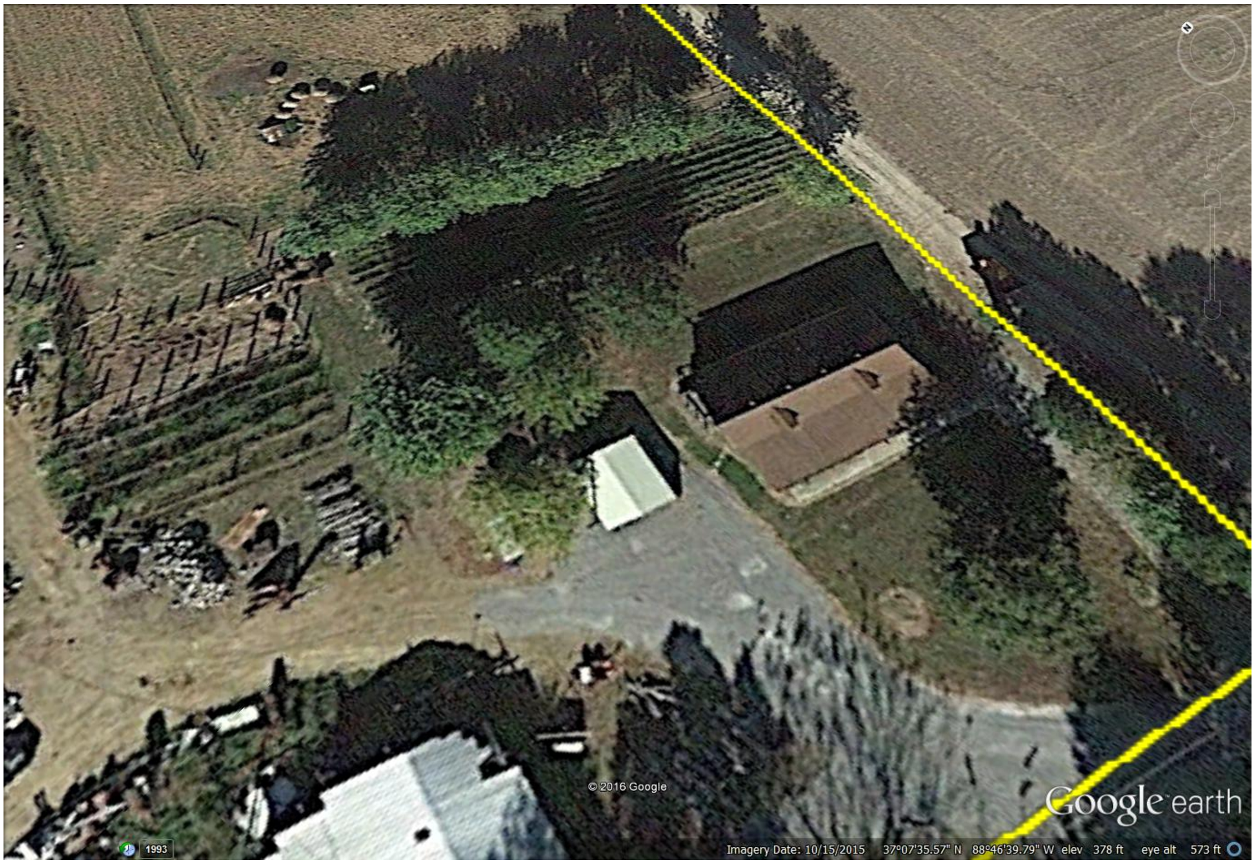

Figure 25. Property 10 Aerial View—Residence with Well Pad

3.1.11 Property 11 Evaluation

Table 11 presents the evaluation results and additional comments concerning Property 11, and Figures 26 and 27 present the overall aerial view of the property along with an example of the aerial examination.

Table 11. Property 11 Evaluation

Evaluation Process	Evaluation Results	Comments
Property overlying or immediately downgradient of the 5 µg/L or greater TCE Plume?	Yes.	Northeast Plume
Land ownership of property	No change from previous year.	--
Municipal water usage	Historically consistent.	--
Known existing wells (residential or monitoring)	Monitoring wells 252, 483-488.	MW252 is sampled annually; MWs 483-488 are sampled biennially.
Historical capping and locking information	None.	--
License Agreement Status	Current agreement in place.	--
Property has a residence	Yes.	Property purchased by parents in 1973.
Review of the Kentucky Database for Water Wells	No new wells have been installed/reported to Kentucky.	The Water Well & Spring Records Database, Kentucky Groundwater Data Repository was reviewed and was current on the Web as of June 2014.
Visual assessment of property*	Visual conducted from driveway, MWs, drive-by, and aerial photograph and noted no visible sign of groundwater usage.	Landowner confirmed not using existing wells. Landowner confirmed no new water well has been installed.

*See Appendix A for Assessment Forms

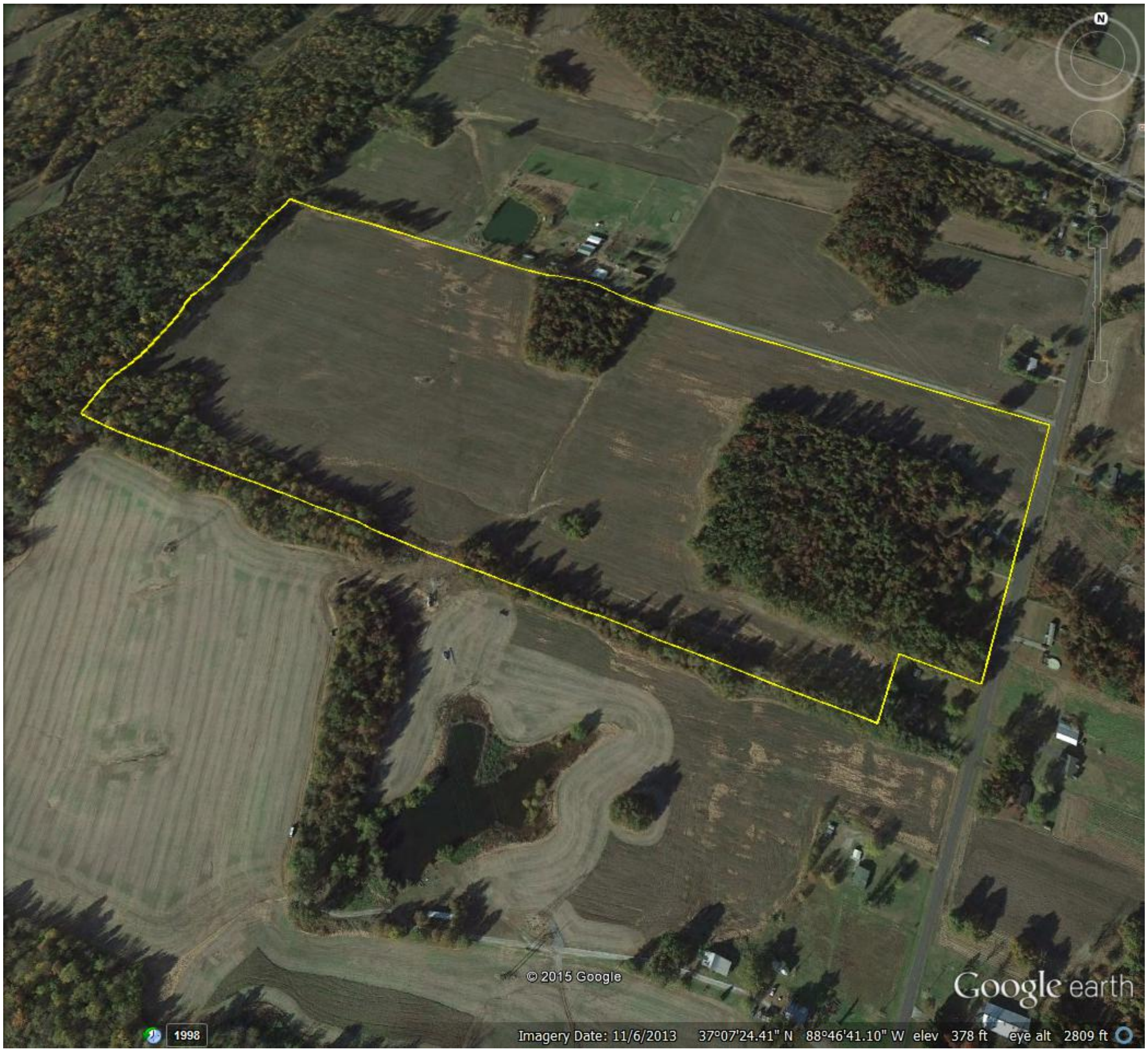

Figure 26. Property 11 Aerial View—Overall

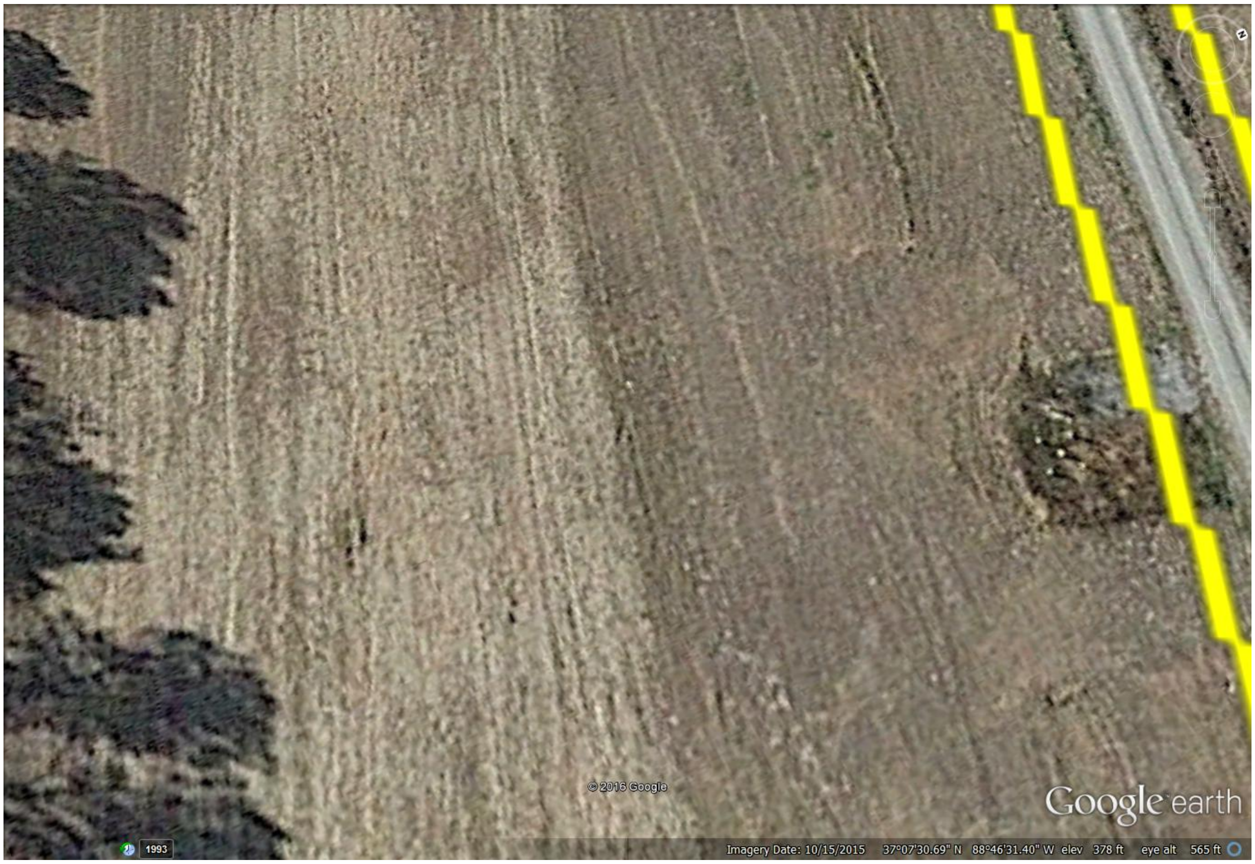

Figure 27. Property 11 Aerial View—Existing Monitoring Well

3.1.12 Property 12 Evaluation

Table 12 presents the evaluation results and additional comments concerning Property 12, and Figures 28 and 29 present the overall aerial view of the property along with an example of the aerial examination.

Table 12. Property 12 Evaluation

Evaluation Process	Evaluation Results	Comments
Property overlying or immediately downgradient of the 5 μg/L or greater TCE Plume?	Yes.	Northeast Plume
Land ownership of property	No change from previous year.	--
Municipal water usage	Historically consistent.	--
Known existing wells (residential or monitoring)	Yes, residential and two monitoring wells (253 and 409).	R528, AKGWA 0003-5132, is inspected in conjunction with the Five-Year Reviews. MW253 and MW409 are sampled annually.
Historical capping and locking information	DOE capping and locking notes state owner reported that the well was buried. Therefore, there is no cap and lock on well.	--
License Agreement Status	Current agreement in place.	--
Property has a residence	Yes.	--
Review of the Kentucky Database for Water Wells	No new wells have been installed/reported to Kentucky.	The Water Well & Spring Records Database, Kentucky Groundwater Data Repository was reviewed and was current on the Web as of June 2014. The Kentucky database reports this well as plugged.
Visual assessment of property*	Visual from approximate location of buried well, drive-by, and aerial photograph noted no visible sign of groundwater usage.	Resident confirmed not using existing wells. Resident confirmed no new water well has been installed.

*See Appendix A for Assessment Forms

Figure 28. Property 12 Aerial View—Overall

Figure 29. Property 12 Aerial View—Farmland

3.1.13 Property 13 Evaluation

Table 13 presents the evaluation results and additional comments concerning Property 13, and Figures 30 and 31 present the overall aerial view of the property along with an example of the aerial examination.

Table 13. Property 13 Evaluation

Evaluation Process	Evaluation Results	Comments
Property overlying or immediately downgradient of the 5 µg/L or greater TCE Plume?	Yes.	Northeast Plume.
Land ownership of property	Property is in estate. Landowner's sister is executor. No change was made to existing information database.	--
Municipal water usage	Historically consistent.	--
Known existing wells (residential or monitoring)	Yes, Residential.	R294, AKGWA 0003-5035, is inspected in conjunction with the Five-Year Reviews and has been sampled annually through 2015. Due to failing pump, R294 has been removed from the annual sampling program.
Historical capping and locking information	Capped and Locked on June 21, 1995.	--
License Agreement Status	Current agreement in place.	--
Property has a residence	Yes.	--
Review of the Kentucky Database for Water Wells	No new wells have been installed/reported to Kentucky.	The Water Well & Spring Records Database, Kentucky Groundwater Data Repository was reviewed and was current on the Web as of June 2014.
Visual assessment of property*	Visual from well, drive-by, and aerial photograph noted no visible sign of groundwater usage.	Executor confirmed not using existing wells. Executor confirmed no new water well has been installed.

*See Appendix A for Assessment Forms

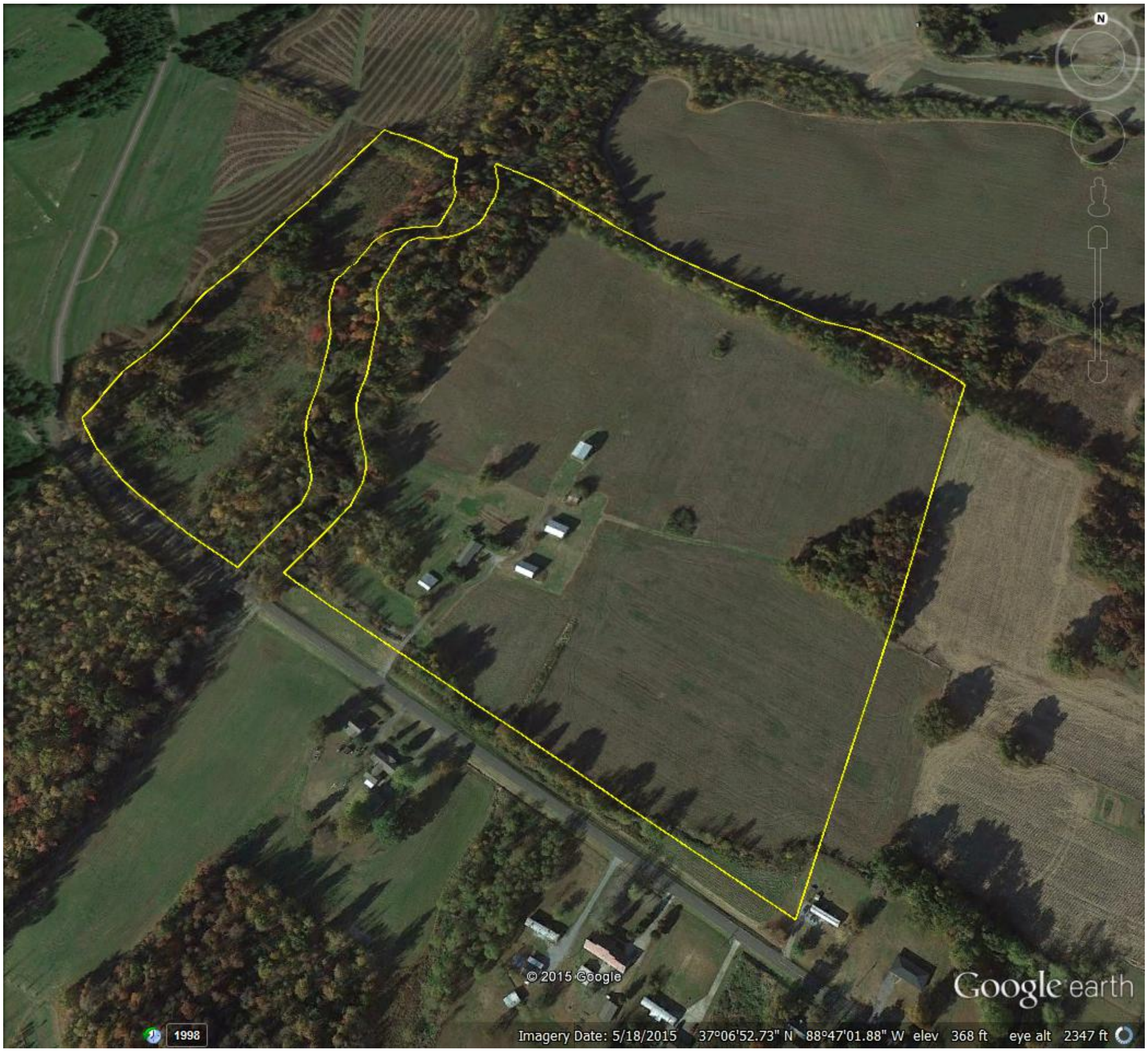

Figure 30. Property 13 Aerial View—Overall

Figure 31. Property 13 Aerial View—Well House near Residence

3.2 SUMMARY OF EVALUATION PROCESS

3.2.1 Determination of Property Overlying or Immediately Downgradient of the 5 µg/L or Greater TCE Plume

The lateral extent of the plume, shown on Figures 1 and 2, is defined by the 5 µg/L TCE contour, which is the Safe Drinking Water Act MCL for TCE. Figure 1 shows a total of 16 parcels situated overlying or immediately downgradient of the 5 µg/L or greater TCE plume.

3.2.2 Review of Land Ownership of Properties Overlying or Immediately Downgradient of the 5 µg/L or Greater TCE Plume

Land ownership was verified for these 16 parcels with the McCracken County Property Valuation Office. There are 13 landowners associated with these 16 parcels. Figure 2 groups the parcels by landowner and provides a unique identifier for each property owner and each individual parcel (1–13). No new landowners were identified by this review.

3.2.3 Review of Municipal Water Usage of Properties 1 through 13

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 Properties 1 through 13.

3.2.4 Review of Known Existing Wells (Residential or Monitoring) and Historical Capping and Locking Information for Properties 1 through 13

DOE contractors periodically inspect residential wells where access is available and a License Agreement is in place to ensure that they remain nonoperational. Residential wells with a License Agreement that are not sampled are inspected in conjunction with the Five-Year Review. When a well is sampled, any signs of use or other issues are noted and reported to the Environmental Monitoring Manager.

3.2.5 Review of the Kentucky Database for Water Wells

The Kentucky database for water wells was reviewed (current on the Web as of June 2014), and the installation of any new wells has not been reported in the Water Policy Area. The database may be accessed using the following link: http://kgs.uky.edu/kgsweb/DataSearching/Water/WaterWellSearch.asp. The following are the parameters for the database search.

Five locations were selected north of PGDP and within the Northeast and Northwest Plumes.

Northwest Plume
- Location 1: latitude 37° 08' 44"; longitude 88° 47' 14"
- Location 2: latitude 37° 08' 21"; longitude 88° 48' 02"
- Location 3: latitude 37° 07' 46"; longitude 88° 48' 35"

Northeast Plume
- Location 4: latitude 37° 08' 01"; longitude 88° 46' 45"
- Location 2: latitude 37° 07' 08"; longitude 88° 47' 11"

A search was conducted for wells within a radius of 4,000 ft.

3.2.6 Visual Assessment of Properties 1 through 13

DOE has attempted to execute license agreements with property owners within the Water Policy area. In the license agreements, DOE agrees to provide and pay for the owner's reasonable municipal water usage in exchange for the property owner's commitment to forego the use of groundwater from the property. In addition, the license agreements grant DOE access to the property to collect samples and to check the status of caps and locks placed on residential wells. DOE has executed license agreements with owners of ten of the thirteen owners of properties situated above the 5 µg/L or greater TCE plume and immediately downgradient. The three properties without a license agreement (Properties 1, 2, and 5) had a visual inspection by drive-by only.

Of the three properties for which there are no license agreements:

- Property 1 has no residence, but has a hunt club; municipal water is paid by DOE;
- Property 2 has a residence, but municipal water is paid by DOE; and
- Property 5 is farmland, has no residence, no water bill, and no known well.

A checklist was developed for the property assessment that includes the following:

- Background (e.g., current license agreement);
- Results of any on-site assessment (e.g., confirming that owner does not use groundwater);
- Results of any off-site assessment where access is not granted; and
- Results of examination of aerial images.

For the aerial images of Properties 1 through 13, existing well locations were examined, looking for disturbed soil around the well. Then the remaining portion of each property was examined in a systematic manner (e.g., Southeastern corner clockwise) for disturbed soil (e.g., mounded in one small location indicating a well could have been installed or in a line indicating a new line could have been installed) and for the presence of new well houses/casings.

Appendix A contains forms from the assessment of each property that overlies or is immediately downgradient of the 5 µg/L or greater TCE plume.

None of the assessments revealed any sign of groundwater use at any of the properties. Of note, two properties (IDs 3 and 10) were found to need replacement locks, and one of the two needed a replacement cap. DOE did not explicitly ask the resident why the locks were missing or why the cap was broken, but DOE confirmed with the residents that they were not using the existing water wells(s) and that neither had drilled a new water well. As noted on the forms, DOE verified that a license agreement is in place with both residents that prohibits using groundwater and that DOE continues to pay both residents' water bills. Each resident was informed that the cap and lock, as necessary, would be replaced. Neither resident expressed any concern or asked any additional questions. Additionally, both of these wells contain a low-flow bladder pump for sampling purposes; this type pump can be used only when attached to an air compressor.

4. CONCLUSION

DOE has examined all reasonably available lines of evidence and has concluded that no owners or occupants of any of the parcels located above the contaminated groundwater plume (i.e., overlying or immediately downgradient of the 5 µg/L or greater TCE plume) are using groundwater. As such, this study meets the requirements set forth in EPA's September 30, 2014, letter requesting that DOE demonstrate that all residents located above the contaminated groundwater plume are not using groundwater from their wells.

5. REFERENCES

DOE (U.S. Department of Energy) 1993. *Engineering Evaluation/Cost Analysis for the Water Policy at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/06-1142&D2, U.S. Department of Energy, Paducah, KY, May.

DOE 1994. *Action Memorandum for the Water Policy at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/06-1201&D2, U.S. Department of Energy, Paducah, KY, June.

DOE 2014. The *Five-Year Review for Remedial Actions at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-1289&D2/R1, U.S. Department of Energy, Paducah, KY, May.

DOE 2016. *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, U.S. Department of Energy, Paducah, KY, February.

EPA (U.S. Environmental Protection Agency) 2014. R. Chaffins, U.S. Environmental Protection Agency, Region 4, Atlanta, GA, letter to J. Woodard, U.S. Department of Energy, Paducah, KY, September 30.

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APPENDIX

ASSESSMENT FORMS

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Assessment of Selected Property within the Water Policy Box

Property ID: 1

1. Background
   a. Current License Agreement expiration date: N/A

   b. Known existing wells: None

2. Onsite Assessment
   a. Means by which consent to enter property is provided (e.g., in person/telephone):

      N/A

   b. Are cap and lock in good condition: N/A

   c. Is well in good condition: N/A

   d. Confirm with occupant that they are not using existing water wells? N/A

   e. Confirm with occupant that they have not drilled a new water well? N/A

   f. From location of existing well, are there signs of additional wells? NO

   g. Other observations related to possible groundwater usage?

      There is no sign of groundwater usage. The property appears to be abandoned.

3. Aerial Observations

   No signs of groundwater well was seen on property.

Completed by: Justin Riley / [signature] 2-4-16 Print/Sign/Date

Teresa Overby / [signature] 2-4-16 Print/Sign/Date

Assessment of Selected Property within the Water Policy Box

Property ID: 2

1. Background
   a. Current License Agreement expiration date: N\A

   b. Known existing wells: 1 well capped below grade. AKGWA # 0003-0205

2. Onsite Assessment
   a. Means by which consent to enter property is provided (e.g., in person/telephone):

      N\A

   b. Are cap and lock in good condition: N\A

   c. Is well in good condition: N\A

   d. Confirm with occupant that they are not using existing water wells? N\A

   e. Confirm with occupant that they have not drilled a new water well? N\A

   f. From location of existing well, are there signs of additional wells? NO

   g. Other observations related to possible groundwater usage?

      Drive by observation indicates no groundwater usage and no visible residential wells.

3. Aerial Observations

   No signs of groundwater well being present on property.

Completed by: Justin Riley / [signature] 2-4-16 Print/Sign/Date

Teresa Overby / [signature] 2/4/2016 Print/Sign/Date

Assessment of Selected Property within the Water Policy Box

Property ID: 3

1. Background
   a. Current License Agreement expiration date: 12-31-18

   b. Known existing wells: R16 - Located under existing house
      R245

2. Onsite Assessment
   a. Means by which consent to enter property is provided (e.g., in person/telephone):

      Telephone

   b. Are cap and lock in good condition: R-245 No (cap is broken, Lock is missing)

   c. Is well in good condition: yes

   d. Confirm with occupant that they are not using existing water wells? yes

   e. Confirm with occupant that they have not drilled a new water well? yes

   f. From location of existing well, are there signs of additional wells? NO

   g. Other observations related to possible groundwater usage?

      No observations of possible ground water usage.

3. Aerial Observations
   No visable sign of water wells being installed on property other than existing well.

Completed by: Justin Riley 2-4-16 — Print/Sign/Date

Teresa Overley 2-4-2016 — Print/Sign/Date

* Replacement parts order as of 2/8/2016. TO 2/12/2016

** cap and lock were fixed on 2/25/2016. TO 3/3/2016

Assessment of Selected Property within the Water Policy Box

Property ID: 4

1. Background
   a. Current License Agreement expiration date: 12-31-18

   b. Known existing wells: None

2. Onsite Assessment
   a. Means by which consent to enter property is provided (e.g., in person/telephone):

      Telephone

   b. Are cap and lock in good condition: N/A

   c. Is well in good condition: N/A

   d. Confirm with occupant that they are not using existing water wells? N/A

   e. Confirm with occupant that they have not drilled a new water well? Yes

   f. From location of existing well, are there signs of additional wells? NO

   g. Other observations related to possible groundwater usage?

      No indication of possible groundwater usage. Owner indicated there was a residential well on the property in the 1950's but it was filled many years ago.

3. Aerial Observations

   No signs of new groundwater well installed on property.

Completed by: Justin Riley / [signature] Print/Sign/Date 2-4-16

Teresa Overby / [signature] Print/Sign/Date 2/4/2016

Assessment of Selected Property within the Water Policy Box

Property ID: 5

1. Background
   a. Current License Agreement expiration date: N\A

   b. Known existing wells: NONE

2. Onsite Assessment
   a. Means by which consent to enter property is provided (e.g., in person/telephone):

      N\A

   b. Are cap and lock in good condition: N\A

   c. Is well in good condition: N\A

   d. Confirm with occupant that they are not using existing water wells? N\A

   e. Confirm with occupant that they have not drilled a new water well? N\A

   f. From location of existing well, are there signs of additional wells? NO

   g. Other observations related to possible groundwater usage?

      Drive by observation of property revealed no evidence of new or existing groundwater wells.

3. Aerial Observations

   No signs of groundwater well on property.

Completed by: Justin Riley [signature] Print/Sign/Date 2-4-16

Teresa Ovenby [signature] Print/Sign/Date 2-4-16

Assessment of Selected Property within the Water Policy Box

Property ID: 6

1. Background
   a. Current License Agreement expiration date: 9-30-19

   b. Known existing wells: None

2. Onsite Assessment
   a. Means by which consent to enter property is provided (e.g., in person/telephone):

      Telephone

   b. Are cap and lock in good condition: N\A

   c. Is well in good condition: N\A

   d. Confirm with occupant that they are not using existing water wells? Yes

   e. Confirm with occupant that they have not drilled a new water well? Yes

   f. From location of existing well, are there signs of additional wells? NO

   g. Other observations related to possible groundwater usage?

      Observations do not indicate any groundwater usage.

3. Aerial Observations

   No signs of groundwater well on property.

Completed by: Justin Riley [signature] 2-4-16
Print/Sign/Date

Teresa Overby / [signature] 2-4-16
Print/Sign/Date

Assessment of Selected Property within the Water Policy Box

Property ID: 7

1. Background
   a. Current License Agreement expiration date: 12-31-18

   b. Known existing wells: R530, AKGWA 0004-2844

2. Onsite Assessment
   a. Means by which consent to enter property is provided (e.g., in person/telephone):

      Person

   b. Are cap and lock in good condition: N/A*

   c. Is well in good condition: N/A*

   d. Confirm with occupant that they are not using existing water wells? Yes

   e. Confirm with occupant that they have not drilled a new water well? Yes

   f. From location of existing well, are there signs of additional wells? NO

   g. Other observations related to possible groundwater usage?

      *The existing residential well is located under an addition To The house. IT is NOT accessible.

      There is no evidence of groundwater usage.

3. Aerial Observations

   No sign of groundwater well on property.

Completed by: Justin Riley / [signature] Print/Sign/Date 2-5-16 Teresa Overby / [signature] Print/Sign/Date 2-5-16

Assessment of Selected Property within the Water Policy Box

Property ID: 8

1. Background
   a. Current License Agreement expiration date: 12-14-17

   b. Known existing wells: None

2. Onsite Assessment
   a. Means by which consent to enter property is provided (e.g., in person/telephone):

      Occupants could not be reached after several attempts in person.

   b. Are cap and lock in good condition: N/A

   c. Is well in good condition: N/A

   d. Confirm with occupant that they are not using existing water wells? N/A

   e. Confirm with occupant that they have not drilled a new water well? NO

   f. From location of existing well, are there signs of additional wells? NO

   g. Other observations related to possible groundwater usage?

      Property surrounding the house was inspected and there is no evidence of possible groundwater usage.

3. Aerial Observations

   No signs of groundwater well on property.

Completed by: Justin Riley / [signature] Print/Sign/Date 2-5-16   Teresa Overby / [signature] Print/Sign/Date 2-5-16

Assessment of Selected Property within the Water Policy Box

Property ID: 9

1. Background
   a. Current License Agreement expiration date: 6-30-17

   b. Known existing wells: R20 - AKGWA 0003-5077

2. Onsite Assessment
   a. Means by which consent to enter property is provided (e.g., in person/telephone):

      Telephone

   b. Are cap and lock in good condition: yes

   c. Is well in good condition: yes

   d. Confirm with occupant that they are not using existing water wells? yes

   e. Confirm with occupant that they have not drilled a new water well? yes

   f. From location of existing well, are there signs of additional wells? NO

   g. Other observations related to possible groundwater usage?

      No observations of possible groundwater usage.

3. Aerial Observations

   No signs of additional groundwater well on property.

Completed by: Justin Riley / Justin Riley
Print/Sign/Date 2-4-16

Teresa Doerby / Teresa Doerby
Print/Sign/Date 2-4-16

Assessment of Selected Property within the Water Policy Box

Property ID: 10

1. Background
   a. Current License Agreement expiration date: 7-21-20

   b. Known existing wells: R31 AKGWA 0003-5008

2. Onsite Assessment
   a. Means by which consent to enter property is provided (e.g., in person/telephone):

      Telephone

   b. Are cap and lock in good condition: Cap is present, lock is missing.

   c. Is well in good condition: yes

   d. Confirm with occupant that they are not using existing water wells? yes

   e. Confirm with occupant that they have not drilled a new water well? yes

   f. From location of existing well, are there signs of additional wells? NO

   g. Other observations related to possible groundwater usage?

      There are no indications of possible groundwater usage. Owner was notified the lock will be replaced on the well cap.

3. Aerial Observations

   No signs of additional groundwater well on property.

Completed by: Justin Riley [signature] Print/Sign/Date 2-4-16

Teresa Ownby [signature] Print/Sign/Date 2-4-16

* Lock replacement has been obtained and scheduled for 2/18/2016. TO 2/16/2016

** Lock was replaced on 2/19/2016. TO 3/3/2016

Assessment of Selected Property within the Water Policy Box

Property ID: 11

1. Background
   a. Current License Agreement expiration date: 9-30-19

   b. Known existing wells: None

2. Onsite Assessment
   a. Means by which consent to enter property is provided (e.g., in person/telephone):

      Telephone

   b. Are cap and lock in good condition: N/A

   c. Is well in good condition: N/A

   d. Confirm with occupant that they are not using existing water wells? yes

   e. Confirm with occupant that they have not drilled a new water well? yes

   f. From location of existing well, are there signs of additional wells? NO

   g. Other observations related to possible groundwater usage?

      There is no evidence of possible groundwater usage.

3. Aerial Observations

   No signs of groundwater well on property.

Completed by: Justin Riley [signature] Print/Sign/Date 2-4-16

Teresa Alberty [signature] Print/Sign/Date 2-4-16

Assessment of Selected Property within the Water Policy Box

Property ID: 12

1. Background
   a. Current License Agreement expiration date: 12-31-17

   b. Known existing wells: R528 (buried)

2. Onsite Assessment
   a. Means by which consent to enter property is provided (e.g., in person/telephone):

      Telephone

   b. Are cap and lock in good condition: N\A

   c. Is well in good condition: N\A

   d. Confirm with occupant that they are not using existing water wells? Yes

   e. Confirm with occupant that they have not drilled a new water well? Yes

   f. From location of existing well, are there signs of additional wells? NO

   g. Other observations related to possible groundwater usage?

      Owner confirmed previous well R528 was buried years ago. There is no evidence to suggest possible groundwater usage.

3. Aerial Observations

   No sign of groundwater well on property

Completed by: Justin Riley [signature] 2-4-16 Print/Sign/Date

Teresa Overby / [signature] 2-4-16 Print/Sign/Date

Assessment of Selected Property within the Water Policy Box

Property ID: 13

1. Background
   a. Current License Agreement expiration date: 12-31-2018

   b. Known existing wells: R294, AKGWA 0003-5035

2. Onsite Assessment
   a. Means by which consent to enter property is provided (e.g., in person/telephone):

      Telephone

   b. Are cap and lock in good condition: Yes

   c. Is well in good condition: yes

   d. Confirm with occupant that they are not using existing water wells? yes*

   e. Confirm with occupant that they have not drilled a new water well? yes*

   f. From location of existing well, are there signs of additional wells? No

   g. Other observations related to possible groundwater usage?

      *Currenty not occupied. Confirmation made with owner's sister.

      No evidence of possible groundwater usage.

3. Aerial Observations

   No signs of new groundwater well was seen on property.

Completed by: Justin Riley [signature] Print/Sign/Date 2-4-16

Teresa [signature] Print/Sign/Date 2-4-16

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APPENDIX D

C-400 VAPOR INTRUSION ADDITIONAL ACTIONS

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Addendum to the
Five-Year Review for Remedial Actions at the Paducah Gaseous Diffusion Plant, Paducah Kentucky, DOE/LX/07-1289&D2/R1/A2/R2, Dated October 2017

A Five-Year Review addendum generally is completed for remedies where the protectiveness determination is deferred until further information is obtained. This Addendum provides progress since the 2013 Five-Year Review for the C-400 Cleaning Building electrical resistance heating (ERH) interim remedial action because the 2013 protectiveness determination was deferred by the U.S. Environmental Protection Agency (EPA). It also includes a revised protectiveness determination based on information obtained since the 2013 Five-Year Review.

The 2013 Five-Year Review report (Report) for the Paducah Gaseous Diffusion Plant in Paducah, Kentucky, outlined the following protectiveness statement(s).

GROUNDWATER OPERABLE UNIT

<u>Northwest Plume</u>

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 plume need to be evaluated for long-term protection.

<u>Northeast Plume</u>

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 need to be evaluated for long-term protection.

<u>Cylinder Drop Test Area</u>

The remedy for the Cylinder Drop Test Area is protective of human health and the environment in the short-term. Exposure pathways that could result in unacceptable risk are being controlled through U.S. Department of Energy (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 trichloroethene (TCE) cleanup level providing long-term protection of groundwater has not been established yet. In order to establish long-term protectiveness, per the Federal Facility Agreement (FFA), "…any necessary remedial action shall be selected and implemented…." as part of the Comprehensive Site Operable Unit (CSOU).

<u>Water Policy</u>

2013 Five-Year Review Original Protectiveness Statement:

> 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 need to be evaluated for long-term protection.

EPA Deferred Protectiveness Statement (September 30, 2014):

> 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.

2013 Five-Year Review Appendix C Revised Protectiveness Statement (October 2017):

> 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.

C-400 Cleaning Building ERH[1]

2013 Five-Year Review Original 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, 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. However, in order to establish long-term protectiveness, additional remedial actions will be evaluated and selected, as necessary, under the GDP Groundwater Sources OU.

EPA Deferred Protectiveness Statement (September 30, 2014):

> The protectiveness determination of the remedy for the C-400 Building cannot be made at this time until further information is obtained. Further information will be obtained by taking the following actions: a vapor intrusion study will be conducted that is consistent with EPA protocol and based on current toxicity values and risk assessment methodology. 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.

2013 Five-Year Review Appendix C Revised Protectiveness Statement (May 2018):

> The Interim Remedial Action (IRA) for volatile organic compound (VOC) contamination at C-400 Cleaning Building is protective of human health and the environment upon completion 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

[1] This addendum addresses the Protectiveness Statement(s) for Groundwater OU, C-400 Cleaning Building ERH.

Response, Compensation, and Liability Act (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 C-400 Cleaning Building. In order to establish long-term protectiveness, however, additional remedial actions will be evaluated and selected, as necessary, under the C-400 Complex Operable Unit (OU).

Southwest Plume

The remedial action for VOC sources at the Southwest Plume is expected to be protective of human health and the environment upon completion. Interim LUCs, consisting of placement of warning signs and the DOE 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.

SURFACE WATER OPERABLE UNIT

North-South Diversion Ditch (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.

NSDD Sections 1 and 2

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 currently are being controlled. This project is not a comprehensive final action for Solid Waste Management Unit 59. In order to establish long-term protectiveness, additional action will be evaluated and selected, as necessary, under the Surface Water OU (SWOU).[2]

C-746-K Landfill

The remedy for the C-746-K Landfill 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.

Fire Training Area

The remedy for the Fire Training Area 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 remedial action shall be selected and implemented…." as part of the CSOU.

[2] The 2018 Five-Year Review will reflect changes to NSDD Sections 1 and 2 strategy that were made and agreed to by the FFA parties for the FY 2018 Site Management Plan. NSDD Sections 1 and 2 changes will be evaluated as necessary under the CSOU.

Surface Water Interim Corrective Measures

The remedy for the surface water interim corrective measures (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.

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, however, additional remedial actions will be evaluated and selected, as necessary, under the SWOU.

BURIAL GROUNDS OPERABLE UNIT

C-749 Uranium Burial Ground

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 remedial action and was not designed to address fully the risks to human health and the environment from the buried wastes or 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 currently is being evaluated under the Burial Grounds OU to ensure long-term protectiveness.

The 2013 Five-Year Review deferred protectiveness determinations for two of the preceding remedies (Water Policy Removal Action and C-400 Cleaning Building ERH Interim Remedial Action). Appendix C (dated October 2017) of the 2013 Five-Year Review contains the necessary information and the revised protectiveness statement for the Water Policy Removal Action (dated October 2017). The necessary information and the revised protectiveness statement for the C-400 Cleaning Building ERH are contained in this document, Appendix D, for the 2013 Five-Year Review.

PROGRESS SINCE THE FIVE-YEAR REVIEW COMPLETION DATE

This addendum was prepared to document the additional information that has been collected to support the protectiveness determination of the C-400 Cleaning Building ERH (Section 9 of the main text), as requested by EPA in a letter dated September 30, 2014. EPA's letter stated the following:

> The FYR protectiveness determination for Building C-400 remedy is currently "short-term protective". Given the magnitude of high concentration volatile organic compounds (VOC) contamination including TCE DNAPL present in surrounding subsurface soils and below the building, the potential for vapor intrusion is likely. Vapor intrusion into building C-400 is identified as an issue in the FYR with the recommendation that a vapor intrusion analysis be performed as part of any subsequent C-400 action. The vapor intrusion study should not be delayed until a subsequent action and should be conducted in the near term to determine whether this potential pathway presents an unacceptable risk to human health such as workers that work in and around the C-400 Building. Until a vapor intrusion study is conducted that is consistent with EPA protocol and based on current toxicity values and risk assessment methodology, the

protectiveness statement should be "deferred" until the protectiveness of the remedy can be determined.

Based on the information provided in the subject document and additional data provided by DOE, EPA has made the following determination for the C-400 Building remedy: The protectiveness determination of the remedy for the C-400 Building cannot be made at this time until further information is obtained. Further information will be obtained by taking the following actions: a vapor intrusion study will be conducted that is consistent with EPA protocol and based on current toxicity values and risk assessment methodology. 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 action:

DOE conducted a vapor intrusion study, consistent with EPA protocol based on current toxicity values and risk assessment methodology (DOE 2018a), in accordance with the approved *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. The results are documented in this Addendum.

Based on the decision rules, the VI study results show that the VI pathway for TCE is complete and exceeded Project Action Levels (PALs) in indoor air at Locations 5, 6, and 8. Based on the sub-slab concentrations in these areas, TCE concentrations in indoor air greater than the screening level continue to be possible, particularly under closed door conditions. However, cumulative excess lifetime cancer risk assuming chronic exposure by unprotected industrial workers was less than 6.0E-06 at all locations, and cumulative hazard index assuming chronic exposure by unprotected industrial workers was less than 1.0 at all but one location. Periodic air monitoring, worker access restriction or both, and/or increased ventilation may be appropriate steps to take if it is anticipated remediation workers will spend substantial time in the building in the vicinity of Locations 5, 6, and 8, until the building is decommissioned or the source is remediated.

The VI pathway is either incomplete (i.e., indoor air sampling result is nondetect) or is complete with a sampling result below the PAL, at all other sampled locations. While sub-slab soil gas concentrations are above PALs at some of the other locations (1, 4, and 7), indoor air concentrations either do not exceed their respective indoor air PALs, or they are nondetect under all tested scenarios.

Considering that the groundwater under C-400 Cleaning Building contains the highest concentrations of TCE and geologic conditions most favorable for vapor transport, it is unlikely that indoor air in other PGDP structures of similar construction with groundwater as the primary potential source of vapors would have VOC concentrations above a level that could pose an unacceptable risk to current protected workers.

It should be noted that this building is undergoing deactivation, and it is not occupied by nonremediation workers.

ISSUES AND RECOMMENDATIONS

None.

PROTECTIVENESS STATEMENTS

Based on new information obtained since the 2013 Five-Year Review, the following is the revised protectiveness statement(s) for the Groundwater OU, C-400 Cleaning Building ERH.

The IRA for the VOC contamination at C-400 Cleaning Building is protective of human health and the environment in the short-term. 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 addressed adequately the known exposure pathways that could result in unacceptable risks originating from C-400 Cleaning Building. In order to establish long-term protectiveness, however, additional remedial actions will be evaluated and selected, as necessary, under the C-400 Complex OU.

NEXT FIVE-YEAR REVIEW

The next five-year review will be completed for the period of January 2013 through December 2017, five years after the last five-year review report.

CONTENTS

FIGURES

TABLES

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ACRONYMS

CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CSM	conceptual site model
CSOU	Comprehensive Site Operable Unit
DNAPL	dense nonaqueous-phase liquid
DOE	U.S. Department of Energy
ELCR	excess lifetime cancer risk
EPA	U.S. Environmental Protection Agency
EPCC	exposure point concentration
FFA	Federal Facility Agreement
FYR	five-year review
HI	hazard index
HQ	hazard quotient
ICM	interim corrective measure
IRA	interim remedial action
KDEP	Kentucky Department for Environmental Protection
KDFWR	Kentucky Department of Fish and Wildlife Resources
LUC	land use control
NSDD	North-South Diversion Ditch
OU	operable unit
OREIS	Oak Ridge Environmental Information System
PAL	Project Action Level
PGDP	Paducah Gaseous Diffusion Plant
QAPP	quality assurance project plan
RGA	Regional Gravel Aquifer
RL	reporting limit
RPD	relative percent difference
SAP	sampling and analysis plan
SWOU	Surface Water Operable Unit
UCRS	Upper Continental Recharge System
VI	vapor intrusion
VISL	Vapor Intrusion Screening Level
VOC	volatile organic compound
WKWMA	West Kentucky Wildlife Management Area
WP	work plan

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D.1. INTRODUCTION

This report presents the results of the vapor intrusion (VI) study performed in accordance with the approved *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 Work Plan (WP) (DOE 2017), which was conducted as an additional action subsequent to the *Five-Year Review for Remedial Actions at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-1289&D2/R1 (DOE 2014a). The WP was developed to document the site-specific VI conceptual site model (CSM) for the C-400 Cleaning Building at the U.S. Department of Energy (DOE) Paducah Gaseous Diffusion Plant (PGDP) and to provide a sampling and analysis plan (SAP) guiding the collection of vapor samples within and around C-400 Cleaning Building. This VI study was conducted under the provisions of Section XXX, Five-Year Review, of the PGDP Federal Facility Agreement (FFA) (EPA 1998), as documented in the Record of Conversation letter dated August 1, 2014 (DOE 2014b).

Consistent with the U.S. Environmental Protection Agency's (EPA) *Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air* (EPA 2015), the WP included the following:

1. Provided a compilation and summary of existing information and data relevant to the VI pathway at C-400 Cleaning Building;

2. Documented the preliminary and detailed VI evaluations for C-400 Cleaning Building;

3. Summarized the C-400 Cleaning Building site-specific VI CSM, analyzed the completeness of the VI pathway in the context of the VI CSM, and identified data gaps;

4. Presented the rationale for additional sampling at C-400 Cleaning Building;

5. Recommended screening levels based on toxicity values from the EPA's Regional Screening Levels—Generic Tables (November 2017) (EPA 2017a);

6. Described the sampling and analysis needed to determine whether volatile organic compound (VOC) [primarily trichloroethene (TCE)] concentrations present an unacceptable risk to human health due to VI in C-400 Cleaning Building; and

7. Provided decision rules for evaluating the data collected as part of this VI study.

The WP was approved by the EPA and the Kentucky Division of Waste Management (KDWM) on August 11, 2017 (EPA 2017b; KDWM 2017, respectively). Previous inspection of C-400 Cleaning Building identified historical releases of TCE to the subsurface around and beneath the building and the presence of cracks and other openings in the concrete flooring in areas. Together, these items suggest that there is potential for vapor migration from the subsurface to indoor air. The goal of this VI study is to determine whether the VI pathway is complete and presents unacceptable risks to humans working in and around C-400 Cleaning Building.

D.1.1 PROJECT OBJECTIVE

The objective of the VI study is to evaluate whether the subsurface-to-indoor air VI pathway is complete and presents an unacceptable risk to workers in and around C-400 Cleaning Building.

D.1.2 PROJECT SCOPE

The C-400 Cleaning Building VI study was completed using three scenarios representative of current and possible future working conditions for C-400 Cleaning Building workers. Each scenario was maintained for 24 hours prior to initiation of sampling. The three sampled scenarios included the following in the order performed:

- Exhaust fan off and large bay doors closed;
- Exhaust fan on and large bay doors open; and
- Exhaust fan on and large bay doors closed.

As part of the VI study, vapor samples were collected at eight indoor and four ambient (outdoor) locations during each scenario. Seven of the eight indoor sampling locations were co-located with sub-slab sampling locations that were collected concurrently to the indoor and ambient vapor samples. One of the indoor air sampling locations was accessed via a sample port installed within an operational exhaust fan and had no corresponding sub-slab sampling. SUMMA® canister samples were collected as 10-hour integrated samples during normal work hours to mirror the exposure duration of a typical worker within C-400 Cleaning Building. Temperature and differential pressure (indoor air to ambient air) were measured in the vicinity of the indoor air SUMMA® canisters, six times per each sampling scenario (i.e., start of the sampling event, end of sampling event, and every two hours during sampling event). Differential pressure also was measured at the sub-slab locations (split manometer) and at the exhaust fan location six times per each sampling event (i.e., start of the sampling event, end of sampling event, and every two hours during sampling event).

D.1.3 PROJECT APPROACH

The following approach was agreed to by the FFA parties to meet the project objective of this VI study.

- Advance seven sub-slab monitoring points through the concrete slab of C-400 Cleaning Building using a hammer drill with a 5/8-inch drill bit to the top of the gravel underlying the slab; record the thickness of the concrete at each location and set the sub-slab probe.

- Set up each sampling scenario (i.e., exhaust fan on and large bay doors open, exhaust fan on and large bay doors closed, and exhaust fan off and large bay doors closed) a minimum of 24 hours prior to the start of the sampling event.

- Collect vapor samples using SUMMA® canisters over a 10-hour integrated sampling period during normal work hours to mirror the exposure duration of a typical worker within C-400 Cleaning Building from eight indoor air, seven sub-slab, and four ambient air vapor samples and analyze for volatile organic compounds (VOCs).

- Collect temperature and differential pressure (relative to ambient air) readings at each of the indoor air and exhaust fan SUMMA® canisters, six times per each sampling scenario.

- Collect differential pressure readings at the sub-slab locations (split manometer) six times per each sampling event (i.e., start of the sampling event, end of sampling event, and every two hours during sampling).

- Set up a weather station outside of C-400 Cleaning Building to record the temperature, barometric pressure, wind direction and speed, and relative humidity from the weather station every two hours for a total of six readings during the sampling period of ten hours.

Figure D.1 presents a map of C-400 Cleaning Building depicting indoor air and co-located sub-slab sampling Locations 1 through 7, and exhaust fan Location 8. Figure D.2 presents a map of C-400 Cleaning Building depicting ambient air sampling Locations 1 through 4, and weather station Location 5.

D.1.4 AREA DESCRIPTION

PGDP, located within the Jackson Purchase region of western Kentucky, is an inactive uranium enrichment facility owned by the DOE. PGDP first was owned and managed by the Atomic Energy Commission and the Energy Research and Development Administration, DOE's predecessors; DOE then managed PGDP until 1993. On July 1, 1993, the United States Enrichment Corporation assumed management and operation of the PGDP enrichment facility under a lease agreement with DOE that continued until October 2014, when the facility was returned to DOE. DOE retains ownership of the enrichment complex.

Of the 3,556 acres owned by DOE, approximately 628 acres of this parcel are inside the PGDP fenced area. Most of the facilities used to support enrichment operations are located inside the PGDP fenced area. Outside the fenced area, several support facilities for DOE projects can be found. The support facilities include landfills (both active and closed), modular office complexes, a water treatment facility, groundwater remediation systems, decontamination facilities, storage areas, and a storm water retention basin. Of the remaining DOE land, approximately 1,986 acres is licensed to the Commonwealth of Kentucky Department of Fish and Wildlife Resources (KDFWR) and serves as a portion of the West Kentucky Wildlife Management Area (WKWMA). The licensed portion of the WKWMA is used by the public for hunting and horse and dog field trials. KDFWR staff work in the licensed area performing wildlife management activities.

The topography of DOE property is level to slightly rolling. It is rural and predominantly open grasslands with scattered wooded areas of mature hardwoods and brush. Approximately 60% of the total area outside PGDP, but on DOE-owned property, is grasslands; much of this non-wooded area is right-of-way for electrical power lines.

D.1.5 GEOLOGY AND SOILS

The Jackson Purchase region of western Kentucky, where PGDP is located, represents the northern tip of the Mississippi Embayment portion of the Coastal Plain. The Jackson Purchase region is an area of land that includes all of Kentucky west of the Tennessee River. The stratigraphic sequence in the region consists of Cretaceous, Tertiary, and Quaternary sediments unconformably overlying Paleozoic bedrock. Relative to the shallow groundwater flow system in the vicinity of PGDP, the continental deposits and the overlying loess and alluvium are of key importance. The continental deposits locally consist of an upper silt member, with lesser sand and gravel interbeds, and a thick, basal sand and gravel member, which fills a buried river valley. A subcrop of the Porters Creek Clay, located beneath and immediately south of PGDP marks the southern extent of the buried river valley. Fine sand and clay of the McNairy Formation

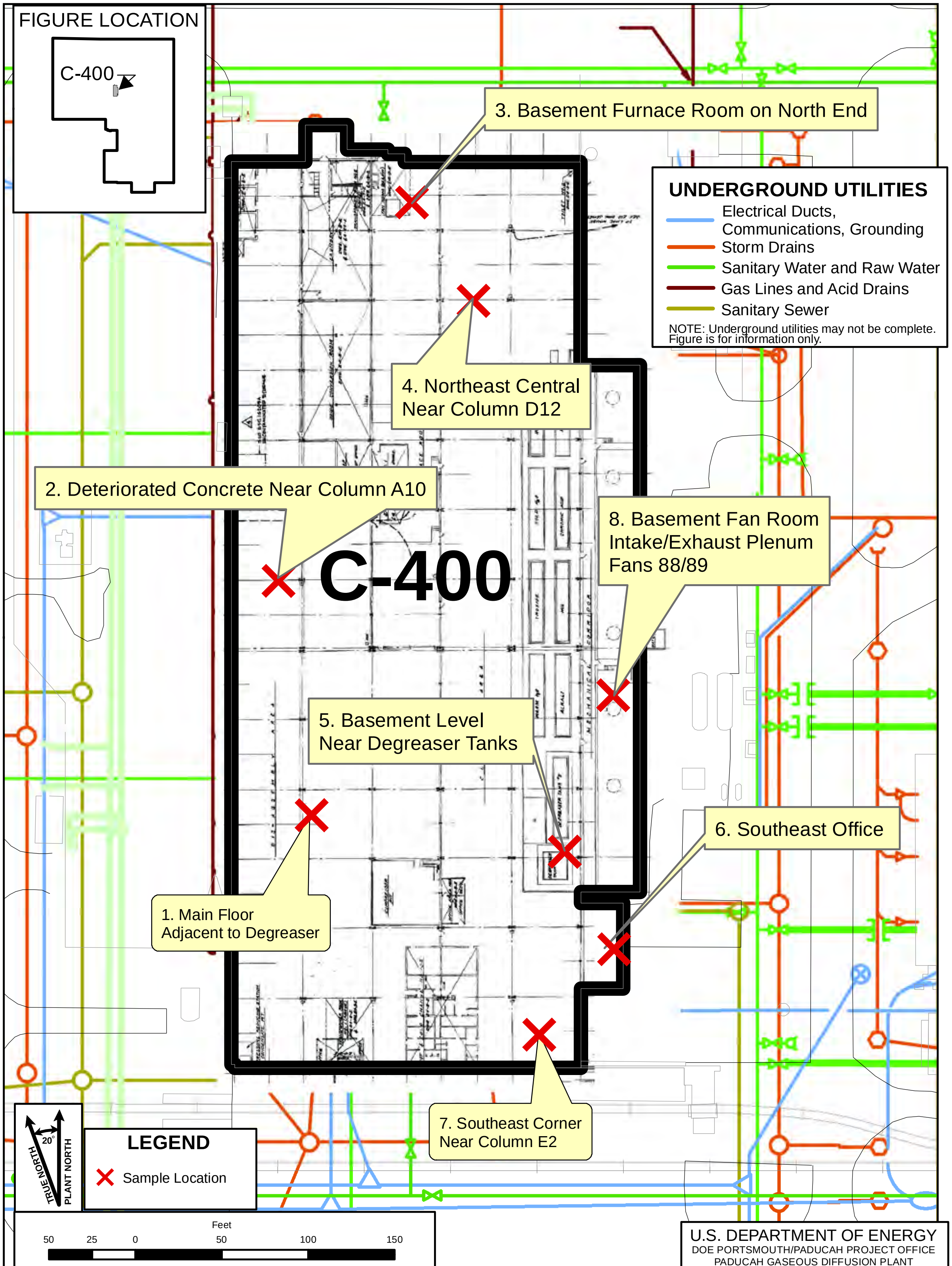


Figure D.1. Indoor Sampling Locations for C-400 Cleaning Building Vapor Intrusion Study

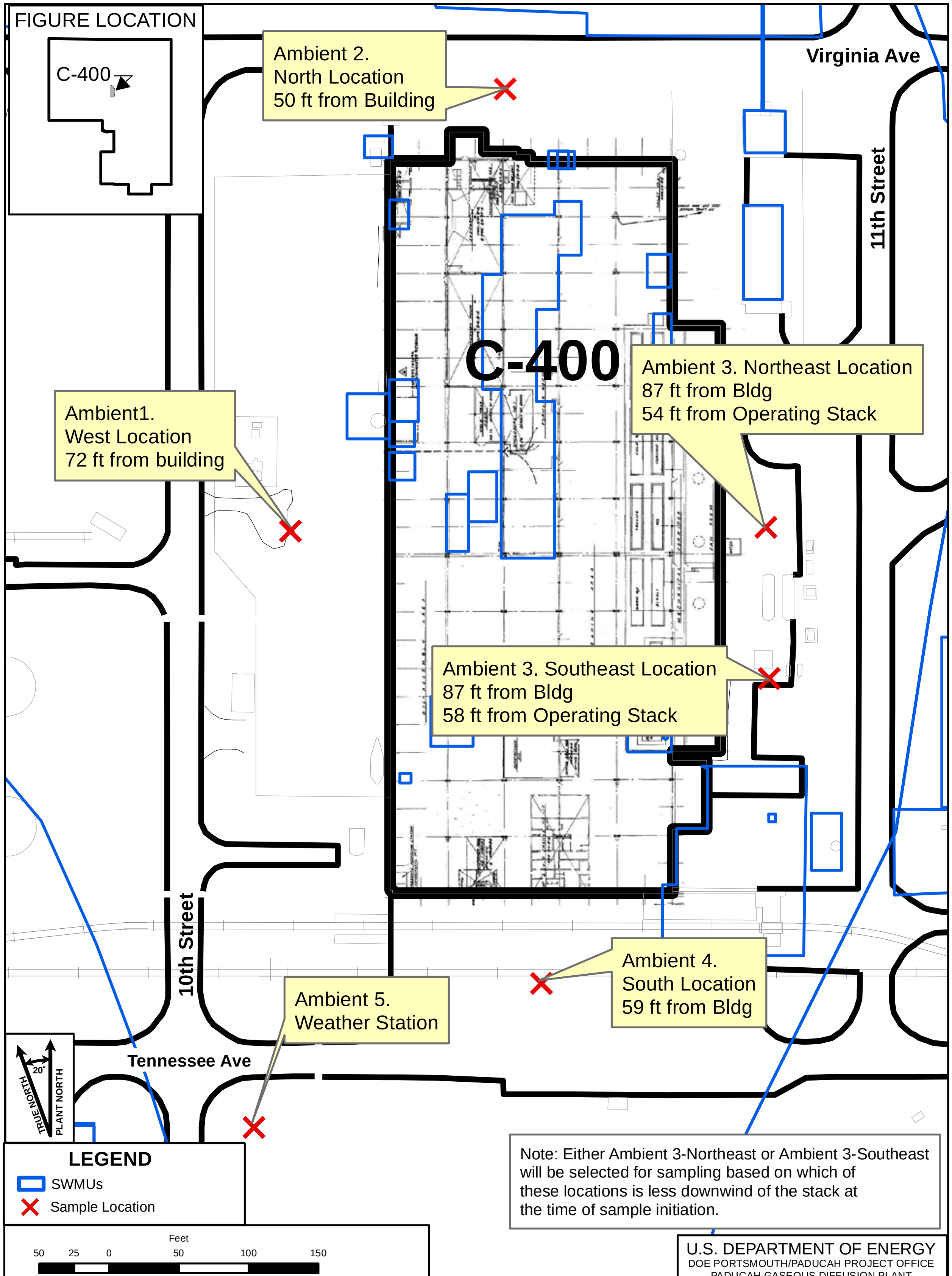


Figure D.2. Ambient Air Sampling Locations for C-400 Cleaning Building Vapor Intrusion Study

FOUR RIVERS NUCLEAR PARTNERSHIP, LLC

directly underlie the continental deposits in the buried river valley. These continental deposits are continuous from beneath PGDP northward beyond the present course of the Ohio River.

The general soil map for Ballard and McCracken Counties indicates that three soil associations are found within the vicinity of PGDP (USDA 1976): the Rosebloom-Wheeling-Dubbs association, the Grenada-Calloway association, and the Calloway-Henry association. The predominant soil association in the vicinity of PGDP is the Calloway-Henry association, which consists of nearly level, somewhat poorly drained, medium-textured soils on upland positions. Many of the characteristics of the original soil have been lost due to industrial activity that has occurred over the past 50-plus years. Activities that have disrupted the original soil classifications include filling, mixing, and grading. The soil type present in these disturbed areas is characterized as urban.

D.1.6 HYDROGEOLOGY

PGDP is located in the western portion of the Ohio River drainage 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, PGDP is within the drainage areas of the Ohio River, Bayou Creek, and Little Bayou Creek.

PGDP is situated on the divide between the two creeks. Bayou Creek is a perennial stream on the western boundary of the plant that flows generally northward, from approximately 2.5 miles south of the plant site to the Ohio River. Little Bayou Creek becomes a perennial stream at the east outfalls of PGDP. Little Bayou Creek drainage originates within WKWMA and extends northward and joins Bayou Creek near the Ohio River. The drainage basins for both creeks are located in rural areas; however, they receive surface drainage from numerous swales that drain residential and commercial properties, including WKWMA, PGDP, and Tennessee Valley Authority Shawnee Fossil Plant. The confluence of the two creeks is approximately 3 miles north of the plant site, just upstream of the location at which the combined flow of the creeks discharges into the Ohio River (DOE 2008).

During uranium enrichment operations (1952–2013) and continuing into 2014, most of the flow within Bayou and Little Bayou Creeks was from process effluents or surface water runoff from PGDP. Contributions from PGDP comprised approximately 85% of flow within Bayou Creek and near 100% of flow within Little Bayou Creek. (Process effluents were reduced significantly during 2015.) A network of ditches discharges effluent and surface water runoff from PGDP to the creeks. Plant discharges are monitored at the Kentucky Pollutant Discharge Elimination System outfalls prior to discharge into the creeks.

The local groundwater flow system at PGDP occurs within the sands of the Cretaceous McNairy Formation, Pliocene Terrace Gravel, Plio-Pleistocene lower continental gravel deposits and upper continental deposits, and Holocene alluvium. The primary local aquifer is the Regional Gravel Aquifer (RGA). The RGA consists of the Quaternary sand and gravel facies of the lower continental deposits and Holocene alluvium found adjacent to the Ohio River and is of sufficient thickness and saturation to constitute an aquifer. These deposits have an average thickness of 30 ft. Groundwater flow is predominantly north toward the Ohio River (DOE 2008).

The primary source of groundwater recharge to the RGA derives as downward percolation of infiltrating rainwater and seepage from streams and ponds, through the shallow silt and fine sand units (and lesser clayey units) overlying the RGA. This flow system is termed the Upper Continental Recharge System (UCRS). The top of the saturated zone within the UCRS is the water table, which is poorly known within the Paducah Site overlying the TCE plumes. These sediments have low hydraulic conductivity

(10^{-7} to 10^{-6} cm/sec); hydraulic gradients often approach -1 ft/ft within the saturated UCRS in response to the downward groundwater flow. In the C-400 Cleaning Building area, groundwater is encountered at approximately 30 to 35 ft below ground surface in the UCRS. Figure D.3 presents the hydrogeology of the C-400 Cleaning Building area.

D.1.7 VAPOR INTRUSION CONCEPTUAL SITE MODEL

Section 6 of the WP presents a site-specific VI CSM for C-400 Cleaning Building. The VI CSM detailed in the WP used site-specific information collected during characterization studies and interim remedial actions to describe the nature, location, spatial extent of the vapor sources in the subsurface, as well as the uses (including those that could have the potential to serve as indoor vapor sources), occupancy, and construction of C-400 Cleaning Building. The VI CSM also portrays the hydrologic, hydrogeologic, and geologic setting and its influence on vapor migration and attenuation in the vadose zone.

As described in the WP, TCE contaminated groundwater and soil adjacent to and under C-400 Cleaning Building are considered sources of vapors that may migrate to indoor air in C-400 Cleaning Building. Subsurface conditions in the C-400 Cleaning Building area are considered to allow vapor transport toward the building. Although TCE concentrations in the RGA near C-400 Cleaning Building have decreased, groundwater concentrations still exceed EPA's groundwater Vapor Intrusion Screening Level (VISL). Similarly, while remedial actions have achieved greater than 95% reduction in soil concentrations in areas addressed by a remedial action, vapor concentrations associated with the remaining TCE-contaminated soil are expected to be orders of magnitude higher than the commercial soil gas and sub-slab TCE VISL screening level of 100 (micrograms per cubic meter) $\mu g/m^3$. Therefore, according to the EPA VI Guide, further investigation is appropriate to evaluate the completeness of the VI pathway in C-400 Cleaning Building.

Vapor migration from subsurface groundwater and soil sources through the vadose zone is promoted by the presence of sand in the UCRS in the vicinity of C-400 Cleaning Building, as well as the presence of gravel immediately beneath the building. The large number of utilities present in the vicinity of the building also may serve as preferential pathways for vapor migration. The presence of cracked concrete in the building slab and other potential, but unidentified VI conduits may provide potential pathways for vapor migration into the building. Figure D.4 depicts the TCE plume in the RGA in 2014.

The building includes an exhaust system (plenum with fans) constructed to induce intake of fresh air into the building and exhaust building air from C-400 Cleaning Building to limit the potential for worker exposure to vapors. At least one fan continues to operate. The plenum is below grade level and is designed to enable air flow downward through gratings and other openings in the floor from the main portion of the building and exhaust it through the stack. The plenum also may induce flow of soil gas through conduits or other potential pathways and exhaust this induced flow.

Evaluation of VI Pathway Completeness

The VI CSM describes sources of TCE immediately under and adjacent to C-400 in the form of dissolved-phase groundwater contamination and residual or adsorbed TCE in soil. Additionally, leaks from building drains and sewers are known to have historically contaminated utility trenches and adjacent soils with TCE dense nonaqueous-phase liquid (DNAPL). TCE concentrations in groundwater underlying C-400 Cleaning Building exceed the groundwater screening levels for TCE in EPA's VISL calculator (updated by EPA February 2018). Where TCE DNAPL may be present (e.g., in abandoned drain lines and utility bedding material) under C-400 Cleaning Building due to past practices, the associated vapor concentrations are expected to be orders of magnitude greater than the sub-slab VISLs.

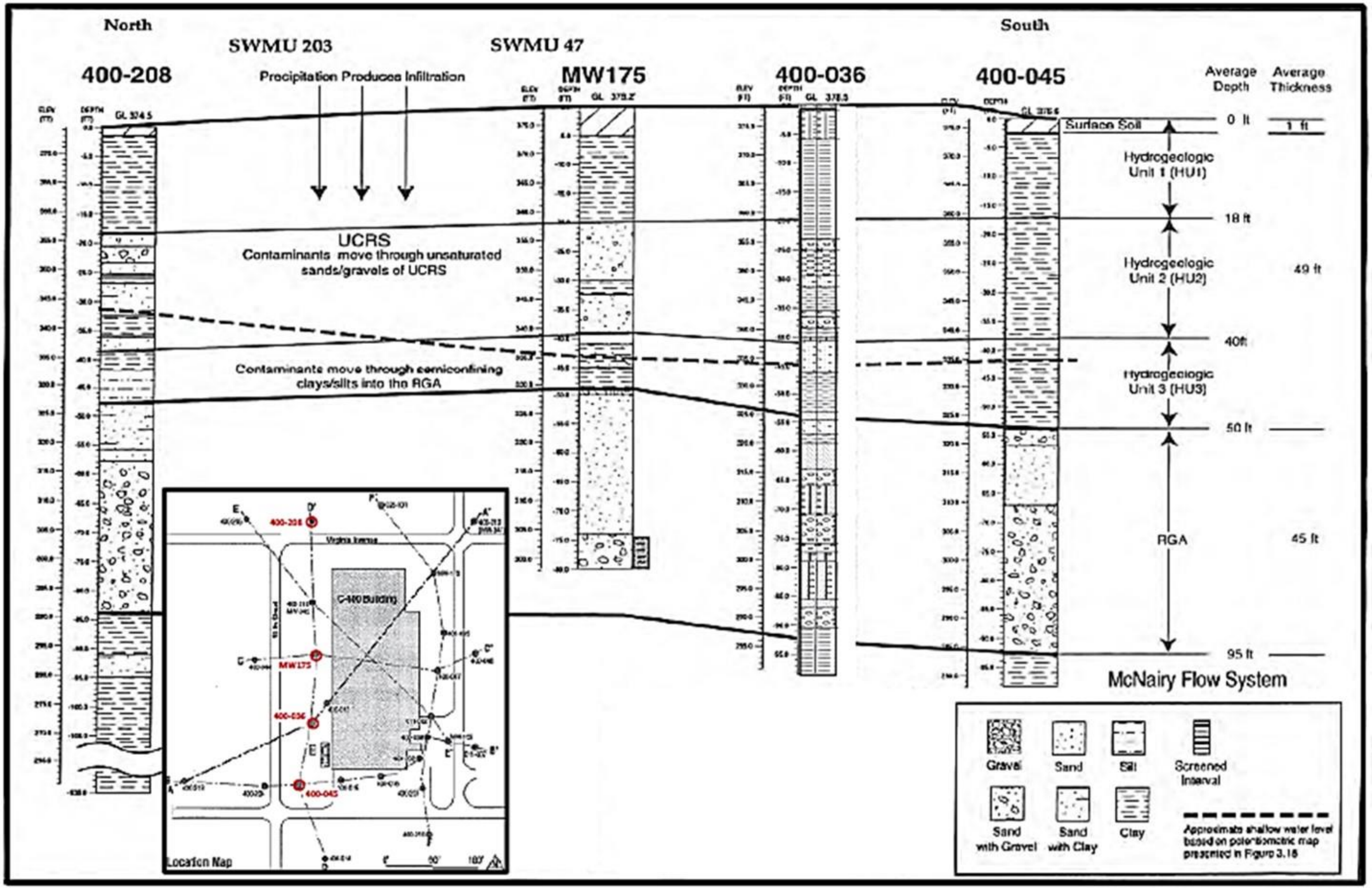
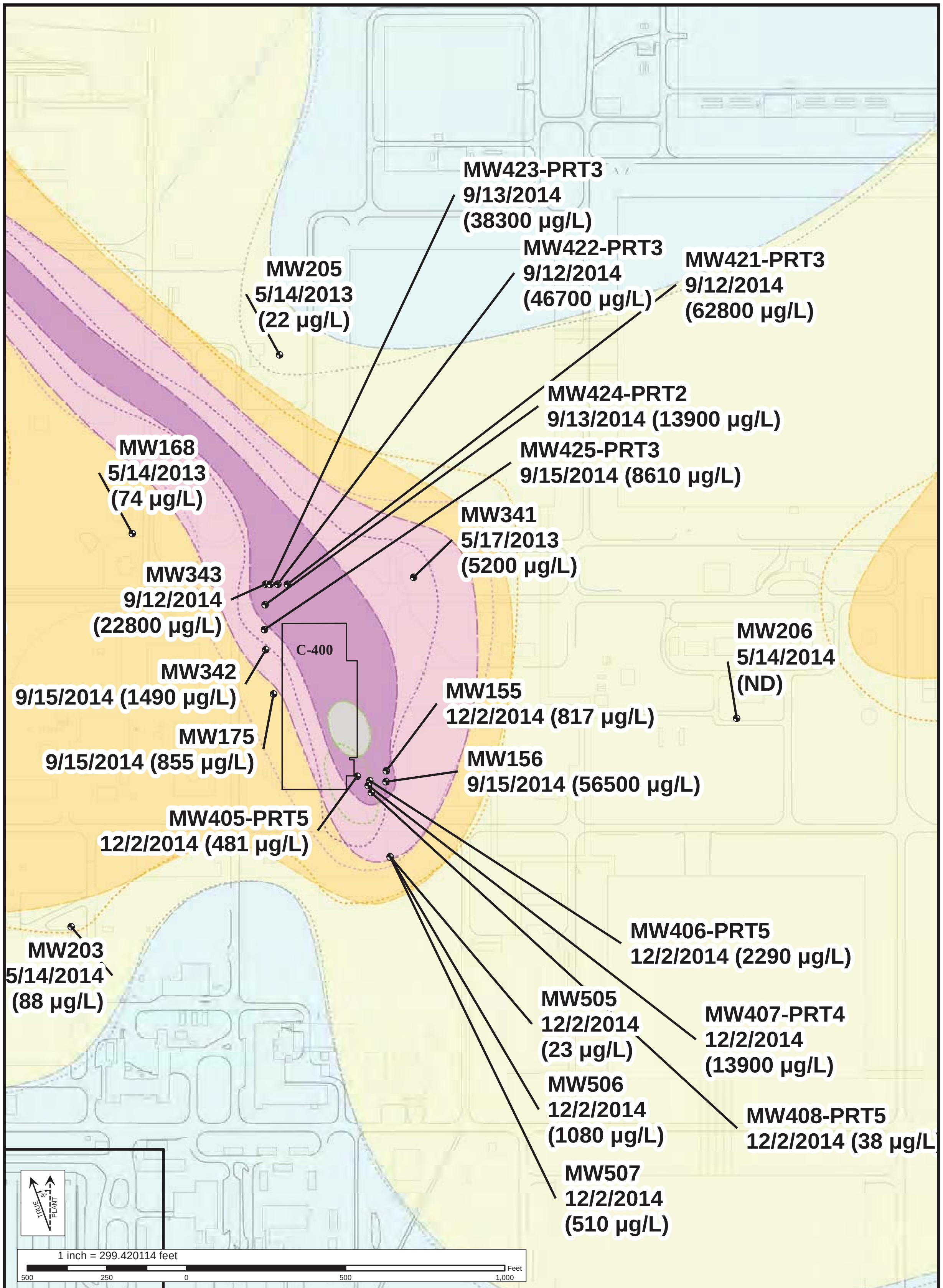


Figure D.3. C-400 Cleaning Building Area Hydrogeology (DOE 1999)



LEGEND

2014 TCE Plume Concentration Fields
- 5 - 100 µg/L
- 100 - 1,000 µg/L
- 1,000 - 10,000 µg/L
- 10,000 - 100,000 µg/L
- ≥ 100,000 µg/L

2012 TCE Plume Isoconcentration Lines
- 5 - 100 µg/L
- 100 - 1,000 µg/L
- 1,000 - 10,000 µg/L
- 10,000 - 100,000 µg/L
- ≥ 100,000 µg/L

MW103 8/17/2014 (ND) - Monitoring Well Identification, Date of Sample & Sample Value
- RGA Well
- Extraction Well
- Former Extraction Well

- Water Policy Area
- DOE Property Boundary
- Roadways
- Streams
- PGDP Boundary

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PADUCAH GASEOUS DIFFUSION PLANT

Figure D.4. 2014 TCE Plume Regional Gravel Aquifer in the Area of C-400 Cleaning Building (DOE 2015a)

Known subsurface conditions, including the presence of sandy material in the vadose zone and gravel under the slab, favor vapor migration. There are no impediments (e.g., no laterally continuous clay layers) considered to inhibit vapor transport between the sources and the building sufficient to limit to below VISL levels. The presence of cracked concrete flooring in the building and potentially unidentified VI conduits in the building may provide pathways for vapor migration into the building. As illustrated in Figure D.5, TCE partitions to gas phase from the source(s) and then diffuses away from the source(s) in response to a concentration gradient. When gas-phase TCE diffuses close to the building's foundation, the TCE can be drawn (advected) into the building's interior and mixed with the indoor air through the combined effects of fans, stack effects, and wind loading.

Based on the information presented in the WP and summarized here, DOE determined that vapors may be migrating from the documented source materials under and adjacent to C-400 Cleaning Building and through the sand and gravel into the building. Openings exist in the building's foundation (openings such as perimeter cracks, stress relief seams, and perforations for utility conduits and structural supports) that could serve as a pathway for vapor entry into the building.

DOE concluded that four of EPA's five conditions that can lead to a complete VI pathway are present and documented with site-specific data, including the following:

1. Subsurface sources of vapor are present in soil and groundwater underneath or near C-400 Cleaning Building;

2. Routes exist for vapor transport to the underside of C-400 Cleaning Building and vapor sources are immediately adjacent to the building slab;

3. C-400 Cleaning Building is susceptible to VI; and

4. C-400 Cleaning Building had been occupied by non-remediation workers.

DOE has completed the indoor air sampling to evaluate the remaining EPA condition regarding completeness of the VI pathway (i.e., one or more of the chemicals in the sub-slab soil gas also are present in the indoor environment and, if present, pose an unacceptable health risk), and the results are discussed in this report.

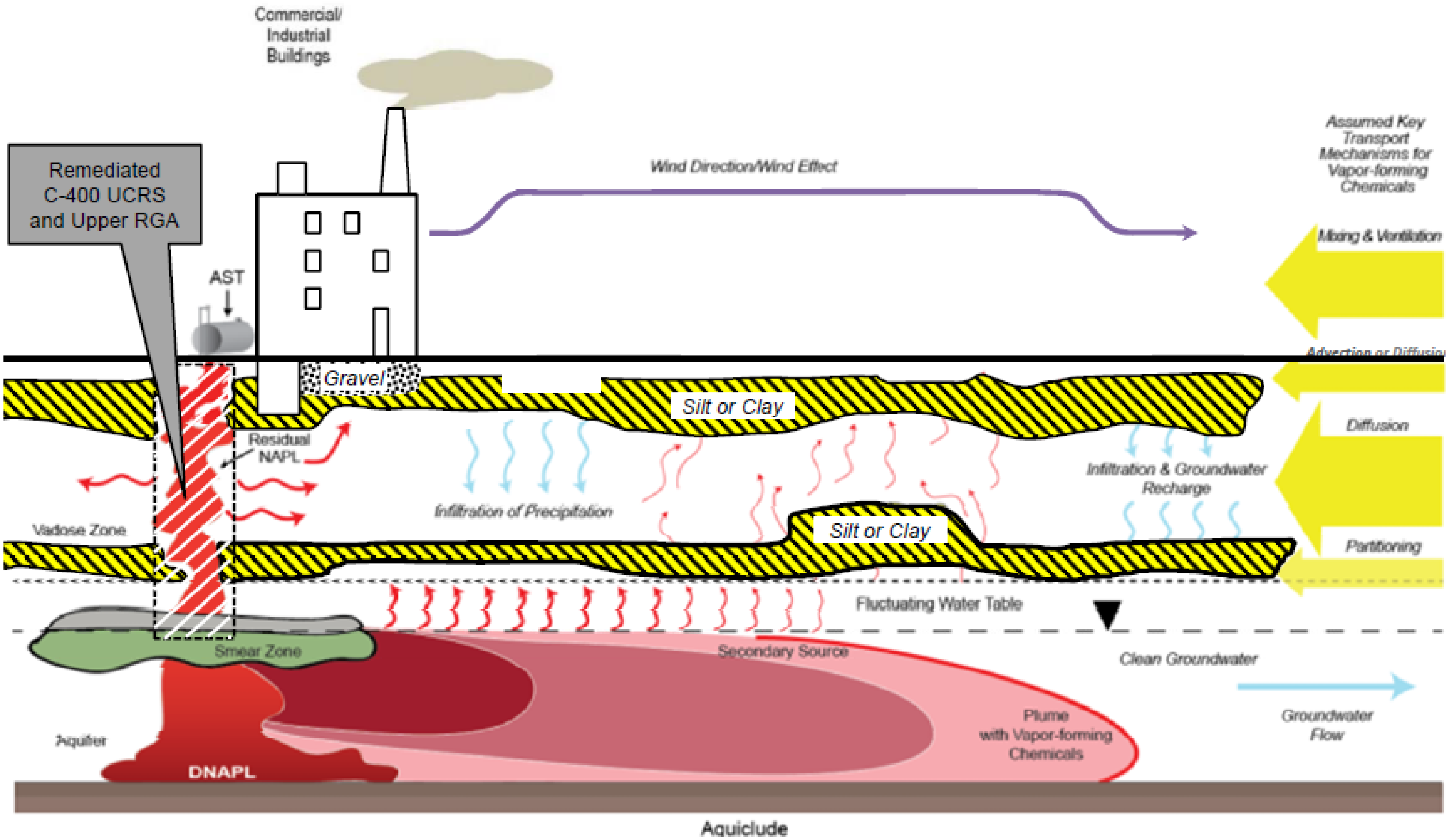

Figure D.5. C-400 Cleaning Building CSM (Approximate Perspective from Northeast Building Corner) Adapted from June 2015 EPA VI Guidance

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D.2. VAPOR INTRUSION STUDY APPROACH

This section describes the methodology used to collect indoor air; sub-slab soil gas, and ambient air samples; and auxiliary data (e.g., 10-second interval differential pressure readings) to support the VI study at C-400 Cleaning Building. All field activities were completed in accordance with the approved WP, except as described below (DOE 2017). Select photographs taken during the sampling events are included in Attachment D1.

D.2.1 SUB-SLAB SOIL GAS SAMPLING FIELD METHODS

Sampling locations were selected based on the areas identified in the WP and areas identified during the walkdown to be away from exterior walls.

Sub-slab Soil Gas Monitoring Probe Installation, Setup, and Leak Checks

On September 14, 18, 19, and 21, 2017, the sub-slab soil gas monitoring probes were installed using a hammer drill with a 5/8-inch drill bit to drill though the concrete to the top of the gravel underlying the slab. The top 2 inches of each monitoring point was enlarged using a 1-inch drill bit to facilitate placement of sub-slab soil gas monitoring probes and surface ports. The sub-slab soil gas monitoring probes were installed after each hole was drilled. The probes consisted of a ¼-inch brass pipe capped with a stainless-steel ball valve and compression fitting, secured, and sealed into the slab using hydraulic anchoring cement. Each probe location was subjected to a helium tracer check to ensure that the annular seal for the probe was not leaking. Nylaflow® tubing and a lung box equipped with a Tedlar® bag were connected to the probe. A plastic shroud was placed over the probe and tubing, then the interior of the shroud was enriched with helium gas. The contents of the Tedlar® bag then were screened for the presence of helium using an electronic helium meter. The helium tracer checks are described and illustrated in a photograph and a diagram in the "Seal Check Procedure for Soil Gas Sampling Operating Procedure" developed by Geosyntec Consultants, included in Attachment D2. The checks include a shut-in vacuum check and a helium tracer check; the results of these leak checks are recorded in the field notes included in Attachment D3. If the leak check failed to meet the guidance, then the hydraulic cement seal was chipped away partially and reset, and the leak check was conducted again to ensure the leak check passed. All locations passed the helium tracer checks that were conducted.

On January 25, 2018, the helium tracer check was conducted again on individual sub-slab soil gas monitoring probes, and all probes passed the leak checks. On January 26, February 9, and 11, 2018, the day prior to each sampling event, 6-liter, individually certified SUMMA® canisters used to collect the gas samples were connected to the seven sub-slab soil gas monitoring probes, and leak checks were conducted to ensure that samples would not be diluted with indoor air.

On January 26, 2018, Locations 3 and 7 failed the initial helium tracer check. The hydraulic cement seal surrounding the probes at both locations was partially chipped out, reset, and allowed to set prior to conducting the leak check again. Both locations passed the second helium tracer check. Locations 3 and 4 failed the initial helium tracer check on February 9, 2018. The hydraulic cement seal surrounding the probe at Location 4 was chipped out partially, reset, and allowed to set; Location 4 passed the second leak check. The hydraulic cement seal surrounding the probe at Location 3 was inspected carefully and found to be intact. Because the probe passed the helium leak test in September 2017, and on January 25 and January 26, 2018, and the analytical results from the January 26 and February 10, 2018, sampling events are similar, the probe location is not suspected of introducing indoor air into the subsurface. A possible explanation for difficulty with the seal check at Location 3 is that material beneath the slab is clay, rather than the anticipated gravel that was present at the other probe locations. Drawing a sub-slab sample was more difficult and required a longer time than at the other probe locations. Sub-slab SUMMA® canisters at Locations 1 through 7 passed the shut-in vacuum check prior to each sampling event.

Helium tracer checks were not completed on February 11, 2018, because the checks had been completed on February 9, 2018, and the probes were not disturbed. Sub-slab SUMMA® canisters at Locations 1 through 7 passed the shut-in vacuum check prior to each sampling event.

After installing the sub-slab soil gas monitoring probes, a ¼-inch tubing was laid from each location to the nearest exterior door. The tubing allowed monitoring of the differential pressure between the indoor air at the sampling location and the ambient air, as required by the WP. Measurement of the differential pressure between sub-slab soil gas and indoor air was enabled by a tee fitting connected to the monitoring probe, the SUMMA® canister, and ¼-inch tubing that was connected to the pressure gauge. The tee fitting on the SUMMA® was equipped with two ball valves, one on either side of the tee fitting, to allow switching between the SUMMA® canister and the pressure gauge and vice versa while collecting pressure readings (see Attachment D2).

D.2.1.1 Sub-slab Soil Gas Sampling

On January 27, February 10, and 12, 2018, the sampling events were conducted under the three scenarios described in the WP. At the start of each sampling event, the SUMMA® canisters were opened at the sub-slab soil gas probes, and the canister vacuum, air temperature at the sampling location, and the differential pressure between the sub-slab soil gas and indoor air was recorded. These measurements were recorded at the start and end of sampling and at two-hour intervals during the sampling event, for a total of six readings per event. Field notes are included in Attachment D3. After 10 hours, the SUMMA® canisters were closed, and final canister vacuums were recorded. The differential pressures were measured using a TEC DG-700 pressure and flow gauge, and the temperature was measured using a TSI 8330 VelociCalc® Plus Multi-Parameter Ventilation Meter.

D.2.1.2 Deviations from the Work Plan

An eighth soil gas monitoring probe was installed near Location 7 to be used for continuous differential pressure logging during each sampling event. The point was drilled and installed following the same methodology described in Section D.2.1.1. No sub-slab soil gas sample was collected from this probe. Differential pressures between sub-slab soil gas and indoor air and between indoor and ambient air were recorded every 10 seconds at this location for each 10-hour sampling event using a 2-channel datalogging micromanometer.[1] Ambient air pressure was measured by running an extra length of ¼-inch tubing from the differential pressure meter located near Location 7 to the nearest exterior door.

No other deviations from the WP were noted during sub-slab soil gas sampling events.

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[1] The TEC DG-700 pressure and flow gauge installed near Location 7 stopped collecting continuous pressure readings approximately 1.5 hours after the start of sampling on January 27, 2018. However, differential pressure readings were still collected at the start, at 2-hour intervals, and at the end of the sampling event as outlined in the WP. The continuous pressure readings were collected for the entire sampling period during the February 10 and 12, 2018, sampling dates.

D.2.2 INDOOR AND AMBIENT FIELD METHODS

D.2.2.1 Indoor and Ambient Air Sample Setup

The indoor and ambient air samples were collected using 6-liter, individually certified SUMMA® canisters. The indoor air canisters were set up on January 26, February 9, and 11, 2018, at Locations 1 through 7 and Location 8 (exhaust fan), concurrent with the sub-slab soil gas canister setup. Seven indoor air sample locations were co-located with sub-slab soil gas monitoring locations. On January 27, February 10, and 12, 2018, the ambient air SUMMA® canisters were set up just prior to the start of each sampling event. Four ambient air sample canisters were positioned around C-400 Cleaning Building at locations required by the WP. The position of ambient air Location 3 was selected in the morning from two predetermined locations, depending on the wind direction to avoid emissions from the operating stack on the east side of the building. The southeast location, Location 3SE, was selected for ambient air sample Location 3 during all three sampling events based on the prevailing wind direction at the start of each sampling event. The indoor air and ambient air canisters were positioned such that the intake was in the "breathing zone," considered to be between 5 and 6-ft above the ground.

The Location 8 indoor air sample was collected from the air plenum fan exhaust by inserting a 3/4-inch, schedule 40 PVC pipe through a canvas joint of the duct work. The PVC pipe was secured such that it did not touch the walls of the duct work. Then the ¼-inch Nylaflow® tubing was inserted into the PVC piping and connected the other end to a SUMMA® canister to collect the sample. Immediately prior to opening the SUMMA® canister at the beginning of each sampling event, a minimum of 3-liters of local air was purged through the tubing leading from the sample port using a lung box.

D.2.2.2 Indoor and Ambient Air Sampling

On January 27, February 10, and 12, 2018, the sampling events were conducted under the three scenarios described in the WP. At the start of each sampling event, the SUMMA® canisters were opened at indoor and ambient air sampling locations and the canister vacuums were recorded. The canister vacuum was recorded every 2-hours after opening the canisters and at the closing of the canisters for a total of 6 readings per event. Duplicate samples were connected by ¼-inch Nylaflow® tubing to a duplicate tee fitting using compression fittings. Field notes are included in Attachment D3. After 10 hours, the SUMMA® canisters were closed and final canister vacuum recorded.

At the Ambient Location 5, a Vantage Pro2 W weather station was set up. The weather station continuously logged measurements of wind speed and direction, ambient air relative humidity, barometric pressure, and temperature. These measurements also were recorded in field notes at the beginning and end of the sampling event and at 2-hour intervals for a total of 6 readings (Attachment D3). Attachment D4 contains the weather data from the National Weather Service located at the Paducah Airport.

D.2.2.3 Deviations from the Work Plan

While preparing for the second sampling scenario, "Fan On and Doors Open," an issue with Door #6 was encountered. While Door #6 was being raised, the chain hoist mechanism broke when the door was approximately one ft off the floor. C-400 Cleaning Building has a total of nine large bay doors. Five doors are on the north end, and four doors are on the south end. Door #6 is located on the south end of C-400 Cleaning Building. EPA and Kentucky Department for Environmental Protection (KDEP) agreed that, with all the other doors open, the partial opening of Door #6 was not seen as an issue for the second sampling scenario, "Doors Open and Fan On." Based upon this agreement, the sampling scenario scheduled for February 10, 2018, would occur.

Additionally, it was discussed that for Sunday, February 11, 2018, the setup for the third sampling scenario, "Doors Closed and Fan On," was potentially impacted by the operation of Door #6. The parties discussed that if Door #6 could not be closed safely, then plastic, similar to what currently is in use in the C-400 Cleaning Building, would be used to seal the door with duct tape and sandbags, as necessary. The plastic would be placed on the inside of Door #6 and on the outside of Door #6 for added protection. EPA and KDEP agreed that the modification to Door #6, should it remain inoperable, would be satisfactory and that the third sampling scenario scheduled for February 12, 2018, would continue.

The door remained inoperable, and the plastic and sandbags were necessary to seal Door #6. On March 2, 2018, DOE provided a record of conversation documenting the February 9, 2018, teleconference (DOE 2018b).

No other deviations from the WP were noted for the indoor air and ambient air canister installation and sampling.

D.2.3 POST-SAMPLING EVENT ACTIVITIES

After 10 hours, the SUMMA® canisters were closed and collected. Labels were affixed to each SUMMA® canister and then released for shipment to the laboratory under chain of custody control for analysis by EPA method TO-15. Stands for indoor and ambient air canisters were removed and tubing was rolled, placed in a Ziploc bag and stored next to the respective sub-slab soil gas monitoring probe for subsequent use. Following the final sampling event, all tubing used within C-400 Cleaning Building was collected and dispositioned appropriately.

D.3. RESULTS

The analytical results, field data, and field observations are summarized below. Attachment D5 contains the Excel files for the analytical results and pressure differential readings.

D.3.1 ANALYTICAL RESULTS

Concentrations of TCE, *cis*-1,2-dichloroethene (*cis*-1,2-DCE), t*rans*-1,2-dichloroethene (*trans*-1,2-DCE) and 1,1-Dichloroethene (1,1-DCE) were detected in the air samples. TCE was the most commonly detected compound at 46 out of 62 samples, and it was detected in all three media. c*is*-1,2-DCE was detected in only seven sub-slab soil gas air samples. *trans*-1,2-DCE was detected in only six indoor air samples. 1,1-DCE was detected in only one sub-slab soil gas sample. Tables D.1 through D.3 present the results. The results by medium are summarized in the following subsections.

D.3.1.1 Indoor Air Analytical Results

Indoor air samples were collected from Locations 1 through 7, and from Location 8 (exhaust fan) within C-400 Cleaning Building on January 27, 2018, under the fan off, doors closed scenario. A second round of indoor air samples was collected from the same locations on February 10, 2018, under the fan on, doors open scenario. The last round of indoor air samples was collected from the same locations on February 12, 2018, under the fan on, doors closed scenario. These samples were collected concurrently with the sub-slab and ambient samples.

TCE and *trans*-1,2-DCE were the only compounds detected in the indoor air samples. During the first sampling event on January 27, 2018, (fan off, doors closed scenario) a final vacuum of 2-inches of mercury was recorded for the indoor air SUMMA® canister collected at Location 7. The laboratory reported a vacuum of 0-inches of mercury upon receipt of the canister. The indoor air sample for Location 7 under the fan off, doors closed scenario could not be analyzed.

During the January 27, 2018, sampling event, TCE was detected in all the indoor air samples at concentrations ranging from 0.22J μg/m^3 at Location 2, with J indicating an estimated TCE concentration because the compound was detected below the method quantitation limit, to 17 μg/m^3 in the duplicate sample collected at Location 5.

During the February 10, 2018, sampling event, TCE was below the reporting limit (RL) of 0.19 μg/m^3 at Locations 1, 2, 3, 4, and 7 and detected at concentrations ranging from 1.4 μg/m^3 at Location 6 to 2.9 μg/m^3 in the duplicate sample collected at Location 5. *trans*-1,2-DCE was below the RL of 0.2 μg/m^3 in all locations, except Location 7, where it was detected at a concentration of 1.3 μg/m^3.

During the final sampling event on February 12, 2018, TCE was below the RL of 0.19 μg/m^3 at Locations 2, 3, and 4, and detected at concentrations ranging from 0.23J μg/m^3 at Location 7 to 7.1 μg/m^3 in the duplicate sample collected at Location 5. *trans*-1,2-DCE was below the RL of 0.2 μg/m^3 at Locations 1, 2, 3, and 6, and detected at concentrations ranging from 0.2J μg/m^3 at Location 5 to 0.43J μg/m^3 at Location 7.

Indoor air analytical results are summarized in Table D.1, including indoor worker Project Action Levels (PALs) for comparison, and illustrated on Figure D.6. Over the three sampling events, the measured

Table D.1. Indoor Air Analytical Results

		Scenario	Fan Off and Doors Closed								
		Location #	1	2	3	4	5	5 Duplicate	6	6 Duplicate	8
		Sample ID	C400VI1INOFCL-R	C400VI2INOFCL-R	C400VI3INOFCL-R	C400VI4INOFCL-R	C400VI5INOFCL-R	C400VI5INOFCLD-R	C400VI6INOFCL-R	C400VI6INOFCLD-R	C400VI8EXHOFCL-R
Parameter	PAL	Date	1/27/2018	1/27/2018	1/27/2018	1/27/2018	1/27/2018	1/27/2018	1/27/2018	1/27/2018	1/27/2018
<u>Volatile Organic Compounds</u>		*<u>Units</u>*									
1,1,1-Trichloroethane	22,000	μg/m^3	< 0.16	< 0.16	< 0.16	< 0.16	< 0.16	< 0.16	< 0.16	< 0.16	< 0.16
1,1,2-Trichloroethane	0.77	μg/m^3	< 0.29	< 0.29	< 0.29	< 0.29	< 0.29	< 0.29	< 0.29	< 0.29	< 0.29
1,1-Dichloroethane	7.7	μg/m^3	< 0.11	< 0.11	< 0.11	< 0.11	< 0.11	< 0.11	< 0.11	< 0.11	< 0.11
1,1-Dichloroethene	880	μg/m^3	< 0.13	< 0.13	< 0.13	< 0.13	< 0.13	< 0.13	< 0.13	< 0.13	< 0.13
1,2-Dichloroethane	0.47	μg/m^3	< 0.19	< 0.19	< 0.19	< 0.19	< 0.19	< 0.19	< 0.19	< 0.19	< 0.19
1,4-Dioxane	2.5	μg/m^3	< 0.29	< 0.29	< 0.29	< 0.29	< 0.29	< 0.29	< 0.29	< 0.29	< 0.29
cis-1,2-Dichloroethene	3,500	μg/m^3	< 0.24	< 0.24	< 0.24	< 0.24	< 0.24	< 0.24	< 0.24	< 0.24	< 0.24
trans-1,2-Dichloroethene	3,500	μg/m^3	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Trichloroethene	3.0	μg/m^3	0.35 J	0.22 J	0.42 J	0.44 J	12	17	2.8	4.3	3.9
Vinyl chloride	2.8	μg/m^3	< 0.18	< 0.18	< 0.18	< 0.18	< 0.18	< 0.18	< 0.18	< 0.18	< 0.18

Notes:
1. μg/m^3 = micrograms per meter cubed
2. "<" Less than laboratory reporting limit
3. "J" Compound detected below method quantitation limit; estimated value provided
4. PAL = Project Action Limi
5. The PALs are the same as the EPA commercial scenario VISLs for CR 1E-6 or HQ=1.0 for all chemicals except *cis*- and *trans*-1,2-DCE. The PALs for *cis*- and *trans*-1,2-DCE are the VISLs provided by EPA R4, which are based on the ATSDR Inhalation MRL of 0.2 ppm (0.8 mg/m^3).
6. Yellow shaded values exceed PAL

Table D.1. Indoor Air Analytical Results (Continued)

Parameter	PAL	Scenario	Fan On and Doors Open									
		Location #	1	2	3	4	5	5 Duplicate	6	6 Duplicate	7	8
		Sample ID	C400VI1INONOP-R	C400VI2INONOP-R	C400VI3INONOP-R	C400VI4INONOP-R	C400VI5INONOP-R	C400VI5INONOP-RD	C400VI6INONOP-R	C400VI6INONOP-RD	C400VI7INONOP-R	C400VI8EXHONOP-R
		Date	2/10/2018	2/10/2018	2/10/2018	2/10/2018	2/10/2018	2/10/2018	2/10/2018	2/10/2018	2/10/2018	2/10/2018
Volatile Organic Compounds		*Units*										
1,1,1-Trichloroethane	22,000	µg/m^3	< 0.16	< 0.16	< 0.16	< 0.16	< 0.16	< 0.16	< 0.16	< 0.16	< 0.16	< 0.16
1,1,2-Trichloroethane	0.77	µg/m^3	< 0.29	< 0.29	< 0.29	< 0.29	< 0.29	< 0.29	< 0.29	< 0.29	< 0.29	< 0.29
1,1-Dichloroethane	7.7	µg/m^3	< 0.11	< 0.11	< 0.11	< 0.11	< 0.11	< 0.11	< 0.11	< 0.11	< 0.11	< 0.11
1,1-Dichloroethene	880	µg/m^3	< 0.13	< 0.13	< 0.13	< 0.13	< 0.13	< 0.13	< 0.13	< 0.13	< 0.13	< 0.13
1,2-Dichloroethane	0.47	µg/m^3	< 0.19	< 0.19	< 0.19	< 0.19	< 0.19	< 0.19	< 0.19	< 0.19	< 0.19	< 0.19
1,4-Dioxane	2.5	µg/m^3	< 0.29	< 0.29	< 0.29	< 0.29	< 0.29	< 0.29	< 0.29	< 0.29	< 0.29	< 0.29
cis-1,2-Dichloroethene	3,500	µg/m^3	< 0.24	< 0.24	< 0.24	< 0.24	< 0.24	< 0.24	< 0.24	< 0.24	< 0.24	< 0.24
trans-1,2-Dichloroethene	3,500	µg/m^3	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	1.3	<0.2
Trichloroethene	3.0	µg/m^3	< 0.19	< 0.19	< 0.19	< 0.19	2.5	2.9	1.4	1.7	< 0.19	2.1
Vinyl chloride	2.8	µg/m^3	< 0.18	< 0.18	< 0.18	< 0.18	< 0.18	< 0.18	< 0.18	< 0.18	< 0.18	< 0.18

Notes:

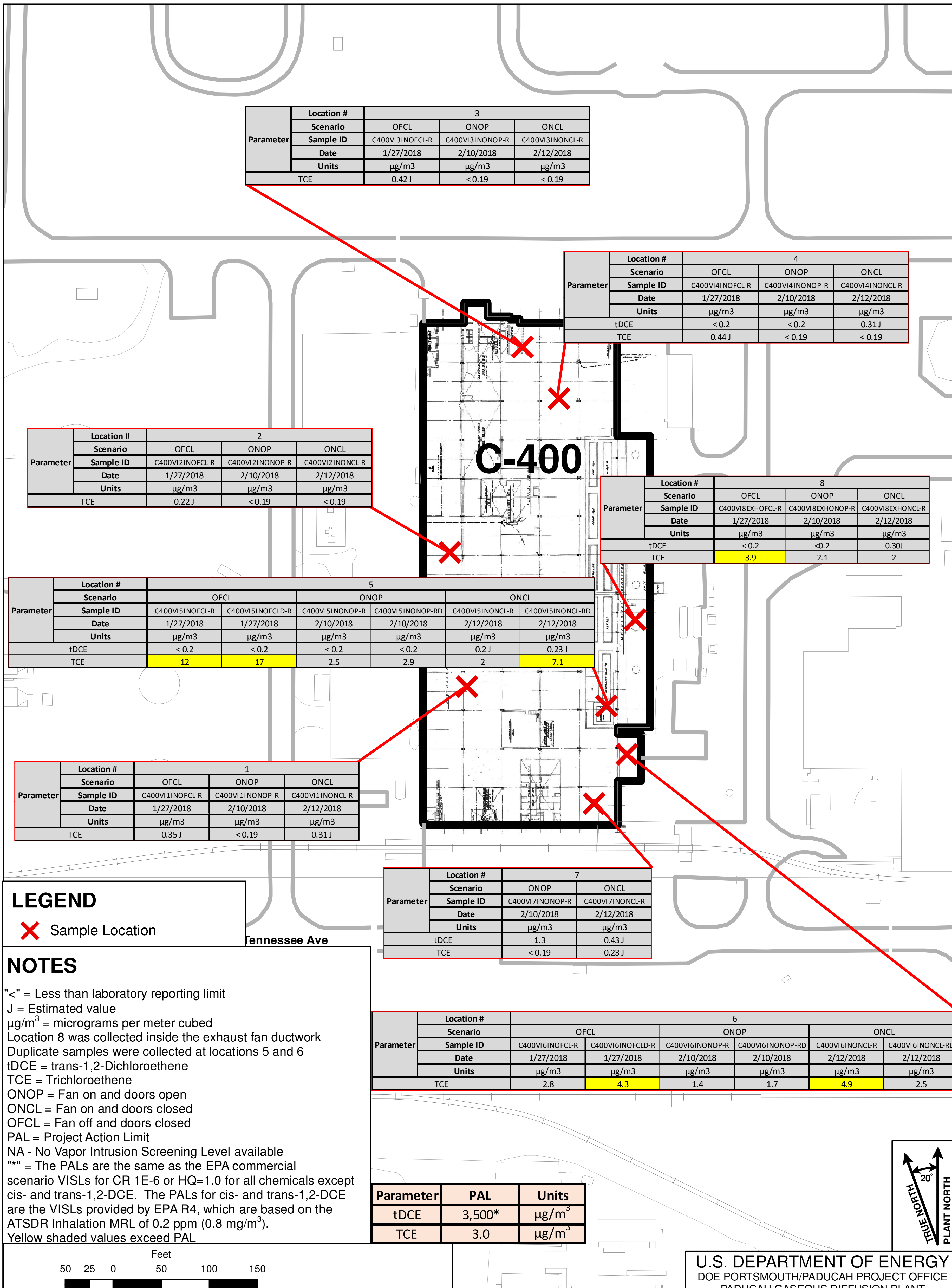
1. µg/m^3 = micrograms per meter cubed
2. "<" Less than laboratory reporting limit
3. "J" Compound detected below method quantitation limit; estimated value provided
4. PAL = Project Action Limi
5. The PALs are the same as the EPA commercial scenario VISLs for CR 1E-6 or HQ=1.0 for all chemicals except *cis*- and *trans*-1,2-DCE. The PALs for *cis*- and *trans*-1,2-DCE are the VISLs provided by EPA R4, which are based on the ATSDR Inhalation MRL of 0.2 ppm (0.8 mg/m^3).
6. Yellow shaded values exceed PAL

Table D.1. Indoor Air Analytical Results (Continued)

		Scenario	Fan On and Doors Closed									
		Location #	1	2	3	4	5	5 Duplicate	6	6 Duplicate	7	8
		Sample ID	C400VI1INONCL-R	C400VI2INONCL-R	C400VI3INONCL-R	C400VI4INONCL-R	C400VI5INONCL-R	C400VI5INONCL-RD	C400VI6INONCL-R	C400VI6INONCL-RD	C400VI7INONCL-R	C400VI8EXHONCL-R
Parameter	PAL	Date	2/12/2018	2/12/2018	2/12/2018	2/12/2018	2/12/2018	2/12/2018	2/12/2018	2/12/2018	2/12/2018	2/12/2018
Volatile Organic Compounds		*Units*										
1,1,1-Trichloroethane	22,000	μg/m^3	< 0.16	< 0.16	< 0.16	< 0.16	< 0.16	< 0.16	< 0.16	< 0.16	< 0.16	< 0.16
1,1,2-Trichloroethane	0.77	μg/m^3	< 0.29	< 0.29	< 0.29	< 0.29	< 0.29	< 0.29	< 0.29	< 0.29	< 0.29	< 0.29
1,1-Dichloroethane	7.7	μg/m^3	< 0.11	< 0.11	< 0.11	< 0.11	< 0.11	< 0.11	< 0.11	< 0.11	< 0.11	< 0.11
1,1-Dichloroethene	880	μg/m^3	< 0.13	< 0.13	< 0.13	< 0.13	< 0.13	< 0.13	< 0.13	< 0.13	< 0.13	< 0.13
1,2-Dichloroethane	0.47	μg/m^3	< 0.19	< 0.19	< 0.19	< 0.19	< 0.19	< 0.19	< 0.19	< 0.19	< 0.19	< 0.19
1,4-Dioxane	2.5	μg/m^3	< 0.29	< 0.29	< 0.29	< 0.29	< 0.29	< 0.29	< 0.29	< 0.29	< 0.29	< 0.29
cis-1,2-Dichloroethene	3,500	μg/m^3	< 0.24	< 0.24	< 0.24	< 0.24	< 0.24	< 0.24	< 0.24	< 0.24	< 0.24	< 0.24
trans-1,2-Dichloroethene	3,500	μg/m^3	< 0.2	< 0.2	< 0.2	0.31 J	0.2 J	0.23 J	< 0.2	< 0.2	0.43 J	0.30J
Trichloroethene	3.0	μg/m^3	0.31 J	< 0.19	< 0.19	< 0.19	2	7.1	4.9	2.5	0.23 J	2
Vinyl chloride	2.8	μg/m^3	< 0.18	< 0.18	< 0.18	< 0.18	< 0.18	< 0.18	< 0.18	< 0.18	< 0.18	< 0.18

Notes:

1. μg/m^3 = micrograms per meter cubed
2. "<" Less than laboratory reporting limit
3. "J" Compound detected below method quantitation limit; estimated value provided
4. PAL = Project Action Limi
5. The PALs are the same as the EPA commercial scenario VISLs for CR 1E-6 or HQ=1.0 for all chemicals except *cis*- and *trans*-1,2-DCE. The PALs for *cis*- and *trans*-1,2-DCE are the VISLs provided by EPA R4, which are based on the ATSDR Inhalation MRL of 0.2 ppm (0.8 mg/m^3).
6. Yellow shaded values exceed PAL



Parameter	Location #	3		
	Scenario	OFCL	ONOP	ONCL
	Sample ID	C400VI3INOFCL-R	C400VI3INONOP-R	C400VI3INONCL-R
	Date	1/27/2018	2/10/2018	2/12/2018
	Units	µg/m3	µg/m3	µg/m3
TCE		0.42 J	< 0.19	< 0.19

Parameter	Location #	4		
	Scenario	OFCL	ONOP	ONCL
	Sample ID	C400VI4INOFCL-R	C400VI4INONOP-R	C400VI4INONCL-R
	Date	1/27/2018	2/10/2018	2/12/2018
	Units	µg/m3	µg/m3	µg/m3
tDCE		< 0.2	< 0.2	0.31 J
TCE		0.44 J	< 0.19	< 0.19

Parameter	Location #	2		
	Scenario	OFCL	ONOP	ONCL
	Sample ID	C400VI2INOFCL-R	C400VI2INONOP-R	C400VI2INONCL-R
	Date	1/27/2018	2/10/2018	2/12/2018
	Units	µg/m3	µg/m3	µg/m3
TCE		0.22 J	< 0.19	< 0.19

Parameter	Location #	8		
	Scenario	OFCL	ONOP	ONCL
	Sample ID	C400VI8EXHOFCL-R	C400VI8EXHONOP-R	C400VI8EXHONCL-R
	Date	1/27/2018	2/10/2018	2/12/2018
	Units	µg/m3	µg/m3	µg/m3
tDCE		< 0.2	<0.2	0.30J
TCE		3.9	2.1	2

Parameter	Location #	5					
	Scenario	OFCL		ONOP		ONCL	
	Sample ID	C400VI5INOFCL-R	C400VI5INOFCLD-R	C400VI5INONOP-R	C400VI5INONOP-RD	C400VI5INONCL-R	C400VI5INONCL-RD
	Date	1/27/2018	1/27/2018	2/10/2018	2/10/2018	2/12/2018	2/12/2018
	Units	µg/m3	µg/m3	µg/m3	µg/m3	µg/m3	µg/m3
tDCE		< 0.2	< 0.2	< 0.2	< 0.2	0.2 J	0.23 J
TCE		12	17	2.5	2.9	2	7.1

Parameter	Location #	1		
	Scenario	OFCL	ONOP	ONCL
	Sample ID	C400VI1INOFCL-R	C400VI1INONOP-R	C400VI1INONCL-R
	Date	1/27/2018	2/10/2018	2/12/2018
	Units	µg/m3	µg/m3	µg/m3
TCE		0.35 J	< 0.19	0.31 J

Parameter	Location #	7	
	Scenario	ONOP	ONCL
	Sample ID	C400VI7INONOP-R	C400VI7INONCL-R
	Date	2/10/2018	2/12/2018
	Units	µg/m3	µg/m3
tDCE		1.3	0.43 J
TCE		< 0.19	0.23 J

Parameter	Location #	6					
	Scenario	OFCL		ONOP		ONCL	
	Sample ID	C400VI6INOFCL-R	C400VI6INOFCLD-R	C400VI6INONOP-R	C400VI6INONOP-RD	C400VI6INONCL-R	C400VI6INONCL-RD
	Date	1/27/2018	1/27/2018	2/10/2018	2/10/2018	2/12/2018	2/12/2018
	Units	µg/m3	µg/m3	µg/m3	µg/m3	µg/m3	µg/m3
TCE		2.8	4.3	1.4	1.7	4.9	2.5

LEGEND

X Sample Location

NOTES

"<" = Less than laboratory reporting limit
J = Estimated value
µg/m^3 = micrograms per meter cubed
Location 8 was collected inside the exhaust fan ductwork
Duplicate samples were collected at locations 5 and 6
tDCE = trans-1,2-Dichloroethene
TCE = Trichloroethene
ONOP = Fan on and doors open
ONCL = Fan on and doors closed
OFCL = Fan off and doors closed
PAL = Project Action Limit
NA - No Vapor Intrusion Screening Level available
"*" = The PALs are the same as the EPA commercial scenario VISLs for CR 1E-6 or HQ=1.0 for all chemicals except cis- and trans-1,2-DCE. The PALs for cis- and trans-1,2-DCE are the VISLs provided by EPA R4, which are based on the ATSDR Inhalation MRL of 0.2 ppm (0.8 mg/m^3).
Yellow shaded values exceed PAL

Parameter	PAL	Units
tDCE	3,500*	µg/m^3
TCE	3.0	µg/m^3

Feet
50 25 0 50 100 150

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Figure D.6. Summary of Indoor Air Sampling Detections for C-400 Cleaning Building Vapor Intrusion Study

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concentrations of TCE varied by a factor of 3.5 or less at all locations, except Location 5, where it varied by a factor of 8.5. The missing Location 7 indoor air sample from the January 27, 2018, sampling event likely would have been within the same range and, therefore, well below the PALs identified in Table D.1.

As indicated in the Quality Assurance Project Plan (QAPP) contained in Appendix B of the WP, data are placed into and reported from the Paducah Oak Ridge Environmental Information System (OREIS) following verification assessment and validation.

All data were found to be usable during validation, and no data were rejected. TCE results were "J" qualified 6 times, indicating that the compound was detected below the method quantitation limit, resulting in an estimated value. *trans*-1,2-DCE results were similarly qualified 5 times. The requisite number of duplicate indoor air samples identified in the WP were successfully collected from Locations 5 and 6 and analyzed during all the sampling events. Individual RLs for nondetect samples were all below screening levels. QAPP criteria established a relative percent difference (RPD) of ≤ 50% for the field duplicates. Of note, the RPD for 4 samples and their duplicates were above the QAPP criteria and were "J" qualified during validation. These samples were for Location 5 and 6 on February 10 and February 12, 2018.

D.3.1.2 Sub-Slab Soil Gas Analytical Results

Sub-slab soil gas samples were collected from Locations 1 through 7 on January 27, 2018, under the fan off, doors closed scenario, on February 10, 2018, under the fan on, doors open scenario, and on February 12, 2018, under the fan on, doors closed scenario. These samples were collected concurrently with the indoor and ambient samples. TCE, *cis*-1,2-DCE, and 1,1-DCE were the only compounds detected in the sub-slab soil gas samples, although 1,1-DCE was detected only once, at a level only slightly above the RL.

During the January 27, 2018, sampling event, TCE was detected at all sampling locations at concentrations ranging from 14 $\mu g/m^3$ at Location 3 to 9,500,000 $\mu g/m^3$ at Location 5. *cis*-1,2-DCE was below the RL of 0.24 $\mu g/m^3$ at Locations 2, 3, and 4 and below an elevated RL of 30,000 $\mu g/m^3$ due to the high TCE concentration at that location. *cis*-1,2-DCE was detected at Locations 1, 6, and 7 at concentrations of 120, 2.2, and 180J $\mu g/m^3$, respectively.

During the February 10, 2018, sampling event, TCE was detected at all sampling locations at concentrations ranging from 14 $\mu g/m^3$ at Location 3 to 10,000,000 $\mu g/m^3$ at Location 5. *cis*-1,2-DCE was below the RL of 0.24 $\mu g/m^3$ at Locations 2, 3, and 4, and below elevated RLs of 9,500 and 200 $\mu g/m^3$ at Locations 5 and 7, respectively, due to the high TCE concentrations at those locations. *cis*-1,2-DCE was detected at Locations 1 and 6 at concentrations of 140 and 0.69J $\mu g/m^3$, respectively.

During the final sampling event on February 12, 2018, TCE was detected at all sampling locations at concentrations ranging from 16 $\mu g/m^3$ at Location 3 to 12,000,000 $\mu g/m^3$ at Location 5. *cis*-1,2-DCE was below the RL of 0.24 $\mu g/m^3$ at Locations 2, 3, and 4 and below an elevated RL of 10,000 $\mu g/m^3$ at Locations 5 due to the high TCE concentrations at that location. *cis*-1,2-DCE was detected at Locations 1, 6, and 7 at concentrations of 150, 2.3, and 220J $\mu g/m^3$, respectively. 1,1-DCE was detected at 0.15J $\mu g/m^3$ at Location 4 and was non-detect at all other locations

The measured concentrations of TCE varied by less than 25% from one sampling event to the next, with the exception of Location 6, where a J-valued concentration for the second sampling event was a factor of three less than the concentrations reported for the other two events. Sub-slab soil gas analytical results are

Table D.2. Sub-slab Soil Gas Air Analytical Results

Parameter	EPA Sub-slab Soil Gas VISL	Scenario	Fan Off and Doors Closed						
		Location #	1	2	3	4	5	6	7
		Sample ID	C400VI1SUBOFCL-R	C400VI2SUBOFCL-R	C400VI3SUBOFCL-R	C400VI4SUBOFCL-R	C400VI5SUBOFCL-R	C400VI6SUBOFCL-R	C400VI7SUBOFCL-R
		Date	1/27/2018	1/27/2018	1/27/2018	1/27/2018	1/27/2018	1/27/2018	1/27/2018
Volatile Organic Compounds		*Units*							
1,1,1-Trichloroethane	730,000	µg/m^3	< 17	< 0.16	< 0.16	< 0.16	< 21000	< 0.16	< 92
1,1,2-Trichloroethane	26	µg/m^3	< 31	< 0.29	< 0.29	< 0.29	< 38000	< 0.29	< 160
1,1-Dichloroethane	256	µg/m^3	< 11	< 0.11	< 0.11	< 0.11	< 13000	< 0.11	< 59
1,1-Dichloroethene	29,200	µg/m^3	< 14	< 0.13	< 0.13	< 0.13	< 17000	< 0.13	< 75
1,2-Dichloroethane	16	µg/m^3	< 20	< 0.19	< 0.19	< 0.19	< 24000	< 0.19	< 110
1,4-Dioxane	82	µg/m^3	< 31	< 0.29	< 0.29	< 0.29	< 37000	< 0.29	< 160
cis -1,2-Dichloroethene	120,000	µg/m^3	120	< 0.24	< 0.24	< 0.24	< 30000	2.2	180 J
trans -1,2-Dichloroethene	120,000	µg/m^3	< 21	< 0.2	< 0.2	< 0.2	< 25000	< 0.2	< 110
Trichloroethene	100	µg/m^3	7,200	23	14	160	9,500,000	180	59,000
Vinyl chloride	93	µg/m^3	< 19	< 0.18	< 0.18	< 0.18	< 23000	< 0.18	< 100

Notes:

1. µg/m^3 = micrograms per meter cubed
2. "<" Less than laboratory reporting limit
3. "J" Compound detected below method quantitation limit; estimated value provided
4. VISL = Vapor Intrusion Screening Level
5. The EPA VISL are the default commercial values for CR 1E-6 or HQ=1.0 for all chemicals except *cis* - and *trans* -1,2-DCE. The VISLs for *cis* - and *trans* -1,2-DCE are provided by EPA R4, and were derived based on the ATSDR Inhalation MRL of 0.2 ppm (0.8 mg/m^3).
6. Yellow shaded values exceed PALs and EPA Sub-slab Soil Gas VISLs

Table D.2. Sub-slab Soil Gas Air Analytical Results (Continued)

Parameter	EPA Sub-slab Soil Gas VISL	Scenario	Fan On and Doors Open						
		Location #	1	2	3	4	5	6	7
		Sample ID	C400VI1SUBONOP-R	C400VI2SUBONOP-R	C400VI3SUBONOP-R	C400VI4SUBONOP-R	C400VI5SUBONOP-R	C400VI6SUBONOP-R	C400VI7SUBONOP-R
		Date	2/10/2018	2/10/2018	2/10/2018	2/10/2018	2/10/2018	2/10/2018	2/10/2018
Volatile Organic Compounds		*Units*							
1,1,1-Trichloroethane	730,000	µg/m^3	< 15	< 0.16	< 0.16	< 0.16	< 6500	< 0.16	< 130
1,1,2-Trichloroethane	26	µg/m^3	< 26	< 0.29	< 0.29	< 0.29	< 12000	< 0.29	< 240
1,1-Dichloroethane	256	µg/m^3	< 9.4	< 0.11	< 0.11	< 0.11	< 4200	< 0.11	< 86
1,1-Dichloroethene	29,200	µg/m^3	< 12	< 0.13	< 0.13	< 0.13	< 5400	< 0.13	< 110
1,2-Dichloroethane	16	µg/m^3	< 17	< 0.19	< 0.19	< 0.19	< 7600	< 0.19	< 160
1,4-Dioxane	82	µg/m^3	< 26	< 0.29	< 0.29	< 0.29	< 11000	< 0.29	< 240
cis-1,2-Dichloroethene	120,000	µg/m^3	140	< 0.24	< 0.24	< 0.24	< 9500	0.69 J	< 200
trans-1,2-Dichloroethene	120,000	µg/m^3	< 18	< 0.2	< 0.2	< 0.2	< 7900	< 0.2	< 160
Trichloroethene	100	µg/m^3	6,500	31	14	180	10,000,000	75	37,000
Vinyl chloride	93	µg/m^3	< 16	< 0.18	< 0.18	< 0.18	< 7200	< 0.18	< 150

Notes:

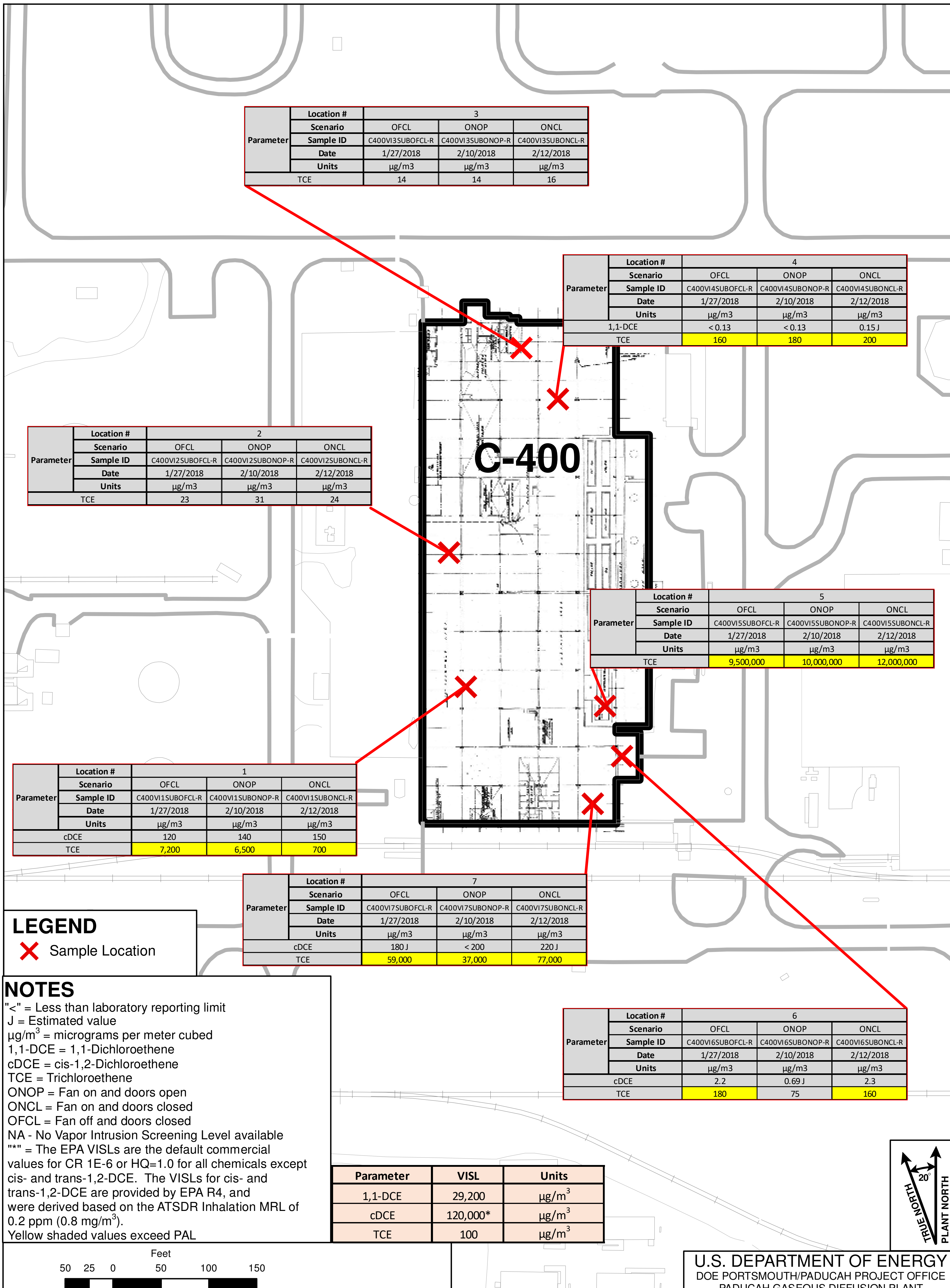
1. µg/m^3 = micrograms per meter cubed
2. "<" Less than laboratory reporting limit
3. "J" Compound detected below method quantitation limit; estimated value provided
4. VISL = Vapor Intrusion Screening Level
5. The EPA VISL are the default commercial values for CR 1E-6 or HQ=1.0 for all chemicals except *cis*- and *trans*-1,2-DCE. The VISLs for *cis*- and *trans*-1,2-DCE are provided by EPA R4, and were derived based on the ATSDR Inhalation MRL of 0.2 ppm (0.8 mg/m^3).
6. Yellow shaded values exceed PALs and EPA Sub-slab Soil Gas VISLs

Table D.2. Sub-slab Soil Gas Air Analytical Results (Continued)

Parameter	EPA Sub-slab Soil Gas VISL	Scenario	Fan On and Doors Closed						
		Location #	1	2	3	4	5	6	7
		Sample ID	C400VI1SUBONCL-R	C400VI2SUBONCL-R	C400VI3SUBONCL-R	C400VI4SUBONCL-R	C400VI5SUBONCL-R	C400VI6SUBONCL-R	C400VI7SUBONCL-R
		Date	2/12/2018	2/12/2018	2/12/2018	2/12/2018	2/12/2018	2/12/2018	2/12/2018
Volatile Organic Compounds		*Units*							
1,1,1-Trichloroethane	730,000	µg/m^3	< 15	< 0.16	< 0.16	< 0.16	< 6900	< 0.16	< 120
1,1,2-Trichloroethane	26	µg/m^3	< 27	< 0.29	< 0.29	< 0.29	< 12000	< 0.29	< 220
1,1-Dichloroethane	256	µg/m^3	< 9.7	< 0.11	< 0.11	< 0.11	< 4400	< 0.11	< 78
1,1-Dichloroethene	29,200	µg/m^3	< 12	< 0.13	< 0.13	0.15 J	< 5700	< 0.13	< 100
1,2-Dichloroethane	16	µg/m^3	< 18	< 0.19	< 0.19	< 0.19	< 8000	< 0.19	< 140
1,4-Dioxane	82	µg/m^3	< 27	< 0.29	< 0.29	< 0.29	< 12000	< 0.29	< 210
cis -1,2-Dichloroethene	120,000	µg/m^3	150	< 0.24	< 0.24	< 0.24	< 10000	2.3	220 J
trans -1,2-Dichloroethene	120,000	µg/m^3	< 18	< 0.2	< 0.2	< 0.2	< 8300	< 0.2	< 150
Trichloroethene	100	µg/m^3	7,000	24	16	200	12,000,000	160	77,000
Vinyl chloride	93	µg/m^3	< 17	< 0.18	< 0.18	< 0.18	< 7600	< 0.18	< 140

Notes:

1. µg/m^3 = micrograms per meter cubed
2. "<" Less than laboratory reporting limit
3. "J" Compound detected below method quantitation limit; estimated value provided
4. VISL = Vapor Intrusion Screening Level
5. The EPA VISL are the default commercial values for CR 1E-6 or HQ=1.0 for all chemicals except *cis* - and *trans* -1,2-DCE. The VISLs for *cis* - and *trans* -1,2-DCE are provided by EPA R4, and were derived based on the ATSDR Inhalation MRL of 0.2 ppm (0.8 mg/m^3).
6. Yellow shaded values exceed PALs and EPA Sub-slab Soil Gas VISLs



Parameter	Location #	3		
	Scenario	OFCL	ONOP	ONCL
	Sample ID	C400VI3SUBOFCL-R	C400VI3SUBONOP-R	C400VI3SUBONCL-R
	Date	1/27/2018	2/10/2018	2/12/2018
	Units	µg/m3	µg/m3	µg/m3
TCE		14	14	16

Parameter	Location #	4		
	Scenario	OFCL	ONOP	ONCL
	Sample ID	C400VI4SUBOFCL-R	C400VI4SUBONOP-R	C400VI4SUBONCL-R
	Date	1/27/2018	2/10/2018	2/12/2018
	Units	µg/m3	µg/m3	µg/m3
1,1-DCE		< 0.13	< 0.13	0.15 J
TCE		160	180	200

Parameter	Location #	2		
	Scenario	OFCL	ONOP	ONCL
	Sample ID	C400VI2SUBOFCL-R	C400VI2SUBONOP-R	C400VI2SUBONCL-R
	Date	1/27/2018	2/10/2018	2/12/2018
	Units	µg/m3	µg/m3	µg/m3
TCE		23	31	24

Parameter	Location #	5		
	Scenario	OFCL	ONOP	ONCL
	Sample ID	C400VI5SUBOFCL-R	C400VI5SUBONOP-R	C400VI5SUBONCL-R
	Date	1/27/2018	2/10/2018	2/12/2018
	Units	µg/m3	µg/m3	µg/m3
TCE		9,500,000	10,000,000	12,000,000

Parameter	Location #	1		
	Scenario	OFCL	ONOP	ONCL
	Sample ID	C400VI1SUBOFCL-R	C400VI1SUBONOP-R	C400VI1SUBONCL-R
	Date	1/27/2018	2/10/2018	2/12/2018
	Units	µg/m3	µg/m3	µg/m3
cDCE		120	140	150
TCE		7,200	6,500	700

Parameter	Location #	7		
	Scenario	OFCL	ONOP	ONCL
	Sample ID	C400VI7SUBOFCL-R	C400VI7SUBONOP-R	C400VI7SUBONCL-R
	Date	1/27/2018	2/10/2018	2/12/2018
	Units	µg/m3	µg/m3	µg/m3
cDCE		180 J	< 200	220 J
TCE		59,000	37,000	77,000

Parameter	Location #	6		
	Scenario	OFCL	ONOP	ONCL
	Sample ID	C400VI6SUBOFCL-R	C400VI6SUBONOP-R	C400VI6SUBONCL-R
	Date	1/27/2018	2/10/2018	2/12/2018
	Units	µg/m3	µg/m3	µg/m3
cDCE		2.2	0.69 J	2.3
TCE		180	75	160

LEGEND

Sample Location

NOTES

"<" = Less than laboratory reporting limit
J = Estimated value
µg/m^3 = micrograms per meter cubed
1,1-DCE = 1,1-Dichloroethene
cDCE = cis-1,2-Dichloroethene
TCE = Trichloroethene
ONOP = Fan on and doors open
ONCL = Fan on and doors closed
OFCL = Fan off and doors closed
NA - No Vapor Intrusion Screening Level available
"*" = The EPA VISLs are the default commercial values for CR 1E-6 or HQ=1.0 for all chemicals except cis- and trans-1,2-DCE. The VISLs for cis- and trans-1,2-DCE are provided by EPA R4, and were derived based on the ATSDR Inhalation MRL of 0.2 ppm (0.8 mg/m^3).
Yellow shaded values exceed PAL

Parameter	VISL	Units
1,1-DCE	29,200	µg/m^3
cDCE	120,000*	µg/m^3
TCE	100	µg/m^3

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Figure D.7. Summary of Sub-slab Sampling Detections for C-400 Cleaning Building Vapor Intrusion Study

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summarized in Table D.2, including EPA VISLs for comparison, and illustrated on Figure D.7. As indicated in the QAPP contained in Appendix B of the WP, data are placed into and reported from OREIS following verification assessment and validation.

All data was found to be usable during validation, and no data was rejected. *cis*-1,2-DCE results were "J" qualified 3 times and 1,2 DCE was "J" qualified once, indicating that the compound was detected below the method quantitation limit, resulting in an estimated value. Individual RLs for nondetect samples at Locations 1, 5, and 7 were above screening levels identified in Table D.2 due to the concentrations of TCE in the samples.

D.3.1.3 Ambient Air Analytical Results

Ambient air samples were collected from Locations 1 through 4 surrounding C-400 Cleaning Building on January 27, 2018, under the fan off, doors closed scenario. A second round of ambient air samples was collected from the same locations on February 10, 2018, under the fan on, doors open scenario. The last ambient air samples were collected from the same locations on February 12, 2018, under the fan on, doors closed scenario.

TCE was the only compound detected in the ambient air samples. These samples were collected concurrently with the indoor and sub-slab samples.

During the January 27, 2018, sampling event, TCE was below the RL of 0.19 $\mu g/m^3$ at ambient Locations 1 and 4 and detected at ambient Locations 2 and 3 at concentrations of 0.21J $\mu g/m^3$ and 0.36J $\mu g/m^3$, respectively.

During the February 10 and 12, 2018, sampling events, TCE was below the RL of 0.19 $\mu g/m^3$ at ambient Locations 1, 2, and 4 and detected only at ambient Location 3 at concentrations of 0.2J $\mu g/m^3$ and 0.28J $\mu g/m^3$, respectively.

Ambient air analytical results are summarized in Table D.3, including PALs for comparison, and illustrated in Figure D.8. All TCE results from the three sampling events were "J" qualified, indicating that the compound was detected below the method quantitation limit, resulting in an estimated value. As indicated in the QAPP contained in Appendix B of the WP, data are placed into and reported from OREIS following verification assessment and validation.

All data were found to be usable during validation, and no data were rejected. Individual RLs for nondetect samples all were below the PALs identified in Table D.3.

D.3.2 OTHER DATA

D.3.2.1 Pressure Monitoring Data

On February 10 and 12, 2018, at the additional sub-slab soil gas monitoring probe installed near Location 7, the differential pressures between sub-slab soil gas and indoor air and between the indoor air and ambient air were logged at 10-second intervals during the 10-hour sampling events. During the January 27, 2018, field event (fan off, doors closed scenario) the logging micromanometer at the additional sub-slab soil gas monitoring probe near Location 7 ceased to function after 1.5 hours. The 2-hour interval differential pressure was collected at all locations in accordance with the approved WP (Locations 1 through 8), and those data are included in Attachment D3.

Table D.3. Ambient Air Analytical Results

Parameter	PAL	Scenario	Fan Off and Doors Closed			
		Location #	1	2	3 SE	4
		Sample ID	C400VI1AMBOFCL-R	C400VI2AMBOFCL-R	C400VI3SEAMBOFCL-R	C400VI4AMBOFCL-R
		Date	1/27/2018	1/27/2018	1/27/2018	1/27/2018
Volatile Organic Compounds		*Units*				
1,1,1-Trichloroethane	22,000	$\mu g/m^3$	< 0.16	< 0.16	< 0.16	< 0.16
1,1,2-Trichloroethane	0.77	$\mu g/m^3$	< 0.29	< 0.29	< 0.29	< 0.29
1,1-Dichloroethane	7.7	$\mu g/m^3$	< 0.11	< 0.11	< 0.11	< 0.11
1,1-Dichloroethene	880	$\mu g/m^3$	< 0.13	< 0.13	< 0.13	< 0.13
1,2-Dichloroethane	0.47	$\mu g/m^3$	< 0.19	< 0.19	< 0.19	< 0.19
1,4-Dioxane	2.5	$\mu g/m^3$	< 0.29	< 0.29	< 0.29	< 0.29
cis -1,2-Dichloroethene	3,500	$\mu g/m^3$	< 0.24	< 0.24	< 0.24	< 0.24
trans -1,2-Dichloroethene	3,500	$\mu g/m^3$	< 0.2	< 0.2	< 0.2	< 0.2
Trichloroethene	3.0	$\mu g/m^3$	< 0.19	0.21 J	0.36 J	< 0.19
Vinyl chloride	2.8	$\mu g/m^3$	< 0.18	< 0.18	< 0.18	< 0.18

Notes:

1. $\mu g/m^3$ = micrograms per meter cubed
2. "<" Less than laboratory reporting limit
3. "J" Compound detected below method quantitation limit; estimated value provided
4. PAL = Project Action Limit
5. The PALs are the same as the EPA commercial scenario VISLs for CR 1E-6 or HQ=1.0 for all chemicals except *cis* - and *trans* - 1,2-DCE. The PALs for *cis* - and *trans* -1,2-DCE are the VISLs provided by EPA R4, which are based on the ATSDR Inhalation MRL of 0.2 ppm (0.8 mg/m^3).

Table D.3. Ambient Air Analytical Results (Continued)

Parameter	PAL	Scenario / Location # / Sample ID / Date	Fan On and Doors Open			
		Location #	1	2	3 SE	4
		Sample ID	C400VI1AMBONOP-R	C400VI2AMBONOP-R	C400VI3SEAMBONOP-R	C400VI4AMBONOP-R
		Date	2/10/2018	2/10/2018	2/10/2018	2/10/2018
Volatile Organic Compounds		*Units*				
1,1,1-Trichloroethane	22,000	µg/m^3	< 0.16	< 0.16	< 0.16	< 0.16
1,1,2-Trichloroethane	0.77	µg/m^3	< 0.29	< 0.29	< 0.29	< 0.29
1,1-Dichloroethane	7.7	µg/m^3	< 0.11	< 0.11	< 0.11	< 0.11
1,1-Dichloroethene	880	µg/m^3	< 0.13	< 0.13	< 0.13	< 0.13
1,2-Dichloroethane	0.47	µg/m^3	< 0.19	< 0.19	< 0.19	< 0.19
1,4-Dioxane	2.5	µg/m^3	< 0.29	< 0.29	< 0.29	< 0.29
cis -1,2-Dichloroethene	3,500	µg/m^3	< 0.24	< 0.24	< 0.24	< 0.24
trans -1,2-Dichloroethene	3,500	µg/m^3	< 0.2	< 0.2	< 0.2	< 0.2
Trichloroethene	3.0	µg/m^3	< 0.19	0.2 J	< 0.19	< 0.19
Vinyl chloride	2.8	µg/m^3	< 0.18	< 0.18	< 0.18	< 0.18

Notes:

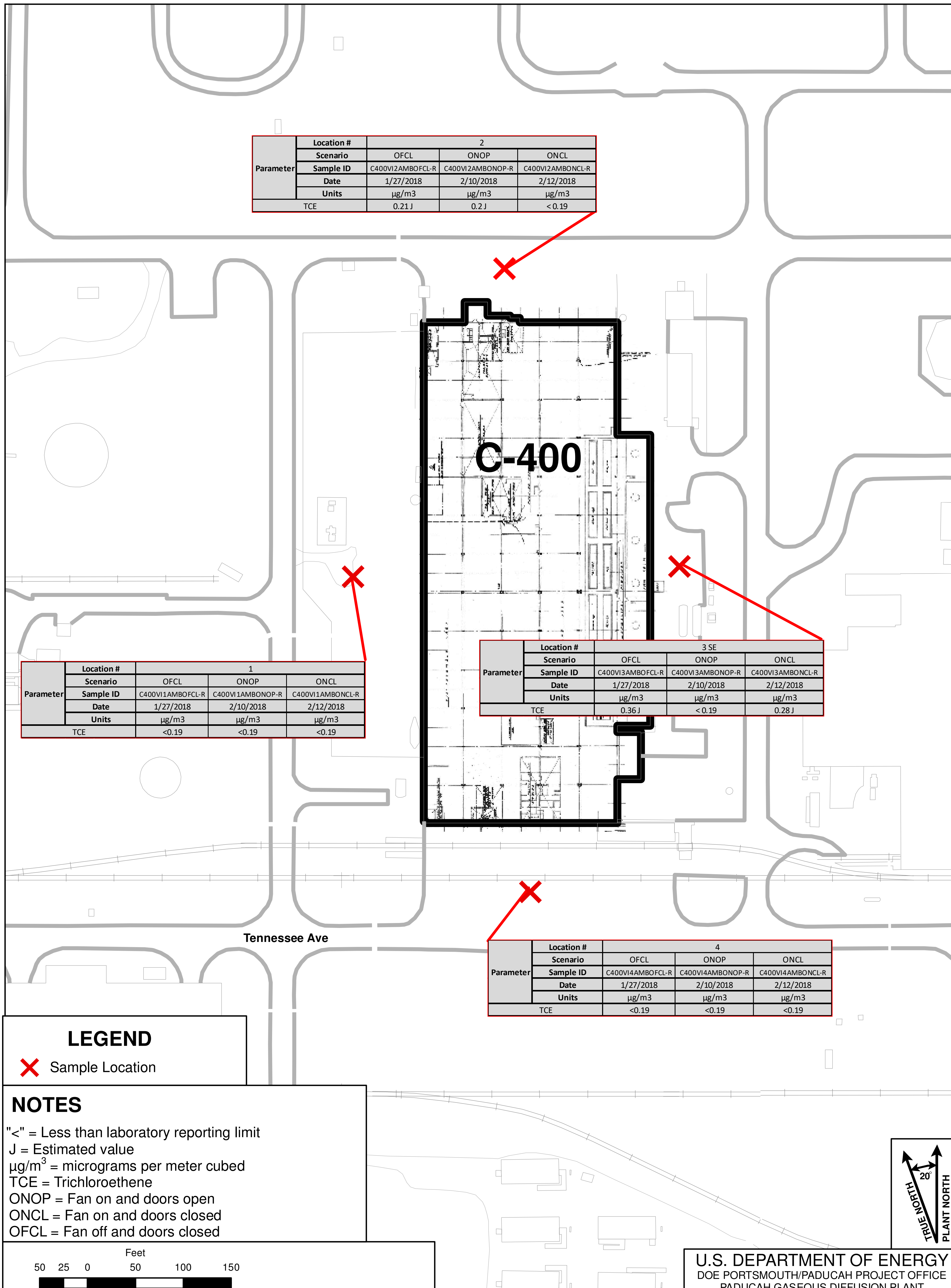
1. µg/m^3 = micrograms per meter cubed
2. "<" Less than laboratory reporting limit
3. "J" Compound detected below method quantitation limit; estimated value provided
4. PAL = Project Action Limit
5. The PALs are the same as the EPA commercial scenario VISLs for CR 1E-6 or HQ=1.0 for all chemicals except *cis* - and *trans* - 1,2-DCE. The PALs for *cis* - and *trans* -1,2-DCE are the VISLs provided by EPA R4, which are based on the ATSDR Inhalation MRL of 0.2 ppm (0.8 mg/m^3).

Table D.3. Ambient Air Analytical Results (Continued)

Parameter	PAL	Scenario	Fans On and Doors Closed			
		Location #	1	2	3 SE	4
		Sample ID	C400VI1AMBONCL-R	C400VI2AMBONCL-R	C400VI3SEAMBONCL-R	C400VI4AMBONCL-R
		Date	2/12/2018	2/12/2018	2/12/2018	2/12/2018
Volatile Organic Compounds		*Units*				
1,1,1-Trichloroethane	22,000	µg/m^3	< 0.16	< 0.16	< 0.16	< 0.16
1,1,2-Trichloroethane	0.77	µg/m^3	< 0.29	< 0.29	< 0.29	< 0.29
1,1-Dichloroethane	7.7	µg/m^3	< 0.11	< 0.11	< 0.11	< 0.11
1,1-Dichloroethene	880	µg/m^3	< 0.13	< 0.13	< 0.13	< 0.13
1,2-Dichloroethane	0.47	µg/m^3	< 0.19	< 0.19	< 0.19	< 0.19
1,4-Dioxane	2.5	µg/m^3	< 0.29	< 0.29	< 0.29	< 0.29
cis -1,2-Dichloroethene	3,500	µg/m^3	< 0.24	< 0.24	< 0.24	< 0.24
trans -1,2-Dichloroethene	3,500	µg/m^3	< 0.2	< 0.2	< 0.2	< 0.2
Trichloroethene	3.0	µg/m^3	< 0.19	< 0.19	0.28 J	< 0.19
Vinyl chloride	2.8	µg/m^3	< 0.18	< 0.18	< 0.18	< 0.18

Notes:

1. µg/m^3 = micrograms per meter cubed
2. "<" Less than laboratory reporting limit
3. "J" Compound detected below method quantitation limit; estimated value provided
4. PAL = Project Action Limit
5. The PALs are the same as the EPA commercial scenario VISLs for CR 1E-6 or HQ=1.0 for all chemicals except *cis* - and *trans* - 1,2-DCE. The PALs for *cis* - and *trans* -1,2-DCE are the VISLs provided by EPA R4, which are based on the ATSDR Inhalation MRL of 0.2 ppm (0.8 mg/m^3).



Parameter	Location #	2		
	Scenario	OFCL	ONOP	ONCL
	Sample ID	C400VI2AMBOFCL-R	C400VI2AMBONOP-R	C400VI2AMBONCL-R
	Date	1/27/2018	2/10/2018	2/12/2018
	Units	µg/m3	µg/m3	µg/m3
TCE		0.21 J	0.2 J	< 0.19

Parameter	Location #	1		
	Scenario	OFCL	ONOP	ONCL
	Sample ID	C400VI1AMBOFCL-R	C400VI1AMBONOP-R	C400VI1AMBONCL-R
	Date	1/27/2018	2/10/2018	2/12/2018
	Units	µg/m3	µg/m3	µg/m3
TCE		<0.19	<0.19	<0.19

Parameter	Location #	3 SE		
	Scenario	OFCL	ONOP	ONCL
	Sample ID	C400VI3AMBOFCL-R	C400VI3AMBONOP-R	C400VI3AMBONCL-R
	Date	1/27/2018	2/10/2018	2/12/2018
	Units	µg/m3	µg/m3	µg/m3
TCE		0.36 J	< 0.19	0.28 J

Parameter	Location #	4		
	Scenario	OFCL	ONOP	ONCL
	Sample ID	C400VI4AMBOFCL-R	C400VI4AMBONOP-R	C400VI4AMBONCL-R
	Date	1/27/2018	2/10/2018	2/12/2018
	Units	µg/m3	µg/m3	µg/m3
TCE		<0.19	<0.19	<0.19

LEGEND

✕ Sample Location

NOTES

"<" = Less than laboratory reporting limit
J = Estimated value
µg/m^3 = micrograms per meter cubed
TCE = Trichloroethene
ONOP = Fan on and doors open
ONCL = Fan on and doors closed
OFCL = Fan off and doors closed

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

FOUR RIVERS NUCLEAR PARTNERSHIP, LLC

Figure D.8. Summary of Ambient Air Sampling Detections for C-400 Cleaning Building Vapor Intrusion Study

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Fan Off, Doors Closed Scenario (January 27, 2018)

2-hour Interval Summary: The differential pressure between sub-slab soil gas and indoor air varied at sample Locations 1 through 7 during the course of the sampling event as indicated on the Differential Pressure and Ambient Temperature Monitoring Records included in Attachment D3. Average differential pressures between sub-slab soil gas and indoor air varied between -5.4 Pascals (Pa) (Location 3) to +2.2 Pa (Location 2). The average differential pressure between indoor air and ambient air ranged between -3.4 Pa (Location 7) and +0.1 Pa (Location 1). The differential pressure between Location 8 and ambient air ranged between -2 and -0.2 Pa and averaged -0.7 Pa.

10-second Interval Summary: The sub-slab to indoor air and indoor air to ambient air differential pressures measured during the first 1.5 hours near Location 7 ranged between approximately +0.04 and -0.07 Pa. These variations around a zero pressure differential are consistent with the expectation of near neutral pressure conditions for a closed building without mechanical ventilation, particularly under the moderate temperatures and calm winds recorded during the test period.

Fan On, Doors Open Scenario (February 10, 2018)

2-hour Interval Summary: The differential pressure between sub-slab soil gas and indoor air varied at sample Locations 1 through 7 during the course of the sampling event, as indicated on the Differential Pressure and Ambient Temperature Monitoring Records included in Attachment D3. Average differential pressures between sub-slab soil gas and indoor air varied between -1.4 Pa (Location 3) to +1.7 Pa (Location 4). The average differential pressure between indoor air and ambient air ranged between -4.3 Pa (Location 4) and +1 Pa (Location 7). The differential pressure between the exhaust fan (Location 8) and ambient air ranged between -0.2 and +2 Pa and averaged +0.7 Pa. These observations are consistent with the observations described above, based on the continuous pressure differential monitoring.

10-second Interval Summary: The differential pressure between sub-slab soil gas and indoor air varied between approximately -8 and +8 Pa and averaged +0.14 Pa, which indicates the building interior was, on average, slightly depressurized relative to the sub-slab. The largest variability in differential pressure measurements also occurred in the middle of the day. The measurements of differential pressure between indoor air and ambient air ranged between -0.25 and +2.69 Pa with a consistent average of +0.8 Pa throughout the day, as illustrated in Figure D.9, indicating the building interior was, on average, slightly pressurized relative to the ambient. Vapor entry would be expected to be slightly enhanced under these conditions, but any vapors entering through the slab would have been expected to be diluted by the additional ventilation provided by operating the exhaust fan and keeping the doors open, particularly considering the consistent breeze from the south blowing into the building's southern bay doors.

The average differential pressure +0.14 Pa between sub-slab soil gas and indoor air indicates a higher pressure in the sub-slab than the building interior; therefore, the building was depressurized relative to the subsurface during the sampling event. The average differential pressure of +0.8 Pa between indoor air and ambient also indicates that the building was depressurized. The differential pressure indicates that samples were collected under conditions that foster VI.

Fan On, Doors Closed Scenario (February 12, 2018)

2-hour Interval Summary: The differential pressure between sub-slab soil gas and indoor air varied at sampling Locations 1 through 7 during the course of the sampling event, as indicated on the Differential Pressure and Ambient Temperature Monitoring Records included in Attachment D3. Average differential pressures between sub-slab soil gas and indoor air varied between -3 Pa (Location 4) to +0.1 Pa

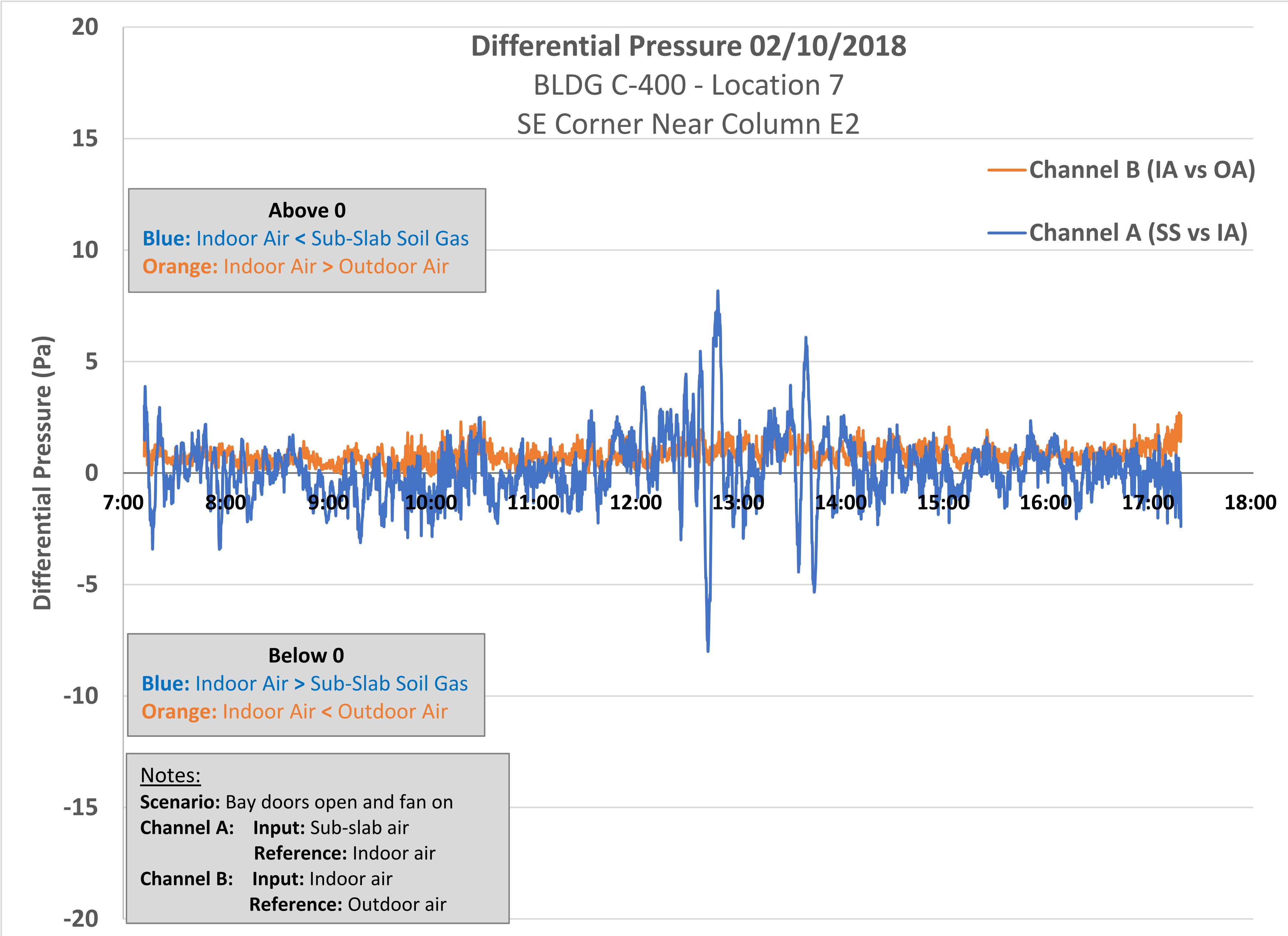

Figure D.9. Differential Pressure between Sub-slab Soil Gas and Indoor Air—Fan On, Doors Open Scenario, February 10, 2018

(Location 6). The average differential pressure between indoor air and ambient air ranged between -10 Pa (Location 3) and -0.5 Pa (Location 7). The differential pressure between Location 8 and ambient air ranged between -2.4 and +5.1 Pa and averaged -2.9 Pa.

10-second Interval Summary: The differential pressure between sub-slab soil gas and indoor air varied between approximately -4.2 and +1.5 Pa and averaged -2.9 Pa, which indicates the sub-slab was, on average, depressurized relative to the building interior at Location 7. The data shows an increasing trend, with pressure differentials starting at about -3 Pa and rising to approximately 0 Pa around 14:00 and thereafter appearing relatively stable as illustrated in Figure D.10, as measured at the eighth sub-slab soil gas monitoring probe near Location 7. The differential pressure between indoor air and ambient air varied between -4.6 and +7.4 Pa and averaged -3.7 Pa, indicating the building was, on average, depressurized relative to the ambient. The time trend plot shows an overall increasing trend with pressure differentials starting around -3 Pa, reaching zero around noon, and rising to levels above +3 Pa in the afternoon. Variability increased throughout the sampling event, as illustrated in Figure D.10.

The sub-slab depressurized condition relative to the building suggests that operating the exhaust fan, which is designed to draw building air through a subgrade plenum, also draws subsurface vapors into the plenum. The building depressurization relative to the ambient suggests that VI will be enhanced in areas more distal from the plenum.

D.3.2.2 Weather Data

On January 27, February 10 and 12, 2018, weather data (temperature, relatively humidity, barometric pressure, wind direction, and wind speed) were collected every 2 hours during the sampling events (Attachment D3).

January 27, 2018, (Fan Off, Doors Closed Scenario): Ambient temperature at the weather station was relatively stable, ranging from 50 to 53 degrees Fahrenheit (°F) throughout the day. Relative humidity started at 76% and rose to 90% within 2 hours of the start of sampling. Barometric pressure was steady, around 30.20 inches of mercury (inHg). Conditions were calm with wind speed recorded as 0 miles per hour (mph) during every reading, except the first hour, which recorded a speed of 4 mph blowing from the south-southeast.

February 10, 2018, (Fan On, Doors Open Scenario): Ambient temperature at the weather station was relatively stable, ranging from 38 to 40°F throughout the day. Relative humidity started at 41% and rose to around 50% within 2 hours of the start of sampling. Barometric pressure decreased slightly throughout the sampling event starting at around 30.04 inHg and finishing at 29.97 inHg. The wind was relatively consistent, blowing at around 5 mph in a northerly direction for most of the sampling event.

February 12, 2018, (Fan On, Doors Closed Scenario): Ambient temperature at the weather station increased throughout the field event, starting at 22°F and ending around 40°F. The relative humidity started at 75% and decreased to around 60%. The barometric pressure started at 30.51 inHg and increased to 30.57 inHg in the first 2 hours of sampling where it remained with little fluctuation for the rest of the event. The wind was recorded consistently as blowing in a northerly direction at speeds around 6 mph, except for a reading in the middle of the day where the wind speed dropped to 1 mph.

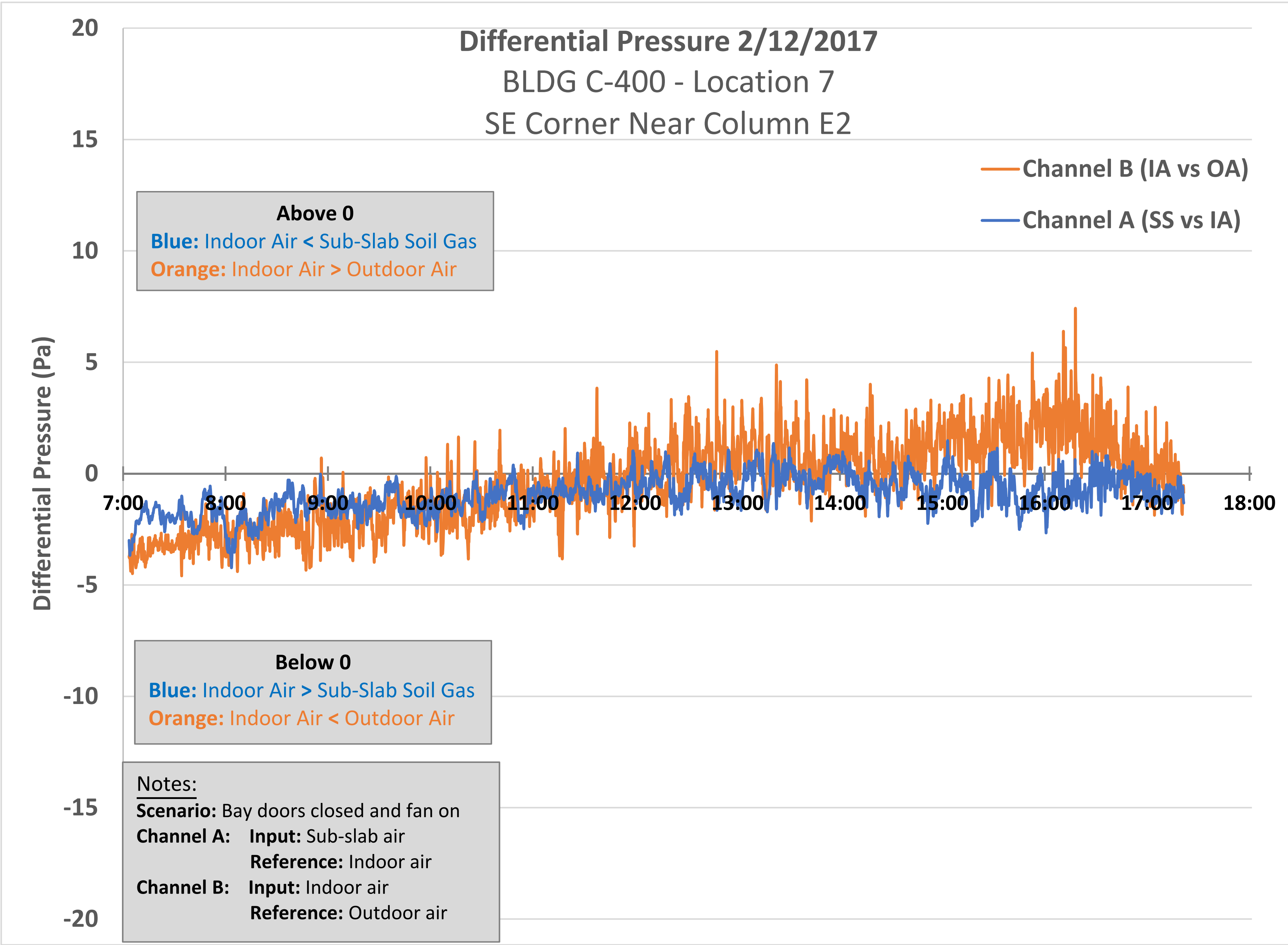

Figure D.10. Differential Pressure between Sub-slab Soil Gas and Indoor Air—Fan On, Doors Closed Scenario, February 12, 2018

D.4. DISCUSSION

This section compares the indoor air analytical results to PALs for indoor workers and discusses the findings from individual building interior samples (Locations 1–7) relative to the integrated fan exhaust results (Location 8) and ambient air concentrations. These results are evaluated in context of the VI CSM to determine whether the VI pathway is complete and if a completed pathway would present an unacceptable risk to unprotected workers in C-400 Cleaning Building, using the decision rules presented in the WP.

D.4.1 PROJECT ACTION LEVEL COMPARISON

The PALs for indoor workers are included in Tables D.1 and D.3 for comparison to analytical results. The PALs are the same as the EPA commercial scenario VISLs for a cancer risk of 1E-6 or hazard quotient (HQ) of 1.0 for all chemicals, except *cis*- and *trans*-1,2-DCE. The PALs for *cis*- and *trans*-1,2-DCE are the VISLs provided by EPA Region 4, which are based on the Agency for Toxic Substances and Disease Registry's Inhalation Minimal Risk Level of 0.2 ppm (0.8 mg/m^3). As of May 14, 2018, there has been no change in EPA's VISLs since the WP was developed.

Indoor Air

TCE is the only detected compound that exceeded indoor air PALs at any location. The RLs for all compounds were below their respective PALs.

During the January 27, 2018, sampling event (fan off, doors closed), the measured TCE concentration in indoor air exceeded the indoor air PAL of 3.0 μg/m^3 in samples collected at Locations 5, 6, and 8, with the highest indoor air concentrations occurring at Location 5 (12–17 μg/m^3). No other compound was detected during this event.

During the February 10, 2018, sampling event (fan on, doors open), the measured TCE concentration in indoor air did not exceed the indoor air PAL of 3.0 μg/m^3 at any location, suggesting an open door scenario may supply sufficient ventilation to ensure indoor air concentrations are below PALs. TCE was detected at Locations 5, 6, and 8 at concentrations ranging from 1.4 to 2.9 μg/m^3; the highest indoor air concentrations occurred at Location 5 (2.5–2.9 μg/m^3). The only other compound detected in indoor air was *trans*-1,2-DCE at Location 7, at a concentration (1.3 μg/m^3) several orders of magnitude below its PAL of 3,500 μg/m^3. The concentration of the integrated fan exhaust (2.1 μg/m^3 at Location 8) was within the range of concentrations reported at the other building interior locations (1–7), indicating the fan exhaust concentration serves as integrated measure of indoor air concentrations in this scenario.

During the February 12, 2018, sampling event (fan on, doors closed), the measured TCE concentration in indoor air exceeded the indoor air PAL of 3.0 μg/m^3 in samples collected at Locations 5 and 6, with the highest indoor air concentration occurring at Location 5 (7.1 μg/m^3). The only other compound detected in indoor air was *trans*-1,2-DCE at Locations 4, 5, 7, and 8, with estimated concentrations (ranging from 0.2J to 0.43J μg/m^3) several orders of magnitude below the PAL of 3,500 μg/m^3. The concentration of the integrated fan exhaust (2.0 μg/m^3 at Location 8) was within the range of concentrations reported at the other building interior locations (1–7), indicating the fan exhaust concentration serves as integrated measure of indoor air concentrations in this scenario.

Over the three sampling events, the measured concentrations of TCE varied by a factor of 3.5 or less at all locations, except Location 5, where it varied by a factor of 8.5. Exceedances of the TCE PAL were observed only under the doors closed scenarios.

A preliminary risk evaluation was conducted because indoor air TCE concentrations exceeded the PAL at some locations. Cumulative excess lifetime cancer risks (ELCR) and non-cancer hazard indices (HIs) for the indoor worker scenario were calculated and are presented in Table D.4. Location 8 is included in the risk evaluation because concentrations at that location fall within the range of indoor air concentrations measured at the building interior locations. Chemicals that were not detected in any indoor air or sub-slab soil gas samples were not included in the risk evaluation. The chemicals included in the risk evaluation are 1,1-DCE, *cis*-1,2-DCE, *trans*-1,2-DCE, and TCE, which were detected at least once in either indoor air or sub-slab soil gas.

The exposure point concentrations (EPCs) for chemicals at individual locations are the laboratory reported concentrations at those locations. Where duplicate samples were taken, the highest of reported results was used in the calculations. Spatially aggregated EPCs for the building were derived from the results reported for Locations 1–8 for each sampling event. Spatially and temporally aggregated EPCs were derived by combining the data for the three sampling events. The building EPCs are reasonable maximum exposure concentrations derived as the 95% upper confidence level recommended by the latest version of ProUCL (Version 5.1, October 2015) when sufficient data were available or where the maximum reported concentration when insufficient data were available. As recommended by ProUCL, the RL was used for nondetect values, and ProUCL accounted for the nondetects in performing the calculations.

The exposure parameters used to perform the risk evaluation for the Paducah indoor worker scenario were ET = 8 hr/d; EF = 250 d/yr; ED = 25 yrs; AT(nc) = 25 yrs × 365 d/yr; and AT(c) = 70 yrs × 365 d/yr. These exposure parameters are the same as the default commercial scenario exposure parameters EPA uses to calculate VISLs. Thus, for this preliminary risk evaluation, ELCR were derived as the ratio of the EPC to the EPA Cancer VISL at CR = 1E-06. Likewise, the HQs were derived from the ratio of the EPC to the EPA Non-cancer VISL at HQ = 1.0. Cumulative ELCRs and HIs were calculated for each location, for the building during each sampling event, and for the aggregate of sampling events in the building.

The risk evaluation presented in Table D.4 shows the calculated risks are driven by the observed TCE concentrations. The cumulative ELCRs for individual locations, for the building during each sampling event, and for the building over the three sampling events are all well within EPA's acceptable ELCR range of 1.0E-6 to 1.0E-4. The cumulative building ELCR for the fan off, doors closed scenario is 5.6E-6. For the fan on, doors open scenario, all ELCRs are below 1.0E-6; for the fan on, doors closed scenario, the cumulative building ELCR is 1.3E-6. Considering all the data, the cumulative ELCR is 1.6E-6. The building HI for the fan off, doors closed scenario is 1.9, due to the measured concentration at Location 5. For the fan on, doors open and fan on, doors closed scenarios, all HIs are less than 1.0. Considering all the data, the cumulative HI is 0.53. Actual exposures and, therefore, risks likely are lower than assumed, based on the default commercial exposure parameters used in this preliminary risk evaluation because DOE has relocated all office workers and laundry workers from C-400 Cleaning Building. Remediation workers (and/or deactivation workers) currently enter the building only to conduct deactivation activities and have a health and safety plan that covers their activities. Cumulative risks for the building as a whole are within or below acceptable levels. Site-specific exposure times, frequencies, durations, or averaging times that are less than the assumed values would result in even lower risks.

Table D.4. Human Health Risk Evaluation—Cumulative Excess Lifetime Cancer Risks and Non-cancer Hazard Indices

Exposure Concentrations Used in Risk Calculations

Chemical	Indoor Worker Scenario PAL*	PAL Toxicity Basis	EPA Cancer VISL CR=1.0E-6	EPA Non-Cancer VISL HQ=1.0	Reporting Limit (RL)	Scenario	Fan Off and Doors Closed - Exposure Point Concentrations									
						Location #	1	2	3	4	5	5 Duplicate	6	6 Duplicate	8	Building EPC
						Sample ID	C400VI1INOFCL-R	C400VI2INOFCL-R	C400VI3INOFCL-R	C400VI4INOFCL-R	C400VI5INOFCL-R	C400VI5INOFCLD-R	C400VI6INOFCL-R	C400VI6INOFCLD-R	C400VI8EXHOFCL-R	
						Date	1/27/2018	1/27/2018	1/27/2018	1/27/2018	1/27/2018	1/27/2018	1/27/2018	1/27/2018	1/27/2018	1/27/2018
<u>*Volatile Organic Compounds*</u>	$\mu g/m^3$		$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$		$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$
1,1,1-Trichloroethane	2.2E+04	NC		2.2E+04	< 0.16		*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
1,1,2-Trichloroethane	0.77	C	0.77	0.88	< 0.29		*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
1,1-Dichloroethane	7.7	C	7.7		< 0.11		*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
1,1-Dichloroethene	8.8E+02	NC		8.8E+02	< 0.13		*0.13*	*0.13*	*0.13*	*0.13*	*0.13*	*0.13*	*0.13*	*0.13*	*0.13*	*0.13*
1,2-Dichloroethane	0.47	C	0.47	31	< 0.19		*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
1,4-Dioxane	2.5	C	2.5	1.3E+02	< 0.29		*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
cis -1,2-Dichloroethene	3500	NC		3500	< 0.24		*0.24*	*0.24*	*0.24*	*0.24*	*0.24*	*0.24*	*0.24*	*0.24*	*0.24*	*0.24*
trans -1,2-Dichloroethene	3500	NC		3500	< 0.2		*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
Trichloroethene	3.0	C	3.0	8.8	< 0.19		**0.35**	**0.22**	**0.42**	**0.44**	**12**	**17**	**2.8**	**4.3**	**3.9**	**17**
Vinyl chloride	2.8	C	2.8	4.4E+02	< 0.18		*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*

Excess Lifetime Cancer Risks (ELCR)

Chemical	Indoor Worker Scenario PAL	PAL Toxicity Basis	EPA Cancer VISL CR=1.0E-6	EPA Non-Cancer VISL HQ=1.0	Reporting Limit (RL)	Scenario	Fan Off and Doors Closed - Excess Lifetime Cancer Risks									
						Location #	1	2	3	4	5	5 Duplicate	6	6 Duplicate	8	Building ELCR
						Sample ID	C400VI1INOFCL-R	C400VI2INOFCL-R	C400VI3INOFCL-R	C400VI4INOFCL-R	C400VI5INOFCL-R	C400VI5INOFCLD-R	C400VI6INOFCL-R	C400VI6INOFCLD-R	C400VI8EXHOFCL-R	
						Date	1/27/2018	1/27/2018	1/27/2018	1/27/2018	1/27/2018	1/27/2018	1/27/2018	1/27/2018	1/27/2018	1/27/2018
<u>*Volatile Organic Compounds*</u>	$\mu g/m^3$		$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$		ELCR	ELCR	ELCR	ELCR	ELCR	ELCR	ELCR	ELCR	ELCR	ELCR
1,1,1-Trichloroethane	2.2E+04	NC		2.2E+04	< 0.16											
1,1,2-Trichloroethane	0.77	C	0.77	0.88	< 0.29		*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
1,1-Dichloroethane	7.7	C	7.7		< 0.11		*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
1,1-Dichloroethene	8.8E+02	NC		8.8E+02	< 0.13											
1,2-Dichloroethane	0.47	C	0.47	31	< 0.19		*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
1,4-Dioxane	2.5	C	2.5	1.3E+02	< 0.29		*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
cis -1,2-Dichloroethene	3500	NC		3500	< 0.24											
trans -1,2-Dichloroethene	3500	NC		3500	< 0.2											
Trichloroethene	3.0	C	3.0	8.8	< 0.19		**1.2E-07**	**7.4E-08**	**1.4E-07**	**1.5E-07**	**4.0E-06**	**5.7E-06**	**9.4E-07**	**1.4E-06**	**1.3E-06**	**5.7E-06**
Vinyl chloride	2.8	C	2.8	4.4E+02	< 0.18		*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
Cumulative ELCR:							**1.2E-07**	**7.4E-08**	**1.4E-07**	**1.5E-07**	**4.0E-06**	**5.7E-06**	**9.4E-07**	**1.4E-06**	**1.3E-06**	**5.7E-06**

Non-Cancer Hazards

Chemical	Indoor Worker Scenario PAL	PAL Toxicity Basis	EPA Cancer VISL CR=1.0E-6	EPA Non-Cancer VISL HQ=1.0	Reporting Limit (RL)	Scenario	Fan Off and Doors Closed - Non-cancer Hazards									
						Location #	1	2	3	4	5	5 Duplicate	6	6 Duplicate	8	Building HQ
						Sample ID	C400VI1INOFCL-R	C400VI2INOFCL-R	C400VI3INOFCL-R	C400VI4INOFCL-R	C400VI5INOFCL-R	C400VI5INOFCLD-R	C400VI6INOFCL-R	C400VI6INOFCLD-R	C400VI8EXHOFCL-R	
						Date	1/27/2018	1/27/2018	1/27/2018	1/27/2018	1/27/2018	1/27/2018	1/27/2018	1/27/2018	1/27/2018	1/27/2018
<u>*Volatile Organic Compounds*</u>	$\mu g/m^3$		$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$		HQ	HQ	HQ	HQ	HQ	HQ	HQ	HQ	HQ	HQ
1,1,1-Trichloroethane	2.2E+04	NC		2.2E+04	< 0.16		*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
1,1,2-Trichloroethane	0.77	C	0.77	0.88	< 0.29		*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
1,1-Dichloroethane	7.7	C	7.7		< 0.11											
1,1-Dichloroethene	8.8E+02	NC		8.8E+02	< 0.13		*1.5E-04*	*1.5E-04*	*1.5E-04*	*1.5E-04*	*1.5E-04*	*1.5E-04*	*1.5E-04*	*1.5E-04*	*1.5E-04*	*1.5E-04*
1,2-Dichloroethane	0.47	C	0.47	31	< 0.19		*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
1,4-Dioxane	2.5	C	2.5	1.3E+02	< 0.29		*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
cis -1,2-Dichloroethene	3500	NC		3500	< 0.24		*6.9E-05*	*6.9E-05*	*6.9E-05*	*6.9E-05*	*6.9E-05*	*6.9E-05*	*6.9E-05*	*6.9E-05*	*6.9E-05*	*6.9E-05*
trans -1,2-Dichloroethene	3500	NC		3500	< 0.2		*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
Trichloroethene	3.0	C	3.0	8.8	< 0.19		**4.0E-02**	**2.5E-02**	**4.8E-02**	**5.0E-02**	**1.4E+00**	**1.9E+00**	**3.2E-01**	**4.9E-01**	**4.5E-01**	**1.9E+00**
Vinyl chloride	2.8	C	2.8	4.4E+02	< 0.18		*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*
Cumulative Hazard (HI):							**4.0E-02**	**2.5E-02**	**4.8E-02**	**5.0E-02**	**1.4E+00**	**1.9E+00**	**3.2E-01**	**4.9E-01**	**4.5E-01**	**1.9E+00**

Table D.4. Human Health Risk Evaluation—Cumulative Excess Lifetime Cancer Risks and Non-cancer Hazard Indices (Continued)

Exposure Concentrations Used in Risk Calculations

Chemical	Indoor Worker Scenario PAL*	PAL Toxicity Basis	EPA Cancer VISL CR=1.0E-6	EPA Non-Cancer VISL HQ=1.0	Reporting Limit (RL)	Scenario	Fan On and Doors Open										
						Location #	1	2	3	4	5	5 Duplicate	6	6 Duplicate	7	8	Building EPC
						Sample ID	C400VI1INONOP-R	C400VI2INONOP-R	C400VI3INONOP-R	C400VI4INONOP-R	C400VI5INONOP-R	C400VI5INONOP-RD	C400VI6INONOP-R	C400VI6INONOP-RD	C400VI7INONOP-R	C400VI8EXHONOP-R	
						Date	2/10/2018	2/10/2018	2/10/2018	2/10/2018	2/10/2018	2/10/2018	2/10/2018	2/10/2018	2/10/2018	2/10/2018	2/10/2018
Volatile Organic Compounds	μg/m^3		μg/m^3	μg/m^3	μg/m^3		μg/m^3	μg/m^3	μg/m^3	μg/m^3	μg/m^3	μg/m^3	μg/m^3	μg/m^3	μg/m^3	μg/m^3	μg/m^3
1,1,1-Trichloroethane	2.2E+04	NC		2.2E+04	< 0.16		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1,2-Trichloroethane	0.77	C	0.77	0.88	< 0.29		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1-Dichloroethane	7.7	C	7.7		< 0.11		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1-Dichloroethene	8.8E+02	NC		8.8E+02	< 0.13		0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
1,2-Dichloroethane	0.47	C	0.47	31	< 0.19		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,4-Dioxane	2.5	C	2.5	1.3E+02	< 0.29		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
cis-1,2-Dichloroethene	3500	NC		3500	< 0.24		0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24
trans-1,2-Dichloroethene	3500	NC		3500	< 0.2		NA	NA	NA	NA	NA	NA	NA	NA	**1.3**	NA	**1.3**
Trichloroethene	3.0	C	3.0	8.8	< 0.19		0.19	0.19	0.19	0.19	**2.5**	**2.9**	**1.4**	**1.7**	0.19	**2.1**	**1.8**
Vinyl chloride	2.8	C	2.8	4.4E+02	< 0.18		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Excess Lifetime Cancer Risks (ELCR)

Chemical	Indoor Worker Scenario PAL	PAL Toxicity Basis	EPA Cancer VISL CR=1.0E-6	EPA Non-Cancer VISL HQ=1.0	Reporting Limit (RL)	Scenario	Fan On and Doors Open										
						Location #	1	2	3	4	5	5 Duplicate	6	6 Duplicate	7	8	Building ELCR
						Sample ID	C400VI1INONOP-R	C400VI2INONOP-R	C400VI3INONOP-R	C400VI4INONOP-R	C400VI5INONOP-R	C400VI5INONOP-RD	C400VI6INONOP-R	C400VI6INONOP-RD	C400VI7INONOP-R	C400VI8EXHONOP-R	
						Date	2/10/2018	2/10/2018	2/10/2018	2/10/2018	2/10/2018	2/10/2018	2/10/2018	2/10/2018	2/10/2018	2/10/2018	2/10/2018
Volatile Organic Compounds	μg/m^3		μg/m^3	μg/m^3	μg/m^3		ELCR	ELCR	ELCR	ELCR	ELCR	ELCR	ELCR	ELCR	ELCR	ELCR	ELCR
1,1,1-Trichloroethane	2.2E+04	NC		2.2E+04	< 0.16												
1,1,2-Trichloroethane	0.77	C	0.77	0.88	< 0.29		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1-Dichloroethane	7.7	C	7.7		< 0.11		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1-Dichloroethene	8.8E+02	NC		8.8E+02	< 0.13												
1,2-Dichloroethane	0.47	C	0.47	31	< 0.19		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,4-Dioxane	2.5	C	2.5	1.3E+02	< 0.29		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
cis-1,2-Dichloroethene	3500	NC		3500	< 0.24												
trans-1,2-Dichloroethene	3500	NC		3500	< 0.2												
Trichloroethene	3.0	C	3.0	8.8	< 0.19		6.4E-08	6.4E-08	6.4E-08	6.4E-08	**8.4E-07**	**9.7E-07**	**4.7E-07**	**5.7E-07**	6.4E-08	**7.0E-07**	**6.0E-07**
Vinyl chloride	2.8	C	2.8	4.4E+02	< 0.18		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
						Cumulative ELCR:	6.4E-08	6.4E-08	6.4E-08	6.4E-08	**8.4E-07**	**9.7E-07**	**4.7E-07**	**5.7E-07**	6.4E-08	**7.0E-07**	**6.0E-07**

Non-Cancer Hazards

Chemical	Indoor Worker Scenario PAL	PAL Toxicity Basis	EPA Cancer VISL CR=1.0E-6	EPA Non-Cancer VISL HQ=1.0	Reporting Limit (RL)	Scenario	Fan On and Doors Open										
						Location #	1	2	3	4	5	5 Duplicate	6	6 Duplicate	7	8	Building HQ
						Sample ID	C400VI1INONOP-R	C400VI2INONOP-R	C400VI3INONOP-R	C400VI4INONOP-R	C400VI5INONOP-R	C400VI5INONOP-RD	C400VI6INONOP-R	C400VI6INONOP-RD	C400VI7INONOP-R	C400VI8EXHONOP-R	
						Date	2/10/2018	2/10/2018	2/10/2018	2/10/2018	2/10/2018	2/10/2018	2/10/2018	2/10/2018	2/10/2018	2/10/2018	2/10/2018
Volatile Organic Compounds	μg/m^3		μg/m^3	μg/m^3	μg/m^3		HQ	HQ	HQ	HQ	HQ	HQ	HQ	HQ	HQ	HQ	HQ
1,1,1-Trichloroethane	2.2E+04	NC		2.2E+04	< 0.16		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1,2-Trichloroethane	0.77	C	0.77	0.88	< 0.29		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1-Dichloroethane	7.7	C	7.7		< 0.11												
1,1-Dichloroethene	8.8E+02	NC		8.8E+02	< 0.13		1.5E-04	1.5E-04	1.5E-04	1.5E-04	1.5E-04	1.5E-04	1.5E-04	1.5E-04	1.5E-04	1.5E-04	1.5E-04
1,2-Dichloroethane	0.47	C	0.47	31	< 0.19		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,4-Dioxane	2.5	C	2.5	1.3E+02	< 0.29		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
cis-1,2-Dichloroethene	3500	NC		3500	< 0.24		6.9E-05	6.9E-05	6.9E-05	6.9E-05	6.9E-05	6.9E-05	6.9E-05	6.9E-05	6.9E-05	6.9E-05	6.9E-05
trans-1,2-Dichloroethene	3500	NC		3500	< 0.2		NA	NA	NA	NA	NA	NA	NA	NA	**3.7E-04**	NA	3.7E-04
Trichloroethene	3.0	C	3.0	8.8	< 0.19		2.2E-02	2.2E-02	2.2E-02	2.2E-02	**2.9E-01**	**3.3E-01**	**1.6E-01**	**1.9E-01**	2.2E-02	**2.4E-01**	**2.1E-01**
Vinyl chloride	2.8	C	2.8	4.4E+02	< 0.18		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
						Cumulative Hazard (HI):	2.2E-02	2.2E-02	2.2E-02	2.2E-02	**2.9E-01**	**3.3E-01**	**1.6E-01**	**1.9E-01**	**2.2E-02**	**2.4E-01**	**2.1E-01**

Table D.4. Human Health Risk Evaluation—Cumulative Excess Lifetime Cancer Risks and Non-cancer Hazard Indices (Continued)

Exposure Concentrations Used in Risk Calculations

Chemical	Indoor Worker Scenario PAL*	PAL Toxicity Basis	EPA Cancer VISL CR=1.0E-6	EPA Non-Cancer VISL HQ=1.0	Reporting Limit (RL)	Scenario / Location #	Fan On and Doors Closed: 1	2	3	4	5	5 Duplicate	6	6 Duplicate	7	8	Building EPC	All Scenarios Building EPC
						Sample ID	C400VI1INONCL-R	C400VI2INONCL-R	C400VI3INONCL-R	C400VI4INONCL-R	C400VI5INONCL-R	C400VI5INONCL-RD	C400VI6INONCL-R	C400VI6INONCL-RD	C400VI7INONCL-R	C400VI8EXHONCL-R		
						Date	2/12/2018	2/12/2018	2/12/2018	2/12/2018	2/12/2018	2/12/2018	2/12/2018	2/12/2018	2/12/2018	2/12/2018	2/12/2018	Jan-Feb 2018
Volatile Organic Compounds	µg/m^3		µg/m^3	µg/m^3	µg/m^3		µg/m^3	µg/m^3	µg/m^3	µg/m^3	µg/m^3	µg/m^3	µg/m^3	µg/m^3	µg/m^3	µg/m^3	µg/m^3	µg/m^3
1,1,1-Trichloroethane	2.2E+04	NC		2.2E+04	< 0.16		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1,2-Trichloroethane	0.77	C	0.77	0.88	< 0.29		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1-Dichloroethane	7.7	C	7.7		< 0.11		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1-Dichloroethene	8.8E+02	NC		8.8E+02	< 0.13		0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
1,2-Dichloroethane	0.47	C	0.47	31	< 0.19		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,4-Dioxane	2.5	C	2.5	1.3E+02	< 0.29		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
cis-1,2-Dichloroethene	3500	NC		3500	< 0.24		0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24
trans-1,2-Dichloroethene	3500	NC		3500	< 0.2		0.2	0.2	0.2	**0.31**	**0.2**	**0.23**	0.2	0.2	**0.43**	**0.3**	**0.32**	**0.39**
Trichloroethene	3.0	C	3.0	8.8	< 0.19		**0.31**	0.19	0.19	0.19	**2**	**7.1**	**4.9**	**2.5**	**0.23**	**2**	**3.8**	**4.6**
Vinyl chloride	2.8	C	2.8	4.4E+02	< 0.18		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Excess Lifetime Cancer Risks (ELCR)

Chemical	Indoor Worker Scenario PAL	PAL Toxicity Basis	EPA Cancer VISL CR=1.0E-6	EPA Non-Cancer VISL HQ=1.0	Reporting Limit (RL)	Scenario / Location #	Fan On and Doors Closed: 1	2	3	4	5	5 Duplicate	6	6 Duplicate	7	8	Building ELCR	All Scenarios Building ELCR
						Sample ID	C400VI1INONCL-R	C400VI2INONCL-R	C400VI3INONCL-R	C400VI4INONCL-R	C400VI5INONCL-R	C400VI5INONCL-RD	C400VI6INONCL-R	C400VI6INONCL-RD	C400VI7INONCL-R	C400VI8EXHONCL-R		
						Date	2/12/2018	2/12/2018	2/12/2018	2/12/2018	2/12/2018	2/12/2018	2/12/2018	2/12/2018	2/12/2018	2/12/2018	2/12/2018	Jan-Feb 2018
Volatile Organic Compounds	µg/m^3		µg/m^3	µg/m^3	µg/m^3		ELCR (-)	ELCR (-)	ELCR (-)	ELCR (-)	ELCR (-)	ELCR (-)	ELCR (-)	ELCR (-)	ELCR (-)	ELCR (-)	ELCR	ELCR
1,1,1-Trichloroethane	2.2E+04	NC		2.2E+04	< 0.16													
1,1,2-Trichloroethane	0.77	C	0.77	0.88	< 0.29		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1-Dichloroethane	7.7	C	7.7		< 0.11		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1-Dichloroethene	8.8E+02	NC		8.8E+02	< 0.13													
1,2-Dichloroethane	0.47	C	0.47	31	< 0.19		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,4-Dioxane	2.5	C	2.5	1.3E+02	< 0.29		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
cis-1,2-Dichloroethene	3500	NC		3500	< 0.24													
trans-1,2-Dichloroethene	3500	NC		3500	< 0.2													
Trichloroethene	3.0	C	3.0	8.8	< 0.19		**1.0E-07**	6.4E-08	6.4E-08	6.4E-08	**6.7E-07**	**2.4E-06**	**1.6E-06**	**8.4E-07**	**7.7E-08**	**6.7E-07**	**1.3E-06**	**1.6E-06**
Vinyl chloride	2.8	C	2.8	4.4E+02	< 0.18		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
						Cumulative ELCR:	**1.0E-07**	6.4E-08	6.4E-08	6.4E-08	**6.7E-07**	**2.4E-06**	**1.6E-06**	**8.4E-07**	**7.7E-08**	**6.7E-07**	**1.3E-06**	**1.6E-06**

Non-Cancer Hazards

Chemical	Indoor Worker Scenario PAL	PAL Toxicity Basis	EPA Cancer VISL CR=1.0E-6	EPA Non-Cancer VISL HQ=1.0	Reporting Limit (RL)	Scenario / Location #	Fan On and Doors Closed: 1	2	3	4	5	5 Duplicate	6	6 Duplicate	7	8	Building HQ	All Scenarios Building HQ
						Sample ID	C400VI1INONCL-R	C400VI2INONCL-R	C400VI3INONCL-R	C400VI4INONCL-R	C400VI5INONCL-R	C400VI5INONCL-RD	C400VI6INONCL-R	C400VI6INONCL-RD	C400VI7INONCL-R	C400VI8EXHONCL-R		
						Date	2/12/2018	2/12/2018	2/12/2018	2/12/2018	2/12/2018	2/12/2018	2/12/2018	2/12/2018	2/12/2018	2/12/2018	2/12/2018	Jan-Feb 2018
Volatile Organic Compounds	µg/m^3		µg/m^3	µg/m^3	µg/m^3		HI (-)	HI (-)	HI (-)	HI (-)	HI (-)	HI (-)	HI (-)	HI (-)	HI (-)	HI (-)	HQ	HQ
1,1,1-Trichloroethane	2.2E+04	NC		2.2E+04	< 0.16		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1,2-Trichloroethane	0.77	C	0.77	0.88	< 0.29		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1-Dichloroethane	7.7	C	7.7		< 0.11													
1,1-Dichloroethene	8.8E+02	NC		8.8E+02	< 0.13		1.5E-04	1.5E-04	1.5E-04	1.5E-04	1.5E-04	1.5E-04	1.5E-04	1.5E-04	1.5E-04	1.5E-04	1.5E-04	1.5E-04
1,2-Dichloroethane	0.47	C	0.47	31	< 0.19		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,4-Dioxane	2.5	C	2.5	1.3E+02	< 0.29		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
cis-1,2-Dichloroethene	3500	NC		3500	< 0.24		6.9E-05	6.9E-05	6.9E-05	6.9E-05	6.9E-05	6.9E-05	6.9E-05	6.9E-05	6.9E-05	6.9E-05	6.9E-05	6.9E-05
trans-1,2-Dichloroethene	3500	NC		3500	< 0.2		5.7E-05	5.7E-05	5.7E-05	**8.9E-05**	**5.7E-05**	**6.6E-05**	5.7E-05	5.7E-05	**1.2E-04**	**8.6E-05**	**9.1E-05**	1.1E-04
Trichloroethene	3.0	C	3.0	8.8	< 0.19		**3.5E-02**	2.2E-02	2.2E-02	2.2E-02	**2.3E-01**	**8.1E-01**	**5.6E-01**	**2.9E-01**	2.6E-02	**2.3E-01**	**4.3E-01**	**5.3E-01**
Vinyl chloride	2.8	C	2.8	4.4E+02	< 0.18		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
						Cumulative Hazard (HI):	**3.6E-02**	2.2E-02	2.2E-02	**2.2E-02**	**2.3E-01**	**8.1E-01**	**5.6E-01**	**2.9E-01**	**2.7E-02**	**2.3E-01**	**4.3E-01**	**5.3E-01**

Notes:

EPC = Exposure Point Concentration: = ProUCL Version 5.1 recommended 95% UCL. Used reporting limit for nondetect results and max of duplicates samples in calculations. NA if results were below RL in all indoor air and sub-slab soil gas samples.

ELCR = Excess Lifetime Cancer Risk. Calculated as measured concentration divided by EPA Cancer VISL at CR=1.0E-06, because Paducah indoor worker exposure parameters are the same as EPA default commercial exposure parameters.

HI = Hazard Index. Calculated as the sum of individual chemical HQs.

HQ = Hazard Quotient. Calculated as measured concentration divided by EPA Non-cancer VISL at HQ=1.0, because Paducah indoor worker exposure parameters are the same as EPA default commercial exposure parameters.

NA = Not applicable. Parameter not calculated, because chemical was below the reporting limit in all sub-slab soil gas and indoor air samples.

PAL = Project Action Level = lower of the EPA Cancer VISL at CR=1.0E0-6 or Noncancer VISL at HQ=1.0, except for *cis* - and *trans* -1,2-DCE. (See asterisk note below.)

RME = Reasonable Maximum Exposure, calculated as the 95% UCL about the mean of the sampled building locations using the Chebyshev Inequality per EPA (2002: OSWER 9285.6-10) guidance for calculating UCLs at hazardous waste sites.

VISL = Vapor Intrusion Screening Level

**cis* - and *trans* -1,2-DCE VISL is based on the 2006 ATSDR Intermediate MRL for *trans* -1,2-DCE of 0.2 ppm (RfC = 0.8 mg/m3) as requested by EPA Region 4.

Yellow highlighted cells indicate concentration is above the PAL, ELCR is above 1.0E-06 or HIQ or HI is above 1.0.

Bold font indicates a detected value.

Italic font indicates measured concentration is below the reporting limit.

Sub-slab Soil Gas

The measured TCE concentrations in sub-slab soil gas exceeded EPA's commercial VISL of 100 $\mu g/m^3$ in samples collected from Locations 1, 4, 5, 6, and 7. The only other detected compounds in the sub-slab soil air were *cis*-1,2-DCE and 1,1-DCE, but were detected at concentrations that are orders of magnitude below their respective screening levels. The TCE concentrations typically did not vary by more than 25% from one sampling event to the next. The analytical RLs for six compounds (1,1,2-trichloroethane, 1,1-dichloroethane, 1,1-DCE, 1,2-dichloroethane, 1,4-dioxane, and vinyl chloride) exceeded their respective screening levels, but only at sample Locations 1, 5, and 7 where sub-slab TCE concentrations were the highest.

Outdoor Air

There were no PAL exceedances in outdoor air. TCE was the only compound detected in the outdoor air samples, with concentrations ranging from 0.2J to 0.36J $\mu g/m^3$. These concentration levels would not constitute a significant source of TCE to indoor air and would not contribute substantially to indoor air risks.

D.4.2 COMPARISON OF INDOOR AIR AND SUB-SLAB SOIL GAS RESULTS

TCE concentrations in indoor air samples were less than 1 $\mu g/m^3$ where TCE was less than approximately 80,000 $\mu g/m^3$ in sub-slab soil gas (Locations 1, 2, 3, 4, and 7), and TCE concentrations were greater than 1 $\mu g/m^3$ in indoor air where the concentration in sub-slab soil gas was greater than 80,000 $\mu g/m^3$ (Location 5). This spatial association is consistent with TCE entering indoor air in the southern portion of C-400 Cleaning Building; that is, the VI pathway is complete. The exception to the spatial association was the Southeast Office (Location 6) where concentrations in indoor air ranged from 1.7 to 4.9 $\mu g/m^3$ and in sub-slab soil gas from 75 to 180 $\mu g/m^3$. Concentrations measured in the exhaust fan (Location 8) also were above 1 $\mu g/m^3$. Sampling Locations 6 and 8 (Southeast Office and exhaust fan, respectively) are relatively close to Location 5 (basement degreaser tanks) and may receive some TCE as it circulates and dilutes in that portion of the building.

The presence of *cis*-1,2-DCE in sub-slab vapor shows there is an underlying groundwater source of TCE. *cis*-1,2-DCE is a common breakdown product of TCE dissolved in groundwater, where groundwater conditions support reductive dechlorination. It is rarely present in commercial products, and it generally is not associated with TCE off-gassing from contaminated vadose zone soil because soils typically are sufficiently oxygenated to preclude reductive dechlorination of TCE (Rivett et al. 2011). In the northern portion of C-400 Cleaning Building, at Locations 2, 3, and 4, *cis*-1,2-DCE was not detected in sub-slab soil gas, and TCE concentrations in sub-slab soil gas ranged from 14 to 200 $\mu g/m^3$, which is consistent with an absence of subsurface sources of TCE that are significant to the VI pathway. In the southern portion of C-400 Cleaning Building, near Locations 1, 6, and 7, TCE concentrations in sub-slab soil gas ranged from 75 to 77,000 $\mu g/m^3$, and *cis*-1,2-DCE was detected in sub-slab soil gas, consistent with a groundwater source of TCE (see Figure D.4) and a complete VI pathway. It also is possible residual TCE in soil is contributing to the TCE in indoor air. In the southern portion of C-400 Cleaning Building near Location 5, high TCE concentrations (ranging from 9,500,000 to 12,000,000 $\mu g/m^3$) were observed in both sub-slab and indoor air, but no *cis*-1,2-DCE was detected, indicating a vadose zone soil source of TCE likely is responsible for the elevated sub-slab and indoor air TCE concentrations in this area.

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D.5. SUMMARY AND CONCLUSIONS

TCE is the only detected compound that exceeded its PAL in indoor air or screening level in sub-slab soil gas at any location (Tables D.1 and D.2). Exceedances of the indoor air PAL were observed only under closed door scenarios. TCE was detected at low concentrations in outdoor air, but only at levels well below its PAL. The detected TCE concentrations in indoor air were greatest at Location 5 (see Figure D.6) coincident the highest detected TCE concentrations in sub-slab soil gas.

A preliminary risk evaluation showed the calculated cumulative ELCRs are within EPA's acceptable cancer risk range of 1.0E-6 to 1.0E-4. All individual location ELCRs are at or below 5.7E-6. The cumulative building ELCR for the fan off, doors closed scenario is 5.7E-6. For the fan on, doors open scenario, all ELCRs are below 1.0E-6 and for the fan on, doors closed scenario, the cumulative building ELCR is 1.3E-6. The cumulative ELCR considering all the data is 1.6E-6. The building HI for the fan off, doors closed scenario is 1.9, due to the measured concentration at Location 5. For the fan on, doors open and fan on, doors closed scenarios, all HIs are less than 1.0. Considering all the data, the cumulative HI is 0.53. The lowest risks are presented by the fan on, doors open scenario. The highest risks are presented by the fan off, doors closed scenario.

Actual exposures and risks likely are lower than calculated based on the default commercial exposure parameters because DOE has relocated all office workers and laundry workers from C-400 Cleaning Building. Remediation workers (and/or deactivation workers) currently enter the building only to conduct deactivation activities and have a health and safety plan that covers their activities. Cumulative risks for the building as a whole currently are within or below acceptable levels. More realistic, site-specific exposure times, frequencies, durations, or averaging times that would be less than the assumed values would result in even lower risks.

The spatial association between elevated indoor air and sub-slab soil gas concentrations is consistent with a conclusion that the VI pathway is complete, particularly in the southern portion of the building. The presence of *cis*-1,2 DCE in sub-slab vapor in some locations shows there is an underlying groundwater source of TCE. The absence of TCE in sub-slab vapor in other locations shows there also are vadose zone soil sources of TCE. The low-level detections of TCE in the outdoor air would not constitute a significant source of TCE to indoor air. These observations are consistent with the preliminary VI CSM presented in the WP.

Based on the decision rules, the VI study results show that the VI pathway for TCE is complete and exceeded PALs in indoor air at Locations 5, 6, and 8. Based on the sub-slab concentrations in these areas, TCE concentrations in indoor air greater than the screening level continue to be possible, particularly under closed door conditions. However, cumulative excess lifetime cancer risk assuming chronic exposure by unprotected industrial workers was less than 6.0E-06 at all locations, and cumulative hazard index assuming chronic exposure by unprotected industrial workers was less than 1.0 at all but one location. Periodic air monitoring, worker access restriction or both, and/or increased ventilation may be appropriate steps to take if it is anticipated remediation workers will spend substantial time in the building in the vicinity of Locations 5, 6, and 8, until the building is decommissioned or the source is remediated.

The VI pathway is either incomplete (i.e., indoor air sampling result is nondetect) or is complete with a sampling result below the PAL, at all other sampled locations. While sub-slab soil gas concentrations are above PALs at some of the other locations (1, 4, and 7), indoor air concentrations either do not exceed their respective indoor air PALs, or they are nondetect under all tested scenarios.

Considering that the groundwater under C-400 Cleaning Building contains the highest concentrations of TCE and geologic conditions most favorable for vapor transport, it is unlikely that indoor air in other PGDP structures of similar construction with groundwater as the primary potential source of vapors would have VOC concentrations above a level that could pose an unacceptable risk to current protected workers.

D.6. REFERENCES

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ATTACHMENT D1

SAMPLING LOCATIONS

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Photographic Record

Client: U.S. Department of Energy	**Project Number:**
Site Name: C-400 Vapor Intrusion Study	**Site Location: Paducah, KY**

Photograph ID: 1	
Date: 1/27/2018	
Direction: NW	
Comments: Ambient 1 sampling location on west side of C-400	

Photograph ID: 2	
Date: 1/27/2018	
Direction: S	
Comments: Ambient 2 sampling location on north side of C-400	

Photographic Record

Client: U.S. Department of Energy	**Project Number:**
Site Name: C-400 Vapor Intrusion Study	**Site Location: Paducah, KY**

Photograph ID: 3

Date: 1/27/2018

Direction: W

Comments: Ambient 3SE sampling location on the east side of C-400

Photograph ID: 4

Date: 2/10/2018

Direction: N

Comments: Ambient 4 sampling location on south side of C-400

Photographic Record

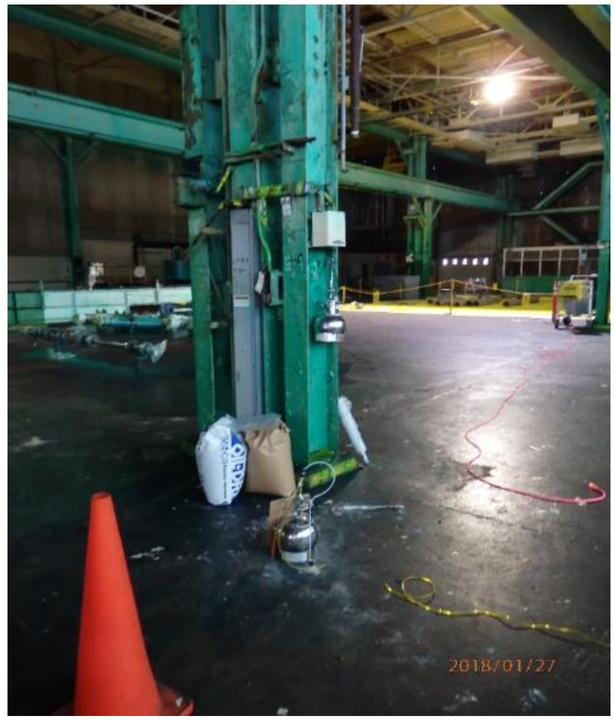
Client: U.S. Department of Energy	**Project Number:**
Site Name: C-400 Vapor Intrusion Study	**Site Location: Paducah, KY**

Photograph ID: 5

Date: 1/27/2018

Direction: SE

Comments: Indoor air and subslab soil gas sampling at Location 1



Photograph ID: 6

Date: 2/10/2018

Direction: W

Comments: Indoor air and subslab soil gas sampling at Location 2

Photographic Record

Client: U.S. Department of Energy	**Project Number:**
Site Name: C-400 Vapor Intrusion Study	**Site Location: Paducah, KY**

Photograph ID: 7	
Date: 1/27/2018	
Direction: W	
Comments: Indoor air and subslab soil gas sampling at Location 3	

Photograph ID: 8	
Date: 2/10/2018	
Direction: W	
Comments: Indoor air and subslab soil gas sampling at Location 4	

Photographic Record

Client: U.S. Department of Energy

Project Number:

Site Name: C-400 Vapor Intrusion Study

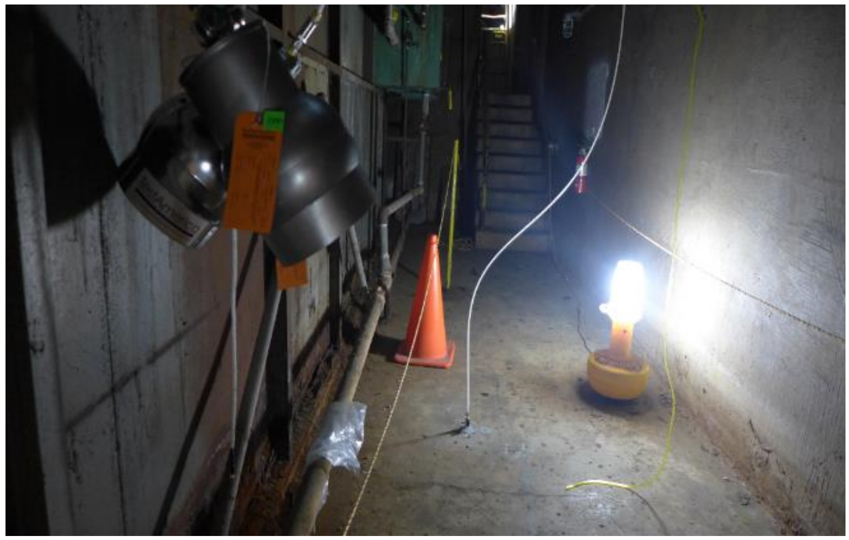
Site Location: Paducah, KY

Photograph ID: 9

Date: 2/10/2018

Direction: E

Comments: Indoor air sampling and subslab soil gas probe at Location 5



Photograph ID: 10

Date: 1/27/2018

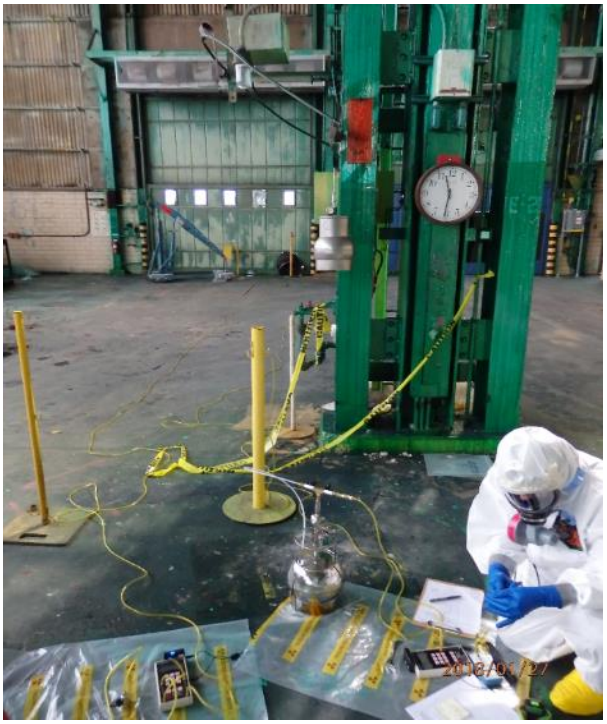
Direction: E

Comments: Subslab soil gas sampling set at Location 5

Photographic Record

Client: U.S. Department of Energy	**Project Number:**
Site Name: C-400 Vapor Intrusion Study	**Site Location: Paducah, KY**

Photograph ID: 11	
Date: 1/27/2018	
Direction: SE	
Comments: Indoor air and subslab soil gas sampling at Location 6	

Photograph ID: 12	
Date: 1/27/2018	
Direction: S	
Comments: Indoor air and subslab soil gas sampling at Location 7, with continuous differential pressure readings	

Photographic Record

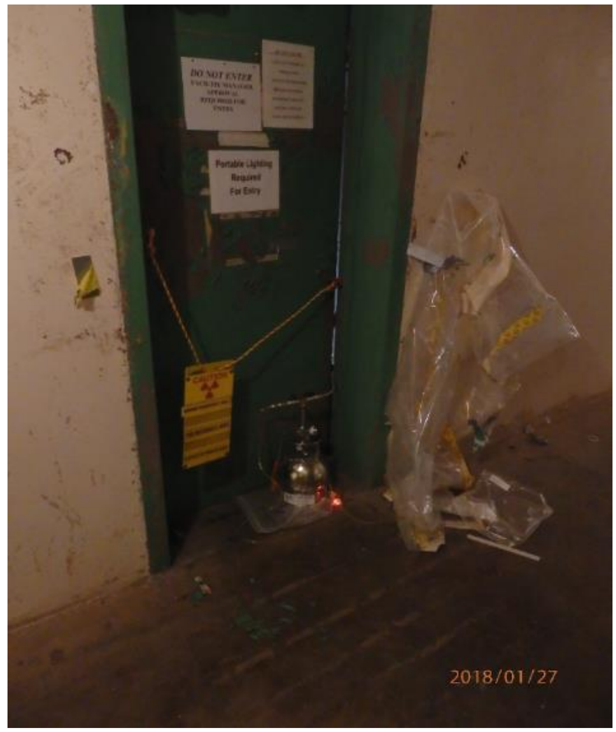
Client: U.S. Department of Energy	**Project Number:**
Site Name: C-400 Vapor Intrusion Study	**Site Location: Paducah, KY**

Photograph ID: 13

Date: 1/27/2018

Direction: SE

Comments: Indoor air sampling from within the exhaust fan at Location 8; port set at the y - junction with tubing advanced to non-radiological contamination area.



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ATTACHMENT D2

OPERATING PROCEDURE, SOIL GAS SAMPLING

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SEAL CHECK PROCEDURE FOR

SOIL GAS SAMPLING

Geosyntec Consultants, Inc.

Last revision: December 2009

1 INTRODUCTION

This procedure describes the methods for completing seal checks and sampling sub- and soil gas probes to assess potential human health risks due to subsurface vapor intrusion to indoor air and subsequent inhalation exposures.

2 VACUUM SHUT-IN SEAL CHECK

The sampling equipment will be assembled as shown in Figure 2, and will be checked for leaks by conducting a "shut-in" check prior to purging. Valves V-1 and V-3 will be closed (valves V-2 and V-4 open) and then the lung box and Tedlar® bag will be used to exert a vacuum on the sampling train (80 - 100 inches of water [in-H_2O]). Valve V-2 will then be closed and the vacuum observed for at least 60 seconds to ensure it does not dissipate.

If the check indicates a leak, the connections should be disconnected and carefully reconnected one at a time until the leak is fixed. The seal check must be repeated until all leaks have been fixed.

3 HELIUM SEAL CHECK

After the "shut –in" check, a Tedlar bag will be attached to the tubing inside the lung-box and the lid of the lung box will be secured. V-2 will remain closed while the valve under the shroud (V-1 and V-4) will be opened and the shroud filled with helium (10 to 30%). The minimum and maximum concentrations of helium observed in the shroud during the collection of each Tedlar bag sample will be recorded. The lung box will be turned on and V-2 opened to begin purging. The Tedlar bag will fill at flow rate constrained by the flow controller, typically about 200 mL/min. The time to fill the Tedlar bag should be recorded. The Tedlar bag will visibly fill inside the lung box. As it approaches ¾ full, valve V-2 will be closed and the lung box will be turned off.

The lid of the lung box will be opened, the valve on the Tedlar bag closed, and the Tedlar bag removed from the lung box. The Tedlar bag will be connected to the helium meter and the stabilized reading will be recorded.

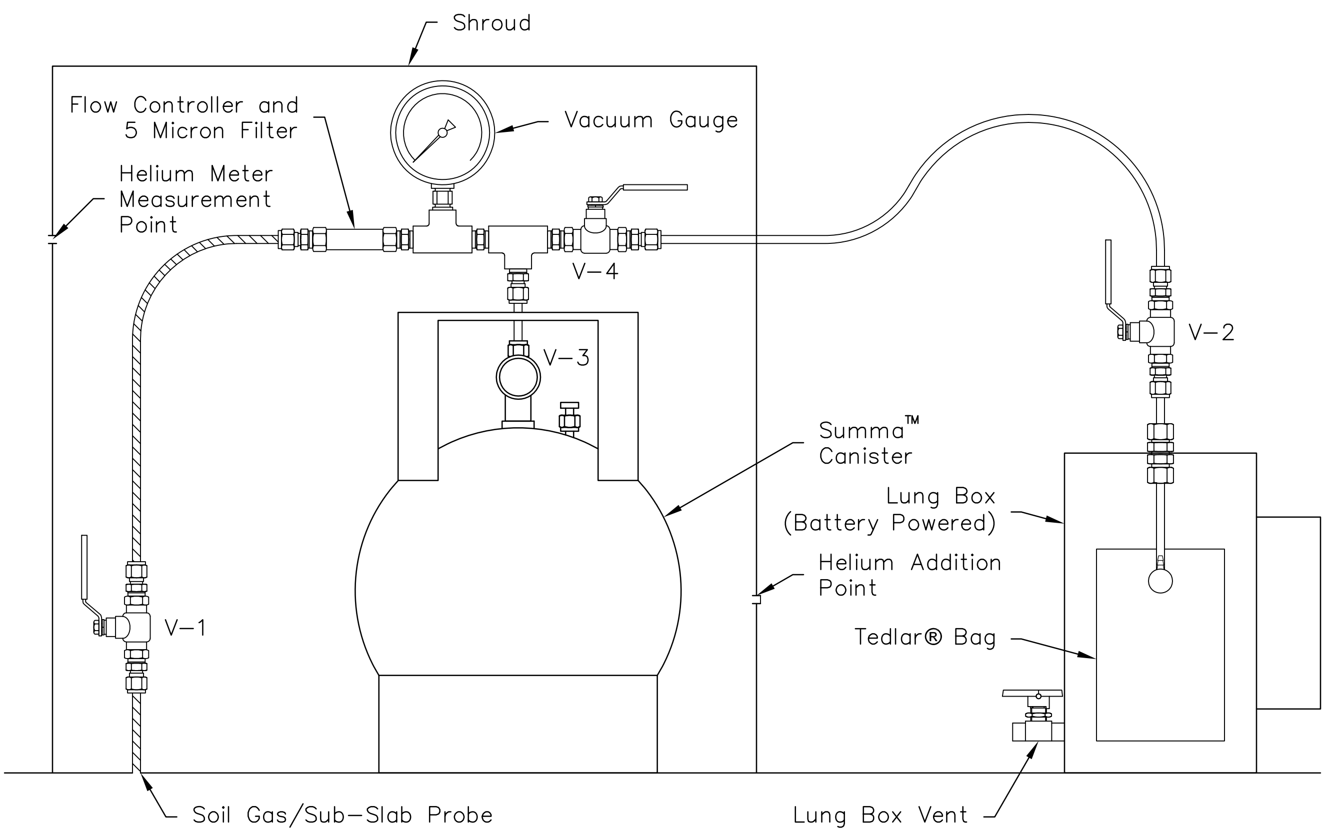
If the concentration of helium in the Tedlar bag is greater than 5% of the concentration in the shroud, the probe seal and fittings should be checked to determine the location of the leak. Once the leak has been fixed, resume purging and field screening. The purging and field screening procedure will be repeated for a minimum of three sets of readings.

4 SUMMA CANISTER SEAL CHECK

Valve V-1 and V-4 will be closed and then valve V-3 (summa canister valve) will be opened to induce a vacuum on the sample train. The vacuum in the sample train will be observed for a short duration (30 seconds) to ensure it does not dissipate as a final check that the sample train does not contain any leaks. Valve V-1 will then be opened and the sample collection time recorded. The vacuum gauge on the Summa canister should be monitored and closed when the residual vacuum in the canister is about 5 in Hg.

5 EQUIPMENT BLANK

The equipment blank is collected by connecting a Summa canister to a fully assembled soil gas probe (screen, tubing, and valve) prior to installation via Swagelok fittings through a 200 milliliter per minute (mL/min) flow controller. The Summa canister valve is opened to draw the contents of the tubing and outdoor air into the canister through the probe tip and Swagelok valve.



Legend

New Nylaflow® Tubing

Non-Dedicated Tubing

Soil Gas Purging and Sampling Assembly

Geosyntec consultants

Guelph	July 2009	Figure 2

P:\PRJ\Marketing-Sales\Indoor Air Quality\SOPs\AutoCAD Figures\Soil Gas Sampling Assembly.dwg

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ATTACHMENT D3

FIELD NOTES

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C-400 Vapor Intrusion Study
Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah
Deactivation Project

DAILY FIELD REPORT

PROJECT: C-400 VAPOR INTRUSION

LOCATION: PGDP PROJECT NO.: KX5883 TASK NO: 43B

DESCRIPTION: VI SAMPLING DATE: 9/11/2017

CONTRACTOR: FPDP, GEOSYNTEC, GEOCONSULTANTS, LSRS

WEATHER: PARTLY CLOUDY, WARM, BREEZY

12:30 PROJECT MEETING; SAFETY TOPIC: WORK ZONE SAFETY

— SILICA AFFECTED WORKER TRAINING

ATTD: RON HYATTE - H&S LEAD, FPDP; CHAD HOLZER (GEO); S. FOUNTAIN;

JOE TOWORNAKI (FPDP); GAYE BREWER (KDWM); BRANDON TAYLOR (GEO)

JASON BOULTON (GEO); STEPHEN COLLINS; SHAY MITCHELL (LSRS)
GEOOFF 4/26/18

— INDUSTRIAL HYGIENE WORK PERMIT

— C-400 HASP, JHA BRIEFING

— JARED COULSON; C-400 MANAGER

1350 GO TO C-400; WALKDOWN SAMPLING LOCATIONS

1500 DEMOB FROM FIELD

TF 9/11/2017

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C-400 Vapor Intrusion Study
Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah
Deactivation Project

9/11/2017

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Teresa Fischer 5/15/2018

SHEET NO 1 OF 1

Geosyntec consultants engineers | scientists | innovators	**C-400 Vapor Intrusion Study Paducah Gaseous Diffusion Plant Fluor Federal Services, Inc. Paducah Deactivation Project**

DAILY FIELD REPORT

PROJECT: C-400 VAPOR INTRUSION

LOCATION: PGDP PROJECT NO.: KX5883 TASK NO: 43B

DESCRIPTION: VI SAMPLING DATE: 9/14/17

CONTRACTOR: FPDP, GEOSYNTEC, GEO CONSULTANTS, LSRS

WEATHER: SUNNY, WARM

12:20 MEETING ON C-400 VI DRILLING

— SAFETY TOPIC: STOP WORK AUTHORITY

— EP/P IN PLACE; CONCRETE SCANNER; WORK ORDER; IHWP; JHA; TASK INSTRUCTION; RWP; DELIBERATE OPERATIONS

— GEOSYNTEC STAFF: Teresa Fischer, Stefanie Fontain, David Jenson, Kristoffer Henderson

— GME RESPIRATOR CART. CHANGE OUT DAILY BASED ON MAX 50 ppm

— DRILLING IN CLEAN AREA TODAY (OFFICE ROOM; LOCATION ~~7~~ 6 [initials])

TF 4/26/18

~~13~~ 14:00 MOBILIZE TO C-400

SET DRILLING LOCATION FOR LOCATION 6 SCANNED FOR REPAIR. RADCON SCANNED LOCATION.

13:50 START DRILLING LOCATION 6 BY SETTING WORK AREA BOUNDARIES. DRILL W/ 5/8" BIT. HEPA VACUUM USED TO COLLECT DUST. 13:52 THROUGH THICKNESS. OVER DRILLING TOP 2" TO 1" DIA. 1353 DRILLING AT LOCATION 6. CREWS CLEAN UP DUST. RADCON SCAN HOLE - OK. PID AT HOLE = 0 ppm; PID AT BZ = 0 ppm CLEAN OUT BORING DEPTH = 8" TOP OF CONCRETE FLOOR TO BOTTOM OF CONCRETE.

14:10 INSTALL PROBE

14:25 COMPLETE PROBE INSTALLATION, CONE PLACED IN FRONT

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C-400 Vapor Intrusion Study
Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah
Deactivation Project

4/26/18

14:25 CONTINUED. SECURE EQUIPMENT PUT UP CAUTION TAPE

1430 DEMOB

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C-400 Vapor Intrusion Study
Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah
Deactivation Project

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion

LOCATION: PGDP PROJECT NO.: KX5883 TASK NO: 43B

DESCRIPTION: VI Sampling DATE: 9/18/2017

CONTRACTOR: FPDP, Geosyntec, Geo Consultants

WEATHER: Warm, Overcast

1300 Assemble at C-412 T12 for POD
- Teresa Fischer (Geosyntec), Jason Boulton (Geo), Brandon Taylor (Geo), Shay Mitchell (USRS), Stephen Collins (RadCon)
- Review Industrial Hygiene Work Permit & RWP
- General safety breifing; STOP WORK authority Regardless of time pressure; STOP WORK as necessary
- 9/19/2017 Meet time is 0630
- Location 3 with Area 14 to be drilled today

1330 Teresa Fischer receives Polar Heat Monitor Training

1400 Mobilize to C400
- Dress out; wait ~~what~~ TAF 4/26/18 on IH/Safety to arrive. Since working in caustic area w/ potential for silica drillers (Jason & Brandon) don respirators. Others to remain outside of exclusion zone perimeter of 25 ft.

1444 Set up at Location 3. Mark monitoring point to be drilled.
- Start drilling after non-respirator wearers leave zone.

1455 Drilling stopped at 18 inches; concrete still intact.
- Continue drilling to hammer drills extent of 25-inches.
- No breakthrough. 36-inch bit to be used.
- Leave supplies for port in area

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1500 Driller doff PPE

1515 Demobilize from C400

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TAF 4/26/18

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Fluor Federal Services, Inc. Paducah Deactivation Project

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study

LOCATION: PGDP PROJECT NO.: KX5883 TASK NO: 43B

DESCRIPTION: VI Sampling DATE: 09/19/2017

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Humid, Warm, Partly Cloudy

0635 Plan of the Day lead by Shay Mitchell at C-412 T12
- Attendance: Shay Mitchell, Teresa Fischer Jason Bolton Brandon Taylor Stephen Collins; Cassidy Mc.
- Safety Topic: Be vigilant about Heat Stress; STOP WORK Authority; Vehicle & Work Area walk arounds; stay times

0700 Mobilize to C-400 to mark locations of monitoring points prior to initaiting drilling

0739 Don PPE to enter C-400

0747 Mark Location 2 in Zone 3; ~~Loc~~ TAF 4/26/18 Location 1 in Zone 4; Location 4 in Zone 12; Location 7 in Zone 10.
- Cannot mark Location 5 in Zone 8 or Location 8 in Zone 13 at this time.

0820 Complete marking monitoring points; doff PPE & scan out of C-400.

0845 Don PPE; IH/Safety has arrived (Cassidy Mc.)
- Set up at Location 2 in Zone 3, establish a 25-ft perimeter for respirable silica
- Drillers in Respirators & Saranac for this location due to caustic surface.

0857 Start drilling Location 2

0902 Finish drilling Location 2; 20-inches deep
- Set probe; barricade area

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4/26/18

0934	Set up at Location 1 in Zone 4, establish a 25 ft ~~perim~~ TAP
	perimeter for respirable silica
0937	Start drilling Location 1
0949	Complete drilling at Location 1; depth is 18 3/4-inch
	- Set probe; barricade area
0958	Set up at Location 7 in Zone 10, establish a 25 ft
	perimeter for respirable silica.
~~0100~~ TAP 4/26/18	
1000	Start drilling Location 7 in Zone 10
1005	Finish drilling Location 7; depth is 20 1/4-inches
	- Set probe; barricade area.
1020	Doff PPE; scan out of C-400. Locations 4 (Zone 12)
	and 5 (Zone 8) to be completed after 1300.
1300	Don PPE to enter C-400.
1307	Set up at Location 4 in Zone 12; establish a 25 ft perimeter.
	- Drillers in repirator protection.
1312	Start drilling at Location 4
1315	Finish drilling Location 4; depth in 15 1/2 inches
	- Set probe; barricade area
1330	Set up at Location 5 in Zone 8; establish a 25 ft
	perimeter for respirable silica
1337	Start drilling; rebar encountered. Point moved
	~3 inches north of original point. Still within 3 ft
	circle pictured in Work Plan
1345	Finish drilling Location 5; depth is 20 1/2-inches
	- Set probe; barricade area
1400	leave basement (Location 5) area
1430	Doff PPE; scan out of C-400
1450	Leave C-400
1500	Field activities complete

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Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah
Deactivation Project

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study

LOCATION: PGDP PROJECT NO.: KX5883 TASK NO: 43B

DESCRIPTION: VI Sampling DATE: 09/21/2017

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Warm & humid; clear

0635 POD in C-412 T12 with TF, JB, BT, SM, SC, CM & CK
- Safety Topic → Pollution Prevention Week
- Use proper lifting technics; Caution w/ suspended loads
- Review RWP → Respirator for JB & BT while drilling monitoring points. No respirator for TF but stay outside 25 ft exclusion zone
- Caution with high pH at Location 2. Don't kneel or lay tools in direct contact with ground.

0710 Mobilize to C400. Wait while POD is completed for C400 personnel.

0800 Don PPE. Go to Location 7 to install point for continous differential pressure monitoring
- 3 ft NE of Location 7
- 18 3/4 inches deep.

0824 Set probe for continuous monitoring

0830 Leave CA; Doff PPE & wait for equipment to be scanned.

0930 Arrive at Location 3; set up 25 ft exclusion zone for respirable silica
- Mark 3 ft circle; select ~~20~~ 2 points for drilling within circle. TAP 9/21/2017
- Provide guidance on which direction to drill outside of circle. (To the NE)

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TAP 9/21/17

- 1st attempt within circle → no breakthrough @ 25.5 ~~ft~~ in.
- 2nd attempt within circle → obstruction at ~14-inches
- 3rd attempt NE of circle → no breakthrough @ 25.5 inches
- 4th attempt NE of circle → break-through at 19 1/4-inches

Silty ~~class~~ clay on drill bit. No gravel encountered. TAP 9/21/2017

1045 Set probe at Location 3.

1100 Leave C400 & LA.

1300 Assemble at ~~C400~~ C412 T12 for afternoon breifing

- JB, BT, TF, DJ, KH, SM & Quality (Nate Ing & Steve Sheeks)
- Safety topic → heat stress. Polar Heart Monitoring for DJ & K completed
- Discuss Helium Shroud Seal Check with personnel from Quality.
  - Information purposes to ensure ambient air in C400 is not entering sub-slab monitoring point.
  - Certification is not necessary.

1400 Mobilize to C400; stage supplies & equipment at CA boundary to conduct Helium Seal Check

- Don PPE; enter C400

1428 Location 5 → Set up equipment & meters

- Fill shroud with Helium → 1st Check
- Pre-tedlar; 26.6 %
- Post-tedar; 20.8 %
- Teldar → 6,600 ppm; less than 1%
- Fill shroud with Helium → 2nd check
- Pre-tedlar; 30.6 %
- Post-tedlar; 28.2 %
- Tedlar → 14,000 ppm; greater than 1%. Add concrete

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Fluor Federal Services, Inc. Paducah
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DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study

LOCATION: PGDP PROJECT NO.: KX5883 TASK NO: 43B

DESCRIPTION: VI Sampling DATE: 09/21/2017

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Afternoon is hot & humid.

1502 Location 7 → Set up Helium Seal Check (Pressure)
- Shroud: 33.9% } 1st Check
- Tedlar: 1500 ppm ; less than 1%
- Shroud: 31.6% } 2nd check
- Tedlar: 1675 ppm ; less tan 1%

1512 Location 7 (Probe) → set up Helium Seal Check
- Shroud: 35% } 1st Check
- Tedlar: 2.2% ; too high
- Tighten fittings
- Shroud: Pre 28.2% & Post 26.7% (pre & post)
- Tedlar: 15,200 ppm ; greater than 1%. Add concrete.

1542 Location 1 Helium Seal Check
- Shroud: Pre - 27% ; Post 27% } 1st check
- Tedlar: 9750 ppm ; less than 1%
- Shroud: Pre - 25.7% ; Post - 23% } 2nd check
- Tedlar: 11,750 ppm ; less than 1%
- Add concrete

1600 Location 2 Helium Seal Check
- Shroud: Pre - 27.6% ; Post - 27.5% } 1st Check
- Tedlar: 0 ; less then 1%
- Shroud: Pre - 18.1% ; Post - 18% } 2nd cher
- Tedlar: 0 ppm ; less then 1%

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1613 Location 4 Helium Seal Check
- Shroud: Pre - 27.8% ; Post 25% } 1st check
- Tedlar: 0 ppm
- Shroud: Pre - 26.7% ; Post 24.8% } 2nd check
- Tedlar: 0 ppm

1630 Exist CA ; Doff PPE

1643 Location 3 Helium Seal Check
- Shroud: Pre - 23% ; Post 20.7%
- Tedlar: 8.2% ; Add cement.

1703 Location ~~4~~ Helium Seal Check
6 TAP 9/21/17
- Shroud: Pre - 21.3% ; Post - 20% } 1st Check
- Tedlar: 3575 ppm ; less than 1%
- Shroud: Pre - 20% ; Post - 19.8% } 2nd check
- Tedlar: 50 ppm ; less than 1%

1745 Leave LA
- Unpack at GEO trailer.
- Prepare equipment for Sceanario setup up.

1800 Field activities complete.

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DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study – Fan Off; Doors Closed

LOCATION: PGDP   PROJECT NO.: KX6467   TASK NO: 01/04

DESCRIPTION: VI Sampling   DATE: 01/25/2018

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Clear & Cold

0630 Assemble @ C-730-TS for JHA, HASR & RWP briefing
- Meet with Jeff Bennett (Acting FLM), Eric Williams (H&S) Jason Bolton & Brandon Taylor (GEO)
- Discuss changed conditions at C-400. West side of C-400 now ARA. Respirators required.

0730 Mobilize to C-400 after loading equipment & materials
- Dress out for CA; TRU with respirators.

0812 Enter C400
- Check probe & tubing at Location 2 → tubing sealed within ziploc bag can be used for differential pressure.
- Chip out seal around probe @ Location 2; reseal
- Location 1 → check probe & tubing → tubing sealed & intact. Chip out seal around probe; reseal

0900 Enter BCS; don additional PPE & monitors for Locations 5 & 8.

0905 Enter C400
- Location 8 → Reset sample intake within Exhaust fan; Lay out new tubing for differential pressure measurements.
- Location 5 → check probe seal & tubing. Add additional grout. Set tubing up to be able to sample from catwalk

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- Location 7 → Check probe & tubing. Chip out grout & re-seal. Tubing entact & contained within ziploc bag.
- Location 4 → check probe & tubing. Chip out grout & re-seal. Tubing entact & containet within ziploc bag.

1030 Doff PPE; screen out of Radcon.
- Check probes & tubing at Locations 3 & 6.
- Location 6 → probe & tubing entact.
- Location 3 → chip out grout & re-seal. Tubing entact & in good condition.

1100 Mark locations of Ambient samples.
1110 Exit Limited Area. Field activities completed for probe & tubing inspections.

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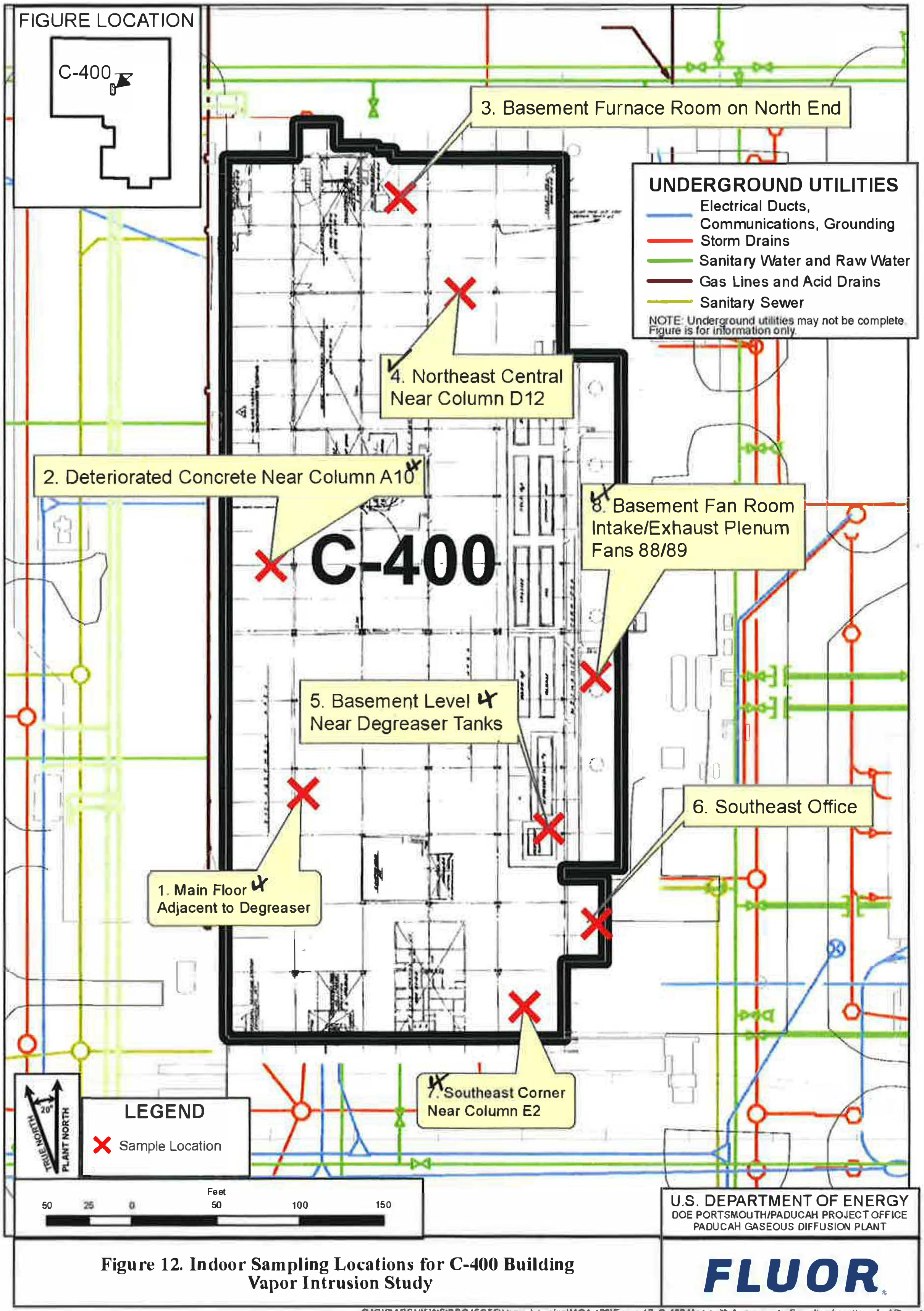

Figure 12. Indoor Sampling Locations for C-400 Building Vapor Intrusion Study

7/25/2017

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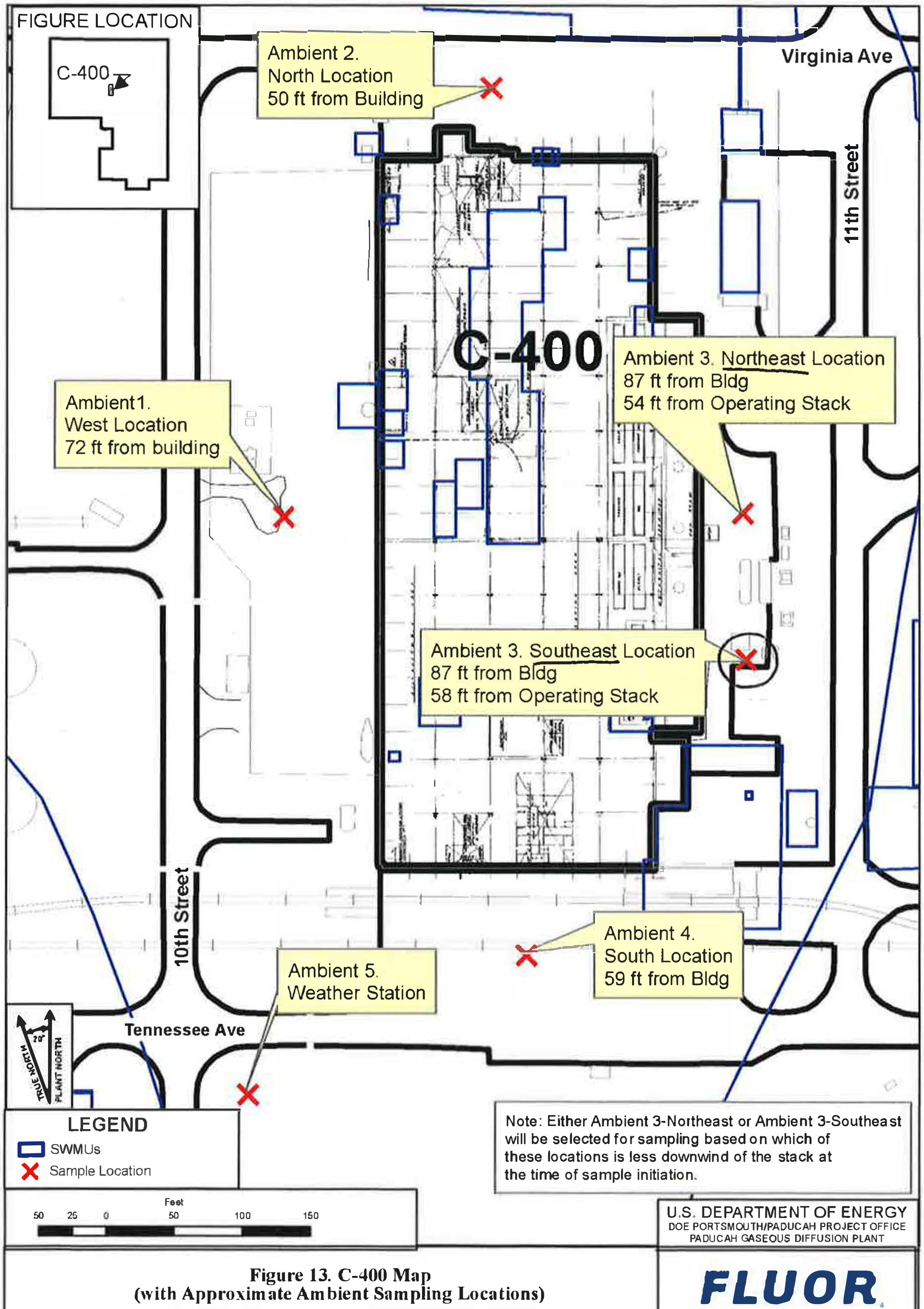

Figure 13. C-400 Map
(with Approximate Ambient Sampling Locations)

FLUOR

G:\GIS\ARCVIEWS\PROJECTS\Vapor Intrusion\MOA 400\Figure 13 C-400 Ambient Sampling Locations.mxd
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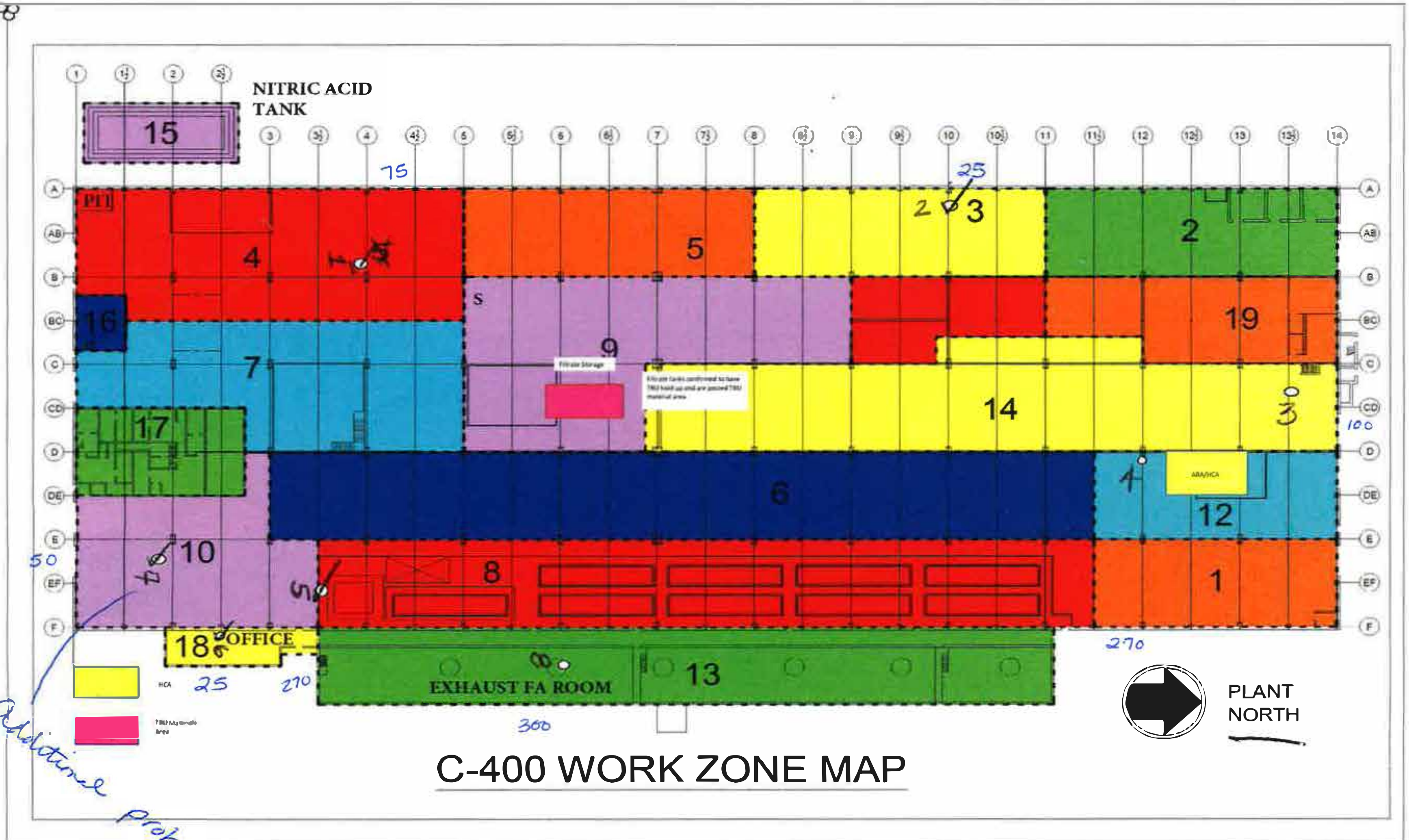

C-400 WORK ZONE MAP

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DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study – Fan Off; Doors Closed

LOCATION: PGDP PROJECT NO.: KX6467 TASK NO: 01/04

DESCRIPTION: VI Sampling DATE: 01/26/2018

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Clear & Cold @0545 → 33°F

0545 Arrive at C-730 TOS. Load meters into vehicles.
- Mobilize to C400; Meet at BCS for JHA, HASP briefing.
- Jason Bolton, Brandon Taylor, Kris Henderson, Shay Mitchell, Tucker Gentle (IH), Teresa Fischer present
- Shay Mitchell conducts breifing; wait on RADCON

0650 RADCON arrives; mobilize to Location 6 for Helium Seal Check. after setting up summas

0905 Don PPE to enter C-400
- Conduct Helium Seal Checks & Shut-In tests at Locations 1, 2, 5 after setting up summas

1105 Doff PPE; Break for lunch

1240 Mobilize to C400

1300 Don PPE to enter C400
- Conduct Shut-In & Helium Seal Checks at Locations 4 & 7 after setting up summas
- Location 7 fails seal check; regrout
- Location 4 passes seal check
- Second test after regrout of Location 7 passes seal check

1500 Doff PPE

1605 Set up summas & conduct Shut-In & Helium

1605 Seal Check at Location 3

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- Location 3 seal checks require ~20 minutes per check due to clay subsurface where probe is installed.
- Initial check 2.1% ; second 5.0% → add grout & let set

  Location 3 second set of seal checks result in 2.1% & 1.7% → pass
- Do not believe grout or equipment setup is leaking; formation that probe is installed into is clay

1700 Complete Shut-In & Helium Seal Check & Scenario Setup field activities; demobilize

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Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah
Deactivation Project

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study – Fan Off; Doors Closed

LOCATION: PGDP   PROJECT NO.: KX6467   TASK NO: 01/04

DESCRIPTION: VI Sampling   DATE: 01/27/2018

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Cloudy & cool; Windy w/ intermittent rain

0545 Leave C-730 TOS for C-400.
- Set up weather station & 4 Ambient locations

0726 Don PPE
- Enter C-400 to start summas
- Set DG-700 near Location 7 for continous monitoring

0759 Doff PPE
- All summas opened; see individual forms for details.

1905 All summas collected & released to GEO Consultants
- See attached individual sampling location forms for details

1840 Field activities complete. Leave limited area.

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DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study – Fan Off; Doors Closed Ambient Locations

LOCATION: PG DP PROJECT NO.: KX6467 TASK NO: 01/04

DESCRIPTION: VI Sampling DATE: 01/27/2018

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Cloudy, Windy, Rain & Cool

0600 Arrive at C-400. Set up Ambient Locations 1-4.
-Ambient 3 set up at SE location → wind coming from the south.
- Start sampling at 0645 → see individual forms for detailed information.
1700 All ambient summa canisters closed & collected
1840 Field activities completed. leave limited area

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Ambient Air
Monitoring Record 1

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study** Date: 01/27/2018 Page 1 of 1
Project Number: KX6467/01/04 Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: T. Fischer / K. Henderson SUMMA ID# and Regulator ID#: 11562/11463
Weather: Cool & cloudy. Windy with intermittent rain

Location ID: Location 1 - Ambient Scenario Type: Fan Off; Doors Closed
Sample Start Time: 0658 Sample Initial Vacuum: -29.5 (certificate)

Time	Summa Canister Vacuum (in Hg)	Comments
0658	-30	NA: Summa opened.
0853	-28	NA
1055	-22	NA
1257	-16	NA
1455	-12	NA
1658	-5	Summa Closed
		Teresa F 1/27/18
—	—	Sample ID - C400V11AMBOFCL-R

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Ambient Air
Monitoring Record 2

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 01/27/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: T. Fischer
SUMMA ID# and Regulator ID#: 09539 / 10157
Weather: Cool & cloudy; Wind w/ intermittent rain

Location ID: Location 2 - Ambient
Scenario Type: Fan Off; Doors Closed
Sample Start Time: 0645
Sample Initial Vacuum: > -30" Hg (Can)

Time	Summa Canister Vacuum (in Hg)	Comments
0645	> -30	Summa opened
0847	-28	NA
1045	-23	NA
1250	-18	NA
1444	-12	NA
1645	-7	Summa closed
	Teresa F 1/27/18	
—	—	Sample ID - C400V12AMB0FCL-R

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Ambient Air
Monitoring Record 3SE

Geosyntec consultants

120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 01/27/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: T. Fischer
SUMMA ID# and Regulator ID#: 10416 / 10666
Weather: Cool & ~~cowldy~~ cowldy ; windy w/ intermittent rain
TF 1/27/18

Location ID: Location 3 - Ambient
Scenario Type: Fan Off; Doors Closed
Sample Start Time: 0648
Sample Initial Vacuum: -29.3" Hg (certified)

Time	Summa Canister Vacuum (in Hg)	Comments
0648	-25 (can)	Summa opened
0849	-20	NA
1049	-15	Monitor more regularly
1251	-10	NA
1345	-8	NA
1446	-6	NA
1546	-3	NA
1631	-0.5	Summa closed ; Sample collected
-	-	over 9 hrs : 43 mins
-	-	Sample ID - C400VI3SEAMBOFCL-R

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Ambient Air
Monitoring Record 4

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 01/27/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: T. Fischer / K. Henderson
SUMMA ID# and Regulator ID#: 11079 | 11245
Weather: Cool & cloudy. Windy with intermittent rain

Location ID: Location 4 - Ambient
Scenario Type: Fan Off; Doors Closed
Sample Start Time: 0652
Sample Initial Vacuum: -28 (Certified)

Time	Summa Canister Vacuum (in Hg)	Comments
0652	-28	NA
0850	-25	NA
1051	-21	NA
1254	-16	NA
1447	-12	NA
1652	-5	Summa Closed
		Sample ID - C400VI4AMBOFCL-R

Teresa Fischer 1/27/18

Teresa Fischer 5/15/2018

5/15/2018

D3-27

Weather Station
Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Project Number: KX6467/01/04
Recorded By: T. Fischer / K. Henderson

Date: 01/27/2018
Page 1 of 1
Project Location: **Paducah Gaseous Diffusion Plant**

Location ID: Weather Station
Scenario Type: Fan Off; Doors Closed

Time	Ambient Temp. (deg. F)	Relative Humidity (%)	Barometric Pressure (inches Hg)	Wind Direction	Wind Speed (mph)
0649	53	76	30.20	S-SE	4
0851	50	90	30.24	S-SW	0
1052	51	94	30.25	W-NW	0
1253	52	94	30.20	SW	0
1449	52	94	30.20	SW	0
1650	51	94	30.22	W	0
		Teresa F.	1/27/18		

D3-28

Teresa Fischer 5/15/2018

[signature] 5/15/2018

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Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah
Deactivation Project

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study – Fan Off; Doors Closed Location 1

LOCATION: PGDP PROJECT NO.: KX6467 TASK NO: 01/04

DESCRIPTION: VI Sampling DATE: 01/26/2018

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER:

1010 Set up shut in & Helium Seal Check
- Indoor Air Summa 09626; Flow Regulator 1005T → -29.4"
- Sub-slab Summa 10704; Flow Regulator 11310 → -29.1"
- Shut-in & Helium Seal Check passed.

1030 Finish activities at Location 1

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SOIL GAS PROBE MEASUREMENTS

Geosyntec consultants

① Project Name: C-400 Vapor Intrusion Study
Date: 01/26/2018 Project Number: KX6467/01
Site Location: Paducah Gaseous Diffusion Plant
Weather: Clear & Cold
Field Personnel: Teresa Fischer, Kris Henderson
Recorded By: T. Fischer

Probe No.: LOCATION 1 ☒ Sub-slab probe ☐ Soil gas probe
Mini Rae 2000 Serial No.: DAQ-248-100-19 Lamp: 10.6 / 11.7 eV
Landtech GEM 2000 Landfill Gas Meter Serial No. M: KAO-399-3
MDG 2002 Helium detector Serial No.: 10702
Tracer Gas: ☒ Helium ☐ Other

② Surface Type: ☐ Asphalt ☒ Concrete ☐ Grass ☐ Other
Surface Thickness (i.e., asphalt or concrete) 10 3/4 inches / centimeters ☐ Unknown

③ 1 Casing Volume
☒ Sub-slab <0.1 L
Soil gas probe ______ (L)

⑤ Field tubing blank reading (ppm$_v$) completed? ☑ Yes ☐ No PID Reading 0 ppm$_v$

⑥ Shut in test prior to purging completed? Yes ☑ No ☐

D3-30

⑦ Purging

Date	Start Time	End Time	Elapsed Time (min.)	Bag Volume (L)	Purge Rate (LPM)	TAF 4/24/2018 NA	CH_4 (%)	CO_2 (%)	O_2 (%)	Tracer Gas Shroud (%) Min	Tracer Gas Shroud (%) Max	Tracer Gas Sample (ppm$_v$, %) (circle one)	VOCs by PID (ppm$_v$)
1/26/18	1020	1022	2	0.75	0.7	NA	0.2	0.1	20.9	21.7	22.5	0	2.0
1/26/18	1024	1025	1	0.50	0.7	NA	0.2	0.1	20.8	20.1	20.8	0	2.7
1/26/18	1028	1029	1	0.50	0.65	NA	0.1	0.1	20.8	21.1	21.5	0	2.8
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

⑧ Helium concentration in field screened samples is less than 5% of minimum concentration in the shroud? ☑ Yes ☐ No **Note:** 1% helium = 10,000 ppm$_v$

⑨ Shut in test prior to sample collection completed? Yes ☑ No ☐

⑩ Sample Collection

Date	Time	Sample ID	Summa Canister ID	Flow Controller #	Vacuum Gauge #	Initial Vacuum (in. Hg)	Final Vacuum (in. Hg)
1/27/2018	1746	C400VI1SUB0FCL-R	10704	11310	—	-29.1	-2
NA	NA	NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	NA	NA	NA

Comments: NA

Teresa Fischer 5/15/2018 [signature] 5/15/2018

Differential Pressure and Ambient Temperature Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 01/27/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
Gauge ID#: 44286-7-700
Weather: Cool & cloudy with wind & rain

Location ID: LOCATION # 1
Scenario Type: Fan Off; Doors Closed
Sample Start Time: 0734
Sample Initial Vacuum: 29.1" [certified]

Time	Differential Pressure (pa)		Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
	sub-slab/ambient	ambient/outside			
0734	-0.2	3.7	52	-24	NA
0933	-0.6	0.0	54	-24	NA
1142	0.7	-0.9	52	-21	NA
1341	1.2	-0.6	55	-15	NA
1539	-1.1	-0.4	51	-10	NA
1746	-1.3	-1.0	51	-2	Summa Closed
—	—	—	—	—	Sample ID C400 VI1 SUBOFCL-R

Teresa Fischer 5/15/2018

[signature] 5/15/2018

Indoor Air Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 01/27/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
SUMMA ID# and Regulator ID#: 09626 / 10051
Weather: Clear & cold; Windy w/ intermittent rain

Location ID: 1
Scenario Type: Fan Off; Doors Closed
Sample Start Time: 0734
Sample Initial Vacuum: -29.4" Hg (certified)

Time	Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
0734	52	> -30	Summa opened
0934	54	-29	NA
1142	52	-23	NA
1341	55	-18	NA
1539	51	-13	NA
1747	51	-8	Summa closed
—	—	—	Sample ID C400VI1INOFCL-R

Teresa Fischer 5/15/2018

[signature] 5/15/2018

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C-400 Vapor Intrusion Study
Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah
Deactivation Project

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study – Fan Off; Doors Closed LOCATION 2

LOCATION: PGDP PROJECT NO.: KX6467 TASK NO: 01/04

DESCRIPTION: VI Sampling DATE: 01/26/2018

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Clear & Cold

0940 Helium Seal Check
- Indoor Air Summa - 10132; Flow Reg - 11512
- Subslab Summa - 10530; Flow Reg - 11497
- Helium Seal Check & Shut In Test passed

1010 Complete activities @ Location 2

Teresa 01/26/2018

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DFR_ One Page Teresa Fisch 5/15/2018 SHEET NO 1 OF 1

SOIL GAS PROBE MEASUREMENTS

Geosyntec consultants

D3-34

① Project Name: C-400 Vapor Intrusion Study
Date: 01/26/2018   Project Number: KX6467/01
Site Location: Paducah Gaseous Diffusion Plant
Weather: Clear & cold
Field Personnel: Teresa Fischer, Kris Henderson
Recorded By: T. Fischer

Probe No.: LOCATION 2   [X] Sub-slab probe   [ ] Soil gas probe
Mini Rae 2000 Serial No.: DAO-248-100-19   Lamp: 10.6 / 11.7 eV
Landtech GEM 2000 Landfill Gas Meter Serial No. M: KAO-399-3
MDG 2002 Helium detector Serial No.: 1072
Tracer Gas: [X] Helium [ ] Other

② Surface Type: [ ] Asphalt [X] Concrete [ ] Grass [ ] Other
Surface Thickness (i.e., asphalt or concrete): 20 inches / centimeters   [ ] Unknown

③ 1 Casing Volume
[X] Sub-slab <0.1 L
Soil gas probe ______ (L)

⑤ Field tubing blank reading (ppm$_v$) completed? [✓] Yes [ ] No   PID Reading 0 ppm$_v$

⑥ Shut in test prior to purging completed? Yes [✓] No [ ]

⑦ Purging

Date	Start Time	End Time	Elapsed Time (min.)	Bag Volume (L)	Purge Rate (LPM)	TAF 4/26/2018 —	CH_4 (%)	CO_2 (%)	O_2 (%)	Tracer Gas Shroud (%) Min	Tracer Gas Shroud (%) Max	Tracer Gas Sample (ppm$_v$, %) (circle one)	VOCs by PID (ppm$_v$)
1/26/2018	0950	0953	3	1.0	0.75	—	0	0.1	20.9	23.6	23.5	0	0
1/26/2018	0957	0959	2	1.0	0.8	—	0.1	0.1	20.9	22.0	21.8	0	0
1/26/2018	1000	1003	3	0.75	0.75	—	0.1	0.1	20.9	21.7	20.0	0	6
—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—

⑧ Helium concentration in field screened samples is less than 5% of minimum concentration in the shroud? [✓] Yes [ ] No   **Note:** 1% helium = 10,000 ppm$_v$

⑨ Shut in test prior to sample collection completed? Yes [✓] No [ ]

⑩ Sample Collection

Date	Time	Sample ID	Summa Canister ID	Flow Controller #	Vacuum Gauge #	Initial Vacuum (in. Hg)	Final Vacuum (in. Hg)
1/27/2018	1750	C400VI2SUB0FCL-R	10530	11497	—	-30	-3
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—

Comments: NA
NA   Teresa Fischer 5/15/2018   [signature] 5/15/2018

Differential Pressure and Ambient Temperature Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 01/27/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
Gauge ID#: 44286-7-700
Weather: Cloudy & cool; intermittent rain; windy in morning

Location ID: LOCATION # 2
Scenario Type: Fan Off; Doors Closed
Sample Start Time: 0737
Sample Initial Vacuum: 29.4" (certified)

Time	Differential Pressure (pa)		Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
	sub-slab/ambient	ambient/outside			
0737	1.1	0.9	51	-30	NA
0936	6.1	-1.2	53	-27	NA
1146	3.8	-0.3	51	-21	NA
1345	2.5	-0.4	55	-15	NA
1542	0.3	-1.6	50	-11	NA
1750	-0.6	-1.0	50	-3	Summa Closed
—	—	—	—	—	Sample ID C400VI2SUBOFCL-R

Teresa Fischer 5/15/2018

[signature] 5/15/2018

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Indoor Air Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study** Date: 01/21/2018 Page 1 of 1
Project Number: KX6467/01/04 Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson SUMMA ID# and Regulator ID#: 10132 (Summa) / 11512 (FR)
Weather: Cloudy & cool; windy & rain

Location ID: 2 Scenario Type: Fan Off; Doors Closed
Sample Start Time: 0737 Sample Initial Vacuum: 29.1" (certified)

Time	Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
0737	51	-28	NA
0939	53	-24	NA
1146	51	-20	NA
1345	55	-15	NA
1542	50	-10	NA
1751	50	-5	Summa Closed
—	—	—	Sample ID C400VI2INOFCL-2

Teresa Fisch 5/15/2018

[signature] 5/15/2018

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C-400 Vapor Intrusion Study
Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah
Deactivation Project

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study – Fan Off; Doors Closed LOCATION 3

LOCATION: PGDP PROJECT NO.: KX6467 TASK NO: 01/04

DESCRIPTION: VI Sampling DATE: 01/26/2018

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Clear & cool

1500 Set up for shut in & helium seal check
- Indoor Air Summa: 11843; Flow Reg 1176 → -29.2"
- Substab Suma 10329; Flow Reg 10863 → -29.5"

1525 Failed Helium Seal Check
- Probe installed in very tight formation & takes 15 to 20 minutes to equilibrate while running test.
- Re-grout probe

1608 Re-start Helium Seal Check; Shut-in test

1634 Complete Helium Seal Check → pass

Teresa [signature] 1/26/2018

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DFR_ One Page Teresa Fisch 5/15/2018 SHEET NO 1 OF 1

SOIL GAS PROBE MEASUREMENTS

Geosyntec consultants

① Project Name: C-400 Vapor Intrusion Study
Date: 01/26/2018 Project Number: KX6467/01
Site Location: Paducah Gaseous Diffusion Plant
Weather: Clear & cold
Field Personnel: Teresa Fischer, Kris Henderson
Recorded By: T. Fischer

Probe No.: LOCATION 3 ☒ Sub-slab probe ☐ Soil gas probe
Mini Rae 2000 Serial No.: DAQ-248-100-19 Lamp: 10.6 / 11.7 eV
Landtech GEM 2000 Landfill Gas Meter Serial No. M: KAO-399-3
MDG 2002 Helium detector Serial No.: 1072
Tracer Gas: ☒ Helium ☐ Other

② Surface Type: ☐ Asphalt ☒ Concrete ☐ Grass ☐ Other
Surface Thickness (i.e., asphalt or concrete) 19 1/4 inches centimeters ☐ Unknown

③ 1 Casing Volume
☒ Sub-slab <0.1 L
Soil gas probe ______ (L)

⑤ Field tubing blank reading (ppm$_v$) completed? ☑ Yes ☐ No PID Reading 0.3 ppm$_v$

⑥ Shut in test prior to purging completed? Yes ☑ No ☐

⑦ Purging

4/26/2018

Date	Start Time	End Time	Elapsed Time (min.)	Bag Volume (L)	Purge Rate (LPM)	—	CH_4 (%)	CO_2 (%)	O_2 (%)	Tracer Gas Shroud (%) Min	Tracer Gas Shroud (%) Max	Tracer Gas Sample (ppm$_v$, %) (circle one)	VOCs by PID (ppm$_v$)
1/26/18	1516	1520	4	0.75	0.1	—	*	*	*	19.8	24.4	2.1	2.6
1/26/18	1525	1527	2	0.75	0.1	—	*	*	*	30.6	33.5	5.0	1.0
1/26/18	1608	1610	2	0.50	0.1	—	*	*	*	26.3	32.4	2.1	*
1/26/18	1631	1634	2	0.50	0.1	—	*	*	*	26.9	33.9	1.7	0.7
—	—	—	—	—	—	—	—	—	—	—	—	—	—

⑧ Helium concentration in field screened samples is less than 5% of minimum concentration in the shroud? ☑ Yes ☐ No **Note:** 1% helium = 10,000 ppm$_v$

⑨ Shut in test prior to sample collection completed? Yes ☑ No ☐

⑩ Sample Collection

Date	Time	Sample ID	Summa Canister ID	Flow Controller #	Vacuum Gauge #	Initial Vacuum (in. Hg)	Final Vacuum (in. Hg)
1/27/18	1810	C400VI3SUBOFCL-R	10329	10863	—	-29.5	-10
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—

Comments: * - Not enough air in Tedlar to screen for these parameters
Teresa Fischer 5/15/2018 [signature] 5/15/2018

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SGP measurements - pneumatic testing.ai

D3-39

Differential Pressure and Ambient Temperature Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study** Date: 01/22/2018 Page 1 of 1

Project Number: KX6467/01/04 Project Location: **Paducah Gaseous Diffusion Plant**

Recorded By: Teresa Fischer/Kris Henderson Gauge ID#: 44286-7-700

Weather: Cloudy & cool; intermittent rain; windy in morning

Location ID: LOCATION # 3 Scenario Type: Fan Off; Doors Closed

Sample Start Time: 0644 Sample Initial Vacuum: -29.5" (certified)

Time	Differential Pressure (pa)		Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
	sub-slab/ambient	ambient/outside			
0642	-9.2	1.4	50	-30.0	Summa Opened
1002	-4.5	~~0.0~~ 0.2	51	-24.0	closed 1002; opened 1022
1201	-1.9	0.4	52	-20.0	closed 1201; opened 1215
1358	-4.7	-0.5	52	-17.0	closed 1358; opened 1412
1556	-6.8	-0.4	54	-11	closed 1556; opened 1609
1810	-5.2	-0.8	51	-8	SUMMA closed
—	—	—	—	—	Sample ID C400V13 SUB0FCL-R

Teresa Fischer 5/15/2018

Kris Henderson 5/15/2018

Indoor Air Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study** Date: 01/27/2018 Page 1 of 1
Project Number: KX6467/01/04 Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson SUMMA ID# and Regulator ID#: 11143 / 11761
Weather: Cool & cloudy; windy w/ intermittent rain

Location ID: 3 Scenario Type: Fan Off; Doors Closed
Sample Start Time: 0642 Sample Initial Vacuum: -29.2" Hg (certified)

Time	Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
0642	50	> -30	Summa Opened
1002	55	-29	NA
1201	52	-25	NA
1358	52	-18	NA
1557	54	-12	NA
1648	55	-10	Summa Closed
—	—	—	Sample ID ~~C400-V13OF~~ C400V13INOFCL-R

TAF 1/27/18

Teresa Fischer 5/15/2018

Kristopher Henderson 5/15/2018

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C-400 Vapor Intrusion Study
Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah
Deactivation Project

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study – Fan Off; Doors Closed LOCATION 4

LOCATION: PGDP PROJECT NO.: KX6467 TASK NO: 01/04

DESCRIPTION: VI Sampling DATE: 01/26/2018

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Clear & cool

1340 Setup shut-in & helium seal check at
Location 4
- Sub-slab summa ~~10013~~ 11701 TAP 1/26/18 ; Flow Reg 09704 → -29.4"
- Indoor air summa 10319 ; Flow Reg 10162 → -29.4"
- Shut-in & helium seal check passed

1407 Field activities completed at Location 4

Teresa F 1/26/2018

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DFR_ One Page Teresa Frisch 5/15/2018 SHEET NO 1 OF 1

SOIL GAS PROBE MEASUREMENTS

Geosyntec consultants

① Project Name: C-400 Vapor Intrusion Study
Date: 01/26/2018 Project Number: KX6467/01
Site Location: Paducah Gaseous Diffusion Plant
Weather: Clear & cool
Field Personnel: Teresa Fischer, Kris Henderson
Recorded By: T. Fischer

Probe No.: LOCATION 4 [X] Sub-slab probe [ ] Soil gas probe
Mini Rae 2000 Serial No.: DAQ-248-100-19 Lamp: 10.6 / 11.7 eV
Landtech GEM 2000 Landfill Gas Meter Serial No. M: KAO-399-3
MDG 2002 Helium detector Serial No.: 1072
Tracer Gas: [X] Helium [ ] Other

② Surface Type: [ ] Asphalt [X] Concrete [ ] Grass [ ] Other
Surface Thickness 15 1/2 inches centimeters [ ] Unknown
(i.e.. asphalt or concrete)

③ 1 Casing Volume
[X] Sub-slab <0.1 L
Soil gas probe ____ (L)

⑤ Field tubing blank reading (ppm_v) completed? [✓] Yes [ ] No PID Reading 0.7 ppm_v

⑥ Shut in test prior to purging completed? Yes [✓] No [ ]

⑦ Purging

TAP 4/26/2018

Date	Start Time	End Time	Elapsed Time (min.)	Bag Volume (L)	Purge Rate (LPM)	—	CH_4 (%)	CO_2 (%)	O_2 (%)	Tracer Gas Shroud (%) Min	Tracer Gas Shroud (%) Max	Tracer Gas Sample (ppm_v, %) (circle one)	VOCs by PID (ppm_v)
1/26/2018	1348	1349	1	1	0.75	—	0.1	0.1	20.9	33.6	33.7	0	2.9
1/26/2018	1352	1353	1	1	0.75	—	0.1	0.1	21.0	30.0	30.6	0	2.4
1/26/2018	1355	1356	1	1	0.75	—	0.2	0.1	21.0	26.4	27.3	0	0.8
NA													
NA													

⑧ Helium concentration in field screened samples is less than 5% of minimum concentration in the shroud? [✓] Yes [ ] No **Note:** 1% helium = 10,000 ppm_v

⑨ Shut in test prior to sample collection completed? Yes [✓] No [ ]

⑩ Sample Collection

TAP 1/29/2018

Date	Time	Sample ID	Summa Canister ID	Flow Controller #	Vacuum Gauge #	Initial Vacuum (in. Hg)	Final Vacuum (in. Hg)
1/27/2018	1756	C400VI4SUBOFCL-R	09704	~~10613~~ 11701	—	-29.4	-5
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—

Comments: NA

Teresa Fischer 5/15/2018 [signature] 5/15/2018

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Differential Pressure and Ambient Temperature Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 01/ 27/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
Gauge ID#: 44286 - 7-700
Weather: Cloudy & cool; intermittent rain; windy in morning

Location ID: LOCATION # 4
Scenario Type: Fan Off; Doors Closed
Sample Start Time: 0747
Sample Initial Vacuum: -29.4" (Certified)

Time	Differential Pressure (pa)		Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
	sub-slab/ambient	ambient/outside			
0747	-0.1	0.1	51	> -30	NA
0945	-2.1	-0.3	52	-27	NA
1149	1.7	-0.4	52	-21	NA
1347	2.8	-0.3	53	-18	NA
1547	-0.5	-[illegible]6	52	-10	NA
1756	-2.7	-1.1	51	-5	Summa Closed
—	—	—	—	—	Sample ID C400 VI4SUBOFCL-R

Teresa Fischer 5/15/2018
Kris Henderson 5/15/2018

Indoor Air Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 01/27/2018
Page 1 of 1
TAF 1/27/2018
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
SUMMA ID# and Regulator ID#: 1031A (S) / ~~10162~~ 10102 (FR)
Weather: Cloudy & Cool; Wind & Rain

Location ID: 4
Scenario Type: Fan Off; Doors Closed
Sample Start Time: 0747
Sample Initial Vacuum: -29.4" Hg (certified)

Time	Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
0747	51	-28	NA
0945	52	-24	NA
1149	52	-18	NA
1347	53	-13	NA
1547	52	-9	NA
1751	52	-6	Summa Closed
—	—	—	Sample ID ~~C400V14INCLOF-R~~

C400V14INOFCL-R TAF 1/27/18

Teresa Fischer 5/15/2018

Kris Henderson 5/15/2018

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Geosyntec consultants engineers | scientists | innovators	**C-400 Vapor Intrusion Study** **Paducah Gaseous Diffusion Plant** **Fluor Federal Services, Inc. Paducah Deactivation Project**

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study – Fan Off; Doors Closed LOCATION 5

LOCATION: PGDP PROJECT NO.: KX6467 TASK NO: 01/04

DESCRIPTION: VI Sampling DATE: 01/26/2018

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Clear & Cool

1035 Set up for shut in & helium seal check
- Indoor Air Summa 10734 ; Flow Reg 11536 → -29.1"
  Duplicate 10682 ; Flow Reg 15011 → -29.3"
- Sub-slab Summa 11196 ; Flow Reg 10662 → -29.4"
- Shut-in & helium seal check passed

1120 Complete field activities at Location 5

Teresa [signature] 1/26/18

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DFR_ One Page Teresa Frisch 5/15/2018 SHEET NO 1 OF 1

SOIL GAS PROBE MEASUREMENTS

Geosyntec consultants

① Project Name: C-400 Vapor Intrusion Study
Date: 01/26/2018 Project Number: KX6467/01
Site Location: Paducah Gaseous Diffusion Plant
Weather: Clear & Cool
Field Personnel: Teresa Fischer, Kris Henderson
Recorded By: T. Fischer

Probe No.: LOCATION 5 ☒ Sub-slab probe ☐ Soil gas probe
Mini Rae 2000 Serial No.: DAQ-248-100-19 Lamp: 10.6 / 11.7 eV
Landtech GEM 2000 Landfill Gas Meter Serial No. M: KAO-399-3
MDG 2002 Helium detector Serial No.: 1072
Tracer Gas: ☒ Helium ☐ Other

② Surface Type: ☐ Asphalt ☒ Concrete ☐ Grass ☐ Other
Surface Thickness 20 1/2 inches centimeters ☐ Unknown
(i.e., asphalt or concrete)

③ 1 Casing Volume
☒ Sub-slab <0.1 L
Soil gas probe ______ (L)

⑤ Field tubing blank reading (ppm_v) completed? ☑ Yes ☐ No PID Reading 0 ppm_v

⑥ Shut in test prior to purging completed? Yes ☑ No ☐

⑦ Purging

Date	Start Time	End Time	Elapsed Time (min.)	Bag Volume (L)	Purge Rate (LPM)	TAP 4/26/2018 —	CH_4 (%)	CO_2 (%)	O_2 (%)	Tracer Gas: Shroud (%) Min	Tracer Gas: Shroud (%) Max	Tracer Gas: Sample (ppm, %) (circle one)	VOCs by PID (ppm_v)
1/26/18	1048	1049	1	0.25	0.7	—	0.1	0	20.8	21.0	21.6	0	>15,000
1/26/18	1052	1057	5	<0.25	0.7	—	*	*	*	20.0	21.7	*	*
1/26/18	1059	1101	2	0.25	0.7	—	0	0.1	20.9	20.8	21.9	0	>15,000
1/26/18	1110	1112	2	0.25	0.6	—	0.1	0.1	20.9	20.0	20.6	0	>15,000
—	—	—	—	—	—	—	—	—	—	—	—	—	—

⑧ Helium concentration in field screened samples is less than 5% of minimum concentration in the shroud? ☑ Yes ☐ No **Note:** 1% helium = 10,000 ppm_v

⑨ Shut in test prior to sample collection completed? Yes ☑ No ☐

⑩ Sample Collection

Date	Time	Sample ID	Summa Canister ID	Flow Controller #	Vacuum Gauge #	Initial Vacuum (in. Hg)	Final Vacuum (in. Hg)
1/27/2018	1735	C400VISSUB0FCL-R	11196	10662	—	-29.4	-6
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—

Comments: * Not enough air in tedlar bags for these parameters to be field screened
Teresa Fischer 3/15/2018 Kris Henderson 5/15/2018

SGP measurements - pneumatic testing

Differential Pressure and Ambient Temperature Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 01/27/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
Gauge ID#: 44286-7-700
Weather: Cloudy & cool; intermittent rain; windy in morning

Location ID: LOCATION # 5
Scenario Type: Fan Off; Doors Closed
Sample Start Time: 0728
Sample Initial Vacuum: 29.4" (certified)

Time	Differential Pressure (pa)		Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
	sub-slab/ambient	ambient/outside			
0728	0.2	0.3	53	> -30	NA
0931	-1.4	0.0	53	-28	NA
1135	0.2	-0.1	54	-22	NA
1337	-1.0	0.1	56	-18	NA
1533	-0.5	-0.1	53	-11	NA
1735	-0.8	-0.5	53	-6	SUMMA closed
—	—	—	—	—	Sample ID C400VISSUBOFCL-R

Teresa Fischer 5/15/2018
Kristofer Henderson 5/15/2018

D3-48

Indoor Air Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study** Date: 01/27/2018 Page 1 of 1

Project Number: KX6467/01/04 Project Location: **Paducah Gaseous Diffusion Plant**

Recorded By: Teresa Fischer/Kris Henderson SUMMA ID# and Regulator ID#: 10734 / 11536

Weather: Cloudy & cool; intermittent rain Duplicate 10602 / 15011

Location ID: 5 Scenario Type: Fan Off; Doors Closed

Sample Start Time: 0728 Sample Initial Vacuum: 29.1" & 29.3" (D) (certified)

Time	Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg) / D	Comments
0728	53	-28 / -29	NA
0928	54	-26 / -24	NA
1135	53	-21 / -19	NA
1335	57	-18 / -12	NA
1536	53	-11 / -8	NA
1737	53	-7 / -2	Summas Closed
—	—	—	Sample ID C400VISINOFCL-R

C400VISINOFCLD-R

Teresa Fischer 5/15/2018

[signature] 5/15/2018

Geosyntec consultants

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C-400 Vapor Intrusion Study
Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah Deactivation Project

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study – Fan Off; Doors Closed LOCATION 6

LOCATION: PG DP PROJECT NO.: KX6467 TASK NO: 01/04

DESCRIPTION: VI Sampling DATE: 01/26/2018

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Clear & cold 33°F @ 0650

0650 Set up for Helium Seal Check

- Indoor Air Summas ID# 10555; Flow Reg ID# 10153 → -29.3"

09617; Flow Reg ID# 10054 → -28.8"

- Subslab Summas ID# 10807; Flow Reg ID# 11527 → -29.4"
- Troubleshoot & repair Lung box.

0905 Complete seal check & shut in tests

- Summa is sealed → pass

Teresa [signature] 1/26/2018

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DFR_ One Page Teresa Fischer 5/15/2018 SHEET NO 1 OF 1

SOIL GAS PROBE MEASUREMENTS

Geosyntec consultants

D3-50

① Project Name: C-400 Vapor Intrusion Study
Date: 01/26/2018 Project Number: KX6467/01
Site Location: Paducah Gaseous Diffusion Plant
Weather: Clear & Cold
Field Personnel: Teresa Fischer, Kris Henderson
Recorded By: T. Fischer

Probe No.: LOCATION 6 ☒ Sub-slab probe ☐ Soil gas probe
Mini Rae 2000 Serial No.: 592-909072 Lamp: 10.6 / 11.7 eV
Landtech GEM 2000 Landfill Gas Meter Serial No. M: GM07658/04
MDG 2002 Helium detector Serial No.: 10702
Tracer Gas: ☒ Helium ☐ Other

② Surface Type: ☐ Asphalt ☒ Concrete ☐ Grass ☐ Other
Surface Thickness 8 inches/centimeters ☐ Unknown
(i.e., asphalt or concrete)

③ 1 Casing Volume
☒ Sub-slab <0.1 L
Soil gas probe ____ (L)

⑤ Field tubing blank reading (ppm_v) completed? ☑ Yes ☐ No PID Reading 0 ppm_v

⑥ Shut in test prior to purging completed? Yes ☑ No ☐

⑦ Purging

Date	Start Time	End Time	Elapsed Time (min.)	Bag Volume (L)	Purge Rate (LPM)	~~TPB~~ 4/26/2018 —	CH_4 (%)	CO_2 (%)	O_2 (%)	Tracer Gas Shroud (%) ~~TPB~~ 4/26/18 Min	Tracer Gas Shroud (%) Max	Tracer Gas Sample (ppm_v, %) (circle one)	VOCs by PID (ppm_v)
1/26/2018	0848	0853	5	0.25	0.6	—	NA	NA	NA	24.8	27.1	0	0.5
1/26/2018	0856	0859	3	0.75	0.7	—	0	0.1	20.7	25.4	25.5	0	0
1/26/2018	0902	0905	3	1.0	0.8	—	0	0.1	20.7	22.4	21.4	0	0
—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—

⑧ Helium concentration in field screened samples is less than 5% of minimum concentration in the shroud? ☑ Yes ☐ No **Note:** 1% helium = 10,000 ppm_v

⑨ Shut in test prior to sample collection completed? Yes ☑ No ☐

⑩ Sample Collection

Date	Time	Sample ID	Summa Canister ID	Flow Controller #	Vacuum Gauge #	Initial Vacuum (in. Hg)	Final Vacuum (in. Hg)
1/27/18	1658	C400VI6SUBOFCL-R	10807	11527	—	-29	-2
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—

Comments: NA

Teresa Fischer 5/15/2018 [signature] 5/15/2018

KH
1/27/18
0656
D3-51

Differential Pressure and Ambient Temperature Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study** Date: 01/27/2018 Page 1 of 1
Project Number: KX6467/01/04 Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson Gauge ID#: 44286-7-700
Weather: Cloudy & cool; Windy & Rain

Location ID: LOCATION # 6 Scenario Type: Fan Off; Doors Closed
Sample Start Time: 0656 Sample Initial Vacuum: -29.4" (cont: Lo(f))

Time	Differential Pressure (pa)		Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
	sub-slab/ambient	ambient/outside			
~~1-27-18~~	0.2	-1.6 - -24.5	52	-29.4	Summa opened
0856	0.0	0.8	58	-24	NA
1056	-0.1	0.4	56	-19	NA
1255	0.0	0.0	55	-12	NA
1455	0.0	0.0	54	-8	NA
1658	0.0	-0.2	53	-2	Summa Closed
—	—	—	—	—	Sample ID C400 V16SUBOFCL-R

Teresa Fischer 5/15/2018
Kris Henderson 5/15/2018

D3-52

Indoor Air Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 01/27/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
SUMMA ID# and Regulator ID#: 16555 / 10163
Duplicate 09617 / 10054
Weather: Clear & cold (33° @ 0600)

Location ID: 6
Scenario Type: Fan Off; Doors Closed
Sample Start Time: 0657
Sample Initial Vacuum: -29.3" Hg / -28.8" Hg Dup (certified)

Time	Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg) / D	Comments
0657	52	-29 / -28	Summas opened
0857	58	-24 / -23	NA
1056	56	-20 / -18	NA
1255	55	-15 / -12	NA
1455	54	-9 / -7	NA
1657	53	-5 / -1	Summas closed
—	—	—	Sample ID C400VI6INOFCL-R

C400VI6INOFCLD-R (Duplicate)

Teresa Fischer 5/15/2018

Kris Henderson 5/15/2018

Geosyntec consultants

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C-400 Vapor Intrusion Study
Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah Deactivation Project

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study – Fan Off; Doors Closed LOCATION 7

LOCATION: PGDP PROJECT NO.: KX6467 TASK NO: 01/04

DESCRIPTION: VI Sampling DATE: 01/26/2018

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Clear & cool

1300 Don PPE to enter C-400
- Setup shut-in test & helium seal check
- Indoor Air Summa 10562 ; Flow Reg 11272 → -29.5
- Subslab Summa 10117 ; Flow Reg 10448 → -29.4

1335 Helium Seal Check failed. Re-grout port
1445 Conduct shut-in & seal check again - passed
1448 Field activities completed at Location 7

Teresa F
1/26/18

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Teresa Fischer 5/15/2018

SHEET NO 1 OF 1

SOIL GAS PROBE MEASUREMENTS

Geosyntec consultants

D3-54

① Project Name: C-400 Vapor Intrusion Study
Date: 01/26/2018 Project Number: KX6467/01
Site Location: Paducah Gaseous Diffusion Plant
Weather: Clear
Field Personnel: Teresa Fischer, Kris Henderson
Recorded By:

Probe No.: LOCATION 7 [X] Sub-slab probe [ ] Soil gas probe
Mini Rae 2000 Serial No.: DAQ-248-100-19 Lamp: 10.6 / 11.7 eV
Landtech GEM 2000 Landfill Gas Meter Serial No. M: KAO-399-3
MDG 2002 Helium detector Serial No.: 1022
Tracer Gas: [X] Helium [ ] Other

② Surface Type: [ ] Asphalt [X] Concrete [ ] Grass [ ] Other
Surface Thickness 20 1/4 inches/centimeters [ ] Unknown
(i.e., asphalt or concrete)

③ 1 Casing Volume
[X] Sub-slab <0.1 L
Soil gas probe ______ (L)

⑤ Field tubing blank reading (ppm$_v$) completed? [✓] Yes [ ] No PID Reading 2.7 ppm$_v$ 1.2@ 1415

⑥ Shut in test prior to purging completed? Yes [✓] No [ ]

⑦ Purging

Date	Start Time	End Time	Elapsed Time (min.)	Bag Volume (L)	Purge Rate (LPM)	TMP 4/26/2018	CH_4 (%)	CO_2 (%)	O_2 (%)	Tracer Gas Shroud (%) Min	Tracer Gas Shroud (%) Max	Tracer Gas Sample (ppm$_v$, %) (circle one)	VOCs by PID (ppm$_v$)
1/26/18	1329	1330	1	1	0.65	TMP 4/26/18	0.1	0.1	20.8	32.1	32.2	8,100	7.0
~~1/26/18~~	~~1333~~				~~0.6~~					~~27~~	~~28.6~~		
* 1/26/18	1334	1335	1	0.25	0.6	— TMP	NA	NA	NA	21.0	21.9	12,000	26.7
1/26/18	1443	1445	2	0.75	0.7	— 4/26/2018	0	0.1	21.0	28.6	29.9	0	28.9
1/26/18	1446	1448	2	0.75	0.65	—	0.1	0.1	21.1	23.2	23.7	0	28.4

⑧ Helium concentration in field screened samples is less than 5% of minimum concentration in the shroud? [✓] Yes [ ] No **Note:** 1% helium = 10,000 ppm$_v$

⑨ Shut in test prior to sample collection completed? Yes [✓] No [ ]

⑩ Sample Collection

Date	Time	Sample ID	Summa Canister ID	Flow Controller #	Vacuum Gauge #	Initial Vacuum (in. Hg)	Final Vacuum (in. Hg)
1/27/2018	1732	C400VI7SUB0FCL-R	10117	10448	—	-29.4	-5
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—

Comments: * Need to re-seal. Probe re-grouted
Kris Henderson 5/15/2018 Teresa Fischer 5/15/2018

Differential Pressure and Ambient Temperature Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 01/27/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
Gauge ID#: 44286-7-700
Weather: Cloudy & cool; intermittent rain; windy in morning

Location ID: LOCATION # 7
Scenario Type: Fan Off; Doors Closed
Sample Start Time: 0723
Sample Initial Vacuum: -29.4" (certified)

Time	Differential Pressure (pa)		Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg) TAF 1/27/18	Comments
	sub-slab/ambient	ambient/outside			
0723	1.4	-19.1	54	-28 ~~-29.4~~	NA
0927	-4.1	0.0	54	-22	NA
1127	-6.0	-0.3	51	-16	NA
1329	-1.8	-0.2	53	-11	NA
1528	-1.3	-0.3	55	-10	NA
1732	-2.2	-0.4	54	-5	Summa closed
—	—	—	—	—	Sample ID C400 VI7SUBOFCL-R

Teresa Fischer 5/15/2018

Kris Henderson 5/15/2018

D3-55

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Indoor Air Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 01/27/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
SUMMA ID# and Regulator ID#: 1052 / 11127 TAF 1/27/18
Weather: Cloudy & cool; intermittent rain; windy in morning

Location ID: 7
Scenario Type: Fan Off; Doors Closed
Sample Start Time: 0723
Sample Initial Vacuum: -29" (certified)

Time	Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
0723	54	-29	NA
0923	54	-24	NA
1127	52	-16	NA
1329	59	-11	NA
1528	54	-5	NA
1733	54	-2	Summa Closed
—	—	—	Sample ID: C400VI7INOFCL-R

TAF 1/27/18

Teresa Fischer 5/15/2018

Kristofer Henderson 5/15/2018

Geosyntec consultants

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C-400 Vapor Intrusion Study
Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah
Deactivation Project

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study – Fan Off; Doors Closed LOCATION 8

LOCATION: PGDP PROJECT NO.: KX6467 TASK NO: 01/04

DESCRIPTION: VI Sampling DATE: 01/26/2018

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Clear & Cool

1530 Set Summa at Location 8
– Summa 11227 –29.3"
– Regulator 11625
TAP 4/26/2018

1-27-18
– 0626 Purged sample line 3 liters
– See field form for details.

1/26 & 27/18

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5/15/2018

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Differential Pressure and Ambient Temperature Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study** Date: 1/27/18 Page 1 of 1

Project Number: KX6467/01/04 Project Location: **Paducah Gaseous Diffusion Plant**

Recorded By: Teresa Fischer/Kris Henderson Gauge ID#: 44286-7-700

Weather: Cool & cloudy; Windy w/ intermittent rain

Location ID: LOCATION 8 Scenario Type: Fan Off; Doors Closed

Sample Start Time: 0650 Sample Initial Vacuum: -29.3 (certified)

Time	Differential Pressure (pa) Exhaust Fan to Ambient	Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
0649	-1.0	48	-29	Summa opened
0849	-2.0	55	-26	NA
1048	-0.3	56	-20	NA
1247	-0.3	53	-15	NA
1448	-0.2	56	-11	NA
1654	-0.1	51	-4	Summa closed
—	—	—	—	Sample ID C400V18EXH OFCL-R

Teresa Fischer 5/15/2018

[signature] 5/15/2018

INSTRUMENT CALIBRATION REPORT

Pine Environmental Services LLC

10521 Research Drive
Suite 102
Knoxville, TN 37932
Toll-free: (877) 355-7907

Pine Environmental Services, Inc.

Instrument ID 20904
Description MIniRae 3000
Calibrated 1/24/2018 9:40:26AM

Manufacturer Rae Systems
Model Number MiniRAE 3000
Serial Number/ Lot Number 592-909072
Location Tennessee
Department

State Certified
Status Pass
Temp °C 21
Humidity % 22

Calibration Specifications

Group # 1
Group Name ISOBUTYLENE
Stated Accy Pct of Reading

Range Acc % 0.0000
Reading Acc % 3.0000
Plus/Minus 0.00

Nom In Val / In Val	In Type	Out Val	Out Type	Fnd As	Lft As	Dev%	Pass/Fail
100.00 / 100.00	PPM	100.00	PPM	100.00	100.00	0.00%	Pass

Test Instruments Used During the Calibration **(As Of Cal Entry Date)**

Test Standard ID	Description	Manufacturer	Model Number	Serial Number / Lot Number	Last Cal Date/ Opened Date	Next Cal Date / Expiration Date
TN 100PPM ISO DAQ-248-100-19	TN 100PPM ISO	Calgaz	34LS-248-100	DAQ-248-100-19		3/28/2020

Notes about this calibration

Calibration Result Calibration Successful
Who Calibrated Derek Farmer

All instruments are calibrated by Pine Environmental Services LLC according to the manufacturer's specifications, but it is the customer's responsibility to calibrate and maintain this unit in accordance with the manufacturer's specifications and/or the customer's own specific needs.

Notify Pine Environmental Services LLC of any defect within 24 hours of receipt of equipment
Please call 800-301-9663 for Technical Assistance

5/15/2018

INSTRUMENT QC/ PACKING LIST

Description	RAE Systems MiniRAE 3000
Instrument ID	20904
Date Calibrated	1-24-18

PINE
www.pine-environmental.com

Standard Items	Prepared	QC check	Received by customer	Returned to Pine
MiniRAE 3000 w/ ______eV lamp and carry case	✓	✓	✓	
Protective rubber boot	✓	✓	✓	
Manual	✓	✓	✓	
Quick reference card	✓	✓	✓	
Probe tip	✓	✓	✓	
Charger/ adapter, or charger and cradle	✓	✓	✓	
(2) Hydrophobic filters	✓	✓	✓	
Alkaline battery adapter	✓	✓	✓	
(4) AA Alkaline batteries	✓	✓	✓	
ProCal calibration sheet	✓	✓	✓	

4/26/2018

TAP

Supporting Items

100 ppm isobutylene calibration gas				
100 ppm Isobutylene SDS				
✓ *Must match cylinder with setup*				
Gas regulator				
Tedlar bag				
Datalogging software				
Communications cable				

Prepared by: JM
QC checked by: [signature]
Date: 1/24

This packing list is to ensure that every item needed to operate the unit was sent and received. Upon receiving a shipment, please fill out the "Received by customer" column. Call Pine within 24 hours of receiving the equipment if any pieces are missing, damaged, or malfunctioning. Thank you for choosing Pine Environmental Services LLC

[signature] 5/15/2018

INSTRUMENT CALIBRATION REPORT

Pine Environmental Services LLC

10521 Research Drive
Suite 102
Knoxville, TN 37932
Toll-free: (877) 355-7907

Pine Environmental Services, Inc.

Instrument ID 12483
Description Landtec GEM-2000
Calibrated 1/24/2018 1:20:52PM

Manufacturer	CES Landtec	**State Certified**	
Model Number	GEM2000	**Status**	Pass
Serial Number/ Lot Number	GM07658	**Temp °C**	21
Location	Tennessee	**Humidity %**	22
Department			

Calibration Specifications

Group # 1
Group Name Methane
Stated Accy Pct of Reading
Range Acc % 0.0000
Reading Acc % 3.0000
Plus/Minus 0.0

Nom In Val / In Val	In Type	Out Val	Out Type	Fnd As	Lft As	Dev%	Pass/Fail
50.0 / 50.0	%Volume	50.0	%Volume	50.0	50.0	0.00%	Pass

Group # 2
Group Name Carbon Dioxide
Stated Accy Pct of Reading
Range Acc % 0.0000
Reading Acc % 3.0000
Plus/Minus 0.0

Nom In Val / In Val	In Type	Out Val	Out Type	Fnd As	Lft As	Dev%	Pass/Fail
35.0 / 35.0	%Volume	35.0	%Volume	35.0	35.0	0.00%	Pass

Group # 3
Group Name Oxygen
Stated Accy Pct of Reading
Range Acc % 0.0000
Reading Acc % 3.0000
Plus/Minus 0.0

Nom In Val / In Val	In Type	Out Val	Out Type	Fnd As	Lft As	Dev%	Pass/Fail
20.9 / 20.9	%Volume	20.9	%Volume	20.9	20.9	0.00%	Pass

Test Instruments Used During the Calibration **(As Of Cal Entry Date)**

Test Standard ID	Description	Manufacturer	Model Number	Serial Number / Lot Number	Last Cal Date/ Opened Date	Next Cal Date / Expiration Date
TN 50 CH4/35 CO2 17LX	TX 50 CH4/35 CO2 17L HAM-399-2	Liquid Technology	GP12116	KAO-399-3		10/31/2018

Notes about this calibration

Calibration Result Calibration Successful
Who Calibrated Derek Farmer

Teresa Fischer 5/15/2018

INSTRUMENT QC/ PACKING LIST

Description	Landtec GEM-2000
Instrument ID	12483
Date Calibrated	1-24-18

PINE
www.pine-environmental.com

Standard Items	**Prepared**	**QC check**	**Received by customer**	**Returned to Pine**
GEM-2000 w/ hard case	✓	✓	✓ 4/26/2018	
Fabric carry case	✓	✓	✓	
Manual	✓	✓	✓	
Quick reference card	✓	✓	✓ TAF	
Charger, AC cord (if applicable)	✓	✓	✓	
(2) 4' lengths of sample tubing w/ filter, housing, and 4 male quick connects			TAF 4/26/2018	
(2) Extra hydrophobic filters	✓	✓	✓	
(2) extra male quick connects				
Comm. Cable and data logging software	✓	✓	✓ 4/26/2018	
Case insert warning			✓	
ProCal calibration sheet	✓	✓	✓ TAF	
Supporting Items				
CH_4 and CO_2 calibration gas mix				
CH_4 and CO_2 calibration gas SDS ✓ *Must match cylinder with setup*				
4% Oxygen, balance N_2 gas mix				
4% Oxygen, balance N_2 gas SDS ✓ *Must match cylinder with setup*				
Gas regulator, female (.25 or .5 lpm)				
Gas regulator, male (.25 or .5 lpm)				
Calibration tubing (6" tubing w/ male quick connect)				
Temperature probe				

Prepared by: JM
QC checked by: 1/24
Date: JF

This packing list is to ensure that every item needed to operate the unit was sent and received. Upon receiving a shipment, please fill out the "Received by customer" column. Call Pine within 24 hours of receiving the equipment if any pieces are missing, damaged, or malfunctioning. Thank you for choosing Pine Environmental Services LLC

Teresa Fischer 5/15/2018

INSTRUMENT CALIBRATION REPORT

Pine Environmental Services LLC

4037 Darling Court
Lilburn, GA 30047
Toll-free: (800) 842-1088

Pine Environmental Services, Inc.

Instrument ID 10702
Description Radiodetection MGD-2002 Multi-Gas Leak Locator
Calibrated 1/23/2018 5:35:20PM

Manufacturer	Radiodetection	**State Certified**	
Model Number	MGD-2002	**Status**	Pass
Serial Number/ Lot Number	040951	**Temp °C**	21
Location	Georgia	**Humidity %**	34
Department			

Calibration Specifications

Group # 1
Group Name Zero to 99.999%
Test Performed: Yes **As Found Result: Pass** **As Left Result: Pass**

Test Instruments Used During the Calibration **(As Of Cal Entry Date)**

Test Standard ID	Description	Manufacturer	Model Number	Serial Number / Lot Number	Last Cal Date/ Opened Date	Next Cal Date / Expiration Date

Notes about this calibration

Calibration Result Calibration Successful
Who Calibrated Jeff Rasmussen

All instruments are calibrated by Pine Environmental Services LLC according to the manufacturer's specifications, but it is the customer's responsibility to calibrate and maintain this unit in accordance with the manufacturer's specifications and/or the customer's own specific needs.

Notify Pine Environmental Services LLC of any defect within 24 hours of receipt of equipment
Please call 800-301-9663 for Technical Assistance

Teresa Fischer 5/15/2018

INSTRUMENT QC/ PACKING LIST

Description	Dielectric MGD-2002
Instrument ID	10702
Date Prepared	1-23-18

PINE
www.pine-environmental.com

Standard Items	**Prepared**	**QC check**	**Received by customer**	**Returned to Pine**
MGD-2002 and carry case	✓	✓	✓	
Manual	✓	✓	✓	
Quick reference card	✓	✓	✓	
Charger	✓	✓	✓	
12VDC auto plug adapter	✓	✓	✓	
Needle probe	✓	✓	✓	
Ground probe	✓	✓	✓	
Handle assembly with moisture filter cartridge	✓	✓	✓	
Extra moisture filter cartridge	✓	✓	✓	
Drying adapter for cartridges	✓	✓	✓	
Carry strap	✓	✓	✓	
ProCal inspection report	✓	✓	✓	

4/26/2018
TAP

Prepared by: JR
QC checked by: SB
Date: 1/23/18

This packing list is to ensure that every item needed to operate the unit was sent and received. Upon receiving a shipment, please fill out the "Received by customer" column. Call Pine within 24 hours of receiving the equipment if any pieces are missing, damaged, or malfunctioning. Thank you for choosing Pine Environmental Services LLC.

Teresa Fischer 5/15/2018

INSTRUMENT CALIBRATION REPORT

Advanced Labs, Inc.

Pine Environmental Services, Inc

Instrument ID 39207
Description TSI 8330 VelociCheck
Calibrated 9/27/2017

Manufacturer	TSI	**Classification**	
Model Number	8330	**Status**	pass
Serial Number	96060227	**Frequency**	Yearly
Location	New Jersey	**Department**	Lab
Temp	76	**Humidity**	33

Calibration Specifications

Group # 1 — **Range Acc %** 0.0000
Group Name Temperature — **Reading Acc %** 0.0000
Stated Accy Plus / Minus — **Plus/Minus** 5.00

Nom In Val / In Val	In Type	Out Val	Out Type	Fnd As	Lft As	Dev%	Pass/Fail
70.00 / 75.60	°F	75.60	°F	76.00	76.00	0.53%	Pass

Group # 2 — **Range Acc %** 0.0000
Group Name Velocity — **Reading Acc %** 5.0000
Stated Accy Pct of Reading — **Plus/Minus** 0.00

Nom In Val / In Val	In Type	Out Val	Out Type	Fnd As	Lft As	Dev%	Pass/Fail
0.00 / 0.00	ft/min	0.00	ft/min	0.00	0.00	0.00%	Pass
40.00 / 40.00	ft/min	40.00	ft/min	40.00	40.00	0.00%	Pass
70.00 / 70.00	ft/min	70.00	ft/min	70.00	70.00	0.00%	Pass
100.00 / 100.00	ft/min	100.00	ft/min	103.00	103.00	3.00%	Pass
150.00 / 150.00	ft/min	150.00	ft/min	153.00	153.00	2.00%	Pass
325.00 / 325.00	ft/min	325.00	ft/min	330.00	330.00	1.54%	Pass
700.00 / 700.00	ft/min	700.00	ft/min	700.00	700.00	0.00%	Pass
1000.00 / 1000.00	ft/min	1000.00	ft/min	990.00	990.00	-1.00%	Pass
1500.00 / 1500.00	ft/min	1500.00	ft/min	1,490.00	1,490.00	-0.67%	Pass
2000.00 / 2000.00	ft/min	2000.00	ft/min	2,000.00	2,000.00	0.00%	Pass

Test Instruments Used During the Calibration

Test Instrument ID	Description	Manufacturer	Serial Number	Last Cal Date (As Of Cal Entry Date)	Next Cal Date (As Of Cal Entry Date)
MICHELL DM-509-TX-01	Relative Humidity Meter	Michell	273296	8/25/2017	8/25/2018
OMEGA HX93AC/DP25-E	Omega HX93AC/DP25-E	Omega Engineering	1010368 035025 035026	9/15/2016	9/15/2018
OMEGA PX02K1-16A5T /DP25-E-A	Omega PX02K1-16A5T/DP25-E-A	Omega Engineering	168377/8375030	9/15/2016	9/15/2018
OMEGA WT4401-D	Omega WT4401-D	Omega Engineering	101105	9/15/2016	9/15/2018

Teresa Fraser 5/15/2018

INSTRUMENT CALIBRATION REPORT

Advanced Labs, Inc.

Pine Environmental Services, Inc

Instrument ID	39207
Description	TSI 8330 VelociCheck
Calibrated	9/27/2017

Notes about this calibration

Calibration Result	Calibration Successful
Who Calibrated	David Galego

Advanced Labs, Inc. hereby certifies that this instrument is calibrated and functions to meet the manufacture's specifications using NIST traceable standards, or is derived from accepted values of physical constants.

Teresa Fischer 5/15/2018

Advanced Labs, Inc., Windsor Industrial Park, 92 North Main Street, Bldg 20, Windsor, NJ 08561, 800-301-9663

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C-400 Vapor Intrusion Study
Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah
Deactivation Project

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study – Fan On; Doors Open

LOCATION: PGDP PROJECT NO.: KX6467 TASK NO: 01/04

DESCRIPTION: VI Sampling DATE: 02/ 9 /2018

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Clear & cold

TAP 2/9/2018

0545 Assemble at ~~C-70~~ C-730
- Jason Brulton, Brandon Taylor; Kris Henderson; David Jensen, Teresa Fischer
- Mobilize to Limited Area to complete Scenario set up

0555 Arrive at C-400
- All Bay Doors on north side open all the way
- Three of four bay doors open all way on south side; Door 6 is broken & open ~1 foot
- Large exterior heaters off
- Exhaust fan on
- Scenario set up is complete; proceed with shut in & Helium Seal Checks

0600 Check PID & Landtec meter calibration
- PID is not operating properly and will not be used.
- Stage equipment & materials in clean area within C-400

0630 Briefing with Jeff Seaton & Paul Colthrop

0705 Don PPE & enter C-400 CA
- Set up sub-slab & indoor air summa canisters at Locations 1, 2, 4, 5, 7
- Conduct shut in & Helium Seal Check at sub-slab locations → see individual Location forms for details

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SHEET NO 1 OF 2

Geosyntec consultants engineers | scientists | innovators	**C-400 Vapor Intrusion Study Paducah Gaseous Diffusion Plant Fluor Federal Services, Inc. Paducah Deactivation Project**

1030 Exit CA of C400; Doff PPE
1115 Set up summa canister at Location 8; lines to be
~~1115~~ purged prior to opening canister
TAP 2/9/18
1125 Set up summa canisters at Location 6
1210 Set up summa canisters at Location 3.
- See individual Locations forms for details

1330 Place tripods at Ambient Locations
1345 Leave Limited Area
- Unpack meters, equipment & materials that will not be used during sampling
- Calibration check

1500 End of field activities

2/9/2018

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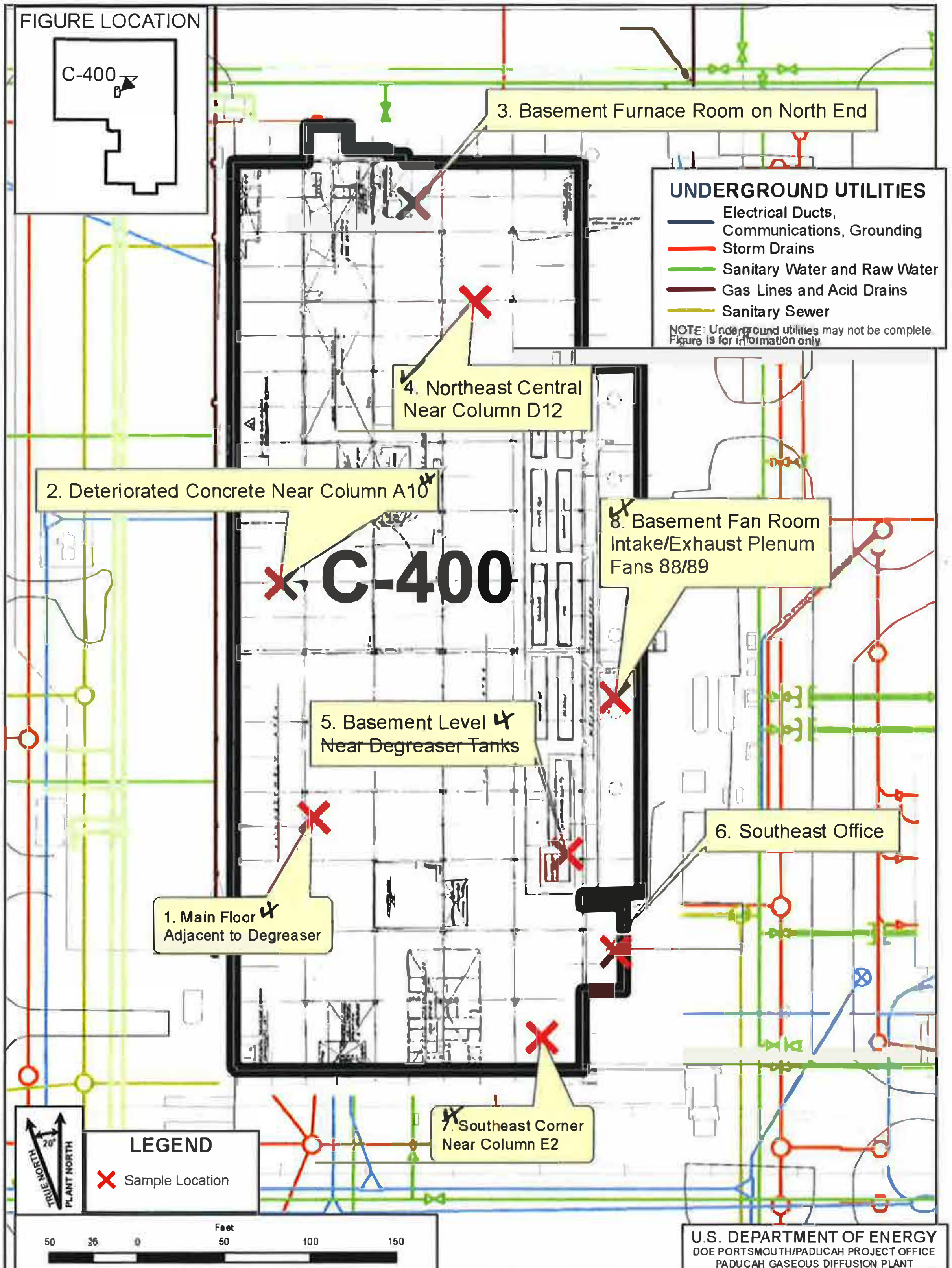


Figure 12. Indoor Sampling Locations for C-400 Building Vapor Intrusion Study

FLUOR

G:\GIS\ARCVIEWS\PROJECTS\Vapor Intrusion\MOA 400\Figure 12 C-400 Map (with Approximate Sampling Locations for VI).mxd
7/25/2017

Tureen Frasher 5/15/2018

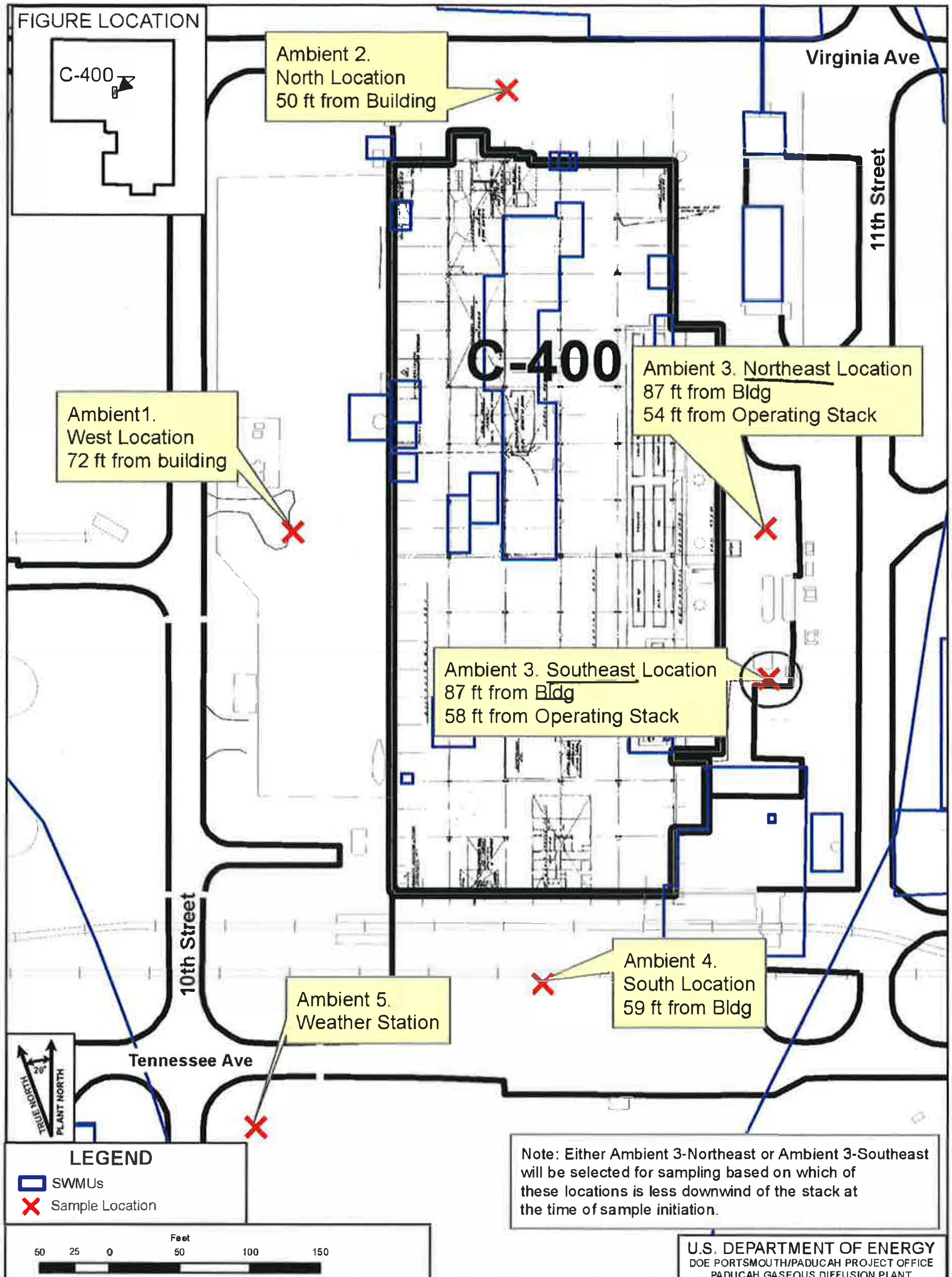
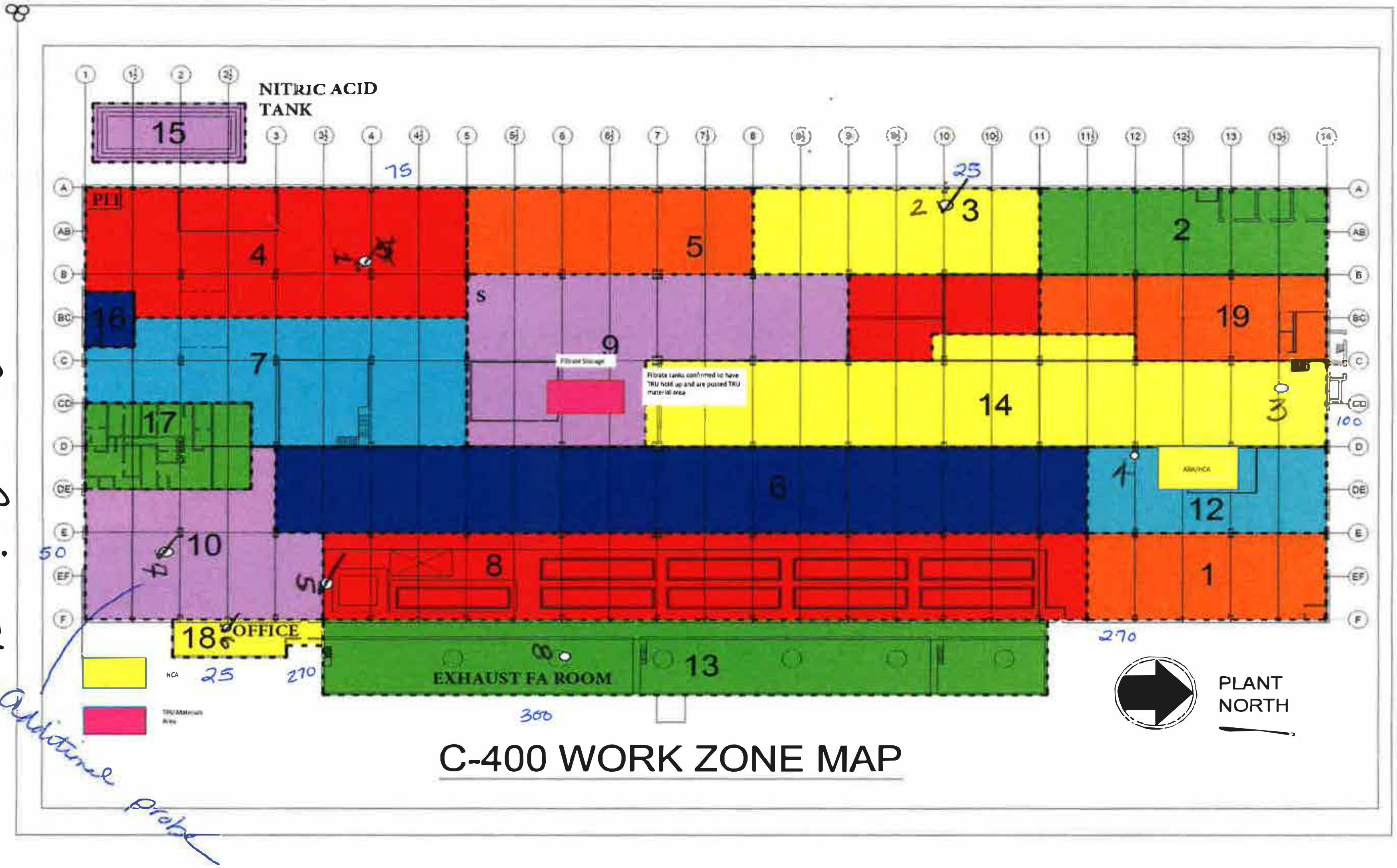


**Figure 13. C-400 Map
(with Approximate Ambient Sampling Locations)**

G:\GIS\ARCVIEWS\PROJECTS\Vapor Intrusion\MOA 400\Figure 13_C-400 Ambient Sampling Locations.mxd
7/25/2017

5/15/2018

D3-71



C-400 WORK ZONE MAP

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**C-400 Vapor Intrusion Study
Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah
Deactivation Project**

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study – Fan On; Doors Open

LOCATION: PGDP PROJECT NO.: KX6467 TASK NO: 01/04

DESCRIPTION: VI Sampling DATE: 02/10/2018

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Cold; light rain; slight wind from NW

0545 Mobilize to limited area from C-730 TOS.
- Brandon Taylor, Sam Martin, Kris Henderson, David Jensen, Teresa Fischer

0555 Arrive at C400
- Set up Ambient Air summa canisters; Weather Station

0615 Mobilize to start Ambient Air summas & other summas outside CA; see individual location forms

0645 Don PPE to enter CA

0705 Enter CA
- Start summa canisters within CA; see individual forms

0730 Leave CA
- Doff PPE
- See individual location forms for details.

0915 RADCON Requested double booties & gloves @ Location 5.
- 10 minute delay while waiting for double booties & gloves before being able to enter Location 5 for indoor air readings.
- Subsequent Location readings also delayed; see individual location forms for details

1757 All ambient & sub-slab/indoor air canisters collected.

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C-400 Vapor Intrusion Study
Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah
Deactivation Project

Samples:

C400VI1SUBONOP-R

C400VI1INONOP-R

C400VI1AMBONOP-R

TAP 4/26/2018

C400VI2SUBONOP-R

C400VI2IN~~OP~~ONOP-R TAP 2/10/18

C400VI2AMBONOP-R

TAP 4/26/2018

C400VI3SUBONOP-R

C400VI3INONOP-R

~~C400VI3AMBONOP-R~~ TAP 2/10/18

C400VI3SEAMBONOP-R

C400VI4SUBONOP-R

C400VI4INONOP-R

C400VI4AMBONOP-R

TAP 4/26/2018

C400VI5SUBONOP-R

C400VI5INONOP-R | C400VI5INONOP-RD

C400VI6SUBONOP-R

C400VI6INONOP-R | C400VI6INONOP-RD

TAP 4/26/2018

C400VI7SUBONOP-R

C400VI7INONOP-R

TAP 4/26/2018

C400VI8EXHONOP-R

1830 Field activities complete; leave limited area

TAP 2/10/18

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C-400 Vapor Intrusion Study
Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah Deactivation Project

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study – Fan On; Doors Open Ambient Locations

LOCATION: PGDP PROJECT NO.: KX6467 TASK NO: 01/04

DESCRIPTION: VI Sampling DATE: 02/10/2018

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Cold; light rain with wind from NW

0605 Set up Ambient Location summa canisters.
- Ambient Location 3 set up at SE location → wind direction is from northwest
- Start sampling at 0616 → see individual location forms for details.

1638 All Ambient Location summa canisters closed and collected

1830 Field activities complete. leave limited area

Teresa [signature] 2/10/18

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Ambient Air
Monitoring Record 1

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/10/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: T. Fischer
SUMMA ID# and Regulator ID#: 11194/ 10446
Weather: Cold & drizzle

Location ID: Location 1 - Ambient
Scenario Type: Fan On; Doors Open
Sample Start Time: 0629
Sample Initial Vacuum: -29.6" certified

Time	Summa Canister Vacuum (in Hg)	Comments
0629	-27 (can)	Summa opened
0827	-24	Rain stopped
1027	-18.5	Windy
1229	-13.5	Windy
1425	-8.5	Windy
1630	-3.5	Windy; summa closed
		2/10/18
		Sample ID - C400VI1AMBONOP-R

5/15/2018

5/15/2018

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D3-76

Ambient Air
Monitoring Record 2

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/10/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer
SUMMA ID# and Regulator ID#: 11690 / 10145
Weather: Cold + drizzle

Location ID: Location 2 - Ambient
Scenario Type: Fan On; Doors Open
Sample Start Time: 0616
Sample Initial Vacuum: -29.4" Hg (cert)

Time	Summa Canister Vacuum (in Hg)	Comments
0616	-28 (can)	Summa opened
0811	-24	Rain stopped
1017	-19.5	NA
1221	-14	NA
1418	-9	NA
1619	-3.5	NA; Summa closed
		Teresa Fischer
		2/10/18
		Sample ID - C400 VI2AMBONOAR

Teresa Fischer 5/15/2018

[signature] 5/15/2018

Ambient Air
Monitoring Record 3 SE

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/ 10 2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: T. Fischer
SUMMA ID# and Regulator ID#: 10187 / 10139
Weather: Cold & drizzle

Location ID: Location 3 - Ambient
Scenario Type: Fan On; Doors Open
Sample Start Time: 0622
Sample Initial Vacuum: - 29.7" Hg (certified)

Time	Summa Canister Vacuum (in Hg)	Comments
0622	- 29.7	Summa opened
0820	- 26	NA ; Rain stopped
~~0819~~ 1019	- 21	NA ; Windy
1225	- 16.5	Windy
1420	- 11.5	Windy
1622	- 6.5	Windy ; Summa closed
		Theresa Fischer 2/10/2018
		Sample ID - ~~C400V13SEAMONOP-R~~

C400V13SEAMBONOP-R TAF 2/10/18

TAF 2/10/2018

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Theresa Fischer 5/15/2018

[signature] 5/15/2018

Ambient Air
Monitoring Record 4

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**

Date: 02/10/2018

Page 1 of 1

Project Number: KX6467/01/04

Project Location: **Paducah Gaseous Diffusion Plant**

Recorded By: T. Fischer

SUMMA ID# and Regulator ID#: 10272 / 10049

Weather: Cold & drizzle

Location ID: Location 4 - Ambient

Scenario Type: Fan On; Doors Open

Sample Start Time: 0637

Sample Initial Vacuum: -29.4" Hg (certified)

Time	Summa Canister Vacuum (in Hg)	Comments
0637	-29 (con)	Summa opened
0835	-25.5	Rain stopped
1035	-21	Windy
1234	-15	Windy
1435	-11	Windy
1637	-5	Windy; Summa closed
		Teresa F 2/10/18
		Sample ID - C400V14AMB0N0P-R

Teresa Fischer 5/15/2018

[signature] 5/15/2018

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Weather Station Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/10/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson

Location ID: Weather Station
Scenario Type: Fan On; Doors Open

Time	Ambient Temp. (deg. F)	Relative Humidity (%)	Barometric Pressure (inches Hg)	Wind Direction	Wind Speed (mph)
0632	40	41	30.04	NW	4
0830	39	48	30.04	N-NW	5
1030	38	51	30.05	N	5
1231	39	49	30.00	N	6
1430	40	48	29.98	N	5
1634	40	51	29.97	N	6

Teresa Fischer 2/10/18

Teresa Fischer 5/15/2018

Kris Henderson 5/15/2018

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C-400 Vapor Intrusion Study
Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah Deactivation Project

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study – Fan On; Doors Open LOCATION 1

LOCATION: PGDP PROJECT NO.: KX6467 TASK NO: 01/04

DESCRIPTION: VI Sampling DATE: 02/ 9 /2018

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Clear & cold

0800 Set up Helium Seal Check
- Sub-slab summa → 10560; Flow Controller 11053; -29.6" Hg (certified).
- Indoor Air summa 11274; Flow controller 11511; -29.4" Hg (certified).

0926 Run Helium Seal Check & Shut in
- Seal check & shut in passed.

~~10~~ TAP 2/9/18

0940 Finish activities at Location 1

Teresa [signature] 2/9/18

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Teresa Fischer 5/15/2018

SHEET NO 1 OF 1

SOIL GAS PROBE MEASUREMENTS

Geosyntec consultants

(1) Project Name: C-400 Vapor Intrusion Study
Date: 02/9/2018
Project Number: KX6467/01
Site Location: Paducah Gaseous Diffusion Plant ; I
Weather: Clear & cold
Field Personnel: Teresa Fischer, Kris Henderson
Recorded By: Teresa Fischer

Probe No.: LOCATION 1
[X] Sub-slab probe [ ] Soil gas probe
Mini Rae 2000 Serial No.: NA
Lamp: 10.6 / 11.7 eV
Landtech GEM 2000 Landfill Gas Meter Serial No. M: KAO-399-3
MDG 2002 Helium detector Serial No.: 10702
Tracer Gas: [X] Helium [ ] Other

(2) Surface Type: [ ] Asphalt [X] Concrete [ ] Grass [ ] Other
Surface Thickness 18 3/4 inches/centimeters [ ] Unknown
(i.e., asphalt or concrete)

(3) 1 Casing Volume
[X] Sub-slab <0.1 L
Soil gas probe ______ (L)

(5) Field tubing blank reading (ppm$_v$) completed? [ ] Yes [X] No PID Reading NA ppm$_v$ *

(6) Shut in test prior to purging completed? Yes [✓] No [ ]

(7) Purging

Date	Start Time	End Time	Elapsed Time (min.)	Bag Volume (L)	Purge Rate (LPM)	TAP 4/26/2018 —	CH_4 (%)	CO_2 (%)	O_2 (%)	Tracer Gas Shroud (%) Min	Tracer Gas Shroud (%) Max	Tracer Gas Sample (ppm, %) (circle one)	VOCs by PID (ppm$_v$)
2/9/18	0931	0932	1	0.75	0.5	—	0.1	0.1	20.8	23.2	23.9	0	NA
2/9/18	0934	0935	1	0.75	0.6	—	0.1	0.1	20.8	24.7	~~23.~~ 25.9 TAP 2/9/18	0	NA
—	—	—	—	—	—	—	—	—	—	—	—	—	—
2/9/18	0937	0939	2	0.75	0.5	—	0.1	0.1	20.8	21.1	23.1	0	NA
—	—	—	—	—	—	—	—	—	—	—	—	—	—

(8) Helium concentration in field screened samples is less than 5% of minimum concentration in the shroud? [✓] Yes [ ] No
Note: 1% helium = 10,000 ppm$_v$

(9) Shut in test prior to sample collection completed? Yes [✓] No [ ]

(10) Sample Collection

Date	Time	Sample ID	Summa Canister ID	Flow Controller #	Vacuum Gauge #	Initial Vacuum (in. Hg)	Final Vacuum (in. Hg)
2/10/2018	1730	C400VI1SUBONOP-R	10560	11053	—	-29.6 (cert)	-6 (can)
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—

Comments: * PID not working properly

Teresa Fischer 5/15/2018 [signature] 5/15/2018

D3-81

Differential Pressure and Ambient Temperature Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/10/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
Gauge ID#: 42900-7-700
Weather: Cold & drizzle

Location ID: LOCATION # 1
Scenario Type: Fan On; Doors Open
Sample Start Time: 0722
Sample Initial Vacuum: -29.6" (certified)

Time	Differential Pressure (pa)		Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
	sub-slab/ambient	ambient/outside			
0722	0.1	-0.4	44	-30 (can)	Summa opened
0930	-1.4	6.4	40	-25	NA
1120	-0.9	-1.5	40	-21	NA
* 1321	2.4	-0.4	39	-16	NA
1423	1.7	-0.8	39	-10.5	NA
1736	1.7	-1.0	38	-6	NA
—	—	—	—	—	Sample ID C400VI1SUBDNDP-A

* Cross check differential pressure readings

Teresa Fischer 5/15/2018

[signature] 5/15/2018

D3-83

Indoor Air Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/10/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
SUMMA ID# and Regulator ID#: 11274/11511
Weather: Cold & drizzle

Location ID: 1
Scenario Type: Fan On; Doors Open
Sample Start Time: 0722
Sample Initial Vacuum: -29.4" (certified)

Time	Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
0722	44	-30 (can)	Summa opened
0930	40	-26.5	NA
1121	40	-22.5	NA
1321	39	-16.5	NA
1423	39	-11	NA
1730	38	-6 (can)	Summa Closed
—	—	—	Sample ID C400V11 INONOP-R

Teresa Fischer 5/15/2018

Kris Henderson 5/15/2018

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C-400 Vapor Intrusion Study
Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah
Deactivation Project

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study – Fan On; Doors Open LOCATION 2 TAF 2/9/18

LOCATION: PGDP PROJECT NO.: KX6467 TASK NO: 01/04

DESCRIPTION: VI Sampling DATE: 02/ 9 /2018

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Clear & cold

0805 Set up Helium Seal Check

- Sub-slab summa 09775; Flow controller 09842; -29.6" Hg certified.
- Indoor air summa 09546; Flow controller 10454; -29.6" Hg certified

0953 Start Helium Seal Check

- Passed check

1004 Complete set up at Location 2.

Teresa [signature] 2/9/18

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DFR_ One Page Teresa Fraction 5/15/2018 SHEET NO 1 OF 1

SOIL GAS PROBE MEASUREMENTS

Geosyntec consultants

① Project Name: C-400 Vapor Intrusion Study
Date: 02/ 9 /2018 Project Number: KX6467/01
Site Location: Paducah Gaseous Diffusion Plant ; 2
Weather: Clear & cold
Field Personnel: Teresa Fischer, Kris Henderson
Recorded By: T. Fischer

Probe No.: LOCATION 2 [X] Sub-slab probe [ ] Soil gas probe
Mini Rae 2000 Serial No.: NA Lamp: 10.6 / 11.7 eV
Landtech GEM 2000 Landfill Gas Meter Serial No. M: KAO - 399-3
MDG 2002 Helium detector Serial No.: 10702
Tracer Gas: [X] Helium [ ] Other

② Surface Type: [ ] Asphalt [X] Concrete [ ] Grass [ ] Other____
Surface Thickness 20 inches/centimeters [ ] Unknown
(i.e., asphalt or concrete)

③ 1 Casing Volume
[X] Sub-slab <0.1 L
Soil gas probe ______ (L)

⑤ Field tubing blank reading (ppm_v) completed? [ ] Yes [✓] No PID Reading NA ppm_v *

⑥ Shut in test prior to purging completed? Yes [✓] No [ ]

⑦ Purging

Date	Start Time	End Time	Elapsed Time (min.)	Bag Volume (L)	Purge Rate (LPM)	TAF 4/26/2018	CH_4 (%)	CO_2 (%)	O_2 (%)	Tracer Gas Shroud (%) Min	Tracer Gas Shroud (%) Max	Tracer Gas Sample (ppm_v, %) (circle one)	VOCs by PID (ppm_v)
2/9/18	0953	0954	1	0.75	0.5	—	0.1	0.1	20.9	21.2	25.8	0	NA
2/9/18	0956	0958	2	0.75	0.5	—	0.0	0.1	20.9	24.1	24.9	0	NA
2/9/18	1000	1002	2	0.75	0.5	—	0.1	0.1	21.0	21.7	22.8	0	NA
—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—

⑧ Helium concentration in field screened samples is less than 5% of minimum concentration in the shroud? [✓] Yes [ ] No **Note:** 1% helium = 10,000 ppm_v

⑨ Shut in test prior to sample collection completed? Yes [✓] No [ ]

⑩ Sample Collection

Date	Time	Sample ID	Summa Canister ID	Flow Controller #	Vacuum Gauge #	Initial Vacuum (in. Hg)	Final Vacuum (in. Hg)
2/10/2018	1734	C400VI2SUB0NOP-R	09775	09842	—	-29.6 (cert)	-6
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—

Comments: * PID not working properly

Teresa Fischer 5/15/2018 [signature] 5/15/2018

D3-85

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Differential Pressure and Ambient Temperature Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/10/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
Gauge ID#: 42990-7-700
Weather: Cold & drizzle

Location ID: LOCATION # 2
Scenario Type: Fan On; Doors Open
Sample Start Time: 0726
Sample Initial Vacuum: -29.6 " Hg (ccrt)

Time	Differential Pressure (pa)		Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
	sub-slab/ambient	ambient/outside			
0726	-0.2	0.3	40	- 30 (can)	Summa opened
0935	0.9	-13.8	-38	-26.5	NA
1124	-1.0	-0.8	36	-21	N/A
1325	-0.6	-0.4	37	-16	Windy
1427	0	1.2	38	-9	Windy
1734	0.21	3.0	36	-6	Windy
—	—	—	—	—	Sample ID C400 V12SUBONOP-R

Teresa Fischer 5/15/2018

Kris Henderson 5/15/2018

D3-87

Indoor Air Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/10/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
SUMMA ID# and Regulator ID#: 09546/10454
Weather: Cold & drizzle

Location ID: 2
Scenario Type: Fan On; Doors Open
Sample Start Time: 0726
Sample Initial Vacuum: -29.6" Hg (cert)

Time	Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
0726	40	-28 (con)	Summa opened
0935	38	-26	NA
1124	36	-22	NA
1325	37	-16.5	Windy
1427	38	-11	Windy
1734 ~~1654~~	36	-6	Summa Closed; Windy
TAF	2/10/18	—	Sample ID C400VI2INONOP-R

Teresa Fischer 5/15/2018

Kris Henderson 5/15/2018

Geosyntec consultants

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C-400 Vapor Intrusion Study
Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah
Deactivation Project

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study – Fan On; Doors Open LOCATION 3

LOCATION: PGDP PROJECT NO.: KX6467 TASK NO: 01/04

DESCRIPTION: VI Sampling DATE: 02/9 /2018

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Clear & cool

1156 Setup Helium Seal Check at Location 3
- Summa canister Indoor Air 09871; Flow Controller 11602;
  - 29.3" Hg (certified)

1254 Helium Seal Check complete.
- Location 3 does not pass test due to tight subsurface sediments (clay).
- Summa canister set up passed shut-in test
- Probe & seal intact; no leaks suspected.

1257 Complete activities at Location 3

Teresa 2/19/2018

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DFR_ One Page Teresa Procher 5/15/2018 SHEET NO 1 OF 1

SOIL GAS PROBE MEASUREMENTS

Geosyntec consultants

① Project Name: C-400 Vapor Intrusion Study
Date: 02/9/2018　Project Number: KX6467/01
Site Location: Paducah Gaseous Diffusion Plant ; 3
Weather: Clear & Cool
Field Personnel: Teresa Fischer, Kris Henderson
Recorded By: T. Fischer

Probe No.: LOCATION 3　[X] Sub-slab probe　[ ] Soil gas probe
Mini Rae 2000 Serial No.: NA　Lamp: 10.6 / 11.7 eV
Landtech GEM 2000 Landfill Gas Meter Serial No. M: KAO-399-3
MDG 2002 Helium detector Serial No.: 1070
Tracer Gas: [X] Helium [ ] Other

② Surface Type: [ ] Asphalt [X] Concrete [ ] Grass [ ] Other
Surface Thickness 19 1/4 inches/centimeters [ ] Unknown
(i.e., asphalt or concrete)

③ 1 Casing Volume
[X] Sub-slab <0.1 L
Soil gas probe ______ (L)

⑤ Field tubing blank reading (ppm_v) completed? [ ] Yes [X] No　PID Reading NA ppm_v*

D3-89

⑥ Shut in test prior to purging completed? Yes [X] No [ ]

⑦ Purging

Date	Start Time	End Time	Elapsed Time (min.)	Bag Volume (L)	Purge Rate (LPM)	TAP 4/26/2018	CH_4 (%)	CO_2 (%)	O_2 (%)	Tracer Gas: Shroud (%) Min	Tracer Gas: Shroud (%) Max	Tracer Gas: Sample (ppm_v, %) (circle one)	VOCs by PID (ppm_v)
2/9/2018	1205	1212	7	0.5	0.2	—	0.1	0.0	20.9	14.5	22.8	15,775ppm	NA
2/9/2018	1217	1224	7	0.5	0.2	—	0.1	0.0	20.1	14.3	23.0	2.1 %	NA
2/9/2018	1228	1235	7	0.5	0.2	—	0.1	0.0	20.6	14.7	24.9	19,575ppm	NA
2/9/2018	1240	1247	7	0.5	0.2	—	0.1	0.0	20.3	14.5	24.9	2.4 %	NA
—	—	—	—	—	—	—	—	—	—	—	—	—	—

⑧ Helium concentration in field screened samples is less than 5% of minimum concentration in the shroud? [X] Yes [ ] No　**Note:** 1% helium = 10,000 ppm_v

⑨ Shut in test prior to sample collection completed? Yes [X] No [ ]

⑩ Sample Collection

Date	Time	Sample ID	Summa Canister ID	Flow Controller #	Vacuum Gauge #	Initial Vacuum (in. Hg)	Final Vacuum (in. Hg)
2/10/2018	1757	C400VL3SDBONOP-R	11167	10621	—	-29.6 (cert)	-7
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—

Comments: * PID not working properly.

Teresa Fischer 5/15/2018　[signature] 5/15/2018

Differential Pressure and Ambient Temperature Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/10/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
Gauge ID#: 42990-7-700
Weather: Cold & drizzle

Location ID: LOCATION # 3
Scenario Type: Fan On; Doors Open
Sample Start Time: 0618
Sample Initial Vacuum: -29.6" Hg (cert)

Time	Differential Pressure (pa)		Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
	sub-slab/ambient	ambient/outside			
0618	0.0	-2.5	41	< -30	NA
0942	-1.0	~~0.0~~ 2.0 2/10/18	43	-24	closed 0942; opened 0952
1138	-4.9	-3.1	45	-20	closed 1138; opened 1149
1339	-2.7	-3.4	46	-17	closed 1339; opened 1346
1535	1.0	-2.7	45	-13	closed 1535: 1543
1757	-1.0	-5.9	46	-7	Summa closed
—	—	—	—	—	Sample ID C400V13SUB0NOP-R

Teresa Fischer 5/15/2018

Kris Henderson 5/15/2018

D3-90

Indoor Air Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/10/2018 Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
SUMMA ID# and Regulator ID#: 09871/11602
Weather: cold, cloudy

Location ID: 3
Scenario Type: Fan On; Doors Open
Sample Start Time: 0615
Sample Initial Vacuum: -29.3" Hg (Certified)

Time	Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
0615	41	-26	NA
0942	43	-19	NA
1138	45	-15	NA
1339	46	-10	NA
1537	45	-5	NA
1618	45	-3.5	~~NA~~ SUMMA closed
—	—	—	Sample ID ~~C400V13INOFOP-R~~

C400V13INONOP-R TAF 2/10/18

Teresa Fischer 5/15/2018

Kristoffer Henderson 5/15/2018

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C-400 Vapor Intrusion Study
Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah
Deactivation Project

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study – Fan On; Doors Open LOCATION 4

LOCATION: PG_ID PROJECT NO.: KX6467 TASK NO: 01/04

DESCRIPTION: VI Sampli ng DATE: 02/ 9 /2018

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Clear & Cold

0711 Set up Helium Seal Check
- Summa Canister for sub-slab → 10190; Flow Con 11600; -29.7" Hg
- Summa Canister for indoor air → 10979; Flow Controller 11477; Certified vacuum -29.6" Hg
- Concrete seal cracked; reseal.

0720 To be seal checked later

1008 Run Helium Seal Check
- Pass check

1025 Complete set up at Location 4

Teresa A F
2/9/2018

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DFR_ One Page Teresa Fischer 5/15/2018 SHEET NO 1 OF 1

SOIL GAS PROBE MEASUREMENTS

Geosyntec consultants

① Project Name: C-400 Vapor Intrusion Study
Date: 02/9 /2018 Project Number: KX6467/01
Site Location: Paducah Gaseous Diffusion Plant ; 4
Weather: Clear ; cold
Field Personnel: Teresa Fischer, Kris Henderson
Recorded By: T. Fischer

Probe No.: LOCATION 4 [X] Sub-slab probe [ ] Soil gas probe
Mini Rae 2000 Serial No.: NA Lamp: 10.6 / 11.7 eV
Landtech GEM 2000 Landfill Gas Meter Serial No. M: KAO - 399-3
MDG 2002 Helium detector Serial No.: 1020
Tracer Gas: [X] Helium [ ] Other

② Surface Type: [ ] Asphalt [X] Concrete [ ] Grass [ ] Other
Surface Thickness 15 1/2 inches/centimeters [ ] Unknown
(i.e., asphalt or concrete)

③ 1 Casing Volume
[X] Sub-slab <0.1 L
Soil gas probe ______ (L)

⑤ Field tubing blank reading (ppm$_v$) completed? [ ] Yes [X] No PID Reading NA ppm$_v$ *

⑥ Shut in test prior to purging completed? Yes [X] No [ ]

⑦ Purging

Date	Start Time	End Time	Elapsed Time (min.)	Bag Volume (L)	Purge Rate (LPM)	TMP 4/26/2018	CH_4 (%)	CO_2 (%)	O_2 (%)	Tracer Gas Shroud (%) Min	Tracer Gas Shroud (%) Max	Tracer Gas Sample (ppm$_v$ %) (circle one)	VOCs by PID (ppm$_v$)
2/9/18	1013	1016	3	0.75	0.5	—	0.1	0.1	21.1	21.2	22.7	0	NA
2/9/18	1018	1020	2	0.50	0.5	—	0.1	0.1	21.0	24.3	25.9	0	NA
2/9/18	1021	1023	2	0.50	0.5	—	0.1	0.1	21.0	22.3	23.1	0	NA
—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—

⑧ Helium concentration in field screened samples is less than 5% of minimum concentration in the shroud? [X] Yes [ ] No **Note:** 1% helium = 10,000 ppm$_v$

⑨ Shut in test prior to sample collection completed? Yes [X] No [ ]

⑩ Sample Collection

Date	Time	Sample ID	Summa Canister ID	Flow Controller #	Vacuum Gauge #	Initial Vacuum (in. Hg)	Final Vacuum (in. Hg)
2/10/2018	1714	C400VI4SUBONOP-R	10190	11600	—	-29.7 (cert)	-5
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—

Comments: *PID not working properly

Teresa Fischer 5/15/2018 [signature] 5/15/2018

D3-93

Differential Pressure and Ambient Temperature Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/10/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
Gauge ID#: 42990-7-706
Weather: Cold ; drizzle

Location ID: LOCATION # 4
Scenario Type: Fan On; Doors Open
Sample Start Time: 0709
Sample Initial Vacuum: -29.7" Hg (cert)

Time	Differential Pressure (pa)		Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
	sub-slab/ambient	ambient/outside			
0709	2.8	2.0	51	-29	Summa opened
0911	0.1.	-3.4	49	-24	NA
1108	1.2	-2.5	50	-19	NA
1310	2.3	-6.9	49	-13	NA
1413	1.6	-4.0	40	-10	NA
~~1614~~	2.0	-11.0	37	-5	Summa Closed ; Windy
1714	—	—	—	—	Sample ID: C400V14SUBONOP-12 ;

TAF
2/10/18

D3-94

Teresa Fischer 5/15/2018

Kris Henderson 5/15/2018

Indoor Air Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/10/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
SUMMA ID# and Regulator ID#: 10979/11477
Weather: Cold; drizzle

Location ID: 4
Scenario Type: Fan On; Doors Open
Sample Start Time: 0708
Sample Initial Vacuum: -29.6" Hg (certified)

Time	Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
0708	51	-30	Summa opened
0911	49	-26.5	NA
1108	50	-22	NA
1310	50	-17	NA
1513	44	-12	NA
1714	37	-8	NA; summa closed
—	—	—	Sample ID C400VI4INONOP-R

Teresa Fischer 5/15/2018

Kris Henderson 5/15/2018

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C-400 Vapor Intrusion Study
Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah
Deactivation Project

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study – Fan On; Doors Open LOCATION 5

LOCATION: PGDP PROJECT NO.: KX6467 TASK NO: 01/04

DESCRIPTION: VI Sampling DATE: 02/9 /2018

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Clear & Cold

0726 Set up Helium Seal Check
- Subslab summa canister 09998; Flow controller 11238; -29.1" Hg certified
- Indoor air summa → 11214; Flow con. 10457; -29.6" Hg certified
- Indoor air summa duplicate → 11081; Flow con. 11420; -29.6" Hg certified

0818 Run Helium Seal Check
- Helium seal check passed

0855 Location 5 set up complete

Teresa A. Frazier 2/9/2018

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DFR_ One Page Teresa Frazier 5/15/2018 SHEET NO 1 OF 1

SOIL GAS PROBE MEASUREMENTS

Geosyntec consultants

① Project Name: C-400 Vapor Intrusion Study
Date: 02/9/2018 Project Number: KX6467/01
Site Location: Paducah Gaseous Diffusion Plant ; 5
Weather: Clear & Cold
Field Personnel: Teresa Fischer, Kris Henderson
Recorded By: T. Fischer

Probe No.: LOCATION 5 [X] Sub-slab probe [ ] Soil gas probe
Mini Rae 2000 Serial No.: NA Lamp: 10.6 / 11.7 eV
Landtech GEM 2000 Landfill Gas Meter Serial No. M: KAO - 399-3
MDG 2002 Helium detector Serial No.: 10702
Tracer Gas: [X] Helium [ ] Other

② Surface Type: [ ] Asphalt [X] Concrete [ ] Grass [ ] Other____
Surface Thickness (i.e., asphalt or concrete): 20 1/2 inches/centimeters [ ] Unknown

③ 1 Casing Volume
[X] Sub-slab <0.1 L
Soil gas probe ______ (L)

⑤ Field tubing blank reading (ppm_v) completed? [ ] Yes [✓] No PID Reading NA ppm_v *

⑥ Shut in test prior to purging completed? Yes [✓] No [ ]

⑦ Purging

Date	Start Time	End Time	Elapsed Time (min.)	Bag Volume (L)	Purge Rate (LPM)	TAP 4/24/2018	CH_4 (%)	CO_2 (%)	O_2 (%)	Tracer Gas Shroud (%) Min	Tracer Gas Shroud (%) Max	Tracer Gas Sample (ppm_v, %) (circle one)	VOCs by PID (ppm_v)
2/9/18	0820	0824	4	0.75	0.5	—	0	0.1	20.9	17.3	23	2.9	NA
2/9/18	0833	0836	3	0.75	0.4	—	0.1	0.1	20.8	23.5	25.9	17,250	NA
2/9/18	0839	0842	3	0.75	0.35	—	0.1	0.1	20.9	23.1	26.9	16,925	NA
2/9/18	0948	0851	3	0.75	0.35	—	0.1	0.1	20.8	17.0	21.1	17,000	NA
—	—	—	—	—	—	—	—	—	—	—	—	—	—

⑧ Helium concentration in field screened samples is less than 5% of minimum concentration in the shroud? [✓] Yes [ ] No **Note:** 1% helium = 10,000 ppm_v

⑨ Shut in test prior to sample collection completed? Yes [✓] No [ ]

⑩ Sample Collection 2/10/18

Date	Time	Sample ID	Summa Canister ID	Flow Controller #	Vacuum Gauge #	Initial Vacuum (in. Hg)	Final Vacuum (in. Hg)
1722	2/10/18	C400VISSOBONOP-R	09998	11238	NA	-29.1 cert	-5
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—

Comments: * PID not working properly.

Teresa Fischer 5/15/2018 Kris Henderson 5/15/2018

D3-97

Differential Pressure and Ambient Temperature Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/10/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
Gauge ID#: 42990-7-700
Weather: Cold & drizzle

Location ID: LOCATION # 5
Scenario Type: Fan On; Doors Open
Sample Start Time: 0716
Sample Initial Vacuum: -29.1 " Hg (certified)

Time	Differential Pressure (pa)		Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
	sub-slab/ambient	ambient/outside			
0716	-0.5	0.1	44	-28	Summa opened
0918	-2.4	0.2	41	-24	NA
1114	-0.4	0.0	41	-19	NA
1317	-1.7	2.2	40	-14	NA
1419	-1.6	1.0	41	-10	NA
1722	0.9	1.2	38	-5	Summa closed
—	—	—	—	—	Sample ID C400V15SUB0N0P-R

Teresa Fischer 5/15/2018

Kris Henderson 5/15/2018

Indoor Air Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/ 10/2018 Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
SUMMA ID# and Regulator ID#: 11214 | 10457
Weather: Cold & drizzle
Duplicate 11081 | 11420

Location ID: S
Scenario Type: Fan On; Doors Open
Sample Start Time: 0716
Sample Initial Vacuum: -29.6" Hg & -29.6" Hg (Dup) (Certified)

Time	Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg) Dup	Summa Can Vacuum (in Hg) R	Comments
0716	44	-28	-30	Summas opened
0915	43	-24	-26	NA
1114	41	-22	-19	NA
1314	40	-15.5	-17	NA
1519	41	-9	-13	NA
1722	38	-8	-4	Summas closed
—	—	—	—	Sample ID C400VISINONOP-RD

C400VIS INONOP-R

Teresa Fischer 5/15/2018

Kris Henderson 5/15/2018

D3-99

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C-400 Vapor Intrusion Study
Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah
Deactivation Project

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study – Fan On; Doors Open LOCATION 6

LOCATION: PGDP PROJECT NO.: KX6467 TASK NO: 01/04

DESCRIPTION: VI Sampling DATE: 02/9 /2018

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Clear & cool

1122 Set up Helium Seal Check
- Summa Canister Indoor Air 10575; Flow Controller 10153; -29.3" Hg (certified)
- Summa Canister Indoor Air Dup. 10114; Flow Controller 10437; -29.2" Hg (certified)
- Summa Canister sub-slab 11042; Flow Controller 11595; -29.6" Hg (certified)

1145 Set up complete. Seal check passed.

Teresa A. Fischer
2/9/2018

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DFR_ One Page

Teresa Fischer 5/15/2018

SHEET NO 1 OF 1

SOIL GAS PROBE MEASUREMENTS

Geosyntec consultants

① Project Name: C-400 Vapor Intrusion Study
Date: 02/9/2018 Project Number: KX6467/01
Site Location: Paducah Gaseous Diffusion Plant ; 6
Weather: Clear & cool
Field Personnel: Teresa Fischer, Kris Henderson
Recorded By: T. Fischer

Probe No.: LOCATION 6 [X] Sub-slab probe [ ] Soil gas probe
Mini Rae 2000 Serial No.: NA Lamp: 10.6 / 11.7 eV
Landtech GEM 2000 Landfill Gas Meter Serial No. M: KAO-399-3
MDG 2002 Helium detector Serial No.: 10702
Tracer Gas: [X] Helium [ ] Other

② Surface Type: [ ] Asphalt [X] Concrete [ ] Grass [ ] Other
Surface Thickness (i.e., asphalt or concrete) 8 inches centimeters [ ] Unknown

③ 1 Casing Volume
[X] Sub-slab <0.1 L
Soil gas probe ____ (L)

⑤ Field tubing blank reading (ppm$_v$) completed? [ ] Yes [✓] No PID Reading 0 ppm$_v$ *

⑥ Shut in test prior to purging completed? Yes [✓] No [ ]

D3-101

⑦ Purging

Date	Start Time	End Time	Elapsed Time (min.)	Bag Volume (L)	Purge Rate (LPM)	TPD 1/24/2018 —	CH_4 (%)	CO_2 (%)	O_2 (%)	Tracer Gas Shroud (%) Min	Tracer Gas Shroud (%) Max	Tracer Gas Sample (ppm, %) (circle one)	VOCs by PID (ppm$_v$)
2/9/2018	1129	1130	1	0.75	0.55	—	0.1	0.1	20.5	22.4	31.4	0	NA
2/9/2018	1132	1134	2	0.75	0.5	—	0.1	0.1	20.6	23.6	26.1	0	NA
2/9/2018	1136	1139	3	0.75	0.4	—	0.1	0.1	20.6	18.2	23.5	0	NA
—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—

⑧ Helium concentration in field screened samples is less than 5% of minimum concentration in the shroud? [✓] Yes [ ] No **Note:** 1% helium = 10,000 ppm$_v$

⑨ Shut in test prior to sample collection completed? Yes [✓] No [ ]

⑩ Sample Collection

Date	Time	Sample ID	Summa Canister ID	Flow Controller #	Vacuum Gauge #	Initial Vacuum (in. Hg)	Final Vacuum (in. Hg)
2/10/18	1636	C400VI6SUB000P-R	11042	11595	—	-29.6	-6
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—

Comments: * PID not working properly

Teresa Fischer 5/15/2018 [signature] 5/15/2018

D3-102

Differential Pressure and Ambient Temperature Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/10/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
Gauge ID#: 42990-7-700
Weather: cold; cloudy

Location ID: LOCATION # 6
Scenario Type: Fan On; Doors Open
Sample Start Time: 0636
Sample Initial Vacuum: -29.6" Hg (certified)

Time	Differential Pressure (pa)		Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
	sub-slab/ambient	ambient/outside			
0636	0.0	-0.5	62	-28	Summa opened
0834	0.0	-0.1	63	-24	NA
1034	-0.1	-0.2	59	-21	NA
1235	0.0	0.3	70	-16	NA
1434	0.1	0.2	69	-11	NA
1636	0.1	-0.1	63	-6	Summa closed
—	—	—	—	—	Sample ID C400VI6SUBONOP-R

Teresa Fischer 5/15/2018

Kris Henderson 5/15/2018

D3-103

Indoor Air Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/ 10/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
SUMMA ID# and Regulator ID#: 10575 / 10153
Weather: Cold; drizzle
Duplicate 10114 / 10437

Location ID: 6
Scenario Type: Fan On; Doors Open
Sample Start Time: 0636
Sample Initial Vacuum: -29.3" Hg & -29.2" Hg (Dup) (Certified)

Time	Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg) R	Summa Can Vacuum (in Hg) D	Comments
0636	62	-28	-30	Summas opened
0834	63	-24	-26	NA
1034	60	-20	-21	NA
1235	70	-15	-17	NA
1434	69	-11	-13	NA
1636	63	-7	-7	Summas closed
—	—	—		Sample ID C400VI6INONOP-R C400VI6INONOP-RD

Teresa Fischer 5/15/2018

Kris Henderson 5/15/2018

Geosyntec consultants

engineers | scientists | innovators

C-400 Vapor Intrusion Study
Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah
Deactivation Project

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study – Fan On; Doors Open LOCATION 7

LOCATION: PGDP PROJECT NO.: KX6467 TASK NO: 01/04

DESCRIPTION: VI Sampling DATE: 02/9/2018

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Clear & cold

0746 Set up Helium Seal check
- Regrout due to cracked seal.
-Indoor air summa 09819; Flow controller K294; -29.6" Hg
certified.
-Sub-slab summa 10566; Flow controller 10633; -29.6" Hg
certified
- Return for check later
0908 Set helium seal check.
0921 Helium seal check passed.

Teresa [signature] 2/9/2018

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DFR_ One Page Teresa Fischer 5/15/2018 SHEET NO 1 OF 1

SOIL GAS PROBE MEASUREMENTS

Geosyntec consultants

① Project Name: C-400 Vapor Intrusion Study
Date: 02/9/2018 Project Number: KX6467/01
Site Location: Paducah Gaseous Diffusion Plant 7
Weather: Clear cold
Field Personnel: Teresa Fischer, Kris Henderson
Recorded By: T. Fischer

Probe No.: LOCATION 7 [X] Sub-slab probe [ ] Soil gas probe
Mini Rae 2000 Serial No.: NA Lamp: 10.6 / 11.7 eV
Landtech GEM 2000 Landfill Gas Meter Serial No. M: KAO-399-3
MDG 2002 Helium detector Serial No.: 10702
Tracer Gas: [X] Helium [ ] Other

② Surface Type: [ ] Asphalt [X] Concrete [ ] Grass [ ] Other____
Surface Thickness 20 1/4 inches/centimeters [ ] Unknown
(i.e., asphalt or concrete)

③ 1 Casing Volume
[X] Sub-slab <0.1 L
Soil gas probe ________ (L)

⑤ Field tubing blank reading (ppm$_v$) completed? [ ] Yes [✓] No PID Reading NA ppm$_v$ *

⑥ Shut in test prior to purging completed? Yes [✓] No [ ]

D3-105

⑦ Purging

Date	Start Time	End Time	Elapsed Time (min.)	Bag Volume (L)	Purge Rate (LPM)	TAF 4/26/2018 —	CH_4 (%)	CO_2 (%)	O_2 (%)	Tracer Gas Shroud (%) Min	Tracer Gas Shroud (%) Max	Tracer Gas Sample (ppm$_v$, %) (circle one)	VOCs by PID (ppm$_v$)
2/9/18 ~~0909~~ TAF 2/9/18	0909	0911	3	0.75	0.5	—	0	0.1	20.8	11.0	23.9	25	NA
2/9/18	0914	0917	3	0.75	0.5	—	0	0.1	20.7	24.4	42.0	0	NA
2/9/18	0918	0919	1	0.75	0.5	—	0	0.1	20.8	19.2	34.1	0	NA
—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—

⑧ Helium concentration in field screened samples is less than 5% of minimum concentration in the shroud? [✓] Yes [ ] No **Note:** 1% helium = 10,000 ppm$_v$

⑨ Shut in test prior to sample collection completed? Yes [✓] No [ ]

⑩ Sample Collection

Date	Time	Sample ID	Summa Canister ID	Flow Controller #	Vacuum Gauge #	Initial Vacuum (in. Hg)	Final Vacuum (in. Hg)
2/10/18	1718	C400VI7SUBONOP-R	10566	10633	—	-29.6 (cert)	-5
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—

Comments: * PID Meter not working

Teresa Fischer 5/15/2018 [signature] 5/15/18

Differential Pressure and Ambient Temperature Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/10/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
Gauge ID#: 42990-7-700
Weather: Cold & drizzle

Location ID: LOCATION # 7
Scenario Type: Fan On; Doors Open
Sample Start Time: 0714
Sample Initial Vacuum: -29.6" Hg cert

Time	Differential Pressure (pa)		Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
	sub-slab/ambient	ambient/outside			
0714	1.0	0.2	44	-30	Summa opened
0915	-1.1	1.7	44	-26	NA
1112	0.3	0.3	41	-22	NA
1314	1.9	0.7	40	~~-15.5~~ -15.5 TAF 2/10/18	
~~1416~~ 1516 TAF 2/10/18	0.7	1.1	41	-10	NA
1718	0.13	1.8	38	-5	Summa Closed
—	—	—	—	—	Sample ID C400VI7FNONOP-R

D3-106

Teresa Fischer 5/15/2018

Kris Henderson 5/15/2018

Indoor Air Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/ 10 /2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
SUMMA ID# and Regulator ID#: 09819 / K294
Weather: Cold & drizzle

Location ID: 7
Scenario Type: Fan On; Doors Open
Sample Start Time: 0712
Sample Initial Vacuum: -29.6" Hg (cert)

Time	Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
0712	44	-29	Summa opened
0915	44	-24	NA
1111	41	-18	NA
1314	40	-13.5	NA
1416	41	-8	NA
1718	38	-3	Summa closed
—	—	—	Sample ID C400VI7INONOP-R

Teresa Fischer 5/15/2018

Kris Henderson 5/15/2018

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C-400 Vapor Intrusion Study
Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah
Deactivation Project

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study – Fan On; Doors Open LOCATION 8

LOCATION: PGDP PROJECT NO.: KX6467 TASK NO: 01/04

DESCRIPTION: VI Sampling DATE: 02/9 /2018 & 2/10/18

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Clear & cool

2/9/18 1118 Set up summa canister at Location 8
- Summa canister 11302; Flow controller 09905; -29.6" Hg (certified).

2/10/18 0631 Started SUMMA sampling at location 8
canister reading -30.0 "Hg
- Purge lines 3 times prior to opening summa

Teresa F 2/10/18

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DFR_ One Page Teresa Fischer 5/15/2018 SHEET NO 1 OF 1

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Differential Pressure and Ambient Temperature Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/10/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
Gauge ID#: 42990-7-700
Weather: cold; cloudy

Location ID: LOCATION 8
Scenario Type: Fan On; Doors Open
Sample Start Time: 0631
Sample Initial Vacuum: -29.6" Hg (certified)

Time	Differential Pressure (pa) Exhaust Fan to Ambient	Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
0631	0.6	52	-30.0	Summa opened
0828	-0.2	55	-26.0	NA
1029	2.0	50	-22.0	NA
1231	KFH 2-10-18 ~~+0.6~~ 0.6	68	-16	NA
1431	0.4	63	-12	NA
1631	0.2	63	-6	Summa closed
—	—	—	—	Sample ID C400VI8EXHONOP-R

Teresa Fischer 5/15/2018

Kris Henderson 5/15/2018

INSTRUMENT CALIBRATION REPORT

Pine Environmental Services LLC

10521 Research Drive
Suite 102
Knoxville, TN 37932
Toll-free: (877) 355-7907

Pine Environmental Services, Inc.

Instrument ID 20904
Description MIniRae 3000
Calibrated 1/24/2018 9:40:26AM

Manufacturer	Rae Systems	**State Certified**	
Model Number	MiniRAE 3000	**Status**	Pass
Serial Number/ Lot Number	592-909072	**Temp °C**	21
Location	Tennessee	**Humidity %**	22
Department			

Calibration Specifications

Group #	1	**Range Acc %**	0.0000
Group Name	ISOBUTYLENE	**Reading Acc %**	3.0000
Stated Accy	Pct of Reading	**Plus/Minus**	0.00

Nom In Val / In Val	In Type	Out Val	Out Type	Fnd As	Lft As	Dev%	Pass/Fail
100.00 / 100.00	PPM	100.00	PPM	100.00	100.00	0.00%	Pass

Test Instruments Used During the Calibration **(As Of Cal Entry Date)**

Test Standard ID	Description	Manufacturer	Model Number	Serial Number / Lot Number	Last Cal Date/ Opened Date	Next Cal Date / Expiration Date
TN 100PPM ISO DAQ-248-100-19	TN 100PPM ISO	Calgaz	34LS-248-100	DAQ-248-100-19		3/28/2020

Notes about this calibration

Calibration Result Calibration Successful
Who Calibrated Derek Farmer

All instruments are calibrated by Pine Environmental Services LLC according to the manufacturer's specifications, but it is the customer's responsibility to calibrate and maintain this unit in accordance with the manufacturer's specifications and/or the customer's own specific needs.

Notify Pine Environmental Services LLC of any defect within 24 hours of receipt of equipment
Please call 800-301-9663 for Technical Assistance

Teresa Fischer 5/15/2018

INSTRUMENT QC/ PACKING LIST

Description	RAE Systems MiniRAE 3000
Instrument ID	20904
Date Calibrated	1-24-18

PINE
www.pine-environmental.com

Standard Items	Prepared	QC check	Received by customer	Returned to Pine
MiniRAE 3000 w/ ______eV lamp and carry case	✓	✓	✓	
Protective rubber boot	✓	✓	✓	
Manual	✓	✓	✓	
Quick reference card	✓	✓	✓	
Probe tip	✓	✓	✓	
Charger/ adapter, or charger and cradle	✓	✓	✓	
(2) Hydrophobic filters	✓	✓	✓	
Alkaline battery adapter	✓	✓	✓	
(4) AA Alkaline batteries	✓	✓	✓	
ProCal calibration sheet	✓	✓	✓	

4/26/2018

TAP

Supporting Items

Supporting Items	Prepared	QC check	Received by customer	Returned to Pine
100 ppm isobutylene calibration gas				
100 ppm Isobutylene SDS				
✓ *Must match cylinder with setup*				
Gas regulator				
Tedlar bag				
Datalogging software				
Communications cable				

Prepared by: JM
QC checked by: [signature]
Date: 1/24

This packing list is to ensure that every item needed to operate the unit was sent and received. Upon receiving a shipment, please fill out the "Received by customer" column. Call Pine within 24 hours of receiving the equipment if any pieces are missing, damaged, or malfunctioning. Thank you for choosing Pine Environmental Services LLC

[signature] 5/15/2018

INSTRUMENT CALIBRATION REPORT

Pine Environmental Services LLC

10521 Research Drive
Suite 102
Knoxville, TN 37932
Toll-free: (877) 355-7907

Pine Environmental Services, Inc.

Instrument ID 12483
Description Landtec GEM-2000
Calibrated 1/24/2018 1:20:52PM

Manufacturer	CES Landtec	**State Certified**	
Model Number	GEM2000	**Status**	Pass
Serial Number/ Lot Number	GM07658	**Temp °C**	21
Location	Tennessee	**Humidity %**	22
Department			

Calibration Specifications

Group # 1 **Range Acc %** 0.0000
Group Name Methane **Reading Acc %** 3.0000
Stated Accy Pct of Reading **Plus/Minus** 0.0

Nom In Val / In Val	In Type	Out Val	Out Type	Fnd As	Lft As	Dev%	Pass/Fail
50.0 / 50.0	%Volume	50.0	%Volume	50.0	50.0	0.00%	Pass

Group # 2 **Range Acc %** 0.0000
Group Name Carbon Dioxide **Reading Acc %** 3.0000
Stated Accy Pct of Reading **Plus/Minus** 0.0

Nom In Val / In Val	In Type	Out Val	Out Type	Fnd As	Lft As	Dev%	Pass/Fail
35.0 / 35.0	%Volume	35.0	%Volume	35.0	35.0	0.00%	Pass

Group # 3 **Range Acc %** 0.0000
Group Name Oxygen **Reading Acc %** 3.0000
Stated Accy Pct of Reading **Plus/Minus** 0.0

Nom In Val / In Val	In Type	Out Val	Out Type	Fnd As	Lft As	Dev%	Pass/Fail
20.9 / 20.9	%Volume	20.9	%Volume	20.9	20.9	0.00%	Pass

Test Instruments Used During the Calibration **(As Of Cal Entry Date)**

Test Standard ID	Description	Manufacturer	Model Number	Serial Number / Lot Number	Next Cal Date / Last Cal Date/ Expiration Date Opened Date
TN 50 CH4/35 CO2 17LX	TX 50 CH4/35 CO2 17L HAM-399-2	Liquid Technology	GP12116	KAO-399-3	10/31/2018

Notes about this calibration

Calibration Result Calibration Successful
Who Calibrated Derek Farmer

Teresa Fischer 5/15/2018

INSTRUMENT QC/ PACKING LIST

Description	Landtec GEM-2000
Instrument ID	12483
Date Calibrated	1-24-18

PINE
www.pine-environmental.com

Standard Items	**Prepared**	**QC check**	**Received by customer**	**Returned to Pine**
GEM-2000 w/ hard case	✓	✓	✓	
Fabric carry case	✓	✓	✓	
Manual	✓	✓	✓	
Quick reference card	✓	✓	✓	
Charger, AC cord (if applicable)	✓	✓	✓	
(2) 4' lengths of sample tubing w/ filter, housing, and 4 male quick connects			TAF 4/26/2018	
(2) Extra hydrophobic filters	✓	✓	✓	
(2) extra male quick connects				
Comm. Cable and data logging software	✓	✓	✓	
Case insert warning			✓	
ProCal calibration sheet	✓	✓	✓	

4/26/2018 TAF

4/26/2018 TAF

Supporting Items

CH_4 and CO_2 calibration gas mix				
CH_4 and CO_2 calibration gas SDS ✓ *Must match cylinder with setup*				
4% Oxygen, balance N_2 gas mix				
4% Oxygen, balance N_2 gas SDS ✓ *Must match cylinder with setup*				
Gas regulator, female (.25 or .5 lpm)				
Gas regulator, male (.25 or .5 lpm)				
Calibration tubing (6" tubing w/ male quick connect)				
Temperature probe				

Prepared by: JM
QC checked by: DH
Date: 1/24

This packing list is to ensure that every item needed to operate the unit was sent and received. Upon receiving a shipment, please fill out the "Received by customer" column. Call Pine within 24 hours of receiving the equipment if any pieces are missing, damaged, or malfunctioning. Thank you for choosing Pine Environmental Services LLC

Teresa Fischer 5/15/2018

INSTRUMENT CALIBRATION REPORT

Pine Environmental Services LLC

4037 Darling Court
Lilburn, GA 30047
Toll-free: (800) 842-1088

Pine Environmental Services, Inc.

Instrument ID 10702
Description Radiodetection MGD-2002 Multi-Gas Leak Locator
Calibrated 1/23/2018 5:35:20PM

Manufacturer	Radiodetection	**State Certified**	
Model Number	MGD-2002	**Status**	Pass
Serial Number/ Lot Number	040951	**Temp °C**	21
Location	Georgia	**Humidity %**	34
Department			

Calibration Specifications

Group # 1
Group Name Zero to 99.999%
Test Performed: Yes **As Found Result: Pass** **As Left Result: Pass**

Test Instruments Used During the Calibration **(As Of Cal Entry Date)**

Test Standard ID	Description	Manufacturer	Model Number	Serial Number / Lot Number	Next Cal Date / Last Cal Date/ Expiration Date Opened Date

Notes about this calibration

Calibration Result Calibration Successful
Who Calibrated Jeff Rasmussen

All instruments are calibrated by Pine Environmental Services LLC according to the manufacturer's specifications, but it is the customer's responsibility to calibrate and maintain this unit in accordance with the manufacturer's specifications and/or the customer's own specific needs.

Notify Pine Environmental Services LLC of any defect within 24 hours of receipt of equipment
Please call 800-301-9663 for Technical Assistance

Teresa Fischer 5/15/2018

INSTRUMENT QC/ PACKING LIST

Description	Dielectric MGD-2002
Instrument ID	10702
Date Prepared	1-23-18

PINE
www.pine-environmental.com

Standard Items	**Prepared**	**QC check**	**Received by customer**	**Returned to Pine**
MGD-2002 and carry case	✓	✓	✓	
Manual	✓	✓	✓	
Quick reference card	✓	✓	✓	
Charger	✓	✓	✓	
12VDC auto plug adapter	✓	✓	✓	
Needle probe	✓	✓	✓	
Ground probe	✓	✓	✓	
Handle assembly with moisture filter cartridge	✓	✓	✓	
Extra moisture filter cartridge	✓	✓	✓	
Drying adapter for cartridges	✓	✓	✓	
Carry strap	✓	✓	✓	
ProCal inspection report	✓	✓	✓	

4/26/2018

TAF

Prepared by: JR
QC checked by: SB
Date: 1/23/18

This packing list is to ensure that every item needed to operate the unit was sent and received. Upon receiving a shipment, please fill out the "Received by customer" column. Call Pine within 24 hours of receiving the equipment if any pieces are missing, damaged, or malfunctioning. Thank you for choosing Pine Environmental Services LLC.

Theresa Fischer 5/15/2018

INSTRUMENT CALIBRATION REPORT

Advanced Labs, Inc.

Pine Environmental Services, Inc

Instrument ID 39207
Description TSI 8330 VelociCheck
Calibrated 9/27/2017

Manufacturer	TSI	**Classification**	
Model Number	8330	**Status**	pass
Serial Number	96060227	**Frequency**	Yearly
Location	New Jersey	**Department**	Lab
Temp	76	**Humidity**	33

Calibration Specifications

Group # 1
Group Name Temperature
Stated Accy Plus / Minus
Range Acc % 0.0000
Reading Acc % 0.0000
Plus/Minus 5.00

Nom In Val / In Val	In Type	Out Val	Out Type	Fnd As	Lft As	Dev%	Pass/Fail
70.00 / 75.60	°F	75.60	°F	76.00	76.00	0.53%	Pass

Group # 2
Group Name Velocity
Stated Accy Pct of Reading
Range Acc % 0.0000
Reading Acc % 5.0000
Plus/Minus 0.00

Nom In Val / In Val	In Type	Out Val	Out Type	Fnd As	Lft As	Dev%	Pass/Fail
0.00 / 0.00	ft/min	0.00	ft/min	0.00	0.00	0.00%	Pass
40.00 / 40.00	ft/min	40.00	ft/min	40.00	40.00	0.00%	Pass
70.00 / 70.00	ft/min	70.00	ft/min	70.00	70.00	0.00%	Pass
100.00 / 100.00	ft/min	100.00	ft/min	103.00	103.00	3.00%	Pass
150.00 / 150.00	ft/min	150.00	ft/min	153.00	153.00	2.00%	Pass
325.00 / 325.00	ft/min	325.00	ft/min	330.00	330.00	1.54%	Pass
700.00 / 700.00	ft/min	700.00	ft/min	700.00	700.00	0.00%	Pass
1000.00 / 1000.00	ft/min	1000.00	ft/min	990.00	990.00	-1.00%	Pass
1500.00 / 1500.00	ft/min	1500.00	ft/min	1,490.00	1,490.00	-0.67%	Pass
2000.00 / 2000.00	ft/min	2000.00	ft/min	2,000.00	2,000.00	0.00%	Pass

Test Instruments Used During the Calibration

Test Instrument ID	Description	Manufacturer	Serial Number	Last Cal Date (As Of Cal Entry Date)	Next Cal Date (As Of Cal Entry Date)
MICHELL DM-509-TX-01	Relative Humidity Meter	Michell	273296	8/25/2017	8/25/2018
OMEGA HX93AC/DP25-E	Omega HX93AC/DP25-E	Omega Engineering	1010368 035025 035026	9/15/2016	9/15/2018
OMEGA PX02K1-16A5T /DP25-E-A	Omega PX02K1-16A5T/DP25-E-A	Omega Engineering	168377/8375030	9/15/2016	9/15/2018
OMEGA WT4401-D	Omega WT4401-D	Omega Engineering	101105	9/15/2016	9/15/2018

Teresa Fischer 5/15/2018

INSTRUMENT CALIBRATION REPORT

Advanced Labs, Inc.

Pine Environmental Services, Inc

Instrument ID	39207
Description	TSI 8330 VelociCheck
Calibrated	9/27/2017

Notes about this calibration

Calibration Result	Calibration Successful
Who Calibrated	David Galego

Advanced Labs, Inc. hereby certifies that this instrument is calibrated and functions to meet the manufacture's specifications using NIST traceable standards, or is derived from accepted values of physical constants.

Teresa Fischer 5/15/2018

Geosyntec consultants

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C-400 Vapor Intrusion Study
Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah
Deactivation Project

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study – Fan On; Doors Closed

LOCATION: PGDP PROJECT NO.: KX6467 TASK NO: 01/04

DESCRIPTION: VI Sampling DATE: 02/11/2018

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Cold; Rain

0645 Assemble at C-730-TOS
-Jason Boulton, Brandon Taylor, Teresa Fischer, Kris Henderson
- Mobilize to Limited Area; C400
0700 Arrive at C400
- Set equipment within clean area of C-400.
- Assemble summa canisters
0745 Don PPE to set summas at Locations 1, 2, 4, 5, & 7
- Set up summas at each location within CA; Helium Seal Check conducted on 2/9/2018. Only a shut in test to verify each sub-slab summa canister is holding vacuum to be conducted.
0845 Doff PPE after completing activities within CA.
0905 Set summas up at Locations 3, 6, & 8. Conduct shut in test at Locations 6 & 3
0930 All sub-slab summas pass shut-in test.
- See individual Location forms for details
1000 Field activities complete. Leave CA.

Teresa F
2/11/18

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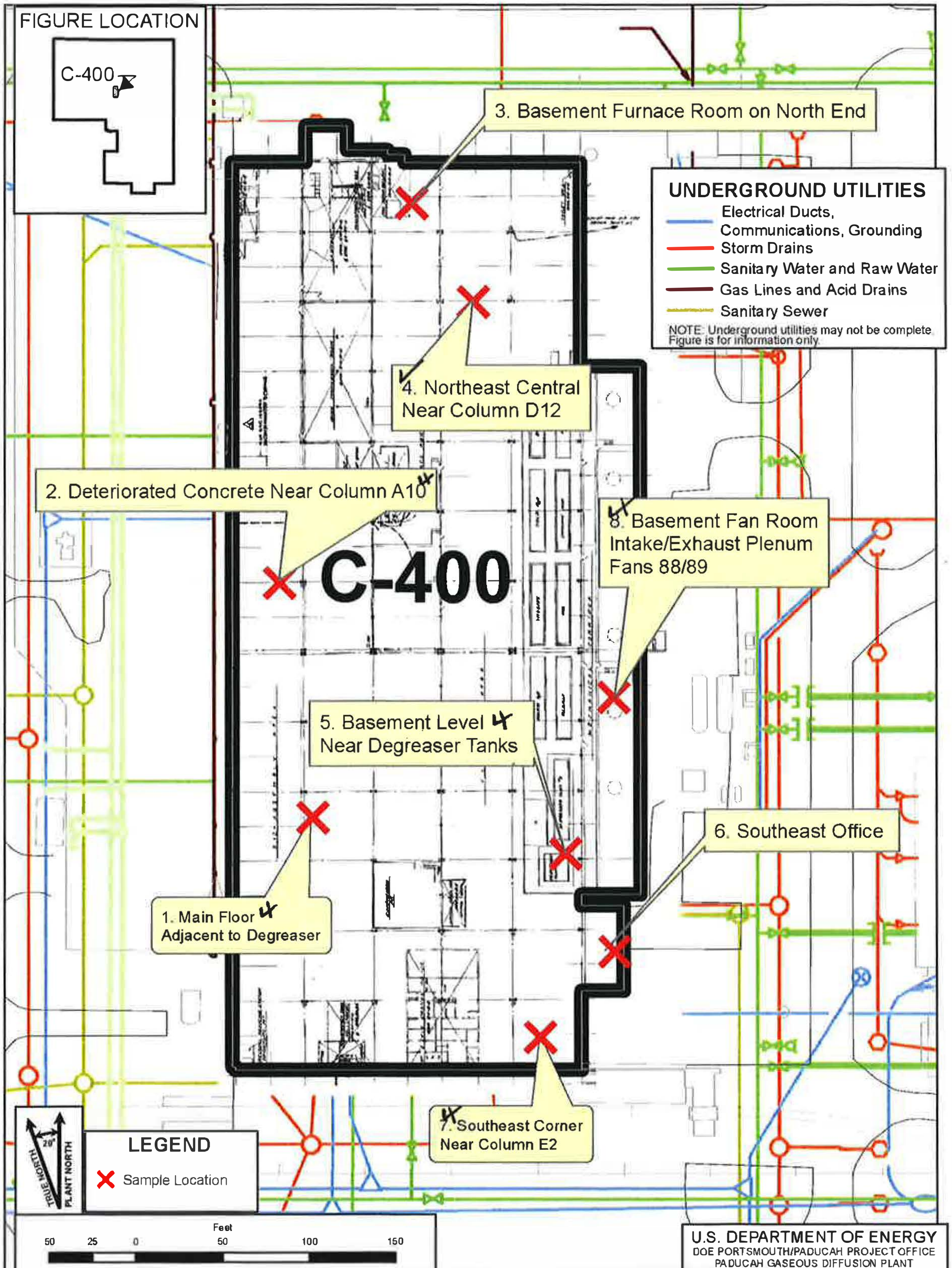


Figure 12. Indoor Sampling Locations for C-400 Building Vapor Intrusion Study

FLUOR

G:\GIS\ARCVIEWS\PROJECTS\Vapor Intrusion\MOA 400\Figure 12 C-400 Map (with Approximate Sampling Locations for VI).mxd
7/25/2017

Turan Fischer 5/15/2018

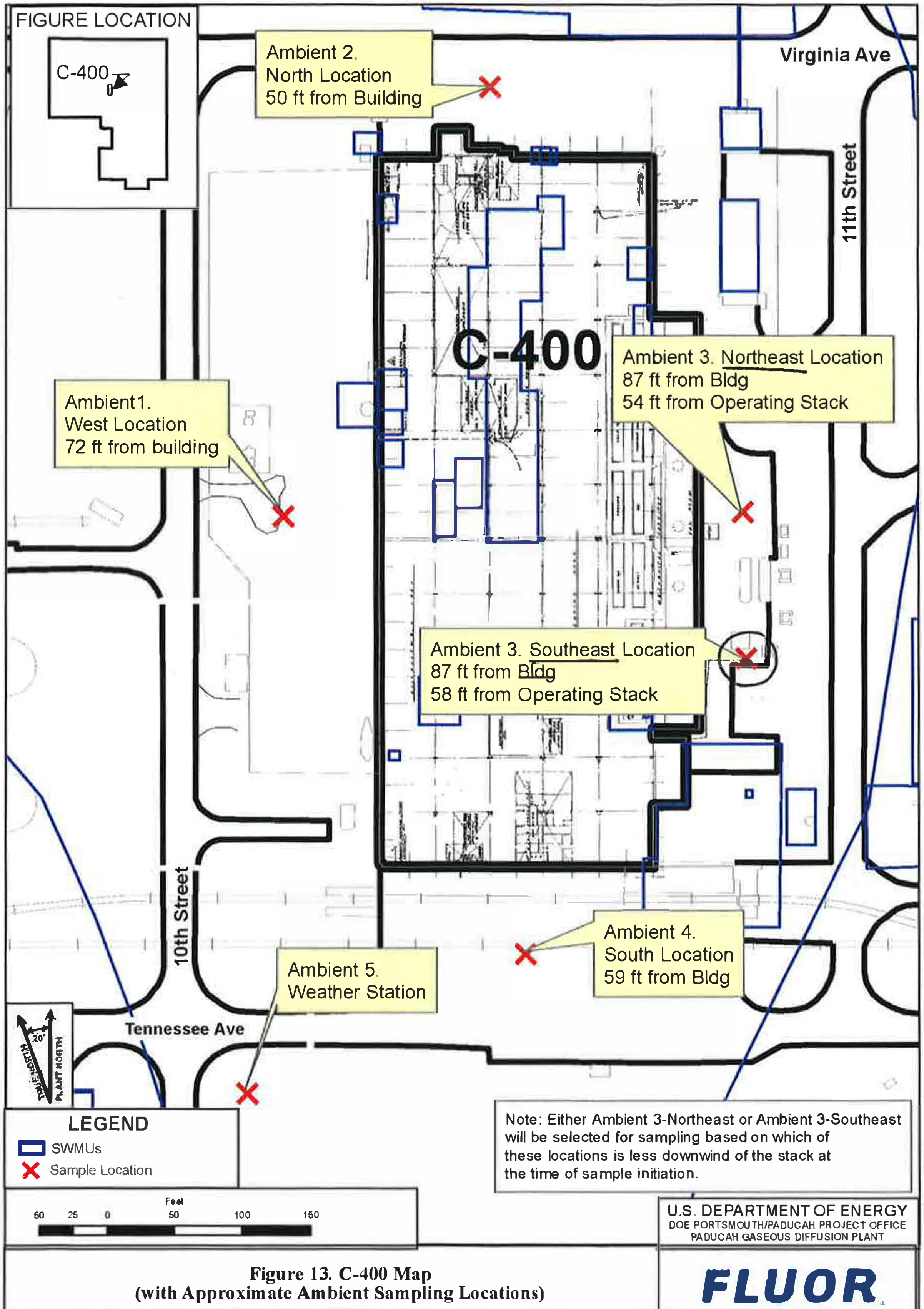
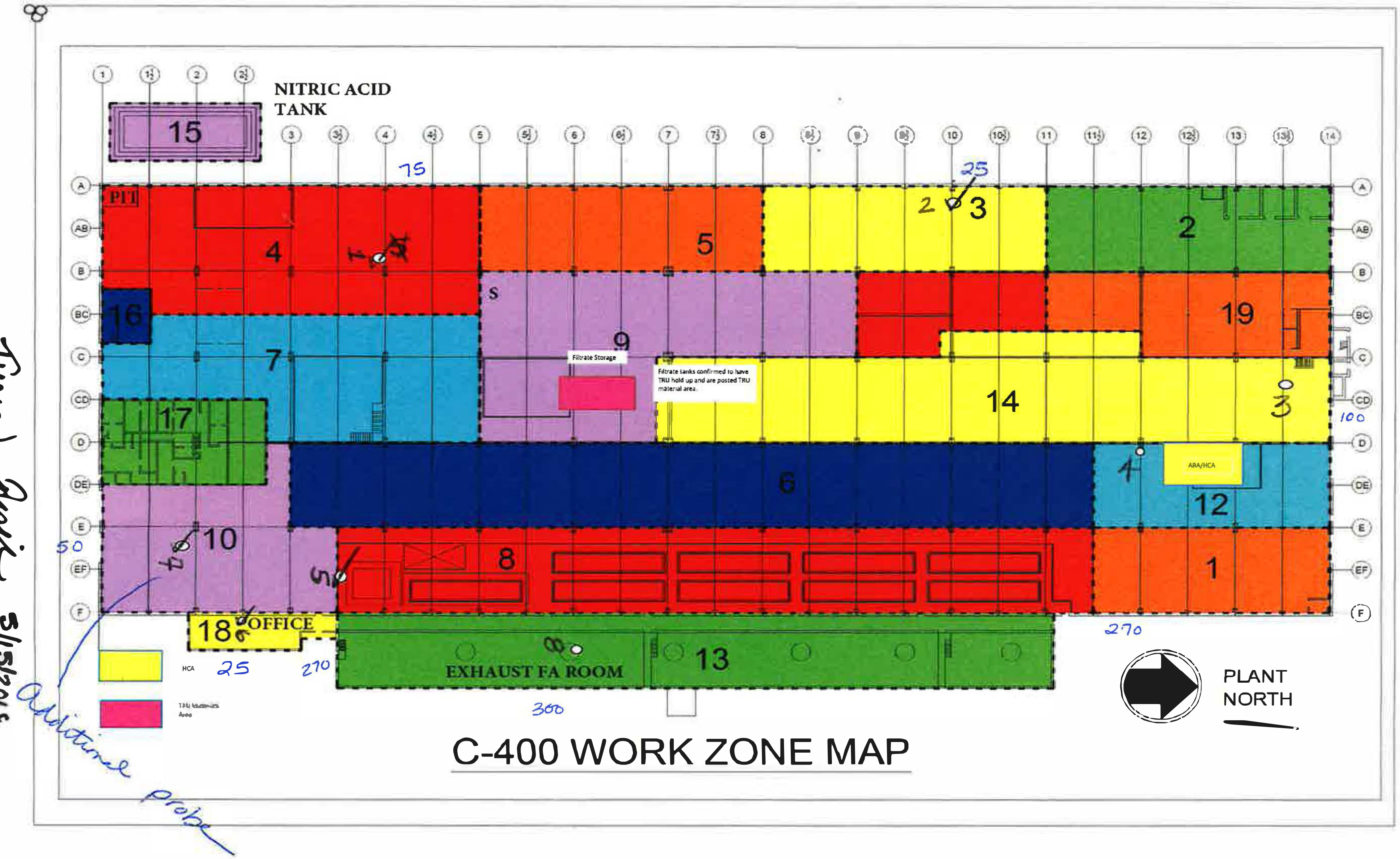


Figure 13. C-400 Map
(with Approximate Ambient Sampling Locations)

G:\GIS\ARCVIEWS\PROJECTS\Vapor Intrusion\MOA 400\Figure 13 C-400 Ambient Sampling Locations.mxd
7/25/2017

Turian Price 5/15/2018

D3-121



5/15/2018

Geosyntec consultants

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C-400 Vapor Intrusion Study
Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah Deactivation Project

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study – Fan On; Doors Closed

LOCATION: PGDP PROJECT NO.: KX6467 TASK NO: 01/04

DESCRIPTION: VI Sampling DATE: 02/12/2018

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Clear & cold (24° @ 0600)

0545 Assemble at C-780
- Jason Brutton; Brandon Taylor; Kris Henderson; Teresa Fischer
- Leave for Limited Area (LA)

0600 Arrive at C400
- Briefing at BCS with Jeff Seaton

0605 Set up Ambient Air summas & weather station
- Conduct line evacuation at Location 8

0620 RADCON arrives
- Mobilize to open summa canisters outside of CA.

0640 Don PPE to enter CA
- Start sub-slab & indoor air summas; collect first set of readings

0720 Doff PPE.
- See individual location forms for details

1625 Start last round of Ambient Air readings; close summa canisters.
- Collect Location 3 Ambient Air summa; close canisters
- Collect other summa canisters outside CA; close canisters.

1705 Don PPE to enter CA; shut down summa canisters

1740 Summas collected from CA; Doff PPE

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Geosyntec consultants engineers | scientists | innovators	**C-400 Vapor Intrusion Study** **Paducah Gaseous Diffusion Plant** **Fluor Federal Services, Inc. Paducah** **Deactivation Project**

Samples:

✓C400V11SUBONCL-R
✓INONCL-R
✓AMBONCL-R
✓C400V12SUBONCL-R
✓INONCL-R
✓AMBONCL-R
✓C400V13SUBONCL-R
✓INONCL-R
✓SEAMBONCL-R
✓C400V14SUBONCL-R
✓INONCL-R
✓AMBONCL-R
✓C400V15SUBONCL-R
✓INONCL-R
✓INONCL-RD
✓C400V16SUBONCL-R
✓INONCL-R
✓INONCL-RD
✓C400V17SUBONCL-R
✓INONCL-R
✓C400V18EXHONCL-R

1815 Field activities complete. Leave Limited area.

Teresa [signature]
2/12/18

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C-400 Vapor Intrusion Study
Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah Deactivation Project

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study – Fan On; Doors Closed Ambient Locations

LOCATION: PG DP PROJECT NO.: KX6467 TASK NO: 01/04

DESCRIPTION: VI Sampling DATE: 02/12/2018

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Clear, cold, windy

0600 Arrive at C400. Set up Ambient Locations 1 - 4.
- Ambient 3 set up at SE location → wind blowing from N-NW at ~5 mph.
- Summas opened starting at 0628 → see individual forms for details

1630 All Ambient locations summas closed.
Field activities completed. Leave limited area

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D3-125

Ambient Air
Monitoring Record 1

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/12/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: T. Fischer
SUMMA ID# and Regulator ID#: 11298 / 11755
Weather: Clear & cold (24° @ 0600)

Location ID: Location 1 - Ambient
Scenario Type: Fan On; Doors Closed
Sample Start Time: 0634
Sample Initial Vacuum: -29.8" Hg (certified)

Time	Summa Canister Vacuum (in Hg)	Comments
0634	-28 (can)	Summa opened
0835	-25	NA
1032	-20	Windy
1230	-15	Windy
1430	-11	Windy
1634	-5	Windy; Summa closed
		[signature] 2/12/18
		Sample ID - C400VI1AMBONCL-R

[signature] 5/15/2018

[signature] 5/15/2018

Ambient Air
Monitoring Record 2

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/12/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: T. Fischer
SUMMA ID# and Regulator ID#: 10103/10448
Weather: Clear & cold (24° @ 0600)

Location ID: Location 2 - Ambient
Scenario Type: Fan On; Doors Open
Sample Start Time: 0635
Sample Initial Vacuum: -29.6" Hg (certified)

Time	Summa Canister Vacuum (in Hg)	Comments
0635	-27 (can)	Summa opened
0836	-24	NA
1033	-17	Windy
1233	-12	Windy
1431	-7	Windy
1635	-1.5	Windy; Summa Closed
		2/12/18
—	—	Sample ID - C400V12AMBONCL-R

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Turean Fischer 5/15/2018

5/15/2018

D3-126

D3-127

Ambient Air
Monitoring Record 35E

Geosyntec consultants
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Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/12/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: T. Fischer
SUMMA ID# and Regulator ID#: 09821 / 11468
Weather: Clear & cold (24° @ 0600)

Location ID: Location 3 - Ambient
Scenario Type: Fan On; Doors Closed
Sample Start Time: 0628
Sample Initial Vacuum: -29.8" Hg (certified)

Time	Summa Canister Vacuum (in Hg)	Comments
0625	≥30" (can)	Summa opened
0830	-27	NA
1027	-22	Windy
1226	-16	Windy
1426	-12	Windy
1627	-7	Windy; Summa closed.
	TAF 2/12/18	
—	—	Sample ID - C400VI35EAMBONCL-R

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[signature] 5/15/2018

Ambient Air
Monitoring Record 4

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study** Date: 02/12/2018 Page 1 of 1
Project Number: KX6467/01/04 Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: T. Fischer SUMMA ID# and Regulator ID#: 10987 / 10048
Weather: Clear & cold (24° @ 0600)

Location ID: Location 4 - Ambient Scenario Type: Fan On; Doors Closed
Sample Start Time: 0630 Sample Initial Vacuum: -29. Hg (certified)

Time	Summa Canister Vacuum (in Hg)	Comments
0630	>30 (can)	Summa opened
0833	-27.5	NA
1029	-23	Windy
1228	-18	Windy
1428	-13	Windy
1630	-8	Windy; Summa closed
	Teresa F	2/12/18
—	—	Sample ID - C400V14AMBONCL-R

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5/15/2018

D3-128

D3-129

Weather Station
Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Project Number: KX6467/01/04
Recorded By: T. Fischer

Date: 02/12/2018
Page 1 of 1
Project Location: **Paducah Gaseous Diffusion Plant**

Location ID: Weather Station
Scenario Type: Fan Off; Doors Closed

Time	Ambient Temp. (deg. F)	Relative Humidity (%)	Barometric Pressure (inches Hg)	Wind Direction	Wind Speed (mph)
0632	22	75	30.51	N	6
0833	24	75	30.57	N	5
1031	32	71	30.59	N	5
1228	37	59	30.57	N	1
1429	40	57	30.55	N	7
1732	38	63	30.56	N	6
		Teresa F 2/12/18			

Teresa Fischer 5/15/2018

[illegible] 5/15/2018

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C-400 Vapor Intrusion Study
Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah
Deactivation Project

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study – Fan On; Doors Closed LOCATION 1

LOCATION: PGDP PROJECT NO.: KX6467 TASK NO: 01/04

DESCRIPTION: VI Sampling DATE: 02/11 /2018

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Cold; Rain

0826 Set up summa canisters at Location 1
- Sub slab → 10985; Flow Con. 11652; -29.7" Hg (certified)
- Indoor Air → 10851; Flow Con 10163; -29.7" Hg (certified)

0828 Shut in test complete. Summa system passed.

Teresa 2/11/18

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Differential Pressure and Ambient Temperature Monitoring Record

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Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/ 12/2018 Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
Gauge ID#: 42900-7-700
Weather: Clear & cold

Location ID: LOCATION # 1
Scenario Type: Fan On; Doors Closed
Sample Start Time: 0717
Sample Initial Vacuum: 29.7" Hg (certified)

Time	Differential Pressure (pa)		Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
	sub-slab/ambient	ambient/outside			
0717	-5.5	-5.6	33	-29.7	Summa Opened
0925	-2.2	-6.4	35	-26.5	NA
1119	-1.5	-4.6	36	-21.5	NA
1318	-0.8	-4.2	38	-16	NA
1515	-1.0	-1.7	39	-12	NA
1725 ~~1625~~	-0.8	-3.3	39	-8	NA; Summa Closed
—	—	—	—	—	Sample ID C400VI1SUBONCL-R

TAP 2/12/2018

Teresa Fischer 5/15/2018

Kris Henderson 5/15/2018

D3-132

Indoor Air Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/ 12/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
SUMMA ID# and Regulator ID#: 10851/ 10163
Weather: Clear & cold

Location ID: 7
Scenario Type: Fan On; Doors Closed
Sample Start Time: 0716
Sample Initial Vacuum: -29.7" Hg (certified)

Time	Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
0716	33	-30(can)	Summa opened
0925	35	-26	NA
1119	36	-20.5	NA
1318	38	-17	NA
1515	39	-12	NA
1725	39	-7	Summa closed
—	—	—	Sample ID C400VI1INONCL-R

Teresa Fischer 5/15/2018

Kris Henderson 5/15/2018

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C-400 Vapor Intrusion Study
Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah
Deactivation Project

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study – Fan On; Doors Closed LOCATION 2

LOCATION: PGDP PROJECT NO.: KX6467 TASK NO: 01/04

DESCRIPTION: VI Sampling DATE: 02/ 11/2018

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Cold; Rain

0830 Set up summas at Location 2
- Sub-slab → 11172; Flow Con. 11272; -29.7" Hg (certified).
- Indoor air → 10770; Flow Con. 11512; No vacuum certificate
Shut in test complete. Summa system passed.

Teresa A. Fischer 2/11/2018

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D3-134

Differential Pressure and Ambient Temperature Monitoring Record

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Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/17/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
Gauge ID#: 42990-7-700
Weather: Clear & Cold

Location ID: LOCATION # 2
Scenario Type: Fan On; Doors Closed
Sample Start Time: 0719
Sample Initial Vacuum: -29.7" Hg (certified)

Time	Differential Pressure (pa)		Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
	sub-slab/ambient	ambient/outside			
0719	-0.0	-5.3	31	-30	Summa Opened
0928	-0.5	-3.5	32	-25	NA
1121	0.1	-2.7	34	-19.5	NA
1321	0.4	2.9	35	-14	NA
1517	-1.4	-1.4	38	-10.5	NA
1729	-0.9	-2.5	37	-5	Summa Closed
—	—	—	—	—	Sample ID C400V12-SUBONCL-R

Teresa Fischer 5/15/2018

Kristopher Henderson 5/15/2018

D3-135

Indoor Air Monitoring Record

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120 Market Place Blvd, Suite 180, Bldg. A
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Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/ 12/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
SUMMA ID# and Regulator ID#: 10470 / 11512
Weather: Clear & cold

Location ID: 2
Scenario Type: Fan On; Doors Closed
Sample Start Time: 0719
Sample Initial Vacuum: -28" (certified)

Time	Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
0719	30	-28	Summa Opened
0928	32	-25	NA
1121	~~34~~	-20	NA
1321	35	-15	NA
1617	37	-10	NA
1729	37	-5	Summa Closed
—	—	—	Sample ID C400VI2INONCL-R

Teresa Fischer 5/15/2018

Kris Henderson 5/15/2018

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C-400 Vapor Intrusion Study
Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah
Deactivation Project

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study – Fan On; Doors Closed LOCATION 3

LOCATION: PG DP PROJECT NO.: KX6467 TASK NO: 01/04

DESCRIPTION: VI Sampling DATE: 02/11/2018

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Cold; Rain

0924 Set up summas at Location 3
- Indoor Air → 09629; Flow Con. 10162; -29.8" Hg
- Sub-Slab → 11014; Flow Con. 10652; -29.6" Hg

0928 Shut in test complete. Summa system holds vacuum.

Teresa A. Fr 2/11/18

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Differential Pressure and Ambient Temperature Monitoring Record

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Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/ 12/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
Gauge ID#: 42990-7-700
Weather: Clear & cold

Location ID: LOCATION # 3
Scenario Type: Fan On; Doors Closed
Sample Start Time: 0632 (TMF) 2/12/18
Sample Initial Vacuum: certified -29.6 " Hg

Time	Differential Pressure (pa)		Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
	sub-slab/ambient	ambient/outside			
0632	-3.1	-11.8	35	-29	Summa opened
0941	-1.1	-24.1	44	-23.5	NA
1132	6.3	-3.7	44	-19	NA
1333	-1.3	-1.0	46	-14	NA
1528	-3.9	-10 to -20	45	-11	NA
1751	-3.2	-11.4	48	-6	Summa Closed
—	—	—	—	—	Sample ID C400 VI 3SUBONCL-R

Teresa Fischer 5/15/2018

Kristoffer Henderson 5/15/2018

Indoor Air Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

D3-138

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/ 12 /2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
SUMMA ID# and Regulator ID#: 09629 / 10162
Weather: Clear & Cold

Location ID: 3
Scenario Type: Fan On; Doors Closed
Sample Start Time: 0629
Sample Initial Vacuum: certified -29.8" Hg

Time	Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
0629	35	-27.5	~~SUMMA opened~~
0941	45	-25	NA
1132	43	-16	NA
1333	46	-11.5	NA
1528	45	-7	NA
1629 ~~1429~~	45	-3	NA ; Summa Closed
—	—	—	Sample ID C400VI3INDNCL-R

TAF
2/12/2018

Teresa Fischer 5/15/2018

Kris Henderson 5/15/2018

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C-400 Vapor Intrusion Study
Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah
Deactivation Project

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study – Fan On; Doors Closed LOCATION 4

LOCATION: PGDP PROJECT NO.: KX6467 TASK NO: 01/04

DESCRIPTION: VI Sampling DATE: 02/11/2018

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Cold; Rain

0800 Set up summas at Location 4
Summa Sub-Slab 10273; Flow Cont 09704;
- 29.8" (certified)
Summa Indoor Air 10121; Flow Cont. 11761;
- 29.7" Hg (certified)
- Shut in test complete. Set up holds vacuum.

Teresa [signature] 2/11/18

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Differential Pressure and Ambient Temperature Monitoring Record

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Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/12/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
Gauge ID#: 42990-7-700
Weather: Clear & Cold

Location ID: LOCATION # 4
Scenario Type: Fan On; Doors Closed
Sample Start Time: 0707
Sample Initial Vacuum: -29.8" Hg (certified)

Time	Differential Pressure (pa)		Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
	sub-slab/ambient	ambient/outside			
0707	-6.9	2.0	38	> -30	Summa opened
0913	-4.0	5.0	42	-28	NA
1109	-2.8	-8.1	45	-25	NA
1308	-1.1	-7.7	47	-20	NA
1505	-0.9	-8.8	45	-16	NA
1712	-2.0	-8.0	39	-12	Summa Closed
—	—	—	—	—	Sample ID C400VI4SUBONCL-R

Teresa Fischer 5/15/2018

[signature] 5/15/2018

D3-141

Indoor Air Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/ 12 /2018 Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
SUMMA ID# and Regulator ID#: 10121 / 11761
Weather: Clear & cold

Location ID: 4
Scenario Type: Fan On; Doors Closed
Sample Start Time: 0705
Sample Initial Vacuum: -29.7" (certified)

Time	Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
0705	39	-30 (can)	Summa opened
0913	42	-28	NA
1109	45	-20	NA
1308	47	-15	NA
1505	45	-10	NA
1712 ~~1612~~	39	-5	Summa closed
TAP	2/12/18	—	Sample ID C400VI4 INONCL-R

Teresa Fischer 5/15/2018

Kris Henderson 5/15/2018

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C-400 Vapor Intrusion Study
Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah
Deactivation Project

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study – Fan On; Doors Closed LOCATION 5

LOCATION: PG DP PROJECT NO.: KX6467 TASK NO: 01/04

DESCRIPTION: VI Sampling DATE: 02/12 /2018

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Cold; Rain

0810 Set up summas at Location 5
- Indoor Air Summas → 10852 ; Flow controller 10157; 29.6" Hg
  Dup → 10801 ; Flow controller ~~10+~~ 11051; No vac. cert. TAF 2/11/18
- Sub slab summa → 11149 ; Flow Con. 11291;
  - 29.7" Hg certified

0815 Shut in test complete. Summa system holds vacuum

Teresa F. 2/11/18

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Teresa Fischer 5/15/2018

D3-143

Differential Pressure and Ambient Temperature Monitoring Record

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Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/12/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
Gauge ID#: 42990-7-700
Weather: Clear & cold

Location ID: LOCATION # 5
Scenario Type: Fan On; Doors Closed
Sample Start Time: 0711
Sample Initial Vacuum: -29.7" Hg (certified)

Time	Differential Pressure (pa) sub-slab/ambient	Differential Pressure (pa) ambient/outside	Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
0711	0.6	-4.3	36	> -30	Summa opened
0915	0.9	-4.3	39	-28	NA
1112	-0.1	-2.7	41	-23	NA
1312	-0.4	-4.9	41	-18	NA
1408	-0.7	-1.8	42	-14	NA
1711	-0.6	-2.5	40	-8	Summa Closed
—	—	—	—	—	Sample ID C400VISSUBONCL-R

Teresa Fischer 5/15/2018

Kris Henderson 5/15/2018

D3-144

Indoor Air Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/12/2018 Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
SUMMA ID# and Regulator ID#: 10801 (Dup)/11051
10852/10157
Weather: Clear & cold

Location ID: 5
Scenario Type: Fan On; Doors Closed
Sample Start Time: 0709
Sample Initial Vacuum: No vacuum/29.6"Hg (D) certified

Time	Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)		Comments
0709	36	D 29	<30	Summas opened
0915	39	-27.5	-30	NA
1112	41	-26	-29	NA
1312	41	-21	-27	NA
1409	42	-17	-20	NA
1711 ~~1611~~	40	-11	-15	NA
2/12/18		—		Sample ID C400VI5INONCL-RD (Duplicate)

C400VI5INONCL-R

Teresa Fischer 5/15/2018

Kristoffer Henderson 5/15/2018

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C-400 Vapor Intrusion Study
Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah
Deactivation Project

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study – Fan On; Doors Closed LOCATION 6

LOCATION: PGDP PROJECT NO.: KX6467 TASK NO: 01/04

DESCRIPTION: VI Sampling DATE: 02/11/2018

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Cold ; Rain

0913 Set up summas at Location 6.

- Indoor air → 10580 ; Flow Con. 10205 ; -29.7" Hg

Dup →

~~Subslab~~ → 09514 ; Flow Con. 10051 ; -29.8" Hg

TAP 2/11/2018

- Subslab → 09524 ; Flow Con. 09843 ; -29.6" Hg

0918 Shut in test complete. Summa system holds vacuum.

Teresa [signature] 2/11/2018

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Teresa Fischer 5/15/2018

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D3-146

Differential Pressure and Ambient Temperature Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/12/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
Gauge ID#: 42990-7-700
Weather: Clear; Cold

Location ID: LOCATION # 6
Scenario Type: Fan On; Doors Closed
Sample Start Time: 0639
Sample Initial Vacuum: -29.6" Hg (certified)

Time	Differential Pressure (pa)		Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
	sub-slab/ambient	ambient/outside			
0639	0.1	-4.0	58	-29	Summa open
0839	0.1	-4.0	62	-26	NA
1038	0.0	-2.1	65	-22	NA
1238	0.0	-3.3	65	-16	NA
1439	0.0	-08	65	-11	NA
1639	0.1	-1.6	62	-6	NA; Summa closed
—	—	—	—	—	Sample ID C400VI6SUBONCL-R

Teresa Fischer 5/15/2018

Kristoffer Henderson 5/15/2018

Indoor Air Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/ 12 /2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
SUMMA ID# and Regulator ID#: 10580 / 10205
09514 / 10051
Weather: Clear & cold

Location ID: 6
Scenario Type: Fan On; Doors Closed
Sample Start Time: 0639
Sample Initial Vacuum: -29.7" Hg / -29.8" Hg (Dup) (Certified)

Time	Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	D	Comments
0639	57	-30	-25	Summas opened
0839	62	-29	-21	NA
1039	65	-27	-17	NA
1238	66	-20	-13	NA
1539	65	-15	-8	NA
1639	62	-11	-3	Summas closed
—	—	—	—	Sample ID C400V16INONCL-RD (Dup)

C400V16INONCL-R

Teresa Fischer 5/15/2018

Kristoffer Henderson 5/15/2018

D3-147

Geosyntec consultants

engineers | scientists | innovators

C-400 Vapor Intrusion Study
Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah
Deactivation Project

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study – Fan On; Doors Closed LOCATION 7

LOCATION: PGDP PROJECT NO.: KX6467 TASK NO: 01/04

DESCRIPTION: VI Sampling DATE: 02/ 11/2018

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Cold; Rain

0816 Set summa canisters up at Location 7
- Sub-slab → 09627; Flow Con. 11536; 29.7" Hg (certified)
- Indoor Air → 09965; Flow Con. 10054; 29.7" Hg (certified)

0820 Shut in test complete; system holds vacuum.

Teresa 28/11/2018

TAP 2/11/18

COPY TO: File PER: — TAP 4/26/2018

DFR_ One Page Teresa Fischer 5/15/2018 SHEET NO 1 OF 1

Differential Pressure and Ambient Temperature Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/ 12/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
Gauge ID#: 42900-7-700
Weather: Clear & cold

Location ID: LOCATION # 7
Scenario Type: Fan On; Doors Closed
Sample Start Time: 0714
Sample Initial Vacuum: -29.7" Hg (certified)

Time	Differential Pressure (pa)		Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
	sub-slab/ambient	ambient/outside			
0714	-1.8	-3.2	37	-29.5	Summa opened
0920	1.9	1.5	39	-26	NA
1116	-0.9	-0.5	40	-20.5	NA
1315	-0.8	-0.6	41	-16	NA
1511	-0.6	1.6	42	-11	NA
1722	-0.5	-1.6	41	-6	Summa closed
—	—	—	—	—	Sample ID C400VI7SUBONCL-R

Teresa Fischer 5/15/2018

Kristoffer Henderson 5/15/2018

D3-149

Indoor Air Monitoring Record

Geosyntec consultants

120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/ 12 /2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
SUMMA ID# and Regulator ID#: 09965/10054
Weather: Clear & cold

Location ID: 7
Scenario Type: Fan On; Doors Closed
Sample Start Time: 0712
Sample Initial Vacuum: -29.7" Hg (certified)

Time	Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
0712	36	-28.5	Summa opened
0920	39	-23.5	NA
1116	40	-19	NA
1315	41	-13	NA
1511	42	-8	NA
1722	41	-2	Summa closed
—	—	—	Sample ID C400VI7INONCL-R

Teresa Fischer 5/15/2018

Kristoffer Henderson 5/15/2018

D3-150

Geosyntec consultants

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C-400 Vapor Intrusion Study
Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah Deactivation Project

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study – Fan On; Doors Closed LOCATION 8

LOCATION: PGDP PROJECT NO.: KX6467 TASK NO: 01/04

DESCRIPTION: VI Sampling DATE: 02/11 /2018

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Cold; Rain

2/11/18 0907 Set up summa canister.
- Summa 10231; Flow Cont 99901; 29.8" Hg (certified)
0910 Set up complete
TAF 4/26/18

2/12/18 0620 Purge lines three times
0636 SUMMA opened
~~1636~~ 1636 Summa closed
TAF 2/12/18

Teresa F 2/12/18

COPY TO: File PER: — TAF 4/26/2018

DFR_ One Page Teresa Fischer 5/15/2018 SHEET NO 1 OF 1

Differential Pressure and Ambient Temperature Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/12/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
Gauge ID#: 42990-7-700
Weather: Clear & cold (24° @ 0600)

Location ID: LOCATION 8
Scenario Type: Fan On; Doors Closed
Sample Start Time: 0636
Sample Initial Vacuum: 29.8" Hg (certified)

Time	Differential Pressure (pa) Exhaust Fan to Ambient	Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
0636	-0.1	50	-26	NA
0837	-2.2	68	-21	NA
1036	-2.4	61	-17	NA
1235	-2.3	59	-11	NA
1436	5.1	61	-7.5	NA; Windy
1636	-1.0	55	-2	Windy
—	—	—	—	Sample ID C400VI8EXHONG-R

Teresa Fischer 5/15/2018

Kristoffer Henderson 5/15/2018

D3-152

INSTRUMENT CALIBRATION REPORT

Advanced Labs, Inc.

Pine Environmental Services, Inc

Instrument ID 39207
Description TSI 8330 VelociCheck
Calibrated 9/27/2017

Manufacturer	TSI	**Classification**	
Model Number	8330	**Status**	pass
Serial Number	96060227	**Frequency**	Yearly
Location	New Jersey	**Department**	Lab
Temp	76	**Humidity**	33

Calibration Specifications

Group # 1
Group Name Temperature
Stated Accy Plus / Minus
Range Acc % 0.0000
Reading Acc % 0.0000
Plus/Minus 5.00

Nom In Val / In Val	In Type	Out Val	Out Type	Fnd As	Lft As	Dev%	Pass/Fail
70.00 / 75.60	°F	75.60	°F	76.00	76.00	0.53%	Pass

Group # 2
Group Name Velocity
Stated Accy Pct of Reading
Range Acc % 0.0000
Reading Acc % 5.0000
Plus/Minus 0.00

Nom In Val / In Val	In Type	Out Val	Out Type	Fnd As	Lft As	Dev%	Pass/Fail
0.00 / 0.00	ft/min	0.00	ft/min	0.00	0.00	0.00%	Pass
40.00 / 40.00	ft/min	40.00	ft/min	40.00	40.00	0.00%	Pass
70.00 / 70.00	ft/min	70.00	ft/min	70.00	70.00	0.00%	Pass
100.00 / 100.00	ft/min	100.00	ft/min	103.00	103.00	3.00%	Pass
150.00 / 150.00	ft/min	150.00	ft/min	153.00	153.00	2.00%	Pass
325.00 / 325.00	ft/min	325.00	ft/min	330.00	330.00	1.54%	Pass
700.00 / 700.00	ft/min	700.00	ft/min	700.00	700.00	0.00%	Pass
1000.00 / 1000.00	ft/min	1000.00	ft/min	990.00	990.00	-1.00%	Pass
1500.00 / 1500.00	ft/min	1500.00	ft/min	1,490.00	1,490.00	-0.67%	Pass
2000.00 / 2000.00	ft/min	2000.00	ft/min	2,000.00	2,000.00	0.00%	Pass

Test Instruments Used During the Calibration

Test Instrument ID	Description	Manufacturer	Serial Number	Last Cal Date (As Of Cal Entry Date)	Next Cal Date (As Of Cal Entry Date)
MICHELL DM-509-TX-01	Relative Humidity Meter	Michell	273296	8/25/2017	8/25/2018
OMEGA HX93AC/DP25-E	Omega HX93AC/DP25-E	Omega Engineering	1010368 035025 035026	9/15/2016	9/15/2018
OMEGA PX02K1-16A5T /DP25-E-A	Omega PX02K1-16A5T/DP25-E-A	Omega Engineering	168377/8375030	9/15/2016	9/15/2018
OMEGA WT4401-D	Omega WT4401-D	Omega Engineering	101105	9/15/2016	9/15/2018

Teresa Fischer 5/15/2018

INSTRUMENT CALIBRATION REPORT

Advanced Labs, Inc.

Pine Environmental Services, Inc

Instrument ID 39207
Description TSI 8330 VelociCheck
Calibrated 9/27/2017

Notes about this calibration

Calibration Result Calibration Successful
Who Calibrated David Galego

Advanced Labs, Inc. hereby certifies that this instrument is calibrated and functions to meet the manufacture's specifications using NIST traceable standards, or is derived from accepted values of physical constants.

Teresa Fischer 5/15/2018

ATTACHMENT D4

NATIONAL WEATHER SERVICE DATA

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Paducah, KY

Barkley Regional

Weather History for KPAH - January, 2018

January

27

2018

View
Saturday, January 27, 2018

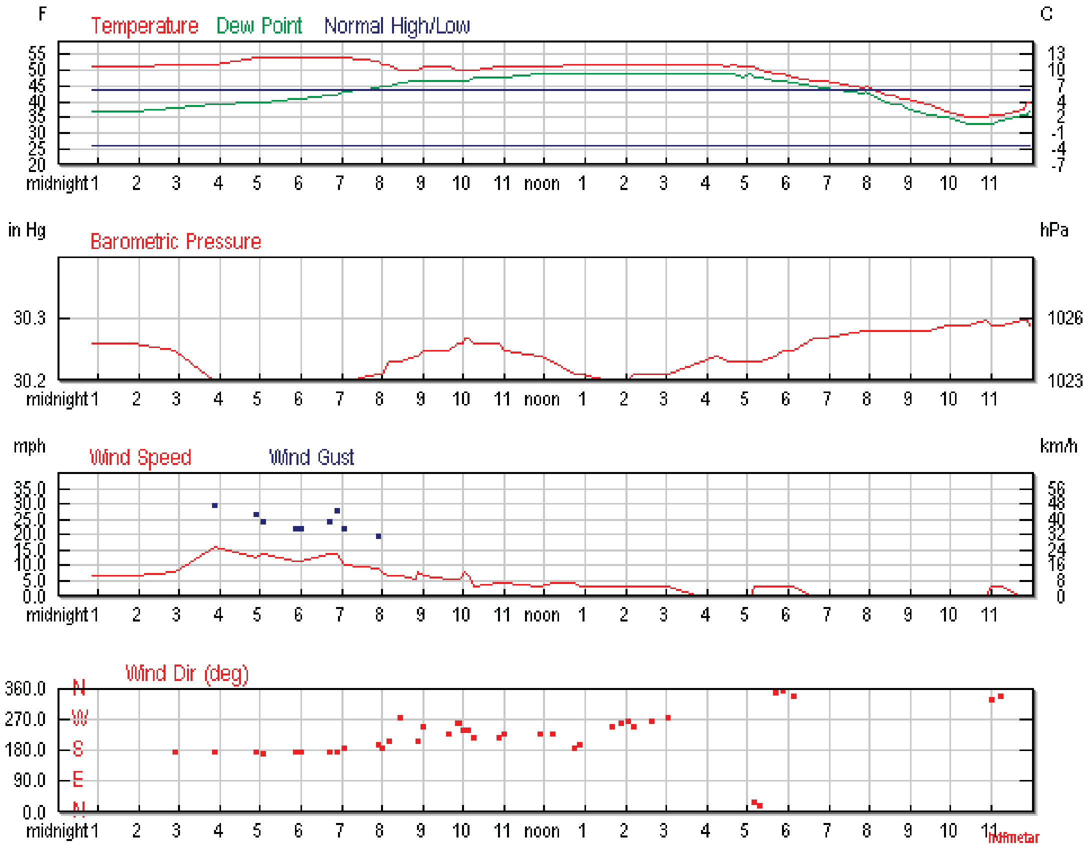
Daily | Weekly | Monthly | Custom

	Actual	Average	Record
Temperature			
Mean Temperature	**45** °F	**35** °F	
Max Temperature	**55** °F	**44** °F	**70** °F (1947)
Min Temperature	**35** °F	**26** °F	**-5** °F (1940)
Degree Days			
Heating Degree Days	20	30	
Month to date heating degree days	931	827	
Since 1 July heating degree days	2465	2458	
Cooling Degree Days	0	0	
Month to date cooling degree days	0	0	
Year to date cooling degree days	0	0	
Moisture			
Dew Point	**44** °F		
Average Humidity	76		

	Actual	Average	Record
Maximum Humidity	93		
Minimum Humidity	59		
Precipitation			
Precipitation	**0.51** in	**0.12** in	**2.49** in (2009)
Month to date precipitation	4.00	3.18	
Year to date precipitation	4.00	3.18	
Snow			
Snow	**0.00** in	**0.10** in	**3.80** in (1985)
Month to date snowfall	12.4	2.5	
Since 1 July snowfall	12.4	4.8	
Snow Depth	**0.00** in		
Sea Level Pressure			
Sea Level Pressure	**30.24** in		
Wind			
Wind Speed	**5** mph (SW)		
Max Wind Speed	**18** mph		
Max Gust Speed	**29** mph		
Visibility	**3** miles		
Events	Fog , Rain		

T = Trace of Precipitation, MM = Missing Value Source: NWS Daily Summary

Daily Weather History Graph



Search for Another Location

Airport or City:

KPAH

Submit

Trip Planner

Search our weather history database for the weather conditions in past years. The results will help you decide how hot, cold, wet, or windy it might be!

Date:

January

27

Submit

Astronomy

Jan. 27, 2018	Rise	Set
Actual Time	7:01 AM CST	5:14 PM CST

Jan. 27, 2018	Rise	Set
Civil Twilight	6:33 AM CST	5:42 PM CST
Nautical Twilight	6:02 AM CST	6:13 PM CST
Astronomical Twilight	5:31 AM CST	6:44 PM CST
Moon	1:30 PM CST (1/27)	2:55 AM CST (1/27)
Length of Visible Light	11h 08m	
Length of Day	10h 13m	

Waxing Gibbous, 80% of the Moon is Illuminated

Jan 27	Jan 31	Feb 7	Feb 15	Feb 23
Waxing Gibbous	Full	Last Quarter	New	First Quarter

Hourly Weather History & Observations

Time (CST)	Temp.	Windchill	Dew Point	Humidity	Pressure	Visibility	Wind Dir	Wind Speed	Gust Speed	Precip	Events
12:53 AM	**51.1** °F	-	**37.0** °F	59%	**30.26** in	**10.0** mi	South	**6.9** mph	-	**0.00** in	Rain
1:53 AM	**51.1** °F	-	**37.0** °F	59%	**30.26** in	**10.0** mi	Variable	**6.9** mph	-	**0.00** in	Rain
2:53 AM	**52.0** °F	-	**37.9** °F	59%	**30.25** in	**10.0** mi	South	**8.1** mph	**20.7** mph	**0.01** in	
3:53 AM	**52.0** °F	-	**39.0** °F	61%	**30.20** in	**10.0** mi	South	**16.1** mph	**29.9** mph	**0.00** in	
4:53 AM	**54.0** °F	-	**39.9** °F	59%	**30.20** in	**10.0** mi	South	**12.7** mph	**26.5** mph	N/A	
5:03 AM	**54.0** °F	-	**39.9** °F	59%	**30.20** in	**10.0** mi	South	**13.8** mph	**24.2** mph	N/A	
5:53 AM	**54.0** °F	-	**41.0** °F	62%	**30.20** in	**10.0** mi	South	**11.5** mph	**21.9** mph	N/A	
6:01 AM	**54.0** °F	-	**41.0** °F	62%	**30.20** in	**10.0** mi	South	**11.5** mph	**21.9** mph	N/A	
6:42 AM	**54.0** °F	-	**42.1** °F	64%	**30.20** in	**10.0** mi	South	**13.8** mph	**24.2** mph	**0.00** in	Rain
6:53 AM	**54.0** °F	-	**42.1** °F	64%	**30.20** in	**10.0** mi	South	**13.8** mph	**27.6** mph	**0.00** in	Rain
7:04 AM	**54.0** °F	-	**43.0** °F	66%	**30.20** in	**8.0** mi	South	**10.4** mph	**21.9** mph	**0.00** in	Rain

Time (CST)	Temp.	Windchill	Dew Point	Humidity	Pressure	Visibility	Wind Dir	Wind Speed	Gust Speed	Precip	Events
7:53 AM	**53.1** °F	-	**44.1** °F	71%	**30.21** in	**9.0** mi	SSW	**9.2** mph	**19.6** mph	**0.01** in	
8:00 AM	**52.0** °F	-	**45.0** °F	77%	**30.21** in	**1.5** mi	South	**8.1** mph	-	**0.02** in	Rain
8:11 AM	**52.0** °F	-	**45.0** °F	77%	**30.23** in	**3.0** mi	SSW	**6.9** mph	**19.6** mph	**0.10** in	Rain
8:27 AM	**50.0** °F	-	**46.0** °F	86%	**30.23** in	**1.8** mi	West	**6.9** mph	-	**0.12** in	Rain
8:51 AM	**50.0** °F	-	**46.4** °F	87%	**30.24** in	**2.5** mi	Variable	**5.8** mph	-	**0.26** in	Rain
8:53 AM	**50.0** °F	-	**46.9** °F	89%	**30.24** in	**2.5** mi	SSW	**8.1** mph	-	**0.26** in	Rain
9:01 AM	**51.1** °F	-	**46.9** °F	86%	**30.25** in	**3.0** mi	WSW	**6.9** mph	-	**0.02** in	Rain
9:37 AM	**51.1** °F	-	**46.9** °F	86%	**30.25** in	**3.0** mi	SW	**5.8** mph	-	**0.08** in	Rain
9:51 AM	**50.0** °F	-	**46.4** °F	87%	**30.26** in	**3.0** mi	West	**5.8** mph	-	**0.10** in	Rain
9:53 AM	**50.0** °F	-	**46.9** °F	89%	**30.26** in	**3.0** mi	West	**5.8** mph	-	**0.10** in	Rain
9:59 AM	**50.0** °F	-	**46.9** °F	89%	**30.26** in	**1.8** mi	WSW	**6.9** mph	-	**0.03** in	Rain
10:03 AM	**50.0** °F	-	**46.9** °F	89%	**30.27** in	**1.8** mi	WSW	**8.1** mph	-	**0.05** in	Rain
10:06 AM	**50.0** °F	-	**46.9** °F	89%	**30.27** in	**2.0** mi	WSW	**6.9** mph	-	**0.05** in	Rain
10:16 AM	**50.0** °F	-	**48.0** °F	93%	**30.26** in	**3.0** mi	SW	**3.5** mph	-	**0.06** in	Rain
10:53 AM	**51.1** °F	-	**48.0** °F	89%	**30.26** in	**6.0** mi	SW	**4.6** mph	-	**0.10** in	Rain
11:01 AM	**51.1** °F	-	**48.0** °F	89%	**30.25** in	**6.0** mi	SW	**4.6** mph	-	**0.00** in	Rain
11:53 AM	**51.1** °F	-	**48.9** °F	92%	**30.24** in	**4.0** mi	SW	**3.5** mph	-	**0.02** in	
12:11 PM	**51.1** °F	-	**48.9** °F	92%	**30.23** in	**2.0** mi	SW	**4.6** mph	-	N/A	
12:44 PM	**52.0** °F	-	**48.9** °F	89%	**30.21** in	**3.0** mi	South	**4.6** mph	-	N/A	
12:53 PM	**52.0** °F	-	**48.9** °F	89%	**30.21** in	**4.0** mi	SSW	**3.5** mph	-	N/A	
1:40 PM	**52.0** °F	-	**48.9** °F	89%	**30.20** in	**1.8** mi	WSW	**3.5** mph	-	**0.00** in	

Time (CST)	Temp.	Windchill	Dew Point	Humidity	Pressure	Visibility	Wind Dir	Wind Speed	Gust Speed	Precip	Events
1:53 PM	**52.0** °F	-	**48.9** °F	89%	**30.20** in	**1.8** mi	West	**3.5** mph	-	**0.01** in	
2:04 PM	**52.0** °F	-	**48.9** °F	89%	**30.20** in	**1.8** mi	West	**3.5** mph	-	N/A	
2:12 PM	**52.0** °F	-	**48.9** °F	89%	**30.21** in	**2.5** mi	WSW	**3.5** mph	-	N/A	
2:37 PM	**52.0** °F	-	**48.9** °F	89%	**30.21** in	**3.0** mi	West	**3.5** mph	-	N/A	
2:53 PM	**52.0** °F	-	**48.9** °F	89%	**30.21** in	**4.0** mi	Variable	**3.5** mph	-	N/A	
3:03 PM	**52.0** °F	-	**48.9** °F	89%	**30.21** in	**3.0** mi	West	**3.5** mph	-	N/A	
3:53 PM	**52.0** °F	-	**48.9** °F	89%	**30.23** in	**6.0** mi	Calm	Calm	-	N/A	
4:15 PM	**52.0** °F	-	**48.9** °F	89%	**30.24** in	**2.5** mi	Calm	Calm	-	N/A	
4:32 PM	**51.1** °F	-	**48.9** °F	92%	**30.23** in	**4.0** mi	Calm	Calm	-	N/A	
4:37 PM	**52.0** °F	-	**48.9** °F	89%	**30.23** in	**4.0** mi	Calm	Calm	-	N/A	
4:53 PM	**51.1** °F	-	**48.0** °F	89%	**30.23** in	**3.0** mi	Calm	Calm	-	N/A	
5:05 PM	**51.1** °F	-	**48.9** °F	92%	**30.23** in	**1.8** mi	Calm	Calm	-	N/A	
5:10 PM	**51.1** °F	-	**48.0** °F	89%	**30.23** in	**0.2** mi	NNE	**3.5** mph	-	N/A	Fog
5:17 PM	**50.0** °F	-	**48.0** °F	93%	**30.23** in	**0.2** mi	NNE	**3.5** mph	-	N/A	Fog
5:41 PM	**48.9** °F	-	**46.9** °F	93%	**30.24** in	**0.2** mi	North	**3.5** mph	-	N/A	Fog
5:53 PM	**48.9** °F	-	**46.9** °F	93%	**30.25** in	**0.2** mi	North	**3.5** mph	-	N/A	Fog
6:08 PM	**48.0** °F	-	**46.0** °F	93%	**30.25** in	**0.2** mi	NNW	**3.5** mph	-	N/A	Fog
6:36 PM	**46.9** °F	-	**45.0** °F	93%	**30.27** in	**0.2** mi	Calm	Calm	-	N/A	Fog
6:51 PM	**46.4** °F	-	**44.6** °F	93%	**30.27** in	**0.2** mi	Calm	Calm	-	N/A	Fog
6:53 PM	**46.9** °F	-	**44.1** °F	90%	**30.27** in	**0.2** mi	Calm	Calm	-	N/A	Fog
7:51 PM	**44.6** °F	-	**42.8** °F	93%	**30.28** in	**0.2** mi	Calm	Calm	-	N/A	Fog

Time (CST)	Temp.	Windchill	Dew Point	Humidity	Pressure	Visibility	Wind Dir	Wind Speed	Gust Speed	Precip	Events
7:53 PM	**45.0** °F	-	**43.0** °F	93%	**30.28** in	**0.2** mi	Calm	Calm	-	N/A	Fog
8:27 PM	**42.1** °F	-	**39.9** °F	92%	**30.28** in	**0.2** mi	Calm	Calm	-	N/A	Fog
8:34 PM	**42.1** °F	-	**39.0** °F	89%	**30.28** in	**0.2** mi	Calm	Calm	-	N/A	Fog
8:48 PM	**41.0** °F	-	**39.2** °F	93%	**30.28** in	**0.5** mi	Calm	Calm	-	N/A	Fog
8:53 PM	**41.0** °F	-	**37.9** °F	89%	**30.28** in	**0.5** mi	Calm	Calm	-	N/A	Fog
9:28 PM	**39.0** °F	-	**36.0** °F	89%	**30.28** in	**0.2** mi	Calm	Calm	-	N/A	Fog
9:53 PM	**37.0** °F	-	**35.1** °F	93%	**30.29** in	**0.2** mi	Calm	Calm	-	N/A	Fog
10:26 PM	**35.1** °F	-	**33.1** °F	92%	**30.29** in	**0.2** mi	Calm	Calm	-	N/A	Fog
10:53 PM	**35.1** °F	-	**33.1** °F	92%	**30.30** in	**0.5** mi	Calm	Calm	-	N/A	Fog
11:01 PM	**36.0** °F	**33.3** °F	**33.1** °F	89%	**30.29** in	**1.0** mi	NNW	**3.5** mph	-	N/A	
11:14 PM	**36.0** °F	**33.3** °F	**34.0** °F	93%	**30.29** in	**3.0** mi	NNW	**3.5** mph	-	N/A	
11:47 PM	**37.4** °F	-	**35.6** °F	93%	**30.30** in	**1.8** mi	Calm	Calm	-	N/A	
11:53 PM	**39.9** °F	-	**36.0** °F	86%	**30.30** in	**1.5** mi	Calm	Calm	-	N/A	
11:57 PM	**39.9** °F	-	**37.0** °F	89%	**30.29** in	**3.0** mi	Calm	Calm	-	N/A	

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Weather observations for the past three days

Paducah, Barkley Regional Airport

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metric en español

Date	Time (cst)	Wind (mph)	Vis. (mi.)	Weather	Sky Cond.	Temperature (ºF) Air	Dwpt	6 hour Max.	6 hour Min.	Relative Humidity	Wind Chill (°F)	Heat Index (°F)	Pressure altimeter (in)	Pressure sea level (mb)	Precipitation (in.) 1 hr	3 hr	6 hr
10	18:53	NE 13	7.00	Overcast	OVC016	37	30			76%	29	NA	29.96	1014.8			
10	17:53	NE 16	7.00	Overcast	OVC015	38	30	40	37	73%	29	NA	29.96	1014.8			
10	16:53	NE 12	6.00	Overcast with Haze	OVC016	39	32			76%	32	NA	29.95	1014.4			
10	15:53	N 12	5.00	Overcast with Haze	OVC016	40	31			70%	33	NA	29.97	1014.8			
10	14:53	NE 13	5.00	Overcast with Haze	OVC015	40	32			73%	32	NA	29.96	1014.8			
10	13:53	N 12	5.00	Overcast with Haze	BKN013 OVC023	39	32			76%	32	NA	29.97	1014.9			
10	12:53	N 10	4.00	Overcast with Haze	OVC009	37	32			82%	30	NA	29.97	1014.9			
10	11:53	N 8	2.50	Overcast with Haze	OVC007	38	33	41	37	83%	32	NA	30.03	1017.0			
10	10:53	N 8	1.50	Fog/Mist	OVC007	37	34			89%	31	NA	30.04	1017.5			
10	09:53	NW 10	3.00	Overcast with Haze	OVC011	39	34			82%	32	NA	30.04	1017.4			
10	08:53	N 7	3.00	Overcast with Haze	OVC011	40	35			83%	35	NA	30.03	1016.9			
10	07:53	NE 9	2.00	Fog/Mist	OVC007	39	35			86%	33	NA	30.03	1016.9			
10	06:53	N 12	2.00	Fog/Mist	OVC006	39	36			89%	32	NA	30.04	1017.1			
10	05:53	NW 6	5.00	Fog/Mist	OVC006	41	37	49	41	86%	37	NA	30.02	1016.7			0.18
10	04:53	NW 3	5.00	Fog/Mist	OVC004	47	45			93%	NA	NA	30.00	1015.8			
10	03:53	Calm	1.75	Fog/Mist	BKN006 BKN025 OVC030	47	45			93%	NA	NA	29.98	1015.1	0.02		
10	02:53	Calm	1.00	Light Rain Fog/Mist	FEW026 OVC037	47	45			93%	NA	NA	30.01	1016.0	0.06	0.16	
10	01:53	Calm	3.00	Light Rain Fog/Mist	FEW018 SCT033 OVC042	48	45			89%	NA	NA	30.02	1016.3	0.06		
10	00:53	SW 3	3.00	Light	BKN019	48	45			89%	NA	NA	30.05	1017.4	0.04		

				Rain Fog/Mist	OVC031									
09	23:53	SW 9	10.00	Light Rain	BKN035 OVC060	52	40	56	46	64%	NA	NA	30.05	1017.4
09	22:53	Calm	10.00	Overcast	SCT045 BKN050 OVC095	48	37			66%	NA	NA	30.05	1017.4
09	21:53	Calm	10.00	Mostly Cloudy	BKN065	46	37			71%	NA	NA	30.05	1017.7
09	20:53	Calm	10.00	Overcast	SCT049 OVC060	50	36			59%	NA	NA	30.06	1018.1
09	19:53	S 3	10.00	Overcast	OVC065	51	35			54%	NA	NA	30.07	1018.2
09	18:53	Calm	10.00	Overcast	OVC070	55	35			47%	NA	NA	30.07	1018.2
09	17:53	Calm	10.00	Overcast	OVC070	56	35	59	56	46%	NA	NA	30.07	1018.3
09	16:53	S 5	10.00	Overcast	BKN060 OVC080	58	35			42%	NA	NA	30.07	1018.3
09	15:53	Vrbl 5	10.00	Overcast	FEW040 OVC050	59	35			41%	NA	NA	30.07	1018.3
09	14:53	Vrbl 5 G 16	10.00	Fair	CLR	58	34			41%	NA	NA	30.08	1018.5
09	13:53	S 8	10.00	Fair	CLR	58	34			41%	NA	NA	30.10	1019.3
09	12:53	S 12 G 23	10.00	Fair	CLR	57	33			41%	NA	NA	30.14	1020.6
09	11:53	SW 16 G 24	10.00	Fair	CLR	56	33	56	30	42%	NA	NA	30.19	1022.2
09	10:53	SW 14 G 25	10.00	Fair	CLR	53	31			43%	NA	NA	30.22	1023.6
09	09:53	S 8	10.00	Fair	CLR	49	30			48%	46	NA	30.23	1023.8
09	08:53	S 9	10.00	Fair	CLR	44	27			51%	39	NA	30.23	1023.8
09	07:53	S 7	10.00	Fair	CLR	39	26			60%	34	NA	30.25	1024.4
09	06:53	S 5	10.00	Fair	CLR	37	24			59%	33	NA	30.25	1024.7
09	05:53	Calm	10.00	Fair	CLR	33	24	38	30	70%	NA	NA	30.24	1024.3
09	04:53	Calm	10.00	Fair	CLR	34	24			67%	NA	NA	30.24	1024.2
09	03:53	Calm	10.00	Fair	CLR	33	24			70%	NA	NA	30.24	1024.4
09	02:53	Calm	10.00	Fair	CLR	36	24			62%	NA	NA	30.25	1024.6
09	01:53	S 5	10.00	Fair	CLR	37	24			59%	33	NA	30.27	1025.1
09	00:53	Vrbl 6	10.00	Fair	CLR	38	25			60%	33	NA	30.27	1025.4
08	23:53	S 5	10.00	Fair	CLR	35	25	38	29	67%	31	NA	30.30	1026.2
08	22:53	S 5	10.00	Fair	CLR	32	24			73%	27	NA	30.33	1027.3
08	21:53	Calm	10.00	Fair	CLR	30	24			79%	NA	NA	30.35	1028.2
08	20:53	Calm	10.00	Fair	CLR	29	25			85%	NA	NA	30.36	1028.5
08	19:53	S 3	10.00	Fair	CLR	30	26			85%	NA	NA	30.36	1028.5
08	18:53	SE 3	10.00	Fair	CLR	34	27			76%	NA	NA	30.37	1028.8
08	17:53	SE 3	10.00	Fair	CLR	38	27	43	36	65%	NA	NA	30.37	1028.9
08	16:53	SE 6	10.00	Fair	CLR	41	28			60%	37	NA	30.38	1029.2
08	15:53	S 6	10.00	Fair	CLR	42	29			60%	38	NA	30.40	1029.8

08	14:53	S 5	9.00	Fair	CLR	41	29			62%	38	NA	30.42	1030.4			
08	13:53	S 8	9.00	A Few Clouds	FEW021	40	29			65%	35	NA	30.44	1031.2			
08	12:53	S 6	9.00	Fair	CLR	37	27			67%	32	NA	30.47	1032.4			
08	11:53	Vrbl 6	8.00	Fair	CLR	37	28	37	19	70%	32	NA	30.51	1033.6			
08	10:53	SW 5	8.00	Mostly Cloudy	BKN016	34	27			76%	29	NA	30.55	1034.9			
08	09:53	SW 3	6.00	Fair with Haze	CLR	31	26			82%	NA	NA	30.54	1034.7			
08	08:53	Calm	3.00	Fog/Mist	CLR	28	24			85%	NA	NA	30.56	1035.4			
08	07:53	Calm	3.00	Fog/Mist	BKN002	22	19			89%	NA	NA	30.54	1034.7			
08	06:53	S 3	4.00	Fair with Haze	CLR	19	14			81%	NA	NA	30.51	1033.8			
08	05:53	NA	5.00	Fair with Haze	CLR	20	15	22	20	81%	NA	NA	30.50	1033.2			
08	04:53	Calm	6.00	Fog/Mist	CLR	20	16			85%	NA	NA	30.48	1032.6			
08	03:53	Calm	6.00	Fog/Mist	CLR	20	16			85%	NA	NA	30.47	1032.2			
08	02:53	Calm	6.00	Fog/Mist	CLR	20	16			85%	NA	NA	30.48	1032.7			
08	01:53	Calm	6.00	Fog/Mist	CLR	21	17			85%	NA	NA	30.49	1032.8			
08	00:53	Calm	6.00	Fog/Mist	CLR	21	17			85%	NA	NA	30.49	1032.9			
07	23:53	Calm	6.00	Fog/Mist	CLR	22	18	29	22	85%	NA	NA	30.49	1032.9			
07	22:53	Calm	6.00	Fog/Mist	CLR	22	18			85%	NA	NA	30.49	1033.0			
07	21:53	Calm	6.00	Fog/Mist	CLR	23	19			85%	NA	NA	30.49	1032.9			
07	20:53	Calm	5.00	Fog/Mist	CLR	24	20			84%	NA	NA	30.48	1032.6			
07	19:53	Calm	5.00	Fair with Haze	CLR	25	20			81%	NA	NA	30.48	1032.5			
Date	**Time (cst)**	**Wind (mph)**	**Vis. (mi.)**	**Weather**	**Sky Cond.**	**Air**	**Dwpt**	**Max.**	**Min.**	**Relative Humidity**	**Wind Chill (°F)**	**Heat Index (°F)**	**altimeter (in.)**	**sea level (mb)**	**1 hr**	**3 hr**	**6 hr**
								6 hour									
						Temperature (ºF)							**Pressure**		**Precipitation (in.)**		

National Weather Service
Southern Region Headquarters
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Paducah, KY

Barkley Regional

Weather History for KPAH - February, 2018

February

12

2018

View
Saturday, February 3, 2018

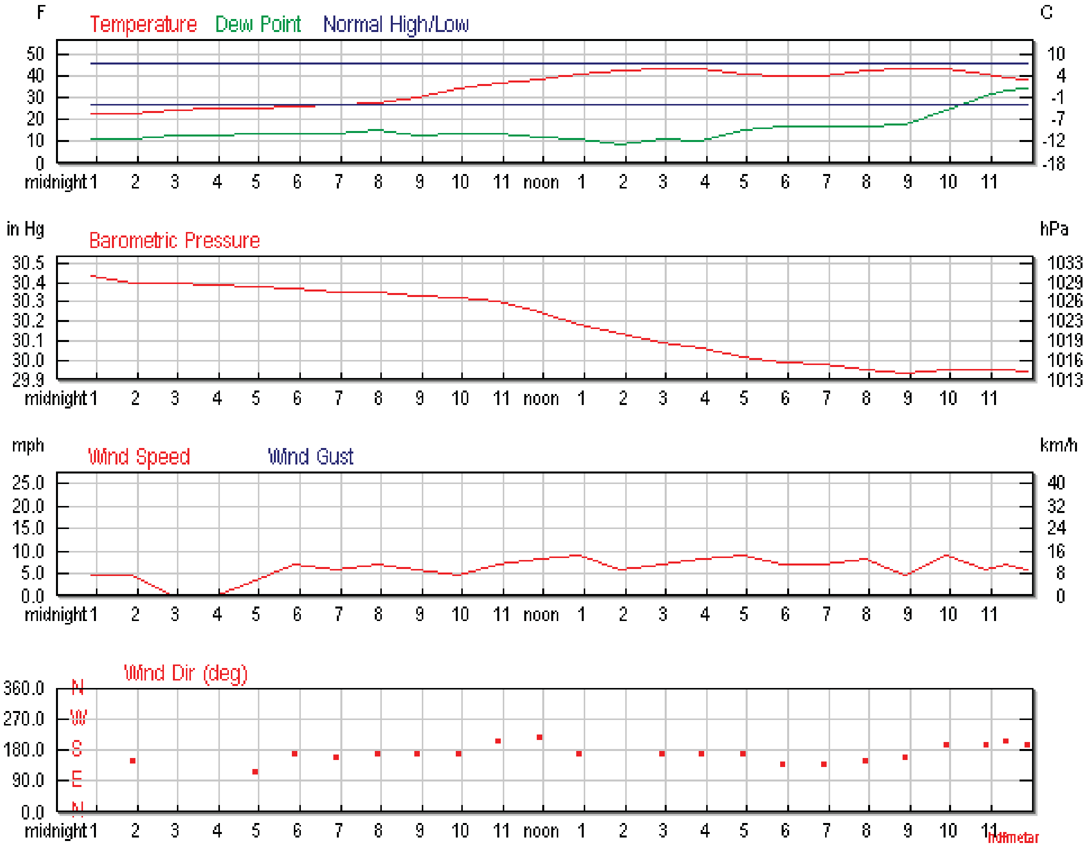
Daily | Weekly | Monthly | Custom

	Actual	Average	Record
Temperature			
Mean Temperature	**33** °F	**36** °F	
Max Temperature	**43** °F	**46** °F	**70** °F (1992)
Min Temperature	**22** °F	**27** °F	**-8** °F (1985)
Degree Days			
Heating Degree Days	32	29	
Month to date heating degree days	104	87	
Since 1 July heating degree days	2678	2660	
Cooling Degree Days	0	0	
Month to date cooling degree days	0	0	
Year to date cooling degree days	0	0	
Moisture			
Dew Point	**17** °F		
Average Humidity	51		

	Actual	Average	Record
Maximum Humidity	77		
Minimum Humidity	24		
Precipitation			
Precipitation	**0.08** in	**0.15** in	**1.68** in (1939)
Month to date precipitation	0.14	0.44	
Year to date precipitation	4.14	4.12	
Snow			
Snow	**T** in	**0.10** in	**3.00** in (1982)
Month to date snowfall	T	0.4	
Since 1 July snowfall	12.4	5.7	
Snow Depth	**0.00** in		
Sea Level Pressure			
Sea Level Pressure	**30.17** in		
Wind			
Wind Speed	**6** mph (South)		
Max Wind Speed	**13** mph		
Max Gust Speed	**18** mph		
Visibility	**10** miles		
Events	Rain		

T = Trace of Precipitation, MM = Missing Value   Source: NWS Daily Summary

Daily Weather History Graph


F
Temperature
Dew Point
Normal High/Low
C
in Hg
Barometric Pressure
hPa
mph
Wind Speed
Wind Gust
km/h
Wind Dir (deg)
midnight
noon
wxmetar

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KPAH

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Trip Planner

Search our weather history database for the weather conditions in past years. The results will help you decide how hot, cold, wet, or windy it might be!

Date:

February

3

Submit

Astronomy

Feb. 03, 2018	Rise	Set
Actual Time	6:55 AM CST	5:22 PM CST
Civil Twilight	6:28 AM CST	5:49 PM CST
Nautical Twilight	5:57 AM CST	6:20 PM CST
Astronomical Twilight	5:27 AM CST	6:51 PM CST
Moon	9:08 PM CST (2/3)	9:04 AM CST (2/3)
Length of Visible Light	11h 20m	
Length of Day	10h 26m	

Waning Gibbous, 87% of the Moon is Illuminated

Feb 3	Feb 7	Feb 15	Feb 23	Mar 1
Waning Gibbous	Last Quarter	New	First Quarter	Full

Hourly Weather History & Observations

Time (CST)	Temp.	Windchill	Dew Point	Humidity	Pressure	Visibility	Wind Dir	Wind Speed	Gust Speed	Precip	Events
12:53 AM	**23.0** °F	**17.0** °F	**10.9** °F	60%	**30.43** in	**10.0** mi	SSE	**4.6** mph	-	N/A	
1:53 AM	**23.0** °F	**17.0** °F	**10.9** °F	60%	**30.40** in	**10.0** mi	SSE	**4.6** mph	-	N/A	
2:53 AM	**24.1** °F	-	**12.9** °F	62%	**30.40** in	**10.0** mi	Calm	Calm	-	N/A	
3:53 AM	**25.0** °F	-	**12.9** °F	60%	**30.39** in	**10.0** mi	Calm	Calm	-	N/A	
4:53 AM	**25.0** °F	**20.7** °F	**14.0** °F	63%	**30.38** in	**10.0** mi	ESE	**3.5** mph	-	N/A	
5:53 AM	**26.1** °F	**18.4** °F	**14.0** °F	60%	**30.37** in	**10.0** mi	South	**6.9** mph	-	N/A	
6:53 AM	**27.0** °F	**20.5** °F	**14.0** °F	58%	**30.35** in	**10.0** mi	SSE	**5.8** mph	-	N/A	
7:53 AM	**28.0** °F	**20.8** °F	**15.1** °F	58%	**30.35** in	**10.0** mi	South	**6.9** mph	-	N/A	
8:53 AM	**30.0** °F	**24.1** °F	**12.9** °F	49%	**30.33** in	**10.0** mi	South	**5.8** mph	-	N/A	
9:53 AM	**34.0** °F	**29.8** °F	**14.0** °F	44%	**30.32** in	**10.0** mi	South	**4.6** mph	-	N/A	

Time (CST)	Temp.	Windchill	Dew Point	Humidity	Pressure	Visibility	Wind Dir	Wind Speed	Gust Speed	Precip	Events
10:53 AM	**37.0** °F	**31.6** °F	**14.0** °F	39%	**30.30** in	**10.0** mi	SSW	**6.9** mph	-	N/A	
11:53 AM	**37.9** °F	**32.1** °F	**12.0** °F	35%	**30.25** in	**10.0** mi	SW	**8.1** mph	-	N/A	
12:53 PM	**41.0** °F	**35.2** °F	**10.9** °F	29%	**30.18** in	**10.0** mi	South	**9.2** mph	-	N/A	
1:53 PM	**42.1** °F	**38.4** °F	**9.0** °F	26%	**30.14** in	**10.0** mi	Variable	**5.8** mph	-	N/A	
2:53 PM	**43.0** °F	**38.8** °F	**10.9** °F	27%	**30.09** in	**10.0** mi	South	**6.9** mph	-	N/A	
3:53 PM	**43.0** °F	**38.2** °F	**10.0** °F	26%	**30.06** in	**10.0** mi	South	**8.1** mph	-	N/A	
4:53 PM	**41.0** °F	**35.2** °F	**15.1** °F	35%	**30.02** in	**10.0** mi	South	**9.2** mph	-	N/A	
5:53 PM	**39.9** °F	**35.1** °F	**17.1** °F	40%	**29.99** in	**10.0** mi	SE	**6.9** mph	-	N/A	
6:53 PM	**39.9** °F	**35.1** °F	**17.1** °F	40%	**29.98** in	**10.0** mi	SE	**6.9** mph	-	N/A	
7:53 PM	**42.1** °F	**37.1** °F	**17.1** °F	37%	**29.95** in	**10.0** mi	SSE	**8.1** mph	-	N/A	
8:53 PM	**43.0** °F	**40.3** °F	**18.0** °F	37%	**29.93** in	**10.0** mi	SSE	**4.6** mph	-	N/A	
9:53 PM	**43.0** °F	**37.7** °F	**24.1** °F	47%	**29.95** in	**8.0** mi	SSW	**9.2** mph	**17.3** mph	**0.01** in	Rain
10:53 PM	**41.0** °F	**37.1** °F	**30.9** °F	67%	**29.95** in	**9.0** mi	SSW	**5.8** mph	-	**0.04** in	Rain
11:22 PM	**39.0** °F	**34.0** °F	**33.1** °F	79%	**29.95** in	**7.0** mi	SSW	**6.9** mph	-	**0.02** in	Rain
11:53 PM	**37.9** °F	**33.5** °F	**34.0** °F	86%	**29.94** in	**7.0** mi	SSW	**5.8** mph	-	**0.03** in	Rain

ATTACHMENT D5

ANALYTICAL RESULTS

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ANALYTICAL RESULTS

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Secondary Document

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

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DOE/LX/07-1289&D2/R1/A3

Secondary Document

Deleted: A2/R2

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

Date Issued—May 2018

Deleted: October 2017

Prepared for the
U.S. DEPARTMENT OF ENERGY
Office of Environmental Management

Prepared by
FLUOR FEDERAL SERVICES, INC.,
Paducah Deactivation Project
managing the
Deactivation Project at the
Paducah Gaseous Diffusion Plant
under Task Order DE-DT0007774

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CONTENTS

Comment [A1]: Changes to the D2/R1/A3 document are tracked in the body of the text. The information in this table of contents is based on the D2/R1/A2/R2.

FIGURES

TABLES

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ACRONYMS

AM	Action Memorandum
AOC	area of concern
AR	Administrative Record
ARAR	applicable or relevant and appropriate requirements
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
D&D	decontamination and decommissioning
DCS	derived concentration standard
DNAPL	dense nonaqueous-phase liquid
DOE	U.S. Department of Energy
DPT	Direct Push Technology
EE/CA	Engineering Evaluation/Cost Analysis
EI	environmental indicator
EIC	Environmental Information Center
ELCR	excess lifetime cancer risk
EM	environmental management
EMP	Environmental Monitoring Plan
EPA	U.S. Environmental Protection Agency
EQ	equalization
ERH	Electrical Resistance Heating
EU	exposure unit
EW	extraction well
FC	final characterization
FFA	Federal Facility Agreement
FS	feasibility study
FY	fiscal year
GDP	gaseous diffusion plant
GPRA	Government Performance Results Act
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
KDOW	Kentucky Division of Water
KDWM	Kentucky Division of Waste Management
KEEC	Kentucky Energy and Environment Cabinet
KPDES	Kentucky Pollutant Discharge Elimination System
KRS	*Kentucky Revised Statutes*
LATA Kentucky	LATA Environmental Services of Kentucky, LLC
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 Contingency Plan
ND	nondetect
NEPCS	Northeast Plume Containment System
NPL	National Priorities List
NSDD	North-South Diversion Ditch
NWPGS	Northwest Plume Groundwater System
O&M	operation and maintenance
OREIS	Oak Ridge Environmental Information System
OSWER	Office of Solid Waste and Emergency Response
OU	operable unit
PGDP	Paducah Gaseous Diffusion Plant
PHEA	Public Health and Ecological Assessment
PRG	Preliminary Remediation Goal
RA	remedial action
RAO	remedial action objective
RAR	Removal Action Report
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
SWMU	solid waste management unit
SWOU	Surface Water Operable Unit
TBC	to be considered
TSCA	Toxic Substances Control Act
TSS	total suspended solids
TVA	Tennessee Valley Authority
UCRS	Upper Continental Recharge System
USCA	*United States Code Annotated*
USEC	United States Enrichment Corporation
VOC	volatile organic compound
WAG	waste area group
WKWMA	West Kentucky Wildlife Management Area

EXECUTIVE SUMMARY

The cleanup strategy under the Site Management Plan (SMP) (DOE 2014) of the *Federal Facility Agreement for the Paducah Gaseous Diffusion Plant* (FFA) establishes five operable units (OUs) to be accomplished as part of the pre-gaseous diffusion plant (GDP) shutdown phase. These include the Groundwater OU (GWOU), the Surface Water OU (SWOU), the Soils OU, Burial Grounds OU (BGOU), and the Decontamination and Decommissioning (D&D OU) (EPA 1998). Each OU is scoped to remediate areas and media associated with the Paducah Gaseous Diffusion Plant (PGDP). A final Comprehensive Site OU evaluation will occur following plant shutdown and completion of D&D of the GDP, D&D of the Depleted Uranium Hexafluoride (DUF_6) Conversion Plant, and completion of post-shutdown cleanup of each of the post–GDP specific OUs. The specific scopes and further discussions for each OU and associated follow-up actions are addressed in the SMP.

The U.S. Environmental Protection Agency (EPA) defines the 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, policy, and discretionary reviews because PGDP has implemented both removal and remedial actions.

This Five-Year Review encompasses the remedial actions that the U.S. Department of Energy (DOE) has taken under the respective OUs, plus the Water Policy removal action, Surface Water Interim Corrective Measures, and Surface Water On-site Sediment Removal. The FFA for PGDP includes requirements for synchronizing Five-Year Reviews of remedial actions (Section XXX). The triggering action for this review is the five-year anniversary of the third synchronized five-year review conducted at PGDP in 2008 for activities associated with response actions from 2003 through 2007. [*Five-Year Review for Remedial Actions at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 2009a)]. This Five-Year Review encompasses activities associated with response actions from 2008 through 2012. A form summarizing PGDP, issues from the review, recommendations, and protectiveness statements is presented as Table ES.1. This form is the updated 2011 version of the form from Appendix F of EPA guidance document *Comprehensive Five-Year Review* (EPA 2001).

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): Cynthia Zvonar		
Author affiliation: U.S. Department of Energy		
Review period: 01/01/2013–08/29/2013		
Date of site inspection: 01/17/2013–02/19/2013		
Type of review: Statutory, Policy, and Discretionary		
Review number: 4		
Triggering action date: 12/30/2008		
Due date (*five years after triggering action date*): 12/30/2013		

Issues/Recommendations				
OU(s) without Issues/Recommendations Identified in the Five-Year Review:				
N/A				
Issues and Recommendations Identified in the Five-Year Review:				
OU(s): Groundwater, Northwest Plume	**Issue Category:** Remedy Performance			
	Issue: The Northwest Plume is an interim remedial action (IRA) designed to initiate hydraulic control of the high trichloroethene (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.			
	Recommendation: Additional action, if necessary, for long-term protection should be evaluated and documented in the final decision document for the Dissolved-Phase Plume and the Comprehensive Site Operable Unit (CSOU).			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	Federal Facility	EPA/State	09/30/2029*

*Date reflects Dissolved-Phase Plume ROD.

OU(s): Groundwater, Northeast Plume	**Issue Category**: Remedy Performance			
	Issue: The Northeast Plume remedial action 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 remedial action objectives (RAOs) were met, additional mass removal can be achieved by an optimization.			
	Recommendation: The FFA parties recommended optimization of the Northeast Plume treatment system to increase TCE and 1,1-dichloroethene mass removal and enhance the contaminant capture in the Northeast Plume in the vicinity of the eastern edge of the PGDP facility. The optimization is planned to occur in fiscal year 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 extraction wells (EWs).			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	No	Federal Facility	EPA/State	12/30/2017

OU(s): Groundwater, Northeast Plume	**Issue Category:** Remedy Performance			
	Issue: The Northeast Plume is an IRA designed to initiate hydraulic control of the high TCE concentration area within the Northeast Plume and does not achieve final cleanup of the groundwater contamination. A follow-up evaluation is needed to ensure long-term protectiveness.			
	Recommendation: Additional action, if necessary, for long-term protection should be evaluated and documented in the final decision document for the Dissolved-Phase Plume and the CSOU.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	Federal Facility	EPA/State	09/30/2029*

*Date reflects Dissolved-Phase Plume ROD.

OU(s): Groundwater, Water Policy	**Issue Category:** Remedy Performance			
	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.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	Federal Facility	EPA/State	12/30/2014

<table>
<tr><td rowspan="3">OU(s):
Groundwater,
C-400 Electrical Resistance Heating (ERH)</td><td colspan="4">Issue Category: Remedy Performance</td></tr>
<tr><td colspan="4">Issue: The ROD selected ERH to address the volatile organic compound (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 the RAOs in the Upper Continental Recharge System and the upper Regional Gravel Aquifer (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.</td></tr>
<tr><td colspan="4">Recommendation: 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.</td></tr>
<tr><td>Affect Current Protectiveness</td><td>Affect Future Protectiveness</td><td>Implementing Party</td><td>Oversight Party</td><td>Milestone Date</td></tr>
<tr><td>No</td><td>Yes</td><td>Federal Facility</td><td>EPA/State</td><td>TBD</td></tr>
</table>

<table>
<tr><td rowspan="3">OU(s):
Groundwater,
C-400 ERH</td><td colspan="4">Issue Category: Remedy Performance</td></tr>
<tr><td colspan="4">Issue: 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. A follow-up evaluation is needed to ensure long-term protection.</td></tr>
<tr><td colspan="4">Recommendation: Additional action, if necessary, for long-term protection should be evaluated and documented in the final decision documents for the GDP Groundwater Sources OU and the CSOU.</td></tr>
<tr><td>Affect Current Protectiveness</td><td>Affect Future Protectiveness</td><td>Implementing Party</td><td>Oversight Party</td><td>Milestone Date</td></tr>
<tr><td>No</td><td>Yes</td><td>Federal Facility</td><td>EPA/State</td><td>TBD*</td></tr>
</table>

*****The GDP Groundwater Sources OU evaluation will occur following GDP ceases operation and a decision has been made to proceed with D&D of the GDP.

<table>
<tr><td rowspan="3">OU(s):
Groundwater,
C-400 ERH</td><td colspan="4">Issue Category: Remedy Performance</td></tr>
<tr><td colspan="4">Issue: 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 and, therefore, 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.</td></tr>
<tr><td colspan="4">Recommendation: To ensure that the remedy is protective for vapor intrusion, it is recommended that a vapor intrusion analysis be performed consistent with the PGDP Risk Methods Document as part of any subsequent follow-up C-400 actions (e.g., GDP Groundwater Sources OU, Dissolved-Phase Plume project).</td></tr>
<tr><td>Affect Current Protectiveness</td><td>Affect Future Protectiveness</td><td>Implementing Party</td><td>Oversight Party</td><td>Milestone Date</td></tr>
<tr><td>No</td><td>Yes</td><td>Federal Facility</td><td>EPA/State</td><td>09/30/2029*</td></tr>
</table>

*Date reflects Dissolved-Phase Plume ROD.

<table>
<tr><td rowspan="3">OU(s):
Groundwater,
Southwest Plume</td><td colspan="4">Issue Category: Remedy Performance</td></tr>
<tr><td colspan="4">Issue: The Southwest Plume project is a remedial action under construction. The remedial action is designed to address VOC releases to groundwater. A follow-up evaluation is needed to ensure long-term protection.</td></tr>
<tr><td colspan="4">Recommendation: 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 Plume project).</td></tr>
<tr><td>Affect Current Protectiveness</td><td>Affect Future Protectiveness</td><td>Implementing Party</td><td>Oversight Party</td><td>Milestone Date</td></tr>
<tr><td>No</td><td>Yes</td><td>Federal Facility</td><td>EPA/State</td><td>09/30/2029*</td></tr>
</table>

*Date reflects Dissolved-Phase Plume ROD.

<table>
<tr><td rowspan="3">OU(s): Surface Water, NSDD Sections 1 and 2</td><td colspan="4">Issue Category: Institutional Controls</td></tr>
<tr><td colspan="4">Issue: The 2008 Five-Year Review recommended that a residual risk evaluation be performed to determine if the remedy could be optimized, leading to the removal of institutional controls and/or cessation of the five-year reviews. 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.</td></tr>
<tr><td colspan="4">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 (LUCAP) 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.</td></tr>
<tr><th>Affect Current Protectiveness</th><th>Affect Future Protectiveness</th><th>Implementing Party</th><th>Oversight Party</th><th>Milestone Date</th></tr>
<tr><td>No</td><td>No</td><td>Federal Facility</td><td>EPA/State</td><td>12/30/2014</td></tr>
</table>

<table>
<tr><td rowspan="3">OU(s): Surface Water, C-746-K Landfill</td><td colspan="4">Issue Category: Monitoring</td></tr>
<tr><td colspan="4">Issue: The shaft of monitoring well (MW) 301 has buckled so that any repair/replacement of the pump would not be possible.</td></tr>
<tr><td colspan="4">Recommendation: 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.</td></tr>
<tr><th>Affect Current Protectiveness</th><th>Affect Future Protectiveness</th><th>Implementing Party</th><th>Oversight Party</th><th>Milestone Date</th></tr>
<tr><td>No</td><td>No</td><td>Federal Facility</td><td>EPA/State</td><td>12/30/2015</td></tr>
</table>

OU(s): Surface Water, Interim Corrective Measures (ICM)	Issue Category: Institutional Controls			
	Issue: An evaluation of both sign programs [Surface Water ICM signs with Environmental Indicator (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.			
	Recommendation: Specifically, the evaluation proposes that, where the signs are co-located, 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 (see Figure ES.1).			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	No	Federal Facility	EPA/State	12/30/2014

Protectiveness Statement(s)

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

Protectiveness Statement:

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 plume, need to be evaluated for long-term protection.

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

Protectiveness Statement:

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, need to be evaluated for long-term protection.

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

Protectiveness Statement:

The remedy for the Cylinder Drop Test Area 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 remedial action shall be selected and implemented…" as part of the CSOU.

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
Groundwater OU, 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 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, need to be evaluated for long-term protection.

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
Groundwater OU, 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, 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. However, in order to establish long-term protectiveness, additional remedial actions will be evaluated and selected, as necessary, under the GDP Groundwater Sources OU.

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
Groundwater OU, Southwest Plume	Will be Protective	N/A

Protectiveness Statement:

The remedial action for VOC sources at Southwest Plume 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.), has addressed adequately known exposure pathways that could result in unacceptable risks originating from the Southwest Plume.

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 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 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.

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

Protectiveness Statement:

The remedy for the C-746-K Landfill 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 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 remedial action shall be selected and implemented…" as part of the CSOU.

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
Surface Water Interim Corrective Measures	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. However, in order to establish long-term protectiveness, additional remedial actions 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 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 remedial action 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 currently is being 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: N/A	*Addendum Due Date (if applicable):* N/A
Protectiveness Statement: N/A	

*Off-site is defined as off DOE property for this document unless otherwise noted.

The assessments of this 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 Five-Year Review.

Table ES.2. Decision Document and Site/Project Name Included in 2013 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	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	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 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	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 Landfill	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	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	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 (i.e., ROD or AM). This 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.

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1. INTRODUCTION

The purpose of this Five-Year Review is to determine whether the remedies at the Paducah Gaseous Diffusion Plant (PGDP) 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. This Five-Year Review is part of the Administrative Record (AR) at PGDP.

The U.S. Department of Energy (DOE) has conducted this 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 (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 March 17, 2013, announcing the Five-Year Review had been initiated and requesting that any suggestions, issues, questions, or concerns regarding this review be provided from March 18 through March 22, 2013. 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 for any operable unit (OU). EPA Guidance (OSWER 9355.7-21) defines the following 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 remedial action [RA], hazardous substances, pollutants, or contaminants will remain on site above levels that allow for unlimited use and unrestricted exposure; and

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

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

- A pre- or post-SARA remedial action 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 remedial action 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 NPL [National Priorities List] 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 remedial action 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 Northwest Plume, Northeast Plume, C-400 Electrical Resistance Heating (ERH), Water Policy, Surface Water Interim Corrective Measures (ICMs), and Surface Water On-site Sediment Removal. The Northwest Plume project, C-400 ERH, and Northeast Plume project are being conducted as Policy Reviews because these actions are interim remedial actions (IRAs) whereby the objectives are not intended to obtain health-based levels to achieve unlimited use and unrestricted exposure and/or may operate for five years or longer. Five-Year Reviews are being conducted for the Water Policy, Surface Water ICM, and Surface Water On-site Sediment Removal as Discretionary Reviews. No Five-Year Addendum reviews are being conducted.

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 PGDP. Various remedial action projects at PGDP 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 will 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 remedial action is implemented as part of the Surface Water Operable Unit (SWOU). The Surface Water On-site Sediment Removal 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 2013 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	Ground-water Operable Unit (GWOU)	Northwest Plume

Table 1.1. Decision Document and Site/Project Name Included in 2013 Five-Year Review (Continued)

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 at the Northeast Plume, Paducah Gaseous Diffusion Plant, Paducah, Kentucky, DOE/OR/06-1356&D2	Northeast Plume	GWOU	Northeast Plume
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 or LasagnaTM	GWOU	Solid Waste Management Unit (SWMU) 91
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	GWOU C-400 ERH, currently underway
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	New to Five-Year Review, currently underway
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 Ditch (NSDD) Source Control	SWOU	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	SWOU	New to Five-Year Review
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 Landfill	SWOU	Waste Area Groups (WAGs) 1 and 7, 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	SWOU	WAGs 1 and 7, SWMU 100
Interim Measure Report for Institutional Control of Off-Site Contamination in Surface Water, DOE/OR/07-1206&D1	Surface Water Interim Corrective Measures	SWOU	Surface Water Interim Corrective Measures
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	New to Five-Year Review

Table 1.1. Decision Document and Site/Project Name Included in 2013 Five-Year Review (Continued)

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 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	Burial Grounds Operable Unit (BGOU)	WAG 22, SWMU 2

*On-site is defined in this document as on DOE property.

The FFA includes provisions for combining Five-Year Reviews of remedial actions 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 (KEEC).

DOE is the lead agency for these response actions, and EPA and the Kentucky Department for Environmental Protection (KDEP) provide regulatory oversight pursuant to the FFA. This Five-Year Review contains reviews of completed projects and summaries of projects currently underway. The triggering action for this review is the five-year anniversary of the third combined Five-Year Review conducted at PGDP [*Five-Year Review for Remedial Actions at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 2009a)].

This 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 life-cycle 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). PGDP subsequently developed a site-specific Memorandum of Agreement (MOA) and Land Use Control Assurance Plan (LUCAP) (DOE 2000a). The PGDP 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. The effectiveness of the institutional controls or LUCs is addressed in this Five-Year Review. The PGDP 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 remedial action(s) resulting from the anticipated land use changes; and

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

The review of the completed response actions was conducted during January through April 2013 for the period extending from January 2008 through December 2012. DOE and its prime remediation contractor, LATA Environmental Services, LLC, (LATA Kentucky) 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 PGDP.

Table 2.1. Chronology of Significant Site Events at PGDP

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	PGDP 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	PGDP 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 for hydraulic containment and treatment of high concentrations of off-site TCE contamination in the Northwest Plume.	Northwest Plume	GWOU	26	201	Ground-water	IRA
Mar–1994	Issued ROD that instituted action to treat certain plant effluent and control the migration of contaminated sediment associated with the NSDD.	North-South Diversion Ditch	SWOU	25	59	Surface water	IRA
May–1994	PGDP is placed on NPL.	N/A	N/A	N/A	N/A	N/A	N/A
Aug–1994	Action memorandum approved for extended municipal water line to residents affected by off-site groundwater contamination.	Water Policy	GWOU	26	201, 202	Ground-water	Non-time-critical Removal action
Jun–1995	Issued ROD for hydraulic containment and treatment of high concentrations of off-site TCE contamination in the Northeast Plume.	Northeast Plume	GWOU	26	202	Ground-water	IRA
Aug–1995	Northwest Plume Groundwater System begins operation.	Northwest Plume	GWOU	26	201	Ground-water	IRA

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

Date of Action	Response Description	Site/Project Name	OU	WAG	SWMU	Media	Response Type
Sept–1995	The interim 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 SWMU 2.	C-749 Uranium Burial Ground	BGOU	22	2	Soil and Ground-water	IRA
Feb–1997	Northeast Plume Groundwater System begins operation.	Northeast Plumes	GWOU	26	202	Ground-water	IRA
Feb–1998	FFA is signed with the 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 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	Non-time-critical removal action
Sep–2002	Remedial action for Sections 1 and 2 of the NSDD	North-South Diversion Ditch	SWOU	25	59	Sediment and soil	IRA
Dec–2003	First combined 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 PGDP (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 Lime House, C-405 Incinerator	D&D	30	480 & 55	Building structures	Non-time-critical removal action
Nov–2008	Second combined Five-Year Review is issued.	All applicable projects	Applies to all activities associated with all OUs.				
Apr–2009	Action Memorandum (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 PGDP.	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	Non-time-critical removal action
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	Non-time-critical removal action
Nov–2009	Issued addendum to document a change in scope of the C-410 removal action to 1) expand the scope of the existing non-time-critical removal action 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	Non-time-critical removal action

Table 2.1. Chronology of Significant Site Events at PGDP (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	Non-time-critical removal action
Sept–2010	Issued an Explanation of Significant Differences to the ROD for the IRA of Northwest Plume. The Northwest Plume Groundwater Treatment System was optimized by placing existing southern extraction wells (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: SWMU 1—*In situ* source treatment using deep soil mixing with interim LUCs. SWMU 211-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. SWMU 211-B—*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 & -B	Soil	Remedial Action

*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.

3. BACKGROUND

3.1 PHYSICAL CHARACTERISTICS

PGDP is located in northwestern 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 PGDP is approximately 650 acres located within a fenced security area. Surrounding the industrial portion of the reservation is the West Kentucky Wildlife Management Area (WKWMA).

Several groundwater-bearing zones are present in the PGDP area. 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 PGDP (MMES 1992). The RGA is the dominant groundwater flow system at PGDP and contains the on-site and off-site contaminant plumes.

Groundwater flow is predominately vertically downward in the UCRS, providing recharge to the RGA. Rainfall infiltration and leakage from PGDP 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 PGDP (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 PGDP, but upward near the Ohio River.

The Porters Creek Clay is a confining unit to groundwater flow south of PGDP. A shallow water table flow system is developed in gravels that overlie the Porters Creek Clay south of the PGDP industrial area and underlies the C-746-K Landfill, (the Terrace Gravel flow system). Discharge from the Terrace Gravel flow system provides baseflow to Bayou Creek and underflow to the UCRS under PGDP.

3.2 LAND AND RESOURCE USE

During the January 2008 through December 2012 review period, PGDP remained an active uranium enrichment plant. The plant is owned by DOE and was leased to and operated by the United States Enrichment Corporation (USEC) during the review period. Enrichment operations began in 1952, and the plant became fully operational in 1955. Hazardous, nonhazardous, and radioactive wastes have been generated, stored, and disposed of at PGDP. The industrial portion of PGDP, 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 PGDP converts DUF_6 stored at Paducah into a more stable chemical form suitable for beneficial reuse or disposal.

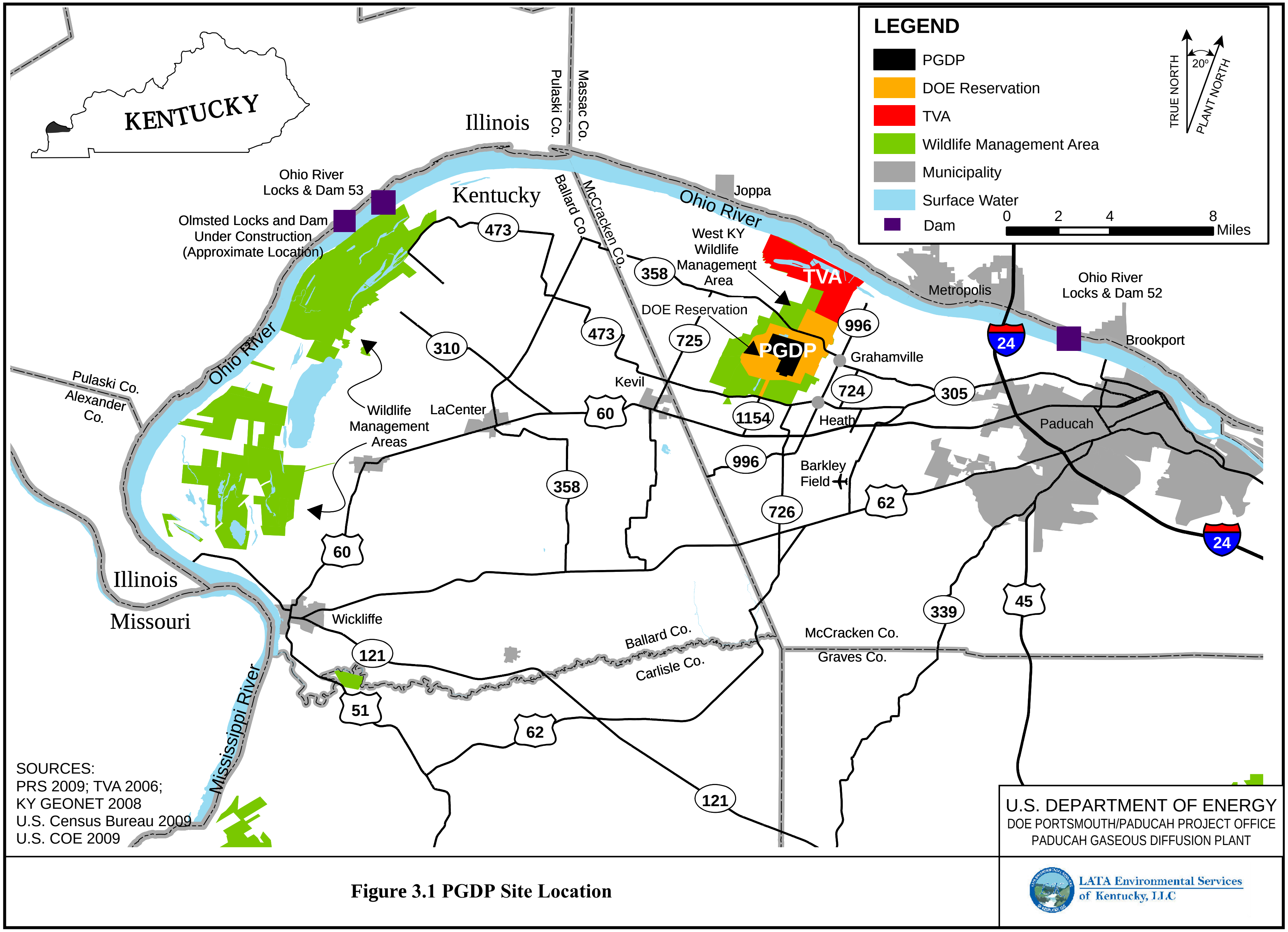
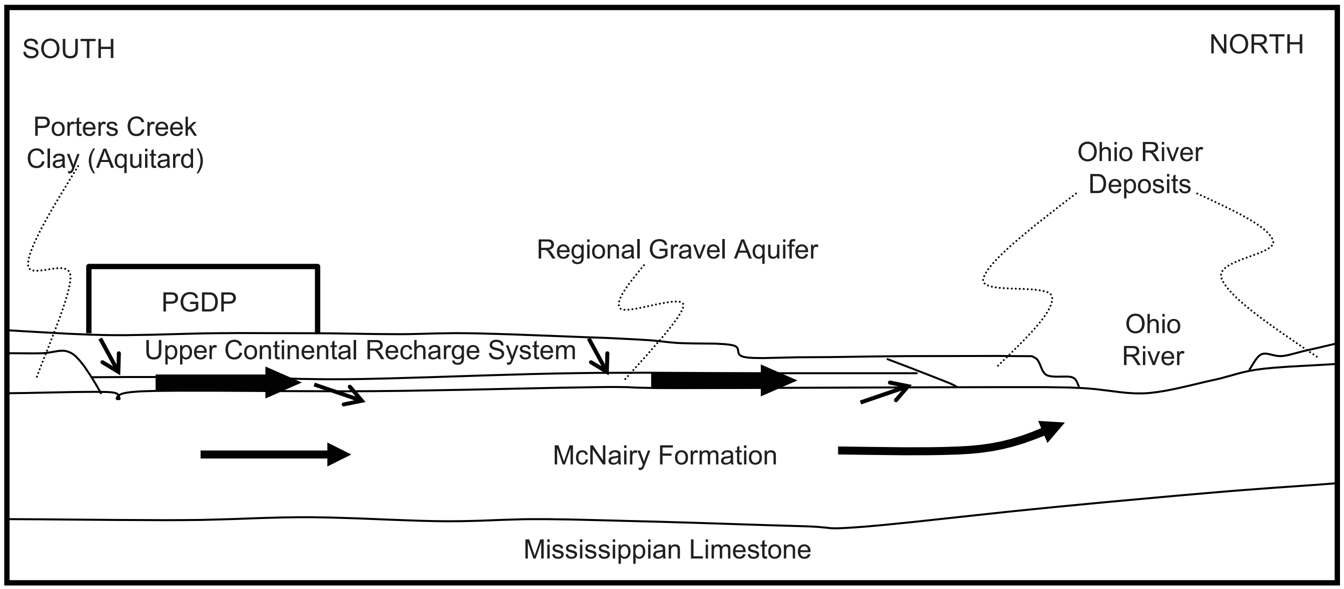


Figure 3.1 PGDP Site Location



Arrows indicate groundwater flow direction

Vertical Exaggeration = 10X

Figure 3.2. Water-Bearing Zones in the PGDP Area

DOE currently holds a lease agreement with USEC for the production facilities at PGDP and 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 the 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 PGDP.

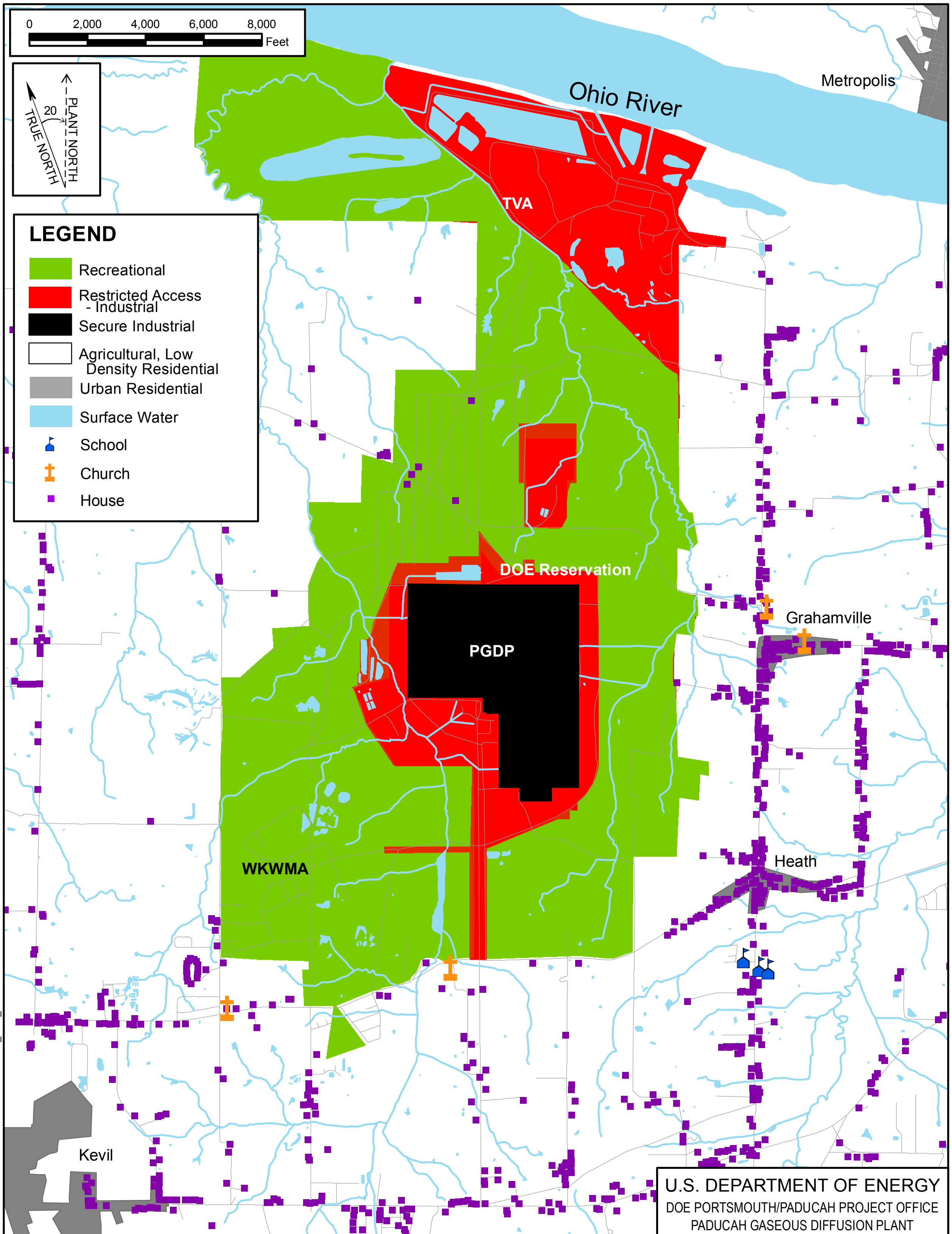
North of the DOE Reservation and WKWMA is the Shawnee Fossil Plant, operated by the Tennessee Valley Authority (TVA). This TVA property is designated as industrial.

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.

As noted above, PGDP 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 PGDP is approximately 534,000. Based on population data from the 2010 census, approximately 104,000 people live within 20 miles of PGDP and homes are scattered along rural roads around the plant. The population of Paducah, based on the 2010 U.S. Census, is 26,307. The closest communities to PGDP are the unincorporated towns of Grahamville and Heath which are 1.24 and 1.86 miles east of the plant, respectively. The nearest schools are Heath Elementary, Middle, and High Schools. These are 1.86 miles southeast of the plant near the Heath community. The nearest hospitals are located in Paducah. PGDP 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 PGDP and connects to the Illinois Central Gulf Railroad. The nearest airport is Barkley Regional Airport located approximately 3.7 miles southeast of the PGDP. Metropolis, Illinois, and Kevil, Kentucky, are the nearest municipal areas and are shown as urban residential land use (see Figure 3.3).

The Ohio River is navigable along its entire length and, near PGDP, has a downstream connection to the Mississippi River and an upstream connection to the Tennessee River. Dams (i.e., Locks and Dams 52 and 53) are located on the Ohio River, both upstream and downstream of PGDP. The Olmstead Locks and Dam currently are under construction to replace Locks and Dam 52 and 53, with an estimated operational date of 2020. In addition, the Kentucky Lock and Dam is located on the Tennessee River near its confluence with the Ohio River. Figure 3.1 is a map showing the land use areas surrounding PGDP. PGDP 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, PGDP is within the drainage areas of the Ohio River, Bayou Creek (also known as Big Bayou Creek), and Little Bayou Creek.

The plant 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 the plant that flows generally northward to the Ohio River. Little Bayou Creek becomes a perennial stream at the east outfalls of PGDP 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 PGDP. Contributions from PGDP comprise approximately 85% of flow within Bayou Creek and 100% of flow within Little Bayou Creek.



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

LATA Environmental Services of Kentucky, LLC

Figure 3.3. Land Use in Proximity to PGDP

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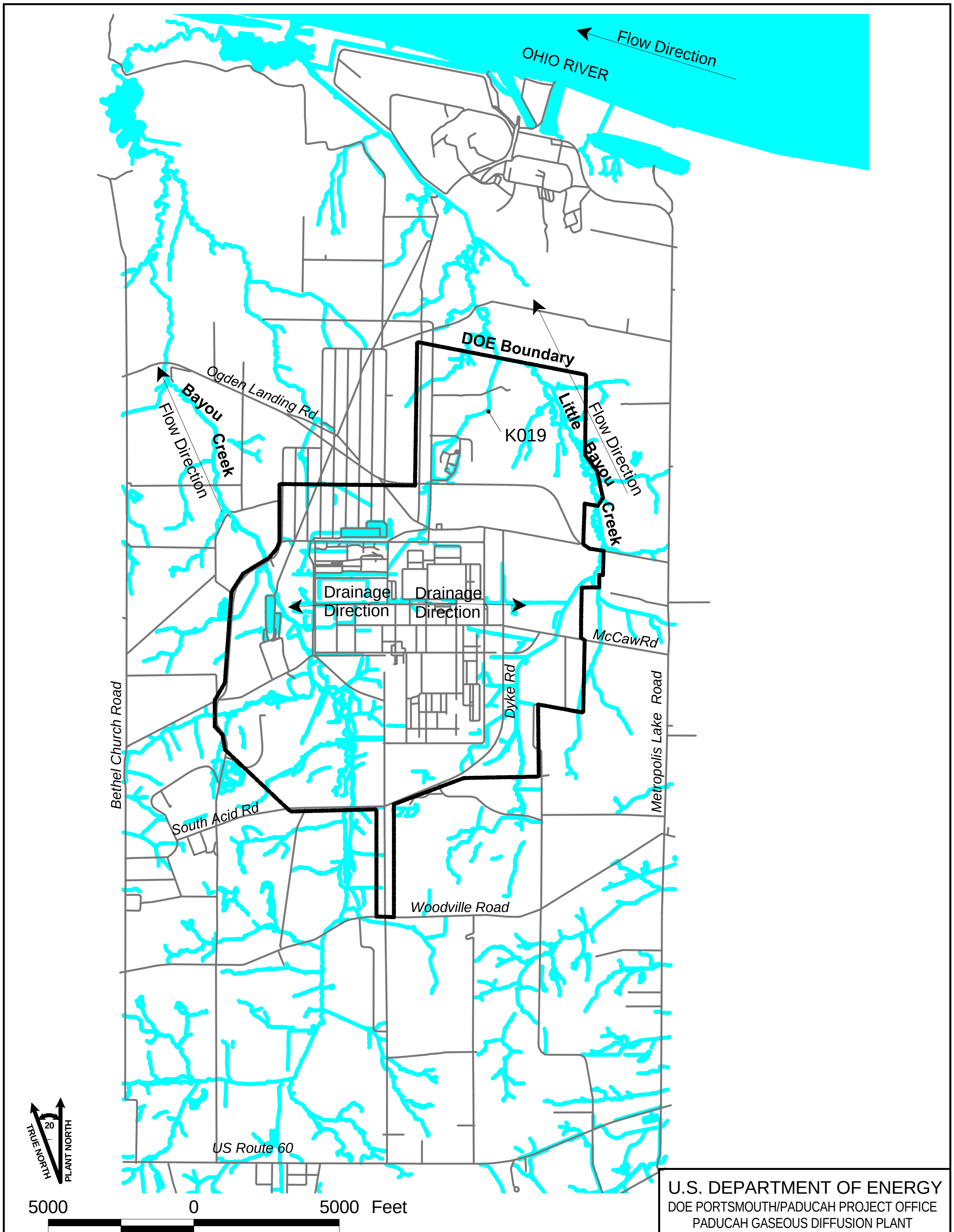

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DOE PORTSMOUTH/PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

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

LATA Environmental Services of Kentucky, LLC

Figure No. Fig 3-4 Revised 4-13.pdf
DATE 4-9-2013

3.3 HISTORY OF CONTAMINATION

Historical activities at PGDP 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 PGDP 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 PGDP facility. DOE placed 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 PGDP in 1953 as a contaminant in feed material during a program in which spent nuclear reactor fuel was fed into the plant processes.

Further sampling showed that a commonly used solvent, TCE, also was present in off-site wells. TCE had been used as a cleaning solvent at PGDP since its construction, but has not been used since 1993 (DOE 2001a). 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 PGDP 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 plant construction. Waste TCE was disposed of in on-site landfills and in a historical landfarming operation. In PGDP cylinder drop test, TCE was placed into a pit and used as a refrigerant in tests to determine cylinder integrity (Chapter 7).

PCBs have been found in sediment and fish downstream of the plant. PCBs have been used extensively as an insulating, nonflammable, thermally conductive fluid in electrical capacitors and transformers at PGDP. 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 plant 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 PGDP 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 where uranium was washed into ditches and creeks.

3.4 INITIAL RESPONSE

After the discovery of groundwater contamination in 1988, DOE placed affected residences and businesses on an alternate water supply and began an intensive monitoring and investigation program to define the extent of contamination. PGDP was proposed for the National Priorities List 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 Northwest Plume Groundwater System and the Northeast Plume Containment

System, and surface water institutional controls to reduce further the risks posed to human health and environment by releases from PGDP.

After addressing immediate off-site risks, DOE identified potential areas of contamination at PGDP (e.g., burial grounds, spill sites, and container storage areas) as SWMUs and areas of concern (AOCs). DOE then grouped most of the SWMUs and AOCs 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 PGDP. This restructuring reflects the accomplishment of sitewide remedial objectives through an OU approach based on the primary exposure pathways.

At PGDP, site cleanup will be implemented in a phased approach including cleanup activities that currently are being conducted prior to shutdown of the operating gaseous diffusion plant (pre-GDP Shutdown activities), followed by post-GDP Shutdown cleanup activities, and then by implementation of the Final Comprehensive Site OU (CSOU). Through implementation of these three phases, a series of prioritized response actions through which short-term protection goals, intermediate performance goals, and long-term final cleanup goals will be attained. Within this approach, the short-term protection goals are to control risks to humans and the environment; intermediate-term performance goals are to reduce, control, or minimize contaminants found in source areas; and long-term goals are to evaluate and pursue additional actions determined necessary to achieve the contaminant level reductions to provide long-term protectiveness. To achieve these goals, DOE and the regulatory agencies have agreed that PGDP cleanup activities will occur in a sequenced approach consisting of (1) pre-shutdown scope, (2) post-shutdown scope, and (3) CSOU scope. The pre-shutdown scope is associated with media-specific OUs initiated prior to shutdown of the operating GDP (pre-GDP shutdown activities). These media-specific OUs were established by developing a site conceptual risk model for each source area. This process included a qualitative evaluation of contaminant types and concentrations, release mechanisms, likely exposure pathways, estimated points of exposure, and potential receptors based on current and reasonably foreseeable future land groundwater uses. The source areas for the pre-GDP shutdown scope have been grouped into five media-specific OUs as follows (DOE 2014):

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

The Site Management Plan (SMP) (DOE 2014) identifies the actions that have been reviewed as part of this Five-Year Review as IRAs or removal actions (with the exception of Southwest Plume). Each of these interim actions and the Southwest Plume will be subject to further evaluation to support long-term protectiveness for future final decisions. The final action to support National Priorities List 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 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	GDP Groundwater Sources
GWOU: Southwest Plume	Dissolved-Phase Plumes OU
SWOU: NSDD Source Control	SWOU
SWOU: NSDD Sections 1 and 2	SWOU
SWOU: C-746-K 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 considerations such as regulator expectations, risk-based decision making, compliance with other programs, technical considerations associated with GDP operations, mortgage reduction, and demonstrated progress toward completing the environmental management (EM) mission. Both the FFA and the SMP document 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 screening 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 plant 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 volatile organic compound (VOC) contamination at the C-400 Cleaning Building area, which is part of the GWOU.

In order to keep residents and the community informed of the remedial efforts taking place at PGDP, 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 PGDP. 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.

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 PGDP, contaminants by media, and results of site investigations are included in the following sections. Table 3.1 contains the COCs by media addressed by the actions included in this Five-Year Review.

Table 3.1. COCs by Media

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

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 the previous Five-Year Review are listed in Table 4.1. The location of the discussion of each action within this document is shown on Figure 4.1, the latest approved plume map, which shows the TCE plume based on 2012 data.

Table 4.1. Site/Project with Response Actions Taken at PGDP

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 Electrical Resistance Heating, currently underway
10.	Southwest Plume	GWOU	New to Five-Year Review, currently underway
11.	NSDD Source Control	SWOU	NSDD Source Control
12.	NSDD Sections 1 and 2	SWOU	NSDD Sections 1 and 2
13.	C-746-K Landfill	SWOU	WAGs 1 and 7, SWMU 8
14.	Fire Training Area	SWOU	WAGs 1 and 7, SWMU 100
15.	Surface Water Interim Corrective Measures	SWOU	Surface Water Interim Corrective Measures
16.	Surface Water On-site Sediment Removal	SWOU	New to Five-Year Review
17.	C-749 Uranium Burial Ground	BGOU	WAG 22, SWMU 2

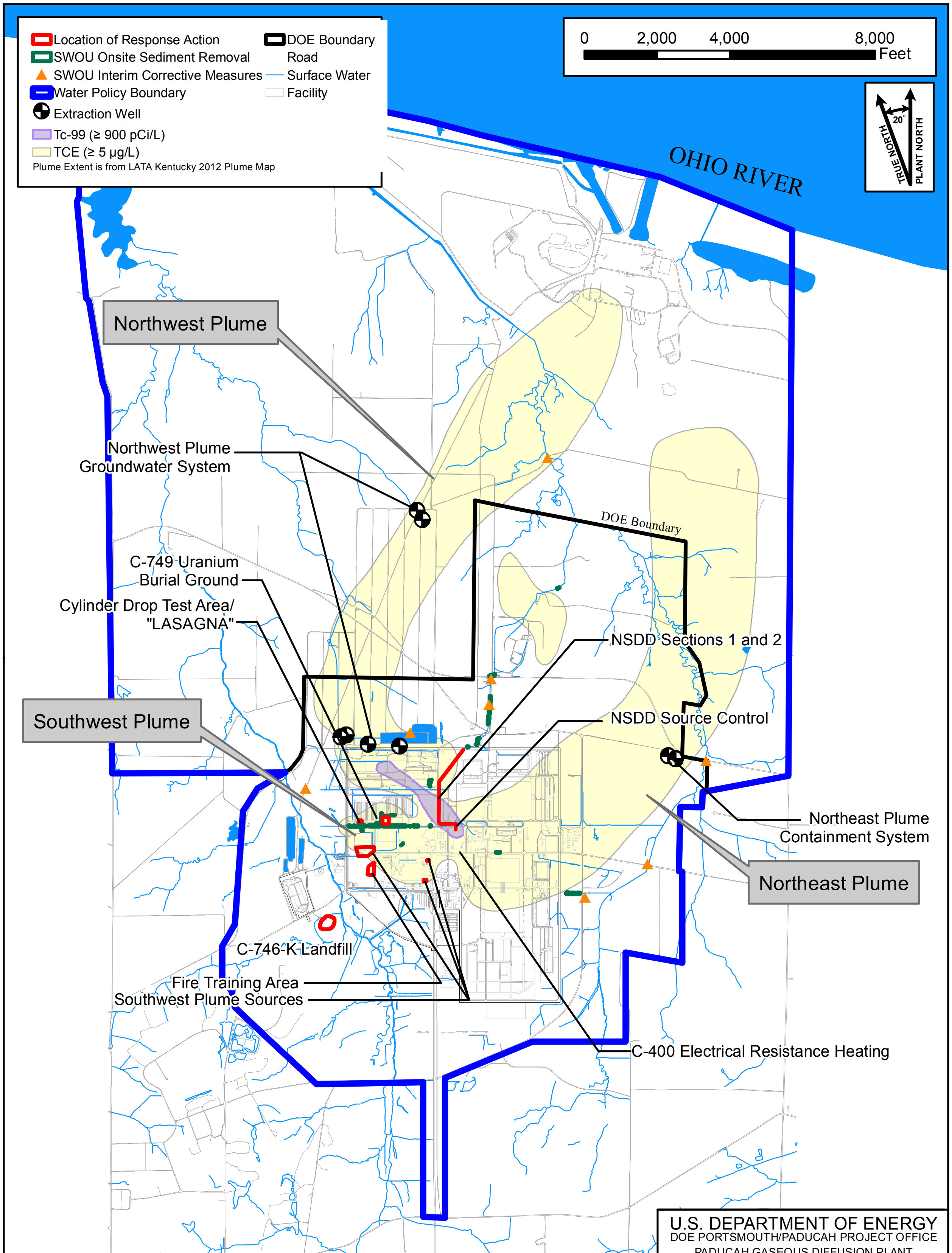

Figure 4.1. Locations of Response Actions Taken at PGDP

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5. NORTHWEST PLUME

After the initial discovery of contamination at PGDP in August 1988, DOE conducted a site investigation (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.

Outside of the immediate vicinity of its PGDP 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) 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 controlled by the PGDP and the TVA Shawnee Fossil Plant and sparsely populated areas between the two reservations. 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. The DOE maintains a Water Policy (evaluated in Section 8) that controls access to the groundwater through a license agreement process with landowners with private wells in the area of the plume, whereby DOE provides a household water supply to the area residents in return, 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 Northwest Plume Groundwater System (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 2012, which is the latest available plume map (LATA Kentucky 2014). 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 Northwest Plume Groundwater System has continued to operate since August 1995.

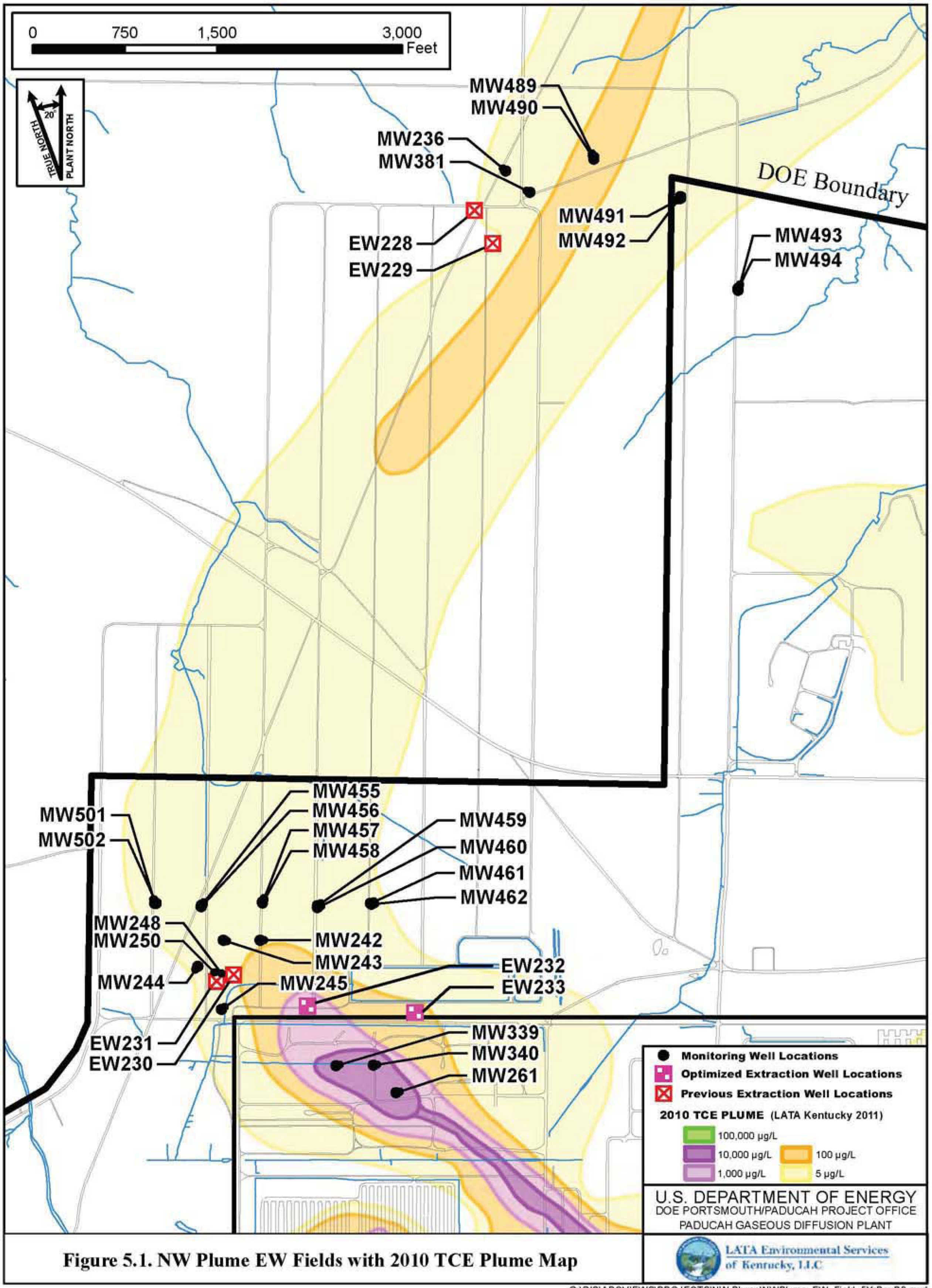

Figure 5.1. NW Plume EW Fields with 2010 TCE Plume Map

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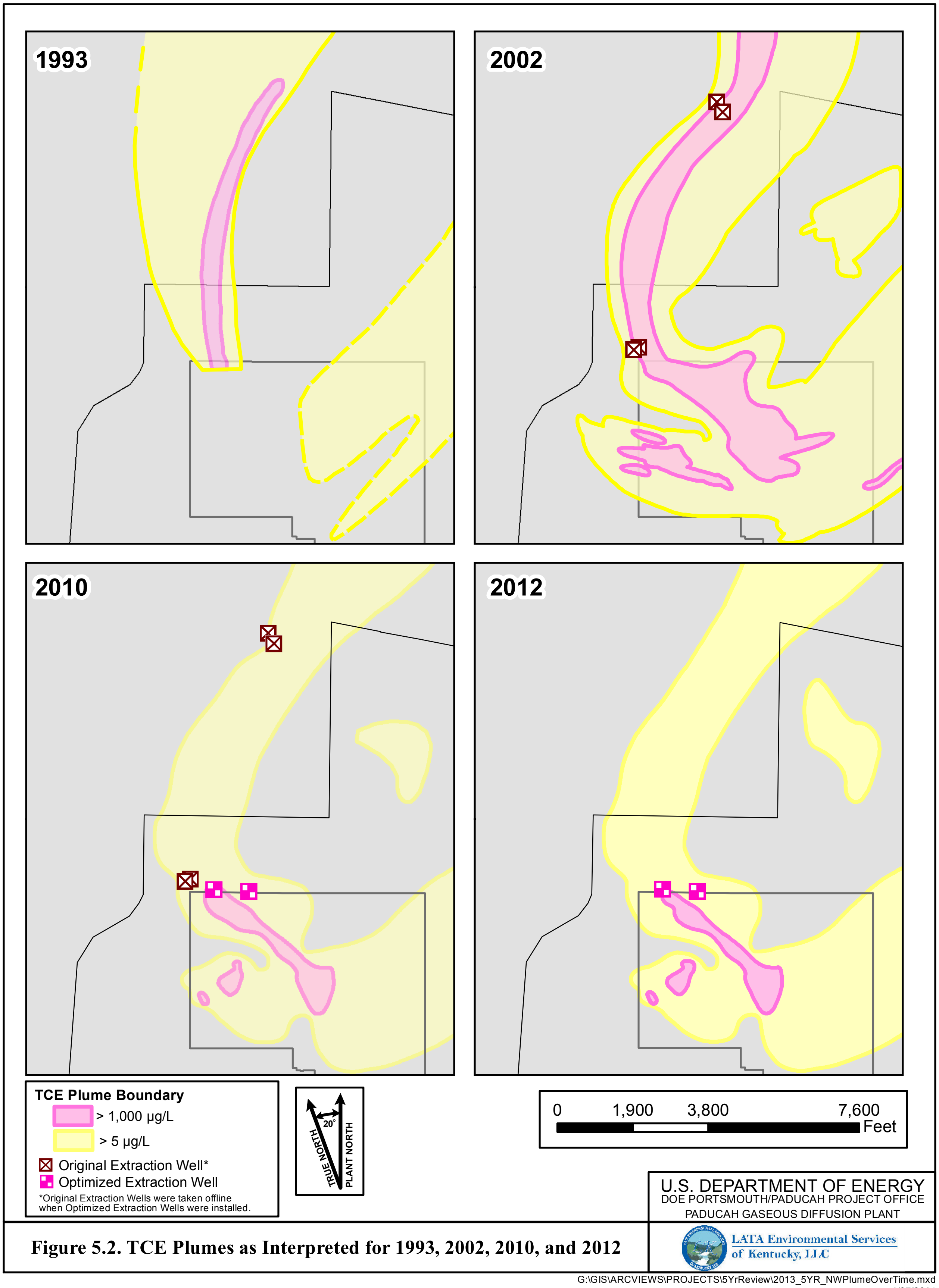


Figure 5.2. TCE Plumes as Interpreted for 1993, 2002, 2010, and 2012

The *Record of Decision for Interim Remedial Action of the Northwest Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* delineated the remedial action 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 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 permitted 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 and remedial action work plan (RAWP) was issued in May 1994 (DOE 1994a). 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, as well as 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, as installed, 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 plant;
- 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 on-line volatile organic analyzer; and
- Support equipment installed in the facility including backwash, 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 remedial action (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 remedial action 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 PGDP. 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 further evaluate natural attenuation processes. 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 PGDP 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. The strategies to increase extraction near the south wellfield included the addition of extraction locations to the east of the original EWs.

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 2010a). The latest revision (September 2010) was prepared to support the Northwest Plume IRA Optimization. Routine and preventive maintenance has been conducted in accordance with the *Paducah Plume Operations Maintenance, Calibration, and Testing Plan* (LATA Kentucky 2012a).

Since initial operations, the frequency of repair to the system has been normal and routine. The Northwest Plume treatment system had processed 1,756,903,636 gal of water, as of December 31, 2012. Mass balance evaluations indicate that the treatment system has removed approximately 34,766 lb (2,871 gal) of TCE.

The costs associated with the O&M of the NWPGS and the Northeast Plume Containment System (separate GWOU action discussed in Chapter 6) are tracked jointly and have been since fiscal year (FY) 2002. The cost for both systems for the five-year reporting period is $3.42M, or an average of $684K per year. This average annual O&M cost of $684K is less than the combined original estimates of $1.5M to $2.0M for the NWPGS and $240K for the Northeast Plume Containment System; the reduction is due primarily to efficiencies gained through continued long-term operation. The total operation cost for both the NWPGS and the Northeast Plume Containment System was $28.6M by the end of December 2012.

No major modifications to the treatment system were made during this reporting period (i.e., replacement of primary equipment). The activated carbon units are changed routinely due to contaminant loading. Only infrequent replacement of the ion exchange resin is required. The two lag ion exchange columns were changed out in April 2010; the two lead columns last were changed in April of 2004. Beginning in August 2010, the NWPGS switched from withdrawal 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 110 gal/minute each).

The Northwest Plume IRA treatment system has continued to operate as intended during the 2008–2012 period.

5.4 PROGRESS SINCE LAST FIVE-YEAR REVIEW

The 2008 Five-Year Review contained the following statement of protectiveness for the Northwest Plume IRA (DOE 2009a):

> 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 plume, need to be evaluated for long-term protection.

The 2008 Five-Year Review contained the following recommendation:

> Evaluate the extraction system to determine whether zones of capture of the EW fields can be optimized to control contaminant migration from the source area more effectively. Examples of follow-up actions resulting from this evaluation may include preferential pumping of wells in high concentration areas, termination of the two extraction wells in the North EW Field, and MW/EW installation.

In response to recommendations contained in the 2008 CERCLA Five-Year Review, construction activities for the Northwest Plume IRA Optimization commenced in March 2010. The NWPGS initially consisted of two EW fields (north and south with each field having two EWs), for a total of four wells, underground pipeline, treatment facility, and MW network. In August 2010, two new EWs (EW232 and EW233) became operational near the original south wellfield, adjacent to the north security fence of PGDP. The north wellfield EWs (EW228 and EW229) were removed from service in August 2010. EW230 and EW231, located in the original south wellfield, are kept in standby mode and may be returned to service, if needed. The location of the new EWs was optimized to enhance mass capture of the Northwest Plume in the area of the north plant boundary through EW placement and increased extraction capacity. Each of the two new EWs can pump 220 gpm, if required, which is the throughput capacity of the C-612 treatment facility. This allows the optimized EWs to be operated separately or together as needed in response to potential changes in plume trajectory resulting from changes in site flow conditions.

DOE issued *Remedial Action Work Plan for the Northwest Plume Interim Remedial Action Optimization at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-0339&D1 (DOE 2010b) in May 2010 to document the groundwater flow modeling used in the optimization approach and revisions to wellfield design and to establish a testing and monitoring program for the new EW field. Major construction for the optimization of the Northwest Plume Treatment System was completed on August 13, 2010. Following completion of construction, the system underwent testing and was commissioned on August 27, 2010, transferring the system to routine operation and maintenance.

Revision of *Operations 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 2010a) was completed in September 2010 and a hydraulics test of the new EW field was performed in October 2010. DOE issued *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, (DOE 2010c) in December 2010 to describe the response action optimization that is expected to result in more effective control of contaminant migration from the source area. DOE followed with the *Postconstruction Report for the Northwest Plume Optimization at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-0359&D1, (DOE 2011b) in January 2011.

The October 2010 hydraulics test and the follow-on computer modeling evaluation of the new EWs demonstrate that the NWPGS zone of capture better intercepts the width of the Northwest Plume at the north security fence. 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. The long-term benefit of the optimization of the IRA will require additional time to become apparent.

5.5 SITE INSPECTION

On January 17, 2013, the Northwest Plume Pump-and-Treat Facility was inspected by a member of the Five-Year Review Team for this Five-Year Review. The facility includes the C-612 Treatment Facility and the south wellfield (EW232/EW233). The treatment facility is located just outside the northwest corner of the perimeter fence of PGDP, but within the security buffer zone around the plant. The EW232/EW233 field is located east of the treatment facility (just north of the PGDP 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 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. Groundwater treatment equipment inside includes a sand filter unit, an air stripper and carbon filtration unit, and four ion exchange columns. The interior of the building is clean, free of clutter and debris, and maintained well. Access-controlled areas within the building 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 were 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 PGDP Fire Services Department.

Well vaults for both the currently operating EWs and the original south wellfield EWs (in standby mode) are maintained properly. The new EWs are operating as intended, with minimal maintenance required.

5.6 TECHNICAL ASSESSMENT

The primary objective of the Northwest Plume IRA is to initiate an action to mitigate the spread of the high concentration zone of TCE and Tc-99 contamination of the Northwest Plume. Monitoring data indicate that this remedial action 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 maximum contaminant levels (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.

Figure 5.3 shows contaminant level trends in each of the south EWs. Targets for the average levels of TCE and Tc-99 in effluent continue to be met as indicated from the latest semiannual reporting period of January 2012 to June 30, 2012 (Table 5.1). The target concentrations for these contaminants are 5 µg/L EW230 and EW231, the EWs of the original south wellfield, are kept in standby mode and will be returned to service, if needed.

Groundwater flow modeling for the optimization study predicted 99.99% capture of the mass of TCE flux in the Northwest Plume at the PGDP security fence using the two new EWs that were installed in 2010. Groundwater analyses for TCE and Tc-99 from the MW systems for the original south EW Field (EW230 and EW231) and for the new south EW field (EW232 and EW233) demonstrate that the EWs have reduced contaminant levels in the RGA and that these reduced levels persist.[1] Table 5.2 summarizes contaminant analyses for late 1995, when groundwater extraction began at EW230 and EW231, compared with 2012 levels. Figure 5.4 shows the trends in TCE and Tc-99 in the two wells of the original south wellfield with highest contaminant levels (MW243 and MW248).

For the years 1998 through 2012, MW261, MW339, and MW340, located in the core of the Northwest Plume and far upgradient of both the original and new south EW fields, EW230/231 and EW232/233 (see Figure 5.1), have continued to yield water with elevated levels of TCE (as much as 10,000 to 40,000 µg/L) and Tc-99 (as much as 1,500 to 6,000 pCi/L) (see Figure 5.5). Marked trends of declining contaminant levels in MW261 and MW339 and increasing trends in MW340 (Figure 5.6) illustrate the eastward migration of the core of the upgradient plume. The rate of eastward migration may increase with continued operation of the new south EW232/233 wellfield. Downgradient MWs for the new south EW232/233 wellfield document reduced contaminant levels (Figures 5.7 and 5.8) and suggest that the new EW field is continuing to reduce contaminant levels in the core of the Northwest Plume, as intended by the ROD.

[1] Contaminant trends in MW242, specifically Tc-99 after late 2007, are less persuasive. Rising Tc-99 levels in MW242 after late 2007 may reflect an eastward migration of the Northwest Plume and the location of the core of Tc-99 contamination on the east side of the Northwest Plume.

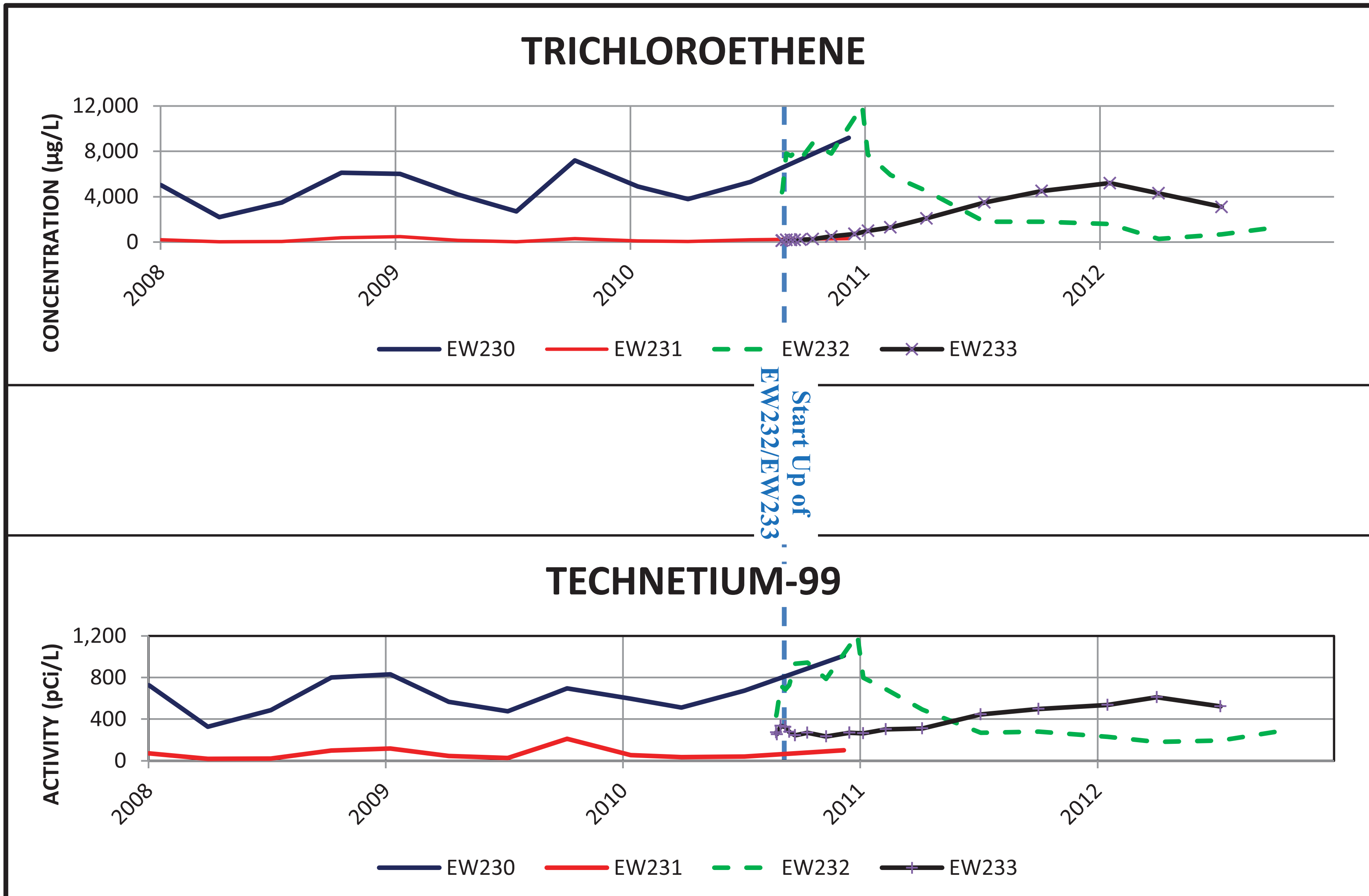


Figure 5.3. Contaminant Trends in the Original (EW230 and EW231) and New (EW232 and EW233) South Well Field EWs

Table 5.1. Northwest Plume Groundwater System Influent and Effluent Concentrations

	TCE (µg/L)			Tc-99 (pCi/L)		
	High	**Low**	**Average[a]**	**High**	**Low**	**Average[a]**
Influent	2,700	2,100	2,422	412	342	365
Effluent	6.6	2.5	4.15	43.3	16.3	28.3

Data is taken from the DOE PGDP FFA Semiannual Progress Report for Fiscal Year 2012 (DOE 2012a).
[a] Average is calculated as an arithmetic average, using the laboratory reporting limit for nondetects.

Table 5.2. Summary of Contaminant Levels at the Original South EW Field (EW230 and EW231)

	TCE Concentration (µg/L)		Reduction in	Tc-99 Activity (pCi/L)		Reduction in
Well	**Late 1995**	**2012**	**Concentration**	**Late 1995**	**2012**	**Activity**
MW242	530	120-160	Yes	247	197-218	Yes[a]
MW243	13,500	30-53	Yes	3,781	ND[b]-38	Yes
MW244	3,600	3-10	Yes	1,048	ND	Yes
MW248	14,000	9-28	Yes	3,488	ND-33	Yes
MW250	13,300	4-21	Yes	3,358	ND	Yes
MW245[c]	28	89-130	No	24	ND	Yes

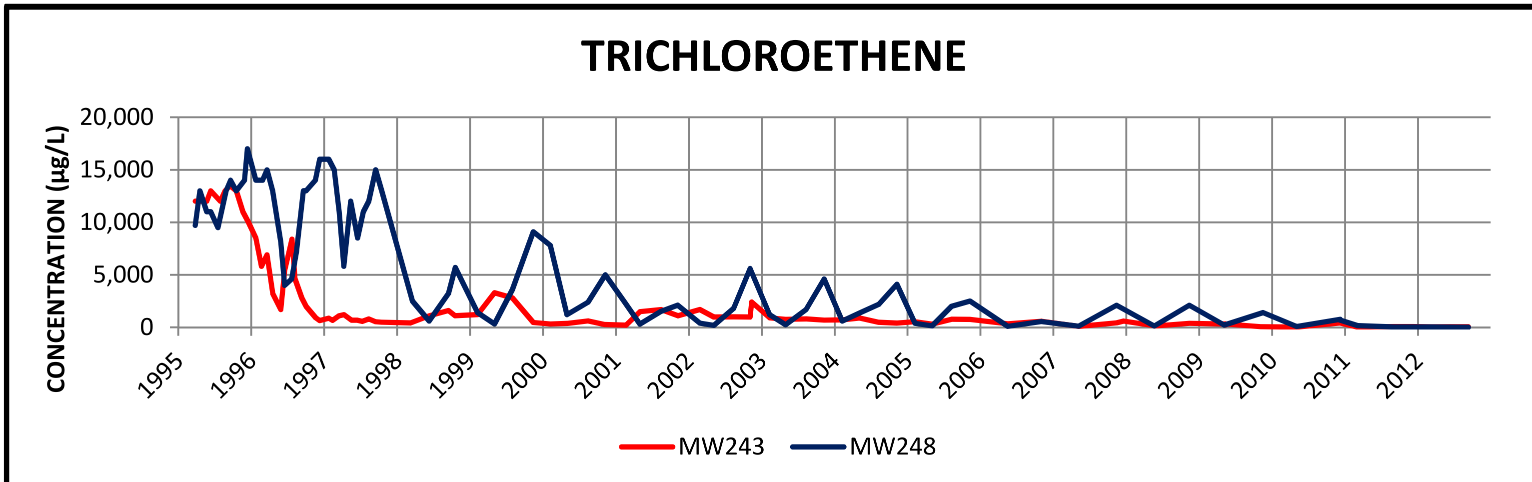
[a] Tc-99 levels have declined through 2007, but have increased over the period 2008 through 2012.
[b] Nondetect
[c] Upgradient well

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 EW228/EW229, north wellfield. RGA MW cluster MW489/MW490 was placed in the centroid of the Northwest Plume and MW cluster MW493/MW494 was placed to the east of the centroid. 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.

In general, contaminant levels in the core of the Northwest Plume in the area of the north wellfield have continued to decline: in 2012, contaminant levels were 200 µg/L or less TCE and 102 pCi/L or less Tc-99. Contaminant levels declined in MW489 and MW490 during 2011 and rose in MW491 and MW492. Further monitoring is required to determine the significance of these trends. Table 5.3 and Figure 5.9 document the contaminant trends in the area of the north wellfield.

The thick interval of relatively low-permeability silt that overlies the Northwest Plume should reduce the potential for transport of VOC vapors from the Northwest Plume to the surface. Moreover, the NWPGS has significantly reduced VOC levels in the off-site plume and is anticipated to further reduce off-site contaminant levels 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 PGDP actions (notably the Water Policy, discussed in Chapter 8).

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. There are no 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.



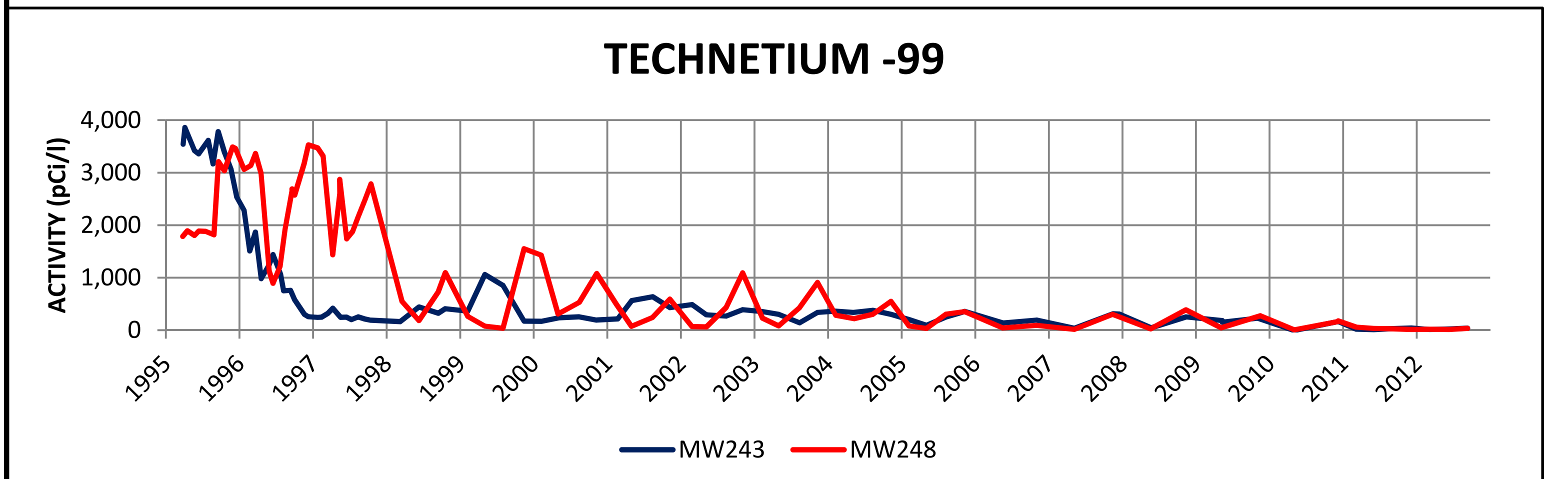


Figure 5.4. Contaminant Trends in MW243 and MW248 of the Original South Wellfield (EW230/EW231)

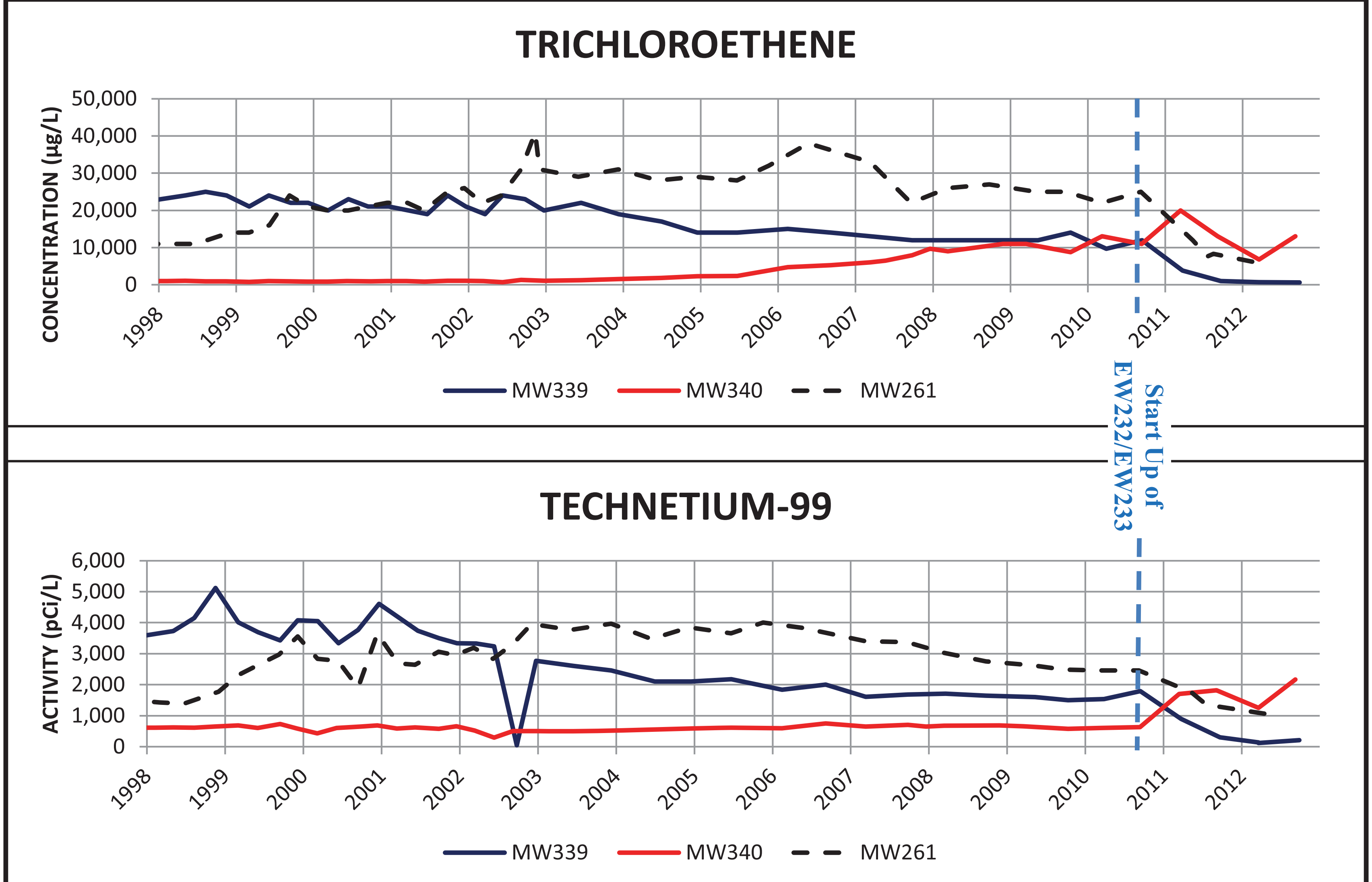


Figure 5.5. Contaminant Trends in MWs Located in the Upgradient NW Plume

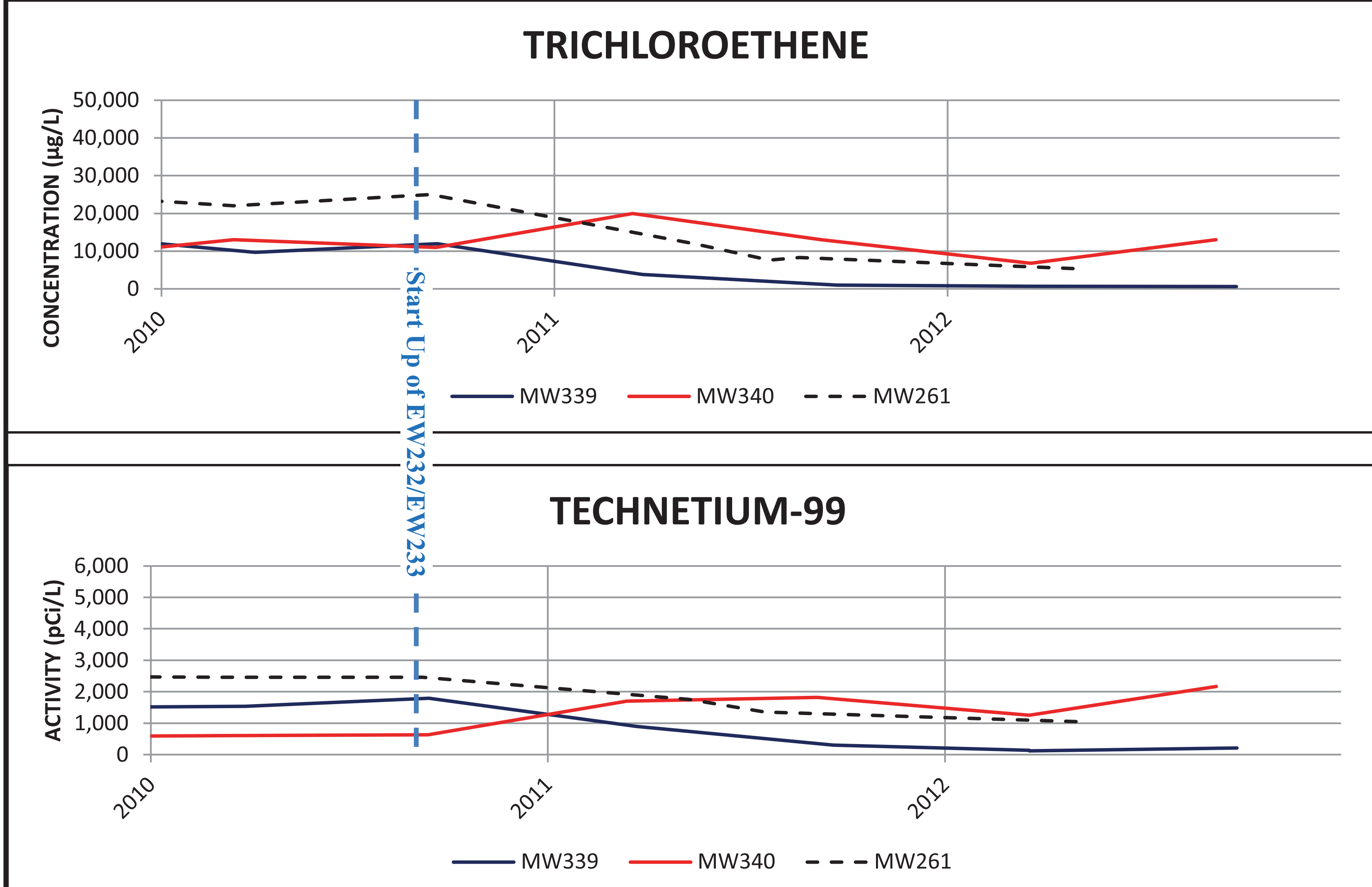


Figure 5.6. Trends in MWs Located in the Upgradient Northwest Plume since Start-Up of EW232/EW233

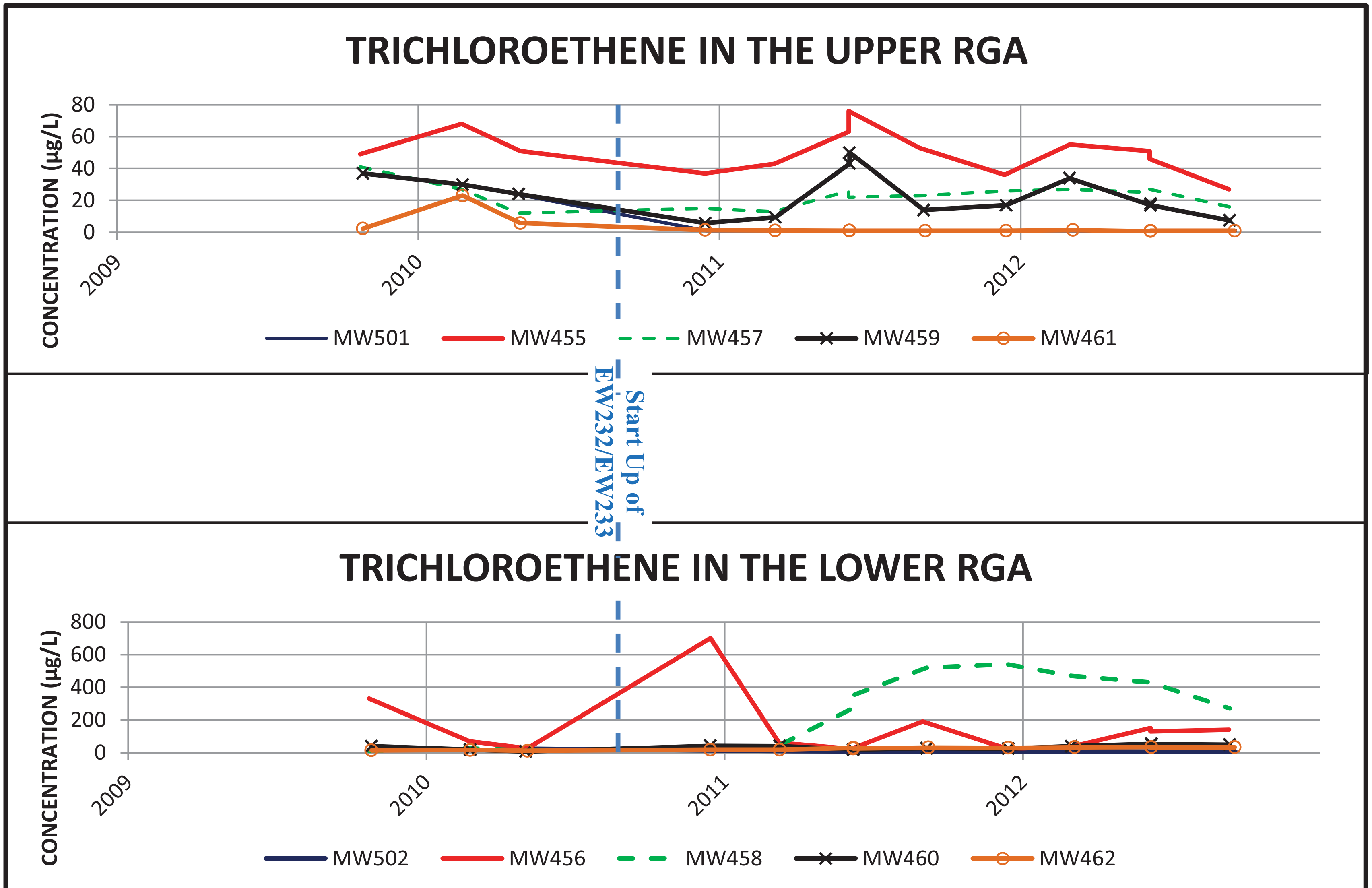


Figure 5.7. Trichloroethene Trends in MWs Located Downgradient of EW232 and EW233

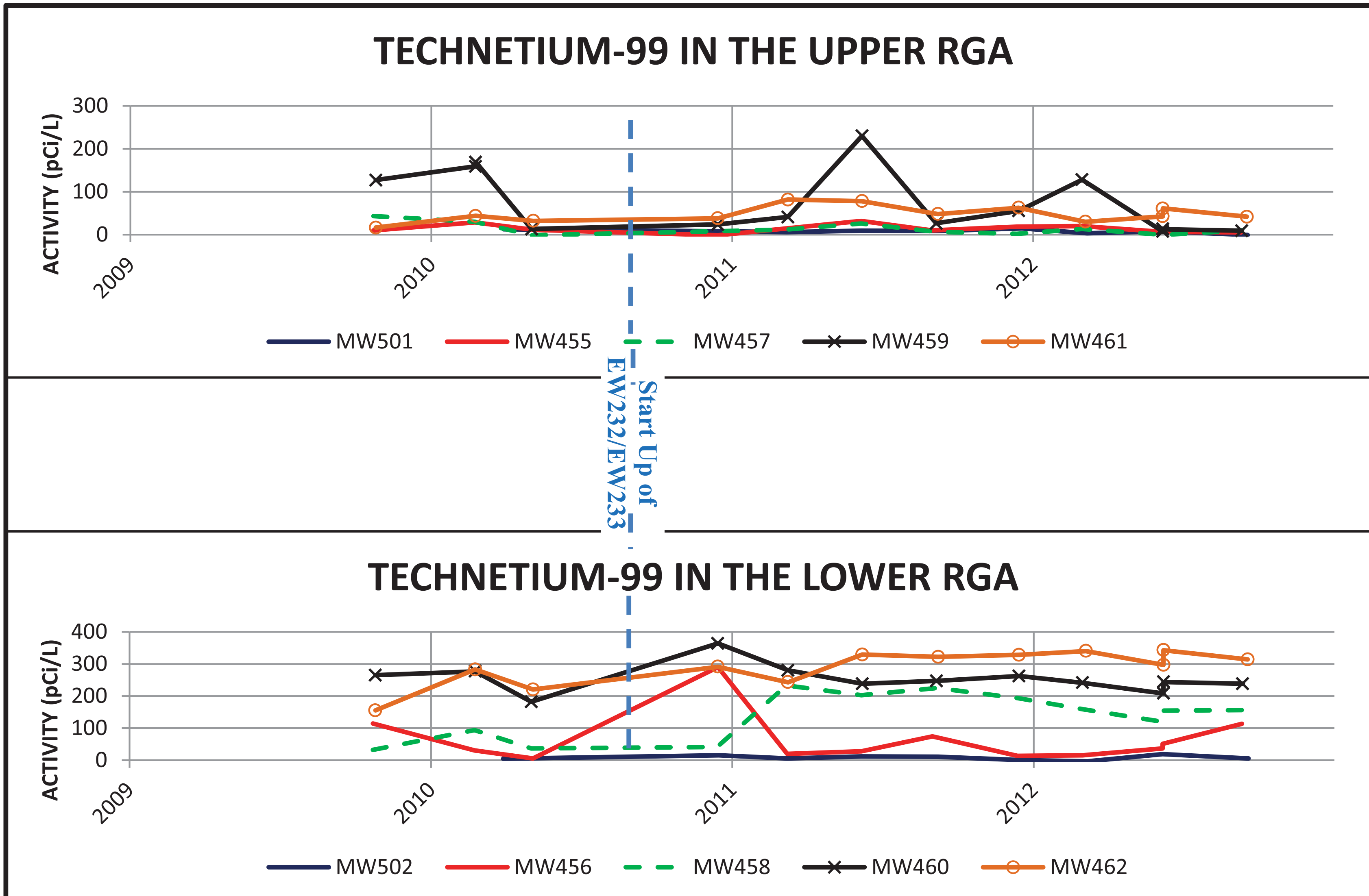


Figure 5.8. Technetium-99 Trends in MWs Located Downgradient of EW232 and EW233

Table 5.3. Summary of Contaminant Levels in the Area of the North EW Field (EW2228 and EW229)

		TCE Concentration (μg/L)			Tc-99 Activity (pCi/L)		
Well	**Screen Interval**	**2010**	**2011**	**2012**	**2010**	**2011**	**2012**
MW236	lower RGA	27	12	N/A[a]	28	ND[b]	N/A
MW381	middle RGA	46	N/A	N/A	27	N/A	N/A
MW489	upper RGA	200–310	220–310	150–200	95–111	76–111	57–61
MW490	lower RGA	320–530	170–320	150–200	141–153	62–122	63–71
MW491	upper RGA	13–20	3–160	100–110	91–110	81–99	87–99
MW492	lower RGA	28–47	8–130	130–140	91–103	84–109	98–102
MW493	upper RGA	4	3-4	2-3	11-30	10-30	14-32
MW494	middle RGA	6	4	ND-3	ND-15	20-46	25-42

[a] Data not available—no sample collected.
[b] Nondetect

Remedial actions are being implemented or planned to minimize further migration from sources. 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 following:

The EW Fields are functioning by 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, 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 the ARARs 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).

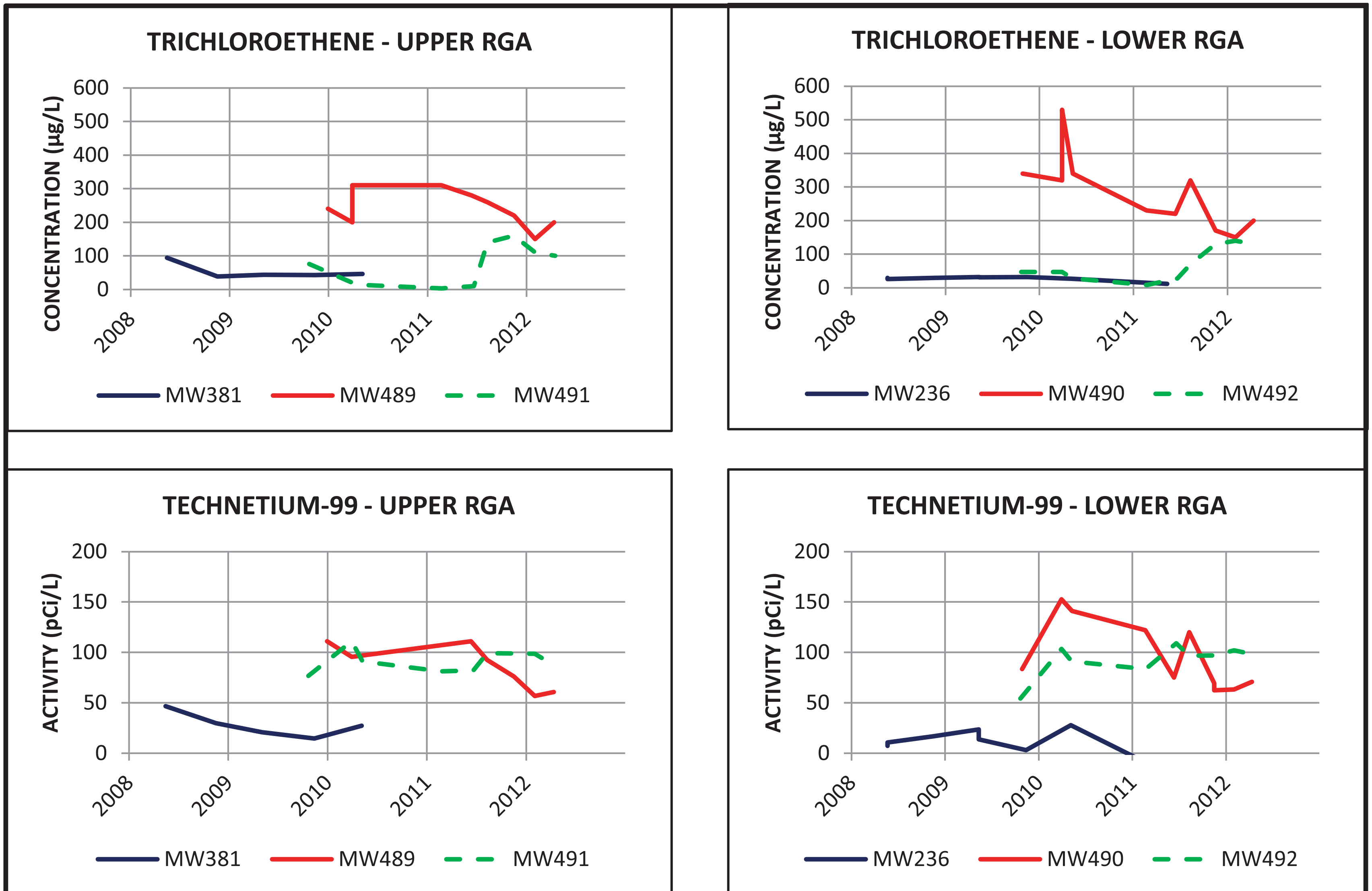


Figure 5.9. Contaminant Trends in MWs Located Proximal to the EW228/EW229 Wellfield

PGDP's 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 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.

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. 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 PGDP industrial area. This EW field is intended to control the source of groundwater contamination to the Northwest Plume immediately north of the PGDP main plant boundary. Contaminant levels in the area of the previous north EW field (EW228/EW229) have significantly decreased since the initiation of the Northwest Plume IRA and are continuing to decline with the operation of the new EW field (EW232/EW233). The remedy remains protective.

5.7 ISSUES

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.

6. NORTHEAST PLUME

After the initial discovery of contamination at PGDP 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 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* delineated numerous plumes within the RGA that coalesce to form the Northeast Plume (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 plant and extends off DOE property. Figure 6.1 depicts the aerial extent of the Northwest and Northeast Plumes based on the latest approved plume map from 2012 (LATA Kentucky 2014).

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 major components of the selected RA included the following:

- Installation of extraction wells and 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 PGDP 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 goal as follows:

> 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 plant security fence.

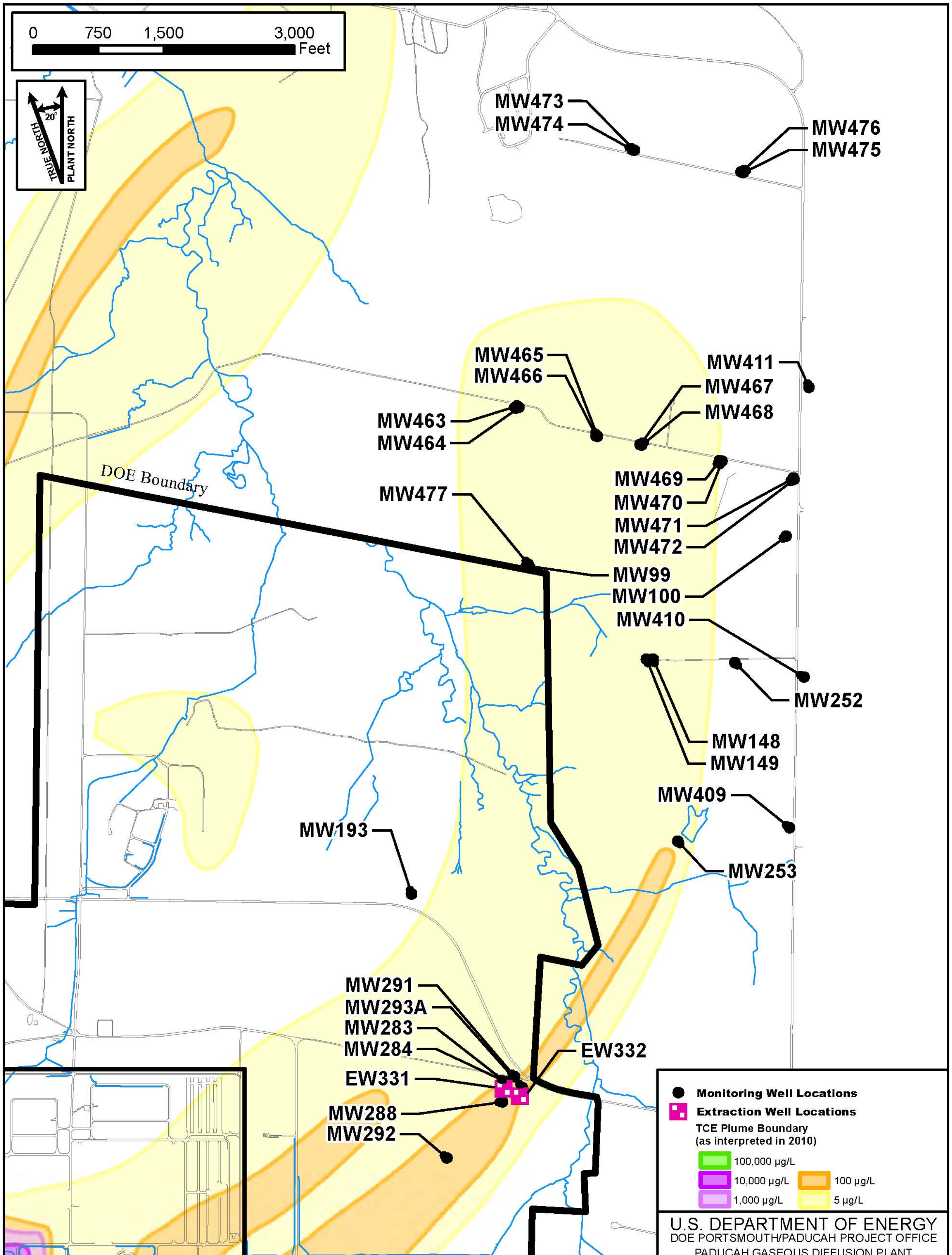


Figure 6.1. NE Plume EW Field with 2010 TCE Plume Map

FIGURE No. NE Plume\NEPlume_EW_Field_R1.mxd
DATE 05-30-2013

The ROD was supported by a PHEA. In the PHEA, TCE is listed as the primary PGDP-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 are identified in the ROD.

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 remedial action 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. Currently, the average pumping rate for the Northeast Plume EWs is approximately 200 gpm.

DOE issued a Notice to Proceed with construction 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, and was issued February 7, 1997 (DOE 1997a). The postconstruction report presents the summary of the construction activities for the RA. Operation of the Northeast Plume IRA began February 28, 1997.

In February and March 2006, DOE Headquarters conducted a Sitewide Remedy Review at PGDP. The Sitewide Remedy Review report recommended optimization of the Northeast Plume and Northwest Plume IRAs. 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 PGDP during October 2006. 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 Northeast Plume IRA 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.

6.3 SYSTEMS OPERATIONS/OPERATIONS AND MAINTENANCE

O&M activities for the Northeast Plume Containment System (NEPCS) are 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 2002b). 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 1,303,955,106 gal of water as of December 31, 2012. The treatment system has removed approximately 3,320 lb (274 gal) of TCE.

The costs associated with the O&M of the NEPCS and the NWPGS (which was 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 $3.42M, or an average of $684K per year. This average annual O&M cost of $684K 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 $28.6M at the end of December 2012. The Northeast Plume IRA treatment system has continued to operate as intended during the 2008–2012 period.

6.4 PROGRESS SINCE LAST FIVE-YEAR REVIEW

The 2008 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.

The previous Five-Year Review noted that the MW network may need to be enhanced to monitor the advancement of the plume toward the north and northwest, specifically by placing a lower RGA well in the northeast corner of the DOE property and placing RGA wells farther to the north along Anderson Road. These wells and others were installed in late 2009 as part of an MW system upgrade project.

The 2008 Five-Year Review reiterated the recommendation previously identified by the Remediation Systems Evaluation Team, that the IRA be placed in standby mode following the development of decision criteria, which specify the conditions under which the system would be restarted. In 2010, DOE initiated development of draft criteria for standby assessment in accordance with a recommendation in the 2008 Five-Year Review (DOE 2009a).

In 2011, the FFA managers identified optimization of the NEPCS as a priority, consistent with the sitewide strategy that includes a series of sequenced activities consisting of source actions and control of off-site groundwater migration followed by a final action for the overall dissolved-phased plume. Optimization activities are ongoing and will be documented in the CERCLA Explanation of Significant Difference.

The results of sampling in the additional Northeast Plume MWs have changed the site's definition of the Northeast Plume. Recent monitoring data define two cores of higher contamination migrating from the east PGDP security fence, previously thought to be one larger core of contamination, and extend the end of the plume to north of Anderson Road. Relocation of EWs for the NEPCS is planned to address each of the plume cores.

6.5 SITE INSPECTION

A site inspection of the NEPCS facilities was made on January 31, 2013. Participants included the Facility Manager, a member of the Five-Year Review team, and the Facility Operator. This facility is located south and west of the intersection of Ogden Landing Road (KY Hwy 358) and Little Bayou

Creek, northeast of PGDP. The facility 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.

The main access road into the area is secured by a chain-link gate located just south of its intersection with Ogden Landing Road. Operators indicated 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 in good condition.

The two EWs are located approximately 200 ft apart. Each well is located in an underground concrete vault with a hinged aluminum lid. Each well also is surrounded by a chain-link security fence 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 appears to be maintained well. During this inspection, both wells were pumping with no apparent problems.

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 completely enclosed 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 is in good condition and functional. During this inspection, the pumps were running and no operating problems were observed. The electrical power and control panels are in good condition and properly labeled.

The Facility Operator was interviewed regarding system operations and system performance. The VOCs are stripped from the water in the C-637 cooling towers. Groundwater and plant process cooling water are collected in the basins of the cooling towers and recirculated through the cooling tower. After recirculation, water eventually is discharged to the C-616 Lagoons and then through the permitted Outfall 001.

Only minor repairs and routine maintenance have been performed. Shutdowns for repairs have been infrequent; no shutdowns have been long-term during the period of this Five-Year Review. A summary of both routine and nonroutine maintenance is reported in the DOE PGDP FFA Semiannual Progress Report. In accordance with the substantive requirements of the ARARs cited in the ROD, a tank tightness test and leak tests were successfully conducted in 2007 on the Northeast Plume EQ tank and high density polyethylene transfer lines, respectively. No leaks were identified during the tests. Per discussions with the FFA managers in March 2012, the tank tightness and leak tests scheduled for 2012 were rescheduled for May 2013 to allow for testing of newly constructed pipelines. These pipelines were installed as part of a new water treatment unit that will work in conjunction with the existing EQ tank and pipelines; however, the EQ tank and transfer lines are ancillary equipment that is connected to the cooling tower which has been determined to meet the definition of an exempt wastewater treatment unit.

For the 2008 through 2012 period, the EWs have operated as intended with minimal maintenance required.

6.6 TECHNICAL ASSESSMENT

The NEPCS is an IRA to control the high concentration area of the Northeast Plume that extends outside the plant security fence and to track contaminant migration to assess the IRA's performance. Monitoring data indicate that this remedial action 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 EWs of the Northeast Plume EW Field (EW331 and EW332) began operation on February 28, 1997 (Figure 6.1). Trends of TCE concentrations in groundwater of the Northeast Plume EW field monitoring system clearly show that TCE levels have been 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	
Well	**Early 1997**	**Low of 2003**	**2012**	**Through 2003**	**2004–2012**
MW283	1,300	120	52–65	Reduction	Near steady reduction
MW291	1,400	100	38–59	Reduction	Near steady reduction
MW294/293A	2,000	280	200–230	Reduction	Near-steady reduction
MW288*	1,600	240	130–210	Reduction	Near steady reduction
MW292*	800	430	200–280	Rise to 1,400 µg/L, then decline to 440 µg/L	Near steady reduction
MW284**	1,500	140	See footnote	Reduction	See footnote, ranged 110–150 µg/L in 2004 and 2005

*MW288 and MW292 are upgradient wells.
**MW284 data for 2012 is not available because the well was last sampled for TCE in August 2005. All results obtained from January 2001, until the last sampling activity, were below 250 µg/L, with steady reduction shown throughout the sampling period.

1,1-DCE, is presented as the only other COC in the ROD. Since the ROD was signed, laboratory reporting limits for 1,1-DCE have 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 Northeast Plume EQ tank (12 and 25 µg/L) in 2007; since February 2009, 1,1-DCE concentrations have ranged from 5 to 10 µg/L. The 1,1-DCE present in the plume is being captured by the Northeast Plume EW Field.

As with the previous EW fields of the Northwest Plume IRA, a primary concern of the NEPCS is the extent of the zone of capture of the EW field. To ensure that an adequate zone of capture remains during periods when only one of the two well pumps has been idled by power supply failure to the pump or due to maintenance, the system operators have increased the pumping rate of the working well.

Operational efficiency (actual run time compared to 100% run time) typically exceeds the operational goal of 85%, often averaging better than 95% over a three-month period. For the period 2003 through 2012, TCE concentration levels from the EWs have remained near steady, declining to approximately 100-200 µg/L (Figures 6.2 and 6.3). Tc-99 levels have risen to approximately 30 pCi/L[2] in EW233 because continued operation of the EWs has pulled Tc-99-contaminated groundwater from the area of the plant.

TCE levels in all MWs and EWs associated with the Northeast Plume Groundwater System exhibit declining trends. The data indicate that the EWs are effective at controlling the high-concentration core of the Northeast Plume and that the TCE levels within the upgradient Northeast Plume are declining.

DOE installed 28 MWs near the east PGDP security fence and in downgradient reaches of the Northeast Plume as part of the recent monitoring well upgrade project (October 2009 through February 2010). A MIP was used to characterize the location of the centroids of the Northeast Plume near the east PGDP security fence to optimize the location of these wells. Results from these MWs were incorporated into the latest update of maps of the PGDP plumes (for calendar year 2010) (see Figure 6.1).

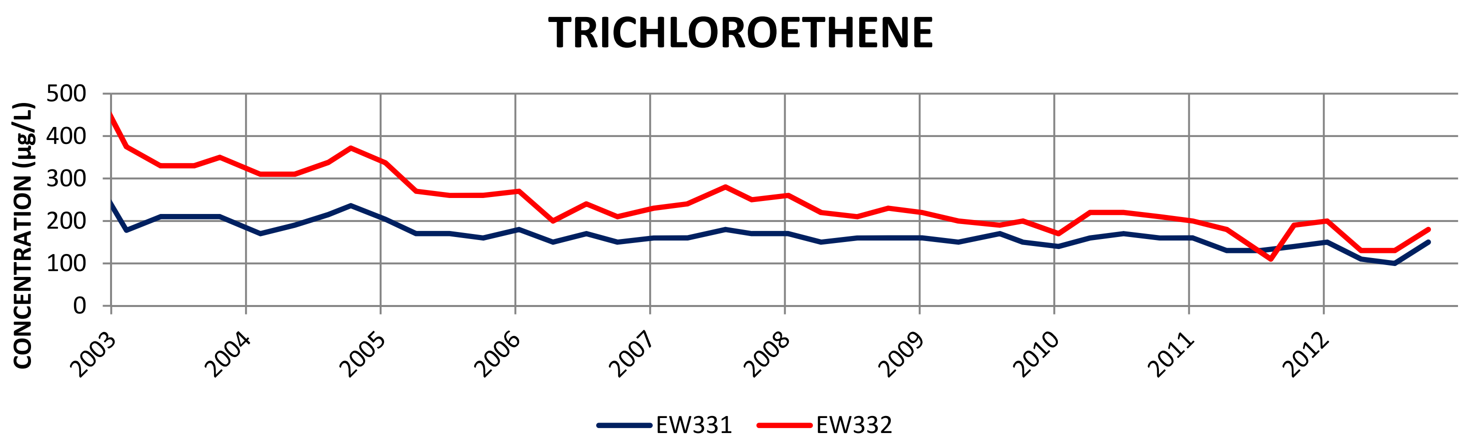
The IRA is intended to control the north end of the high concentration core of the Northeast Plume (1,000 µg/L and greater TCE). Monitoring data from throughout the plume document that the Northeast Plume TCE concentrations have diminished and are significantly less than 1,000 µg/L. Consistent with the sitewide strategy, which includes control of the migration of groundwater contamination from the site, DOE continues to operate the NEPCS. The TCE concentrations in the treatment system effluent continue to meet the target levels. TCE concentrations are less than 5 ppb, as indicated in the latest FFA semiannual reporting period of January–June 2012 (see Table 6.2).

Table 6.2. Northeast Plume Groundwater System Influent and Effluent Concentrations

	TCE (µg/L)		
	High	**Low**	**Average[a]**
Influent	170	120	153
Effluent	< 1	< 1	< 1

Data is taken from the DOE PGDP FFA Second Semiannual Progress Report for Fiscal Year 2012, Paducah, Kentucky (DOE 2012a).
[a] Average is calculated as an arithmetic average.

[2] The current 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 ICRP Publication 107 (ICRP 2008) were also 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.



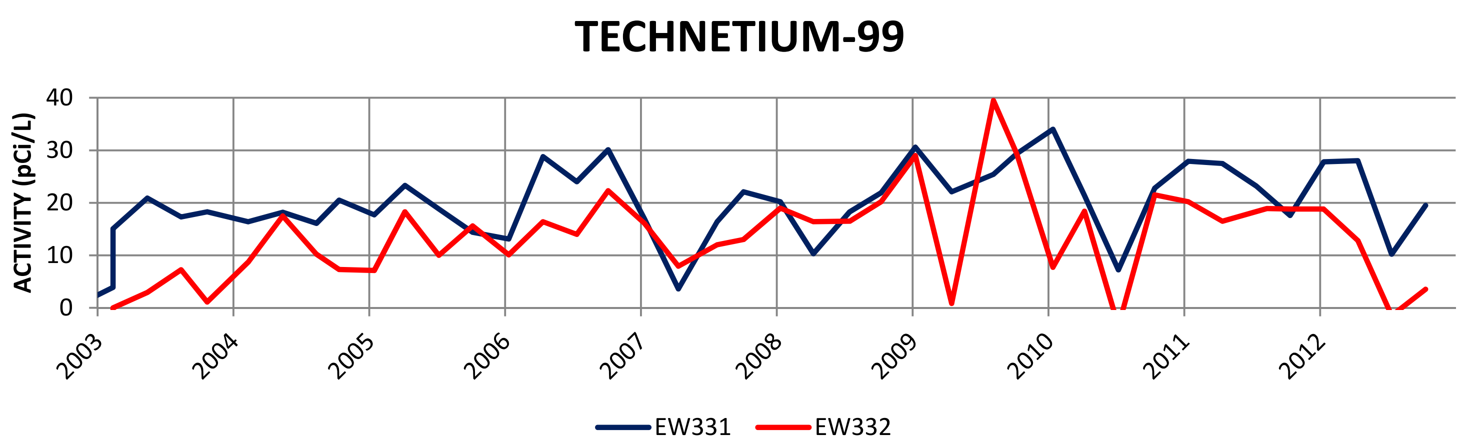
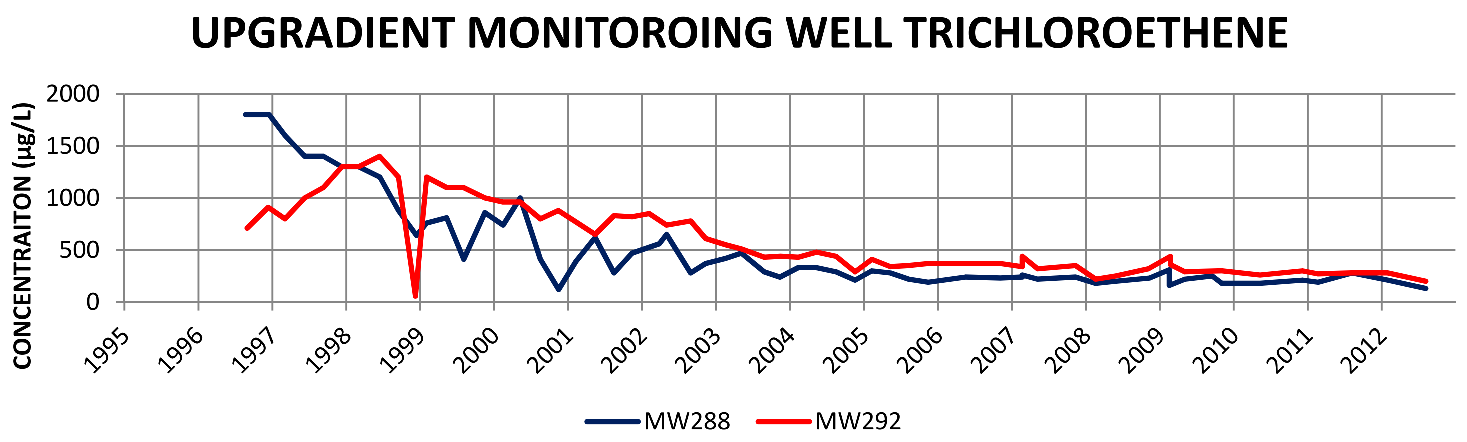


Figure 6.2. Contaminant Trends in EW332 and EW333



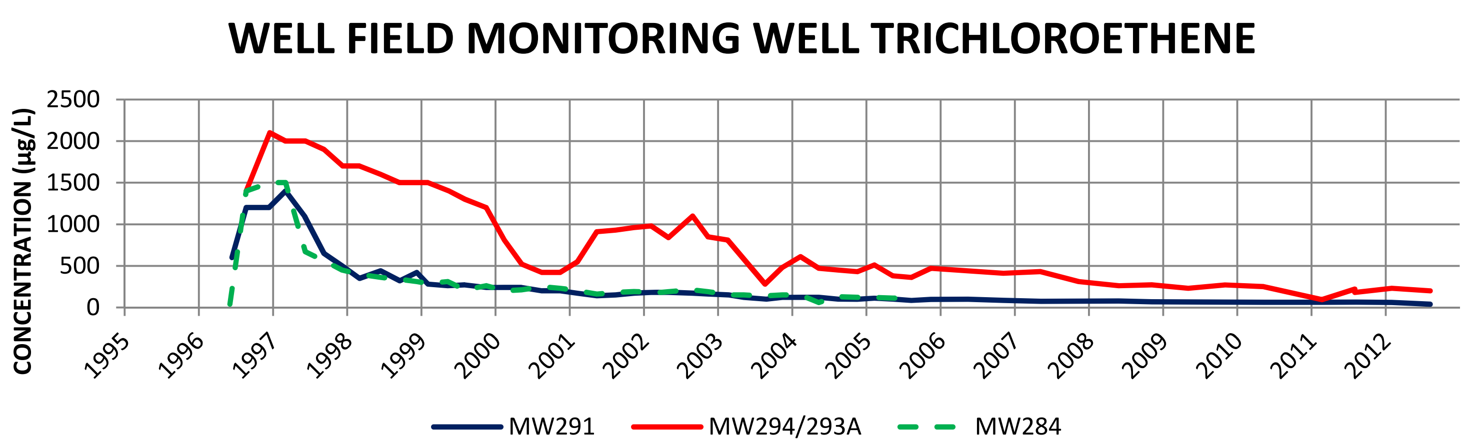


Figure 6.3. Trichloroethene Trends in the Northeast Plume

This review of data and the site inspection indicate that the remedy is functioning as described in the ROD and objectives have been met. DOE continues to operate the NEPCS to control off-site migration of contaminated groundwater, consistent with the sitewide strategy. There have been no changes in the physical conditions of the site 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 is functioning as designed. The planned optimization of the NEPCS includes relocation of the EWs to increase the rate of contaminant mass removal of 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 only to control 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 single goal identified for the Northeast Plume ROD, to initiate hydraulic control of the high concentration area that extends outside the plant security fence, remains 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 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:

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

- 401 *KAR* 63:022 was replaced with 401 *KAR* 63:020; however, guidance from 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.

PGDP's Northeast Plume underlies land controlled by DOE and sparsely populated areas northeast of the PGDP 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 Northeast Plume IRA consists of groundwater extraction from two EWs located near Ogden Landing Road at Little Bayou Creek. This EW field is intended to control migration of the high-concentration core of TCE contamination off the DOE property. Contaminant levels in the area 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. While operation of the NEPCS is an interim action, it is effectively protective in conjunction with other PGDP programs (notably the Water Policy).

Moreover, DOE is performing an optimization of the NEPCS in response to the recommendation of the 2008 Five-Year Review. DOE has performed groundwater modeling to optimize the configuration of groundwater extraction near the eastern fenceline for the Northeast Plume and is currently in the process of designing two new EWs (with air stripper treatment systems) to be placed near the east PGDP security fence. The new EWs to be constructed near the east PGDP security fence are expected to provide an interim, optimized approach to capture dissolved contamination derived from the sources of the Northeast Plume.

6.7 ISSUES

The Northeast Plume remedial action 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 Northeast Plume is an IRA designed to initiate hydraulic control of the high TCE concentration area within the Northeast Plume and does not achieve final cleanup of the groundwater contamination. A follow-up evaluation is needed to ensure long-term protection.

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7. CYLINDER DROP TEST AREA OR LASAGNA^{TM} TECHNOLOGY DEMONSTRATION

The Cylinder Drop Test Area (SWMU 91) encompasses approximately 1.7 acres and is located in the extreme west-central area of PGDP 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 pit. After the cylinders were chilled, a crane lifted 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* (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* (LMES 1996a).

Results of the initial investigations conducted at SWMU 91 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 into the UCRS, but had not fully penetrated the aquitard above the RGA at the unit. 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 electro-osmosis to move shallow groundwater and contaminants 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* (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 cleanup effectiveness of Lasagna^{TM} would achieve the cleanup goals. The results of the Phase IIA are discussed further in the *Lasagna^{TM} Soil Remediation: Innovative Technology Summary Report* (LMES 1996b).

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 for the remedy selection. The remedy consisted of treatment of contaminated soil pore water by the Lasagna^{TM} electro-osmosis

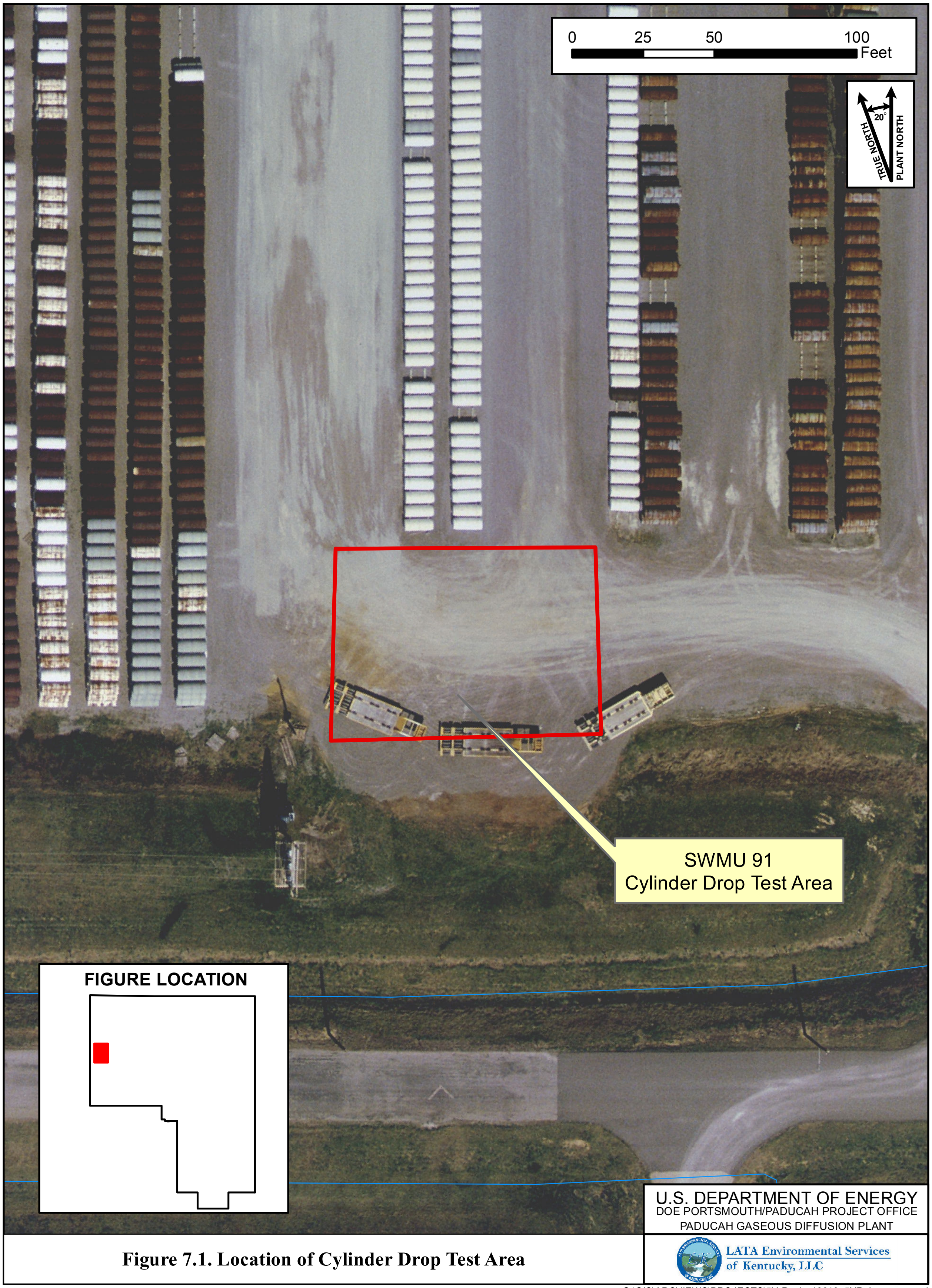

Figure 7.1. Location of Cylinder Drop Test Area

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.

- Treatment zones containing reagents that either decompose the TCE to nontoxic products or adsorb the TCE and make it immobile (DOE 1998a).

- Electrodes (a cathode and an anode) that, when energized, moved contaminants (i.e., TCE) into or through the treatment zones and heat the soil. The contaminated water in the soil pores flowed from the anode through treatment zones toward the cathode (DOE 1998a).

- A water management system that recycles and returns the water that accumulates at the cathode back to the anode for acid-base neutralization (DOE 1998a).

The ROD specified that the Lasagna™ system operate for two years, but, if necessary to meet the clean-up objectives, the operation may 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 SWMU 91 (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 the 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 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 90°C, 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 2002c). The Commonwealth of Kentucky and EPA approved the final remedial action report on October 31, 2002.

Lasagna™ verification sampling and analysis were conducted in April 2003 and confirmed that the remediation objective was met. Details of the Lasagna™ verification sampling and analysis are included in the *Addendum to 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 2003a).

The Lasagna™ equipment and site was demobilized on September 30, 2002. The remediation site has been returned to its original condition. The total cost of the implementation of the Lasagna™ 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 summation of the 2008 Five-Year Review protectiveness statement follows: The remedy for the Cylinder Drop Test Area is protective of human health and the environment. Exposure pathways that could result in unacceptable risk are being controlled (DOE 2009a).

There have been no previous issues or recommendations for the Cylinder Drop Test Area. The site remains unchanged as described in the 2008 Five-Year Review, and no new actions have occurred.

7.5 SITE INSPECTION

A site inspection was conducted on February 4, 2013, by a member of the Five-Year Review Team. The site includes a grassy area south of the C-745-B cylinder yard and part of the area underlying 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.

7.6 TECHNICAL ASSESSMENT

The remedy was designed to be protective of future groundwater use at the fence line of PGDP by meeting the TCE MCL value of 5 µg/L. The MCL for TCE remains at 5 µg/L, and the average residual soil level of TCE at the SWMU is less than one-tenth of the original level calculated to be protective of groundwater in the ROD; therefore, the remedy employed is as protective as it was when the ROD was implemented.

The residual concentrations of TCE in soil (post-remediation) are an average 0.38 mg/kg and a maximum of 4 mg/kg.

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

Yes. The remedy is functioning as designed by being protective of future groundwater use at the fence line by the reduction of TCE concentrations in soil.

In 2011, EPA revised the cancer slope factors and toxicity data for TCE. The 2011 PGDP no-further-action level was based on a more conservative KDEP cancer slop factor and had an industrial screening value of 0.0619 mg/kg for the excavation worker at 1×10^{-6} (DOE 2011b). Using these screening levels, the mean concentration corresponds to 6×10^{-6} risk using the PGDP/KDEP value. The maximum value at the SWMU corresponds to 6.5 $\times 10^{-5}$ risk using this same value. Based on a comparison with draft 2012 PGDP screening values (i.e., 2.35 mg/kg for toxicity and 6.21 for cancer using the EPA slope factor), the effectiveness of the remedy for soil remains protective for future use of the SWMU based on the measured concentrations of TCE in soil after the remediation was completed.

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 SWMU 91 encompasses, and the land use remains industrial with no groundwater use on DOE property. The plant'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. 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.

Based on a comparison with draft 2012 PGDP screening values (i.e., 2.35 mg/kg for toxicity and 6.21 for cancer using the EPA slope factor), the effectiveness of the remedy for soil remains protective for the excavation worker, and future groundwater use at the fenceline of the facility based on the measured concentrations of TCE in soil after the remediation was completed.

The soil cleanup levels (Table 7.1) established in the ROD to be protective of groundwater at the POE were met and still are protective based on no groundwater use on DOE property.

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

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

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?

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 PGDP in August 1988, DOE immediately placed 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 PGDP Water Policy in accordance with the *Engineering Evaluation/Cost Analysis for the Water Policy at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (EE/CA) (DOE 1993b), and the *Action Memorandum for the Water Policy at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 1994b).

The actions associated with the remedy selections of the Northwest and Northeast Plumes mitigate the continued migration of the higher concentration portion of the plumes. The Water Policy response action mitigates risk that could be posed through use of the contaminated groundwater by residents. The 2008 Five-Year Review did not identify any issues or recommendations. No significant changes have occurred during the previous five-year period.

8.1 REMEDY SELECTION

The PGDP 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 Paducah Gaseous Diffusion Plant (affected area)." With the adoption of the Water Policy, DOE focused its groundwater monitoring program on the Water Policy Box and adjacent areas that might be affected if and when the plume migrates or expands. Figure 8.1 is a map of the groundwater contaminant plume boundaries and the Water Policy boundary as of 2007.

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.[3]

The AM included the following conditions:

- DOE offered to provide municipal water to all existing residences and businesses within the affected area surrounding PGDP. They also offered to pay for installation of water supply mains and connection of those residences 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.

[3] It should be noted that signing of the agreement is voluntary and that 60% 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.

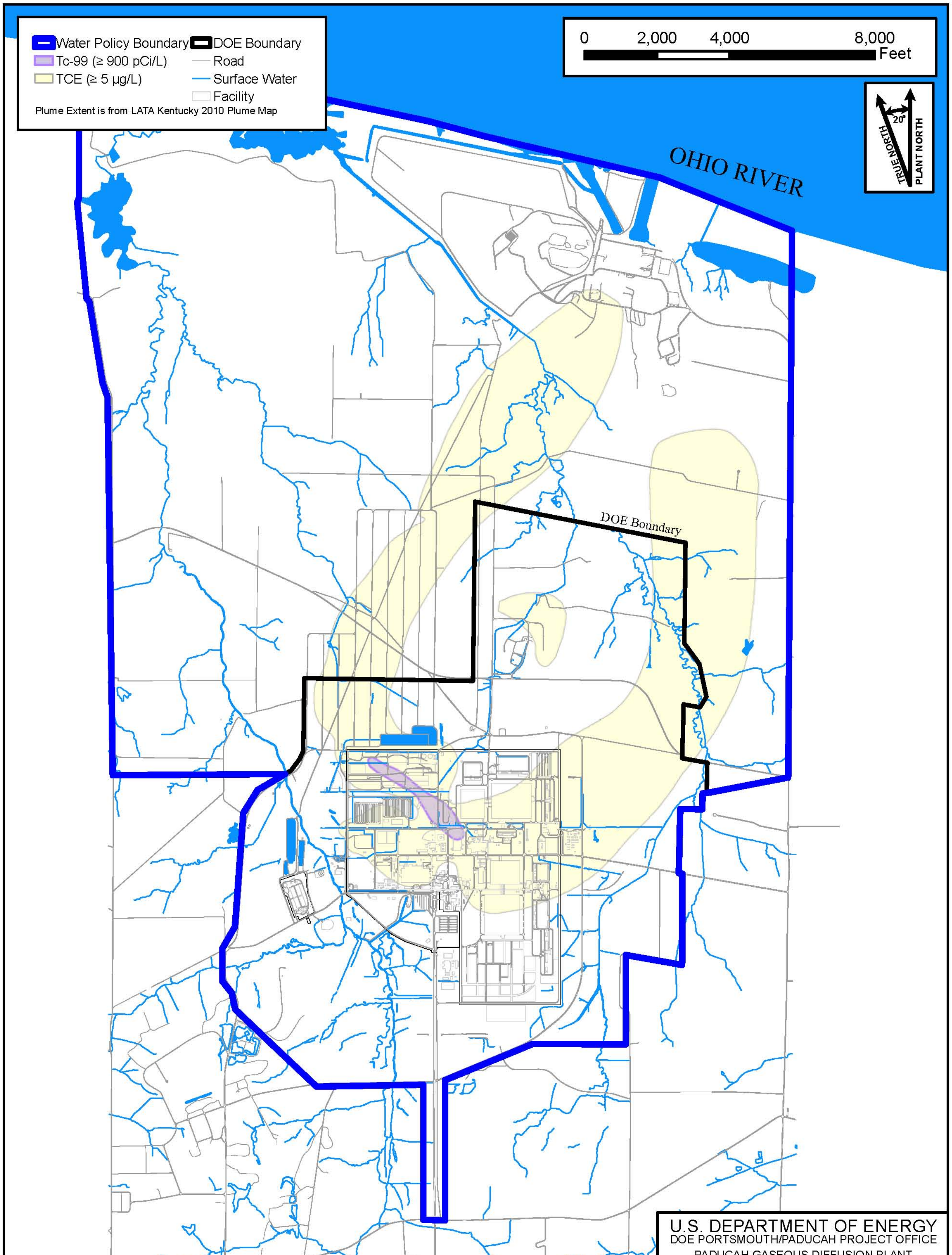

Figure 8.1. Location of Water Policy Boundary in 2013

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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 owners' 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 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 PGDP personnel are permitted access to the property for sampling purposes. PGDP 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 60% 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.

As noted in the 2008 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 either 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.

DOE regularly collects groundwater samples from the area in the Water Policy Box and recently has 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 monitoring wells, are sampled quarterly (LATA Kentucky 2013). 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 2008 review stated the following protectiveness statement.

> The remedy for the Water Policy Box currently protects human health and the environment by institutional controls; however, additional actions under the dissolved-phase plume need to be evaluated for long-term protection.

There have been no previous issues or recommendations for the Water Policy.

8.5 SITE INSPECTION

The site inspection by a member of the Five-Year Review Team included review of license agreements and review of the water bills. A periodic inspection program checks numerous residential wells to ensure that they remain nonoperational.

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.

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 55 of 91 landowners within the area affected by the Water Policy. Thirty four 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 land owners who have requested this, were informed of the risk associated with consuming the groundwater. An inspection program checks numerous residential wells to ensure that they remain nonoperational.

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 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 Action Memorandum 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.

It is recommended that DOE optimize the remedy to ensure that all landowners are educated about the potential contamination in their groundwater and that land ownership be reviewed at the McCracken County Property Valuation Assessment office annually to search for new owners of land parcels within the Water Policy Box.

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 PGDP that could be affected by migration of groundwater contamination originating from the plant. 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 60% of residents located within the Water Policy Boundary that prohibit use of groundwater; therefore, the potential exists that current and possibly new landowners could use their 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 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

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.

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9. C-400 ELECTRICAL RESISTANCE HEATING

The C-400 ERH project currently is underway. This project is included in this Five-Year Review with summaries of activities consistent with the progress of the project up to the date of the review; therefore, the entire five-year evaluation is not included.

The C-400 Cleaning Building is located near the center of the industrial section of PGDP. 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 of machinery parts, decontaminating the interiors of used UF_6 cylinders, disassembling and testing of cascade components, and laundering of plant 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. After the initial discovery of contamination, four borings were installed to better define the extent of the soil contamination. SWMU 11 and the C-400 Building area have 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 hydrostratigraphic 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 with a thickness range of approximately 25 ft to 36 ft.

Two previous actions have remediated some of the soil contamination near the southeast corner of C-400 Building. 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 310 ft^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 (5,378 yd^3 of contaminated soil and subsurface aquifer) in the southeast corner of the area near the C-400 Building.

9.1 REMEDY SELECTION

Following the RI (DOE 1999a) and the 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 because DNAPL is present, TCE in the source zone in the UCRS and the RGA at the C-400 Cleaning Building area can be considered principal threat source material. The ROD also documented the selection of ERH as the technology to address the source area contaminated with TCE and other VOCs.

In 2007, DOE commissioned an independent technical review (ITR) of a draft of the C-400 90% RDR (ITR 2007). The 2007 ITR team consisted of subject matter experts from DOE, the environmental remediation field, and the U.S. Environmental Protection Agency. The ITR team published their report in

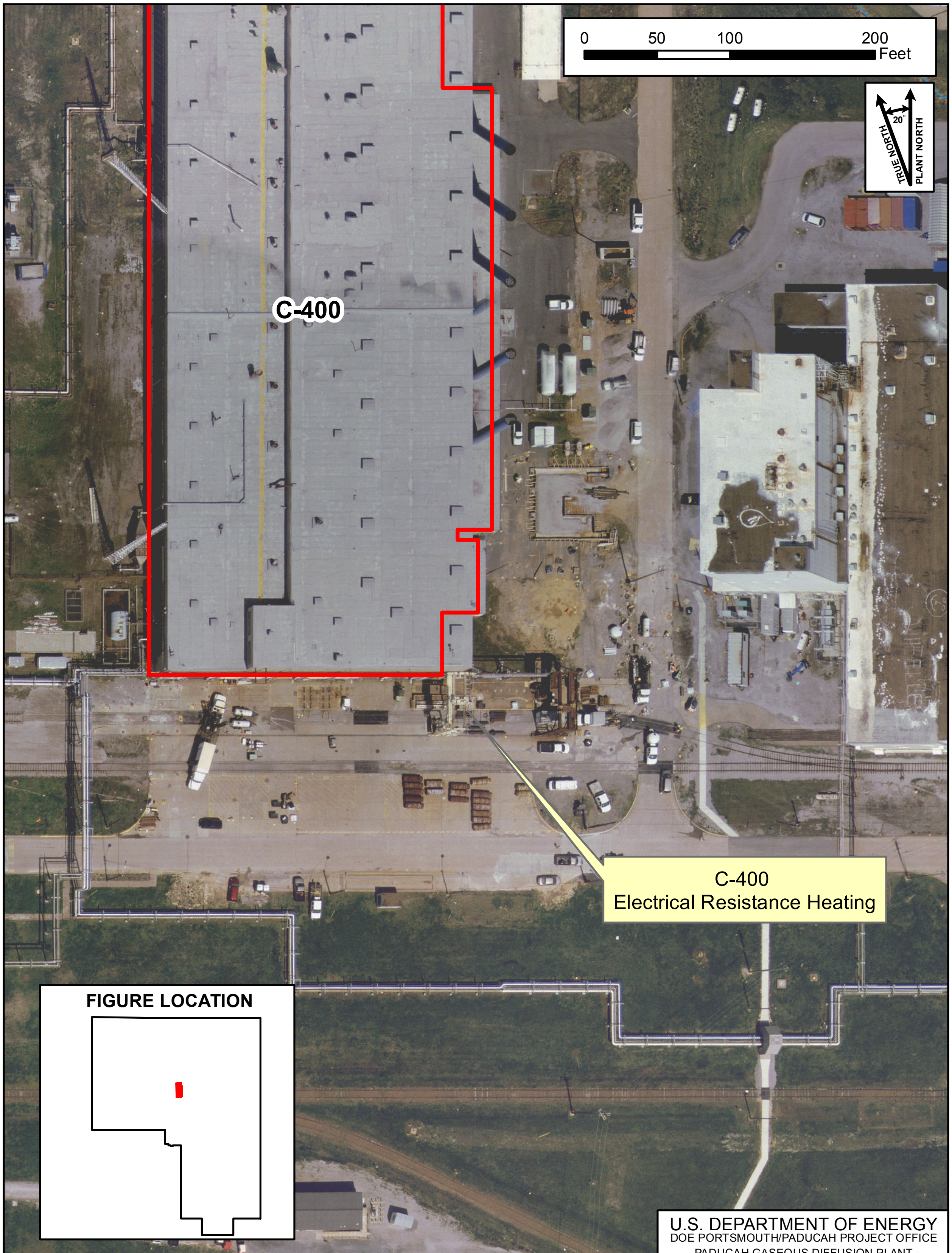

Figure 9.1. Location of C-400 Electrical Resistance Heating

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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.

The C-400 ERH actions (Phase I and Phase II) include 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), is to operate the ERH system until monitoring indicates that heating has stabilized in the subsurface and that recovery of TCE, as measured in the recovered vapor, diminishes to a point at which the recovery rate is constant (i.e., recovery is asymptotic).

The following are 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 has stabilized in the subsurface and when recovery diminishes to a point at which the rate of removal of TCE, as measured in the recovered vapor, becomes asymptotic;

- Implementation, maintenance, enforcing, 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 will remain in place following the IRAs.

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

The ROD stipulates 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 will be filed at the McCracken County Clerk’s Office, in accordance with state law, within 120 days of regulatory approval of the Land Use Control Implementation Plan (LUCIP);

- Deed Restrictions to limit use of the property to industrial activities, to prevent exposure of groundwater to industrial workers, and 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 are to be recorded at the McCracken County Clerk’s Office 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 remedial action.

The RAOs in the ROD are 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.

9.2 REMEDY IMPLEMENTATION

The RDSI, conducted in accordance *with Remedial Design Support Investigation Characterization Plan for the Interim Remedial Action for the Volatile Organic Compound Contamination at the C-400 Cleaning Building at the Paducah Gaseous Diffusion Plant, Paducah Kentucky* (DOE 2005b), was completed in August 2006. The DNAPL source zone was delineated during the RDSI and, coupled with data from previous investigations, was assessed to delineate 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.

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). The design incorporated two phases to mitigate the risks and uncertainties associated with large scale deployment of ERH in the highly permeable RGA.

Phase I heated and treated subsurface soils in the southwest and east treatment areas (see Figure 9.2). In addition to removing VOCs, another important objective of Phase I was to evaluate the heating performance of the base design in the lower RGA to the McNairy Formation interface in the southwest treatment area. ERH treatment in the east area involved only the UCRS. Phase I operations also provided an opportunity to evaluate the performance of the vapor recovery system, assess hydraulic containment, and optimize the aboveground vapor/liquid treatment system.

Phase I construction began in December 2008 and was substantially complete in December 2009; at that time, start up and shakedown testing began. Testing was completed and operations commenced at the end of March 2010. Heating operations ceased (soil vapor extraction continued) at the end of October 2010, and all system operations ended on December 4, 2010.

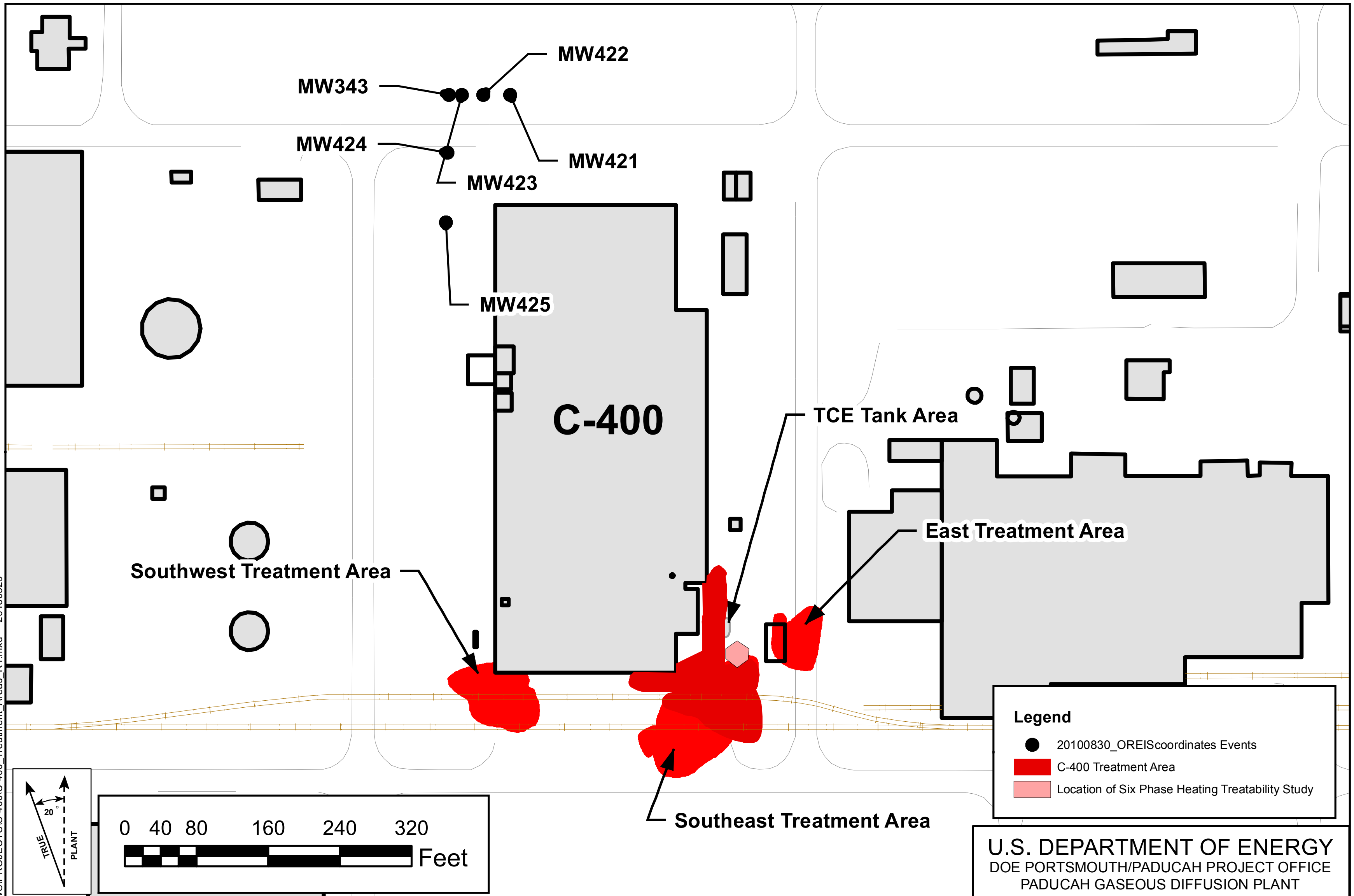

Figure 9.2. C-400 Treatment Areas

A second ITR team, chartered by DOE in September 2010, *Independent Technical Review of the C-400 Interim Remedial Project Phase I Results, Paducah, Kentucky*, SRNL-STI-2010-00681, evaluated Phase I performance and results of preliminary Phase II thermal design modeling (ITR 2010). Observations by the 2010 ITR were included in *Technical Performance Evaluation for Phase I of the C-400 Interim Remedial Action at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-1260&D1, (DOE 2011c), issued in August 2011. This report provides descriptions and details of the construction and implementation of the Phase I remedial action, as well as the results of operational and monitoring data collected during and subsequent to Phase I implementation. These data form the basis for evaluation of Phase I performance.

DOE began construction of an ERH system for the Phase II UCRS target zone (Phase IIa) in September 2012, with completion of underground components (electrodes, vapor extraction wells, etc.) scheduled in April 2013. The second ITR team determined that ERH did not reach target temperatures in the lower RGA despite implementation of contingency measures intended to assist in attaining temperature goals. As a result, it was recommended that ERH not be used for the lower RGA as part of Phase II. DOE, with the participation of the other FFA parties, currently is evaluating alternative remedies for the lower RGA (Phase IIb) and the need to implement treatability studies.

Groundwater monitoring in the area of the Phase I and II source zones is provided by six RGA MWs installed during the WAG 6 RI and the Six-Phase Heating Treatability Study: MW155, MW156, MW405 Port 5, MW406 Port 5, MW407 Port 4, and MW408 Port 5. Phase I activities interrupted sampling in these wells during 2009, 2010, and 2011. Quarterly sampling of these wells resumed in 2012.

DOE installed five MW nests, with screens in the middle and lower RGA, across the northwest corner of C-400 in June 2009 to monitor dissolved contaminant trends near the C-400 source(s) better. These wells were sampled monthly for the period July 2009 through October 2011. The sampling schedule for these wells switched to quarterly collection during 2012, from the basal RGA screen only in each MW nest. (The highest TCE levels were present routinely in the basal RGA screens.)

The C-400 LUCIP was issued in February 2008 and was attached as an appendix to the C-400 Remedial Design Report (DOE 2008a). Each of the LUCs under the ROD was implemented, as appropriate, during the review period. The C-400 area property record notice was filed in the McCracken County Clerk's Office in 2009. DOE did not transfer any of the property covered by the C-400 ROD during the review period so deed restrictions were not applicable. The plant's excavation/penetration permit program required formal authorization prior to performance of all excavations and other intrusive activities. Access controls were maintained during and following each phase of the remedial action, where needed, to ensure protection of plant workers.

9.3 SYSTEMS OPERATIONS/OPERATIONS AND MAINTENANCE

For Phase I, drilling and subsurface completion of ERH components (electrodes, multiphase extraction wells, temperature monitoring strings, vacuum piezometers, and water-level monitoring instruments) was completed in June 2009. System testing concluded in March 2010 and normal operations began. Normal operations continued through September 2010 when TCE concentrations in recovered vapor had dropped to asymptotic levels. Pulsed operations then were initiated as detailed in the Paducah C-400 Project pulsed operations plan. The strategy for the pulsing operations was intended to maximize removal of the remaining contaminants from the 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 was then repeated for two cycles. Pulsed operations ended in October 2010 and power to the electrodes was turned off at the end of October 2010. Vapor extraction continued for approximately five weeks to facilitate subsurface cooling.

O&M activities for Phase I were conducted in accordance with the *Operations and Maintenance Plan for the Interim Remedial Action for the Volatile Organic Compound Contamination at the C-400 Cleaning Building at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-0187&D2 (DOE 2009b). Phase I treatment system removed approximately 6,548 lb (535 gal) of TCE. The cost of Phase I was approximately $32.5M.

Phase I heating began on March 27, 2010 and continued over a 164-day period prior to the commencement of pulsed operations on September 7, 2010. During that time, operation of the electrodes was interrupted (power failures and other system problems) for approximately 48 days (29% of the time). Temperature plots in the treatment areas document that the two most significant downtime events in May 2010 and July 2010 had an impact on heating and extended the time needed to reach target temperatures.

9.4 PROGRESS SINCE LAST FIVE-YEAR REVIEW

The 2008 review stated the following protectiveness statement.

> The remedy at C-400 involving ERH is expected to be protective of human health and the environment upon completion, and, in the interim, exposure pathways that could result in unacceptable risks are being controlled.

During the period addressed by this Five-Year Review, DOE has continued to implement the C-400 remedy, completing the Phase I remedial action and beginning construction to implement the Phase II remedial action in the UCRS and upper RGA. Because Phase I showed that ERH may be unable to reach target temperatures in the lower RGA, DOE, with the participation of the other FFA parties, currently is evaluating alternative remedies for the lower RGA (Phase IIb) and the need to implement treatability studies.

9.5 SITE INSPECTION

A site inspection of the area of the C-400 remedial action was made on May 21, 2013, by a member of the Five-Year Review Team, using the C-400 Area Land Use Controls Checklist from the C-400 LUCIP. The inspection revealed no evidence of land use changes or prohibited activity (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). Access controls were in place to prevent unauthorized entry into the remedial action construction zone, and the warning sign prescribed by the LUCIP was present. Documentation was available to verify that the Property Record Notice was on file in the McCracken County Clerk's Office.

9.6 TECHNICAL ASSESSMENT

The C-400 ROD is an IRA to reduce the concentration of TCE and other VOCs in the source soils in the UCRS and RGA at the C-400 area. Monitoring data indicate that this remedial action has reduced the contaminant concentrations in the Phase I area by implementation of ERH in the UCRS and upper RGA. However, Phase I data suggest that ERH may be ineffective in the lower RGA.

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

In August 2011, DOE transmitted a *Technical Performance Evaluation for the C-400 Interim Remedial Action at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-1260&D1, to EPA and KDEP, which provided the results of the Phase I implementation and identified lessons learned and recommendations for Phase II design and implementation (DOE 2011c).

Phase I ERH removed approximately 6,830 lb of TCE (560 gal), which was a small fraction of the original estimate of TCE in the combined east and southwest treatment areas (285,781 lb/23,350 gal). The original estimate of TCE for the southwest treatment area was based on a faulty conceptual model and grossly overestimated the amount of TCE that was present. Collocated baseline (collected before heating) and postoperation (collected after heating) soil samples document 95% and greater reduction in TCE contamination in the treatment zones.

Soil samples obtained from borings used to install ERH equipment were used to determine the concentrations of TCE and TCE degradation products in the soil prior to the operation of the ERH electrodes. Postoperational samples from collocated borings were obtained for comparison to baseline soil sample analyses to determine the residual TCE concentrations subsequent to the operation of Phase I. The paired baseline and postoperational sample results were compared to assess the reduction in concentrations.

Baseline and postoperational soil samples were collected from 12 locations in the east area (Table 9.1 and Figure 9.3). For the east treatment area, there are 25 paired sampling sets for comparison. Comparing the baseline to the postoperational shows a 95% reduction in concentration, shifting the average concentration of 584 μg/kg to 29 μg/kg. These data demonstrate significant mass reduction within the UCRS in the East Area. Postoperational soil sampling results indicate that the RAOs were achieved in the east treatment area in accordance with the second RAO.

Baseline and postoperational soil samples were collected from 15 locations in the southwest area (Table 9.2 and Figure 9.4). For the southwest treatment area, there are 63 paired sampling sets for comparison. Comparing the baseline to the postoperational shows a 99% reduction in concentration, shifting the average concentration of 1,046 μg/kg to 15 μg/kg. These data demonstrate significant mass reduction in the southwest area. Postoperational soil sampling results indicate that the RAOs were achieved in the treatment areas (UCRS) in the southwest locations in accordance with the second RAO. The data from 60 to 80 ft intervals demonstrate a reduction in concentrations in the upper RGA in accordance with the third RAO.

Target temperatures were attained in treatment areas and depths targeted for VOC removal, indicating that the ERH design was adequate for thermal treatment of UCRS soils; however, target temperatures were not attained in the deep RGA. Key factors that affected attainment of target temperature in the deep RGA include groundwater flow velocity, formation resistivity, and heat loss due to convective flow.

Observed maximum formation temperatures attained during Phase I operations in the lower RGA fell short of target temperature by over 100°F. Contingency thermal engineering techniques identified in the RAWP to boost formation heating were implemented during Phase I in attempts to attain target temperatures. These techniques included injection of saline solutions and maximizing the delivery of electrical power to the electrodes in the lower RGA. Phase I operating experience in the southwest treatment area and subsequent modeling results using a groundwater velocity of 3.0 ft per day indicate

Table 9.1. East Area Baseline and Postoperational Soil TCE Results

Location	Depth (ft bgs)	Baseline Result (µg/kg)	Post Op Result (µg/kg)	Baseline—Post Op[1] (µg/kg)	Reduction[2] (%)
E095	20	10.9	5.5	5.4	49.5
	35	6.91	9.28	-2.37	-34.3
	52	1,880	< 5	1,875	99.7
	60	5.46	75	-69.54	-1,273.6
	80	8.08	20.2	-12.12	-150.0
E097	35	< 4.98	36	-31.02	-622.9
E098	20	< 5.03	< 4.99	0.04	0.8
	35	< 5.02	< 5.01	0.01	0.2
E099	35	6.37	< 5.02	1.35	21.2
E100	20	7,820	< 5	7,815	99.9
	35	1,860	< 5.02	1,854.98	99.7
E102	20	27.9	< 4.99	22.91	82.1
	35	30.5	7.73	22.77	74.7
E103	20	< 4.99	< 5	-0.01	-0.2
	35	< 5.01	< 5.02	-0.01	-0.2
	52	< 5.02	< 5.01	0.01	0.2
E104	20	< 4.97	< 5.01	-0.04	-0.8
	35	196	9.4	186.6	95.2
E105	35	< 5	< 5	0	0
E106	20	20	315	-295	-1,475
	35	< 5	9.15	-4.15	-83
E107	35	60.2	118	-57.8	-96
E110	20	8.46	< 5.03	3.43	40.5
	35	10.6	46.1	-35.5	-334.9
	52	2,610	5.23	2,604.77	99.8
Count		25	25		
Average (µg/kg)		584	29		95
Minimum (µg/kg)		4.97	4.99		
Maximum (µg/kg)		7,820	315		
Count < 70 µg/kg		20	22		
Count nondetectable		9	16		

[1] Difference of baseline and postoperational samples
[2] Reduction Percentage = (Baseline Result - Post Op Result)/Baseline Result*100

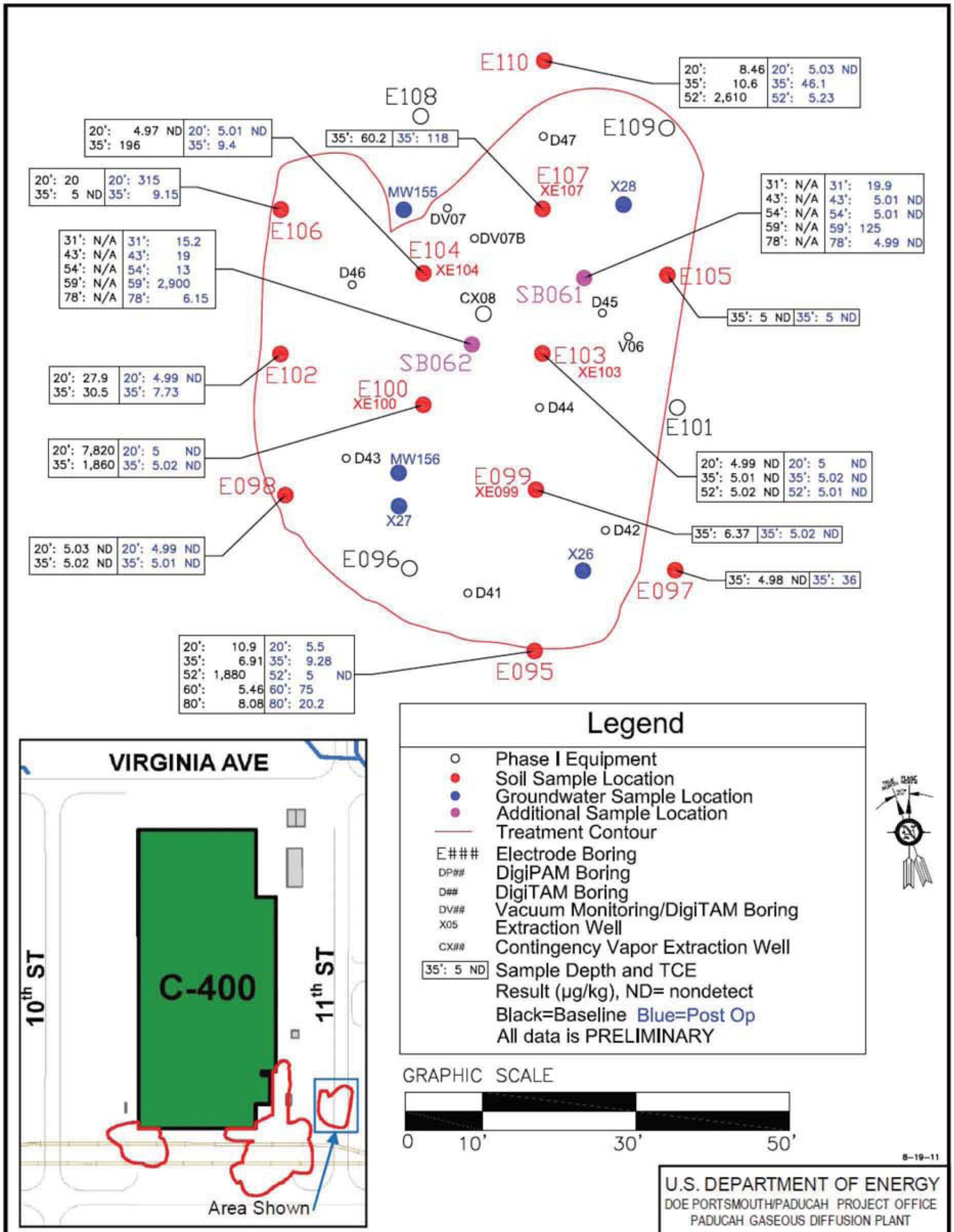

Figure 9.3. East Area Sample Locations and Soil Data

Table 9.2. Southwest Area Baseline and Postoperational Soil TCE Results

Location	Depth (ft bgs)	Baseline Result (µg/kg)	Post Op Result (µg/kg)	Baseline—Post Op[1] (µg/kg)	Reduction[2] (%)
E003	20	< 5.01	< 5.01	0	0
E003	35	< 4.97	< 4.97	0	0
E006	20	6.31	< 5.02	1.29	20.4
E006	35	176	< 5.01	170.99	97.2
E006	52	373	< 4.98	368.02	98.7
E006	60	< 5.03	< 5	0.03	0.6
E006	80	< 5.01	13.2	-8.19	-163.5
E006	103	< 4.99	< 5.02	-0.03	-0.6
E007	20	< 5.02	< 5.04	-0.02	-0.4
E007	35	< 4.97	< 5.02	-0.05	-1
E007	52	124	< 5.03	118.97	95.9
E007	60	21.2	< 5.01	16.19	76.4
E007	80	< 5	< 4.98	0.02	0.4
E007	103	8.94	< 5	3.94	44.1
E009	20	12.3	< 4.98	7.32	59.5
E009	35	8,670	< 5.03	8,664.97	99.9
E010	20	1,010	< 5.03	1,004.97	99.5
E010	35	3,590	< 5.03	3,584.97	99.9
E010	52	873	< 5.01	867.99	99.4
E010	60	15	5.31	9.69	64.6
E010	80	< 5.01	< 5.03	-0.02	-0.4
E010	103	< 4.98	14.5	-9.52	-191.2
E011	20	5,720	< 5.02	5,714.98	99.9
E011	35	1,230	< 5.04	1,224.96	99.6
E011	52	5,240	5.01	5,234.99	99.9
E011	60	7,860	11	7,849	99.9
E011	80	14	8.14	5.86	41.9
E011	103	17.3	< 5.04	12.26	70.9
E012	20	99.5	< 5.03	94.47	94.9
E012	35	6,590	< 5.01	6,584.99	99.9
E012	52	14,500	< 5	14,495	100
E012	60	469	< 5.02	463.98	98.9
E012	80	195	38.1	156.9	80.5
E012	103	< 5.03	< 5.01	0.02	0.4
E013	20	7.09	< 5.02	2.07	29.2
E013	35	50.1	34	16.1	32.1
E016	20	< 5.03	18.8	-13.77	-273.8

Table 9.2. Southwest Area Baseline and Postoperational Soil TCE Results (Continued)

Location	Depth (ft bgs)	Baseline Result (µg/kg)	Post Op Result (µg/kg)	Baseline—Post Op[1] (µg/kg)	Reduction[2] (%)
E016	35	28.9	< 5.03	23.87	82.6
E017	20	607	< 5.02	601.98	99.2
E017	35	3,770	< 5.02	3,764.98	99.9
E017	52	55.7	< 5.03	50.67	91
E017	60	< 46.3	< 4.99	41.31	89.2
E017	80	< 49.3	< 5.04	44.26	89.8
E017	103	< 4.97	< 5.01	-0.04	-0.8
E018	20	676	92.6	583.40	86.3
E018	35	522	14.3	507.70	97.3
E018	52	323	< 5.02	317.98	98.4
E018	60	706	228	478	67.7
E018	80	< 5.01	< 5.01	0	0
E018	103	6.57	< 5	1.57	23.9
E019	20	11.9	68.9	-57	-479
E019	35	69.7	< 4.98	64.72	92.9
E019	52	1,900	13.8	1,886.2	99.3
E020	20	120	< 5.04	114.96	95.8
E020	35	< 5.04	9.93	-4.89	-97
E026	20	26.7	< 4.99	21.71	81.3
E026	35	< 5	27.2	-22.2	-444
X06	20	< 5.02	< 5.03	-0.01	-0.2
X06	35	< 5.03	< 4.99	0.04	0.8
X06	52	< 5.03	88	-82.97	-1,649.5
X06	60	14.5	7.88	6.62	45.7
X06	80	< 5.03	24.6	-19.57	-389.1
X06	103	< 4.99	12.7	-7.71	-154.5
Count		63	63		
Average (µg/kg)		1,046	15		99
Minimum (µg/kg)		4.97	4.97		
Maximum (µg/kg)		14,500	228		
Count <70 µg/kg		39	60		
Count nondetectable		23	43		

[1] Difference of baseline and post operational samples
[2] Reduction Percentage = (Baseline Result - Post Op Result)/Baseline Result*100

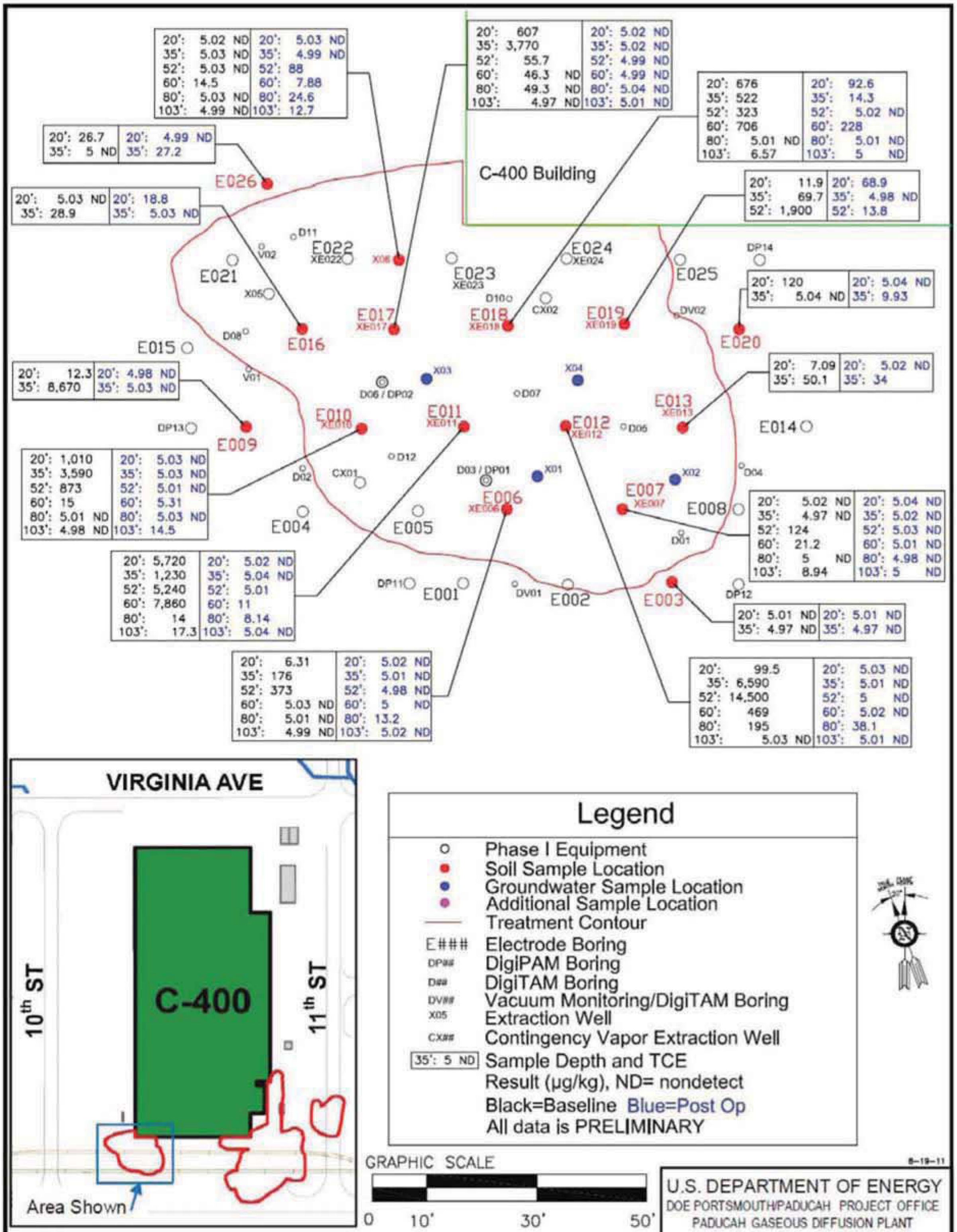

Figure 9.4. Southwest Area Sample Locations and Soil Data

that, in order to achieve target temperatures in the RGA, the ERH configuration developed for Phase I would require significant scale up (e.g., additional electrodes, with hot water injection within the target zone, upgradient electrodes for preheating, and upgradient groundwater extraction to reduce the flux of groundwater through the target volume). A 2010 ITR assessment of Phase I (ITR 2010) concluded that Phase II should implement ERH for the UCRS, but noted that, based on the Phase I results, ERH (or any of the other thermally enhanced removal technologies) is poorly matched to the RGA conditions in the vicinity of the C-400 Building. As an interim action, the ITR recommended modification of the existing water treatment infrastructure for Phase II support (to reduce unnecessary costs) and implementation of pump-and-treat of contaminated groundwater from the RGA in the Phase II RGA target zone.[4] The ITR recommended that heating technology be eliminated from Phase II for the RGA. Instead, the ITR recommended using a technology that is better matched to the RGA, such as oxidation using chemical reagents or solubilization using cosolvents or surfactants.

Six RGA groundwater MWs provide characterization of TCE levels in the area of the Phase I source zones: MW155, MW156, MW405 Port 5, MW406 Port 5, MW407 Port 4, and MW408 Port 5 (see Figure 9.5). TCE levels are markedly highest in MW408 Port 5 (typically greater than 250,000 ppb). Prior to Phase I, TCE levels were generally below 40,000 ppb in the other area wells. Subsequent to Phase I, TCE levels decreased in MW155 (from 14,000 to 3,700 ppb), MW406 Port 5 (from 5,200 to as low as 1,200 ppb), and MW407 Port 4 (from 29,000 to as low as 4,900 ppb). TCE levels were markedly increased in MW156 (from 34,000 to as high as 65,000 ppb), MW405 Port 5 (from 23,000 to as high as 97,000 ppb), and MW408 Port 5 (from 520,000 to as high as 1,400,000 ppb). During 2012, TCE levels declined in MW156 (to as low as 1,700 ppb) and MW405 Port 5 (to as low as 41,000 ppb). Further sampling will be required to assess the trend of TCE levels in MW408 Port 5 and the overall impact of Phase I upon TCE levels in the source zone.

DOE installed five MW nests, with screens in the middle and lower RGA, across the northwest corner of C-400 in June 2009 to monitor better dissolved contaminant trends near the C-400 source(s). In general, the level of dissolved TCE (see Figure 9.6) increases eastward across the well transect on the north side of C-400 (from MW423 to MW424 to MW421) and 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. Through 2012, the C-400 remedial actions have not resulted in any significant decline of contaminant levels in the Northwest Plume at the north side of C-400.

9.6.2 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 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 only to extent practicable, and no specific risk-based level or MCL was established as a cleanup criteria for the project.

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

[4] Preliminary ITR calculations indicate that pump--and-treat in the Phase II RGA target zone would remove contamination at rates that are on par with the Phase I RGA system, while substantially reducing the potential for adverse impacts.

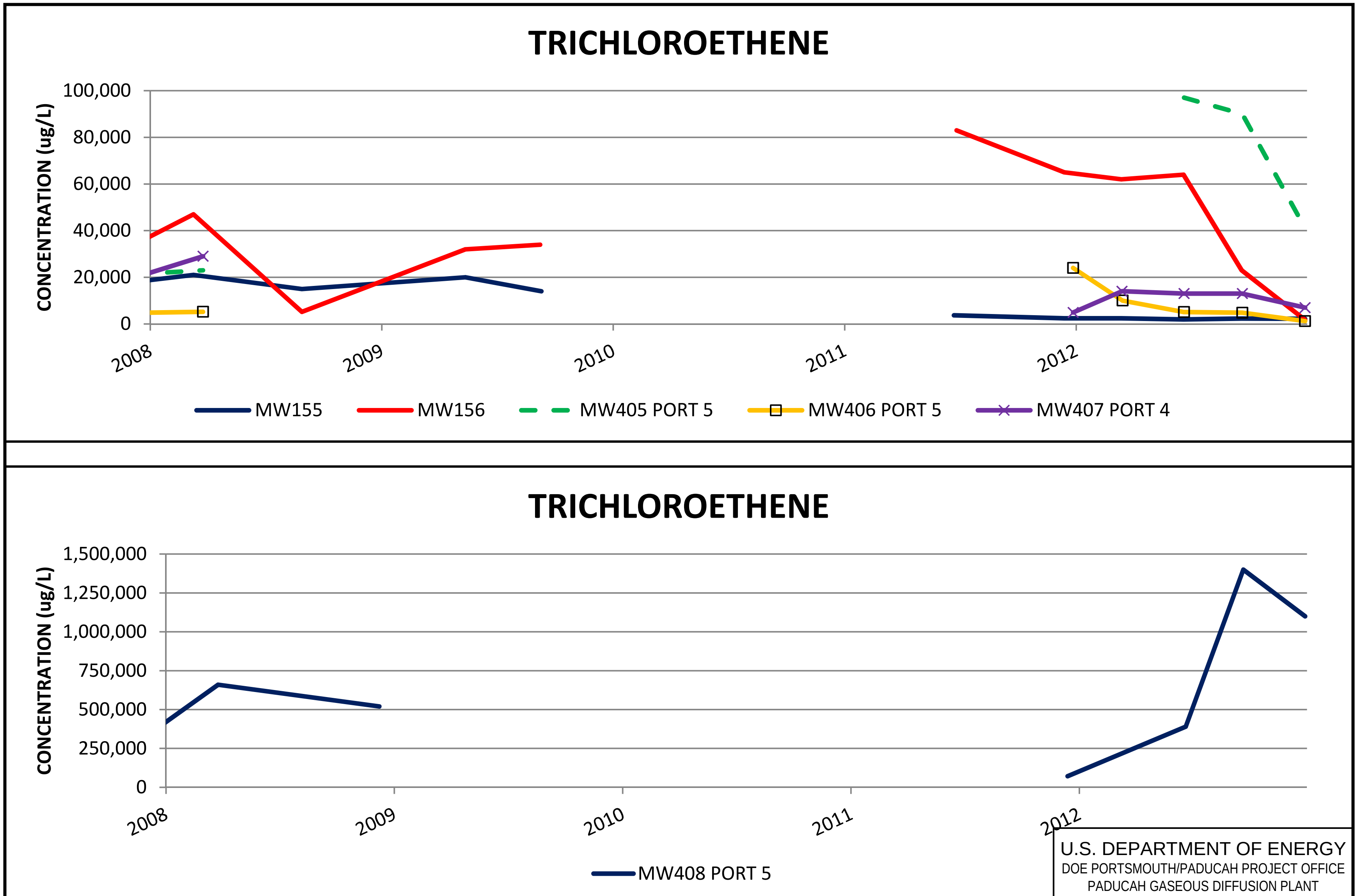

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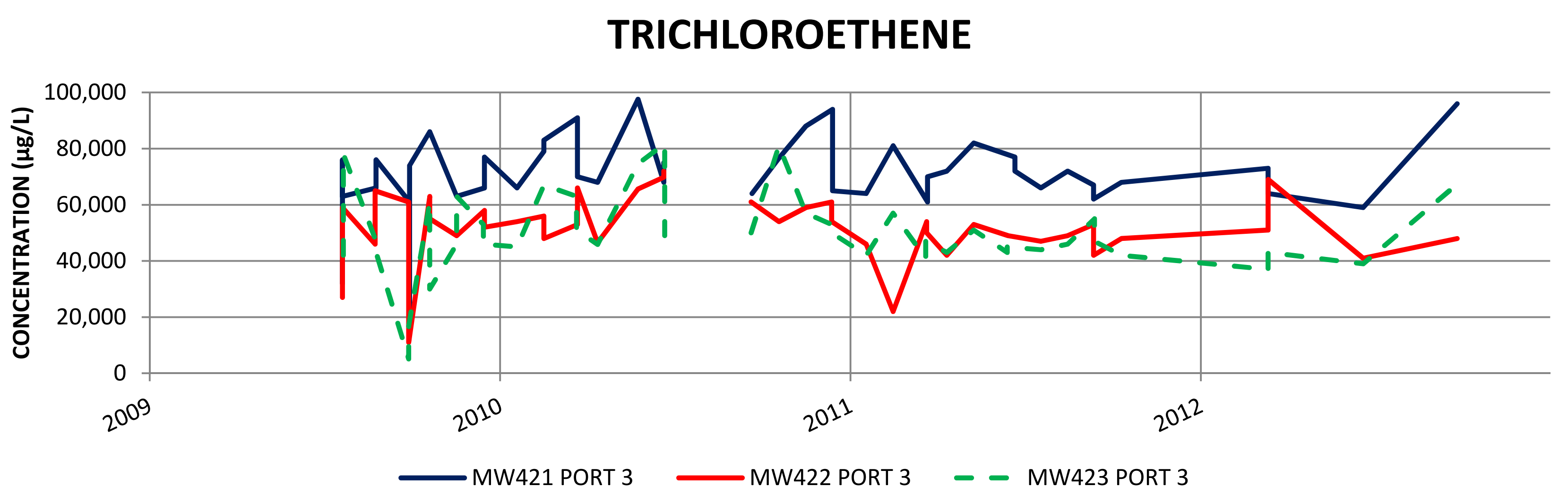
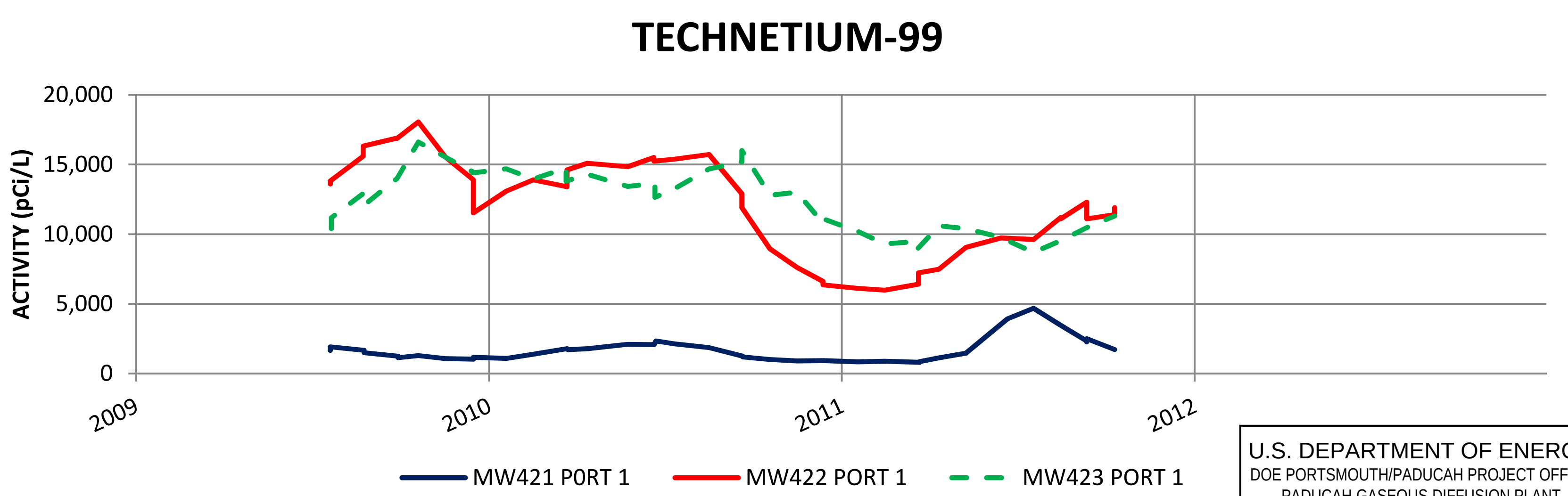
Figure 9.5. Contaminant Trends in MWs Located Near the C-400 Phase I Source Zones

LATA Environmental Services of Kentucky, LLC





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PADUCAH GASEOUS DIFFUSION PLANT

Figure 9.6. Contaminant Trends in MWs Located on the North Side of C-400

LATA Environmental Services of Kentucky, LLC

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:

- 401 *KAR* 5:029(2) references have been moved 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 PGDP, within security 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.

9.6.3 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.

9.6.4 Technical Assessment Summary

The Phase I ERH action effectively removed UCRS contamination associated with a former break in a sewer pipe to the east of C-400 and associated with an unknown source at the southwest corner of C-400. The upcoming Phase II ERH action is anticipated to reduce effectively the remaining VOC contamination in the UCRS to the south and southeast of C-400. This IRA will be protective of the site worker.

DOE, with the participation of the other FFA parties, currently is evaluating alternative remedies for the lower RGA (Phase IIb) and the need to implement treatability studies.

9.7 ISSUES

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 the RAOs in the Upper Continental Recharge System 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.

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. A follow-up evaluation is needed to ensure long-term protection.

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 and, therefore, 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.

10. SOUTHWEST PLUME

The Southwest Plume project currently is underway. The scope of this project is to implement selected remedies for some of the known VOC sources to the Southwest Plume. This project is included in this 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, less than a year time frame is included in this evaluation.

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 2007)]. Then a Focused Feasibility Study for the Southwest Groundwater Plume VOC Sources (Oil Landfarm and C-720 Northeast and Southeast Sites) was conducted (DOE 2012b).

The Southwest Plume consists of groundwater in the RGA contaminated primarily with TCE, a VOC, and is located within the DOE property, west of the C-400 Building and south of the larger groundwater contamination area identified as the Northwest Plume. Sources to the Southwest Plume included in this action are the SWMU 1 Oil Landfarm, SWMU 211-A C-720 Building TCE Northeast Spill Site, and the SWMU 211-B C-720 Building TCE Southeast Spill Site.

10.1 REMEDY SELECTION

The ROD for these SWMUs implements *in situ* source treatment using deep soil mixing with interim LUCs at SWMU 1. The ROD requires field data collection followed by either enhanced *in situ* bioremediation with interim LUCs or long-term monitoring with interim LUCs, pending further investigation, for SWMUs 211-A and 211-B (DOE 2012c). These interim LUCs, for both SWMU 1 and SWMUs 211-A and 211-B, consist of the site's excavation-penetration permit program and warning signs.

The SWMU 1 remedial action includes an RDSI to determine the extent and distribution of VOCs in the UCRS, implementation of deep soil mixing with injection of steam and zero-valent iron, confirmatory sampling, site restoration, and groundwater monitoring. The remediation goal for TCE (the primary VOC) and other COCs for this action, as documented in the ROD (DOE 2012c), is 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

DOE will refine the design, based on the TCE mass at SWMU 1, as determined from the RDSI, to meet the remedial action goals. Implementation of deep soil mixing is planned for calendar year 2014.

The SWMUs 211-A and 211-B remedial actions began with a final characterization (FC)/RDSI for each site. Based on the results of the FC/RDSI, the FFA parties will determine if treatment (*in situ* source treatment using enhanced *in situ* bioremediation) is appropriate for each of the SWMUs or if long-term monitoring alone is sufficient for each SWMU. The alternative actions contain the following components.

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

The selection of the remedial action for the C-720 sites will be based upon the results on the FC, 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 SWMUs 211-A and 211-B is to reduce average VOC levels in the UCRS soil to below the following 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

The response actions selected in this ROD provide for timely remediation of VOCs at the Southwest Plume sources. Deep soil mixing at SWMU 1 will volatilize contaminants in the groundwater and soil. The volatilized contaminants are captured by vacuum in a shroud that extends over the auger zone and leads to aboveground equipment for processing and later disposal as hazardous waste. Enhanced *in situ* bioremediation destroys the contaminants in place.

This ROD designates the high-concentration-TCE soils and residual TCE DNAPL as principal threat waste. The RAOs in the ROD are as follows:

- Treat and/or remove the principal threat waste consistent with the National Oil and Hazardous Substances Pollution Contingency Plan.

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

- Prevent exposure to non-VOC contamination and residual VOC contamination through interim LUCs within the Southwest Plume source areas (i.e., SWMU 1, SWMU 211-A, and SWMU 211-B) pending final remedy selection as part of a subsequent OU that addresses the relevant media.

- Reduce VOC migration from contaminated subsurface soils in the treatment areas at the Oil Landfarm and the C-720 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.

10.2 REMEDY IMPLEMENTATION

The SWMU 1 RDSI was conducted in accordance with the RDSI Characterization Plan found in *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*, DOE/LX/07-1268&D2/R2, during July and August 2012 using direct push technology (DPT) sampling (DOE 2012d). DPT provides a continuous soil core while minimizing the generation of investigation-derived waste. The RDSI sampled 24 DPT soil borings (with preliminary next-day VOC results) to a depth of 60 to 65 ft (top of the RGA gravel member or depth of refusal) to determine the extent of the VOC source zone at SWMU 1 (see Figure 10.1). The DPT soil cores provided for sampling in each 5-ft depth interval for VOCs, sampling for geotechnical testing, and logging of soil texture. The extent of the VOC source zone delineated during the RDSI is being used by the design team to optimize the placement and spacing of the deep soil mixing borings. The 30% and 60% RDRs, DOE/LX/07-1276&D1, were issued in June and September 2012, respectively.

Well installation and soil sampling for the SWMU 211-A and 211-B FC/RDSI began in August 2012 in accordance with the RDSI Characterization Plan (DOE 2012e). The project crew completed DPT sampling, as done at SWMU 1, and well testing at SWMU 211-B in October 2012. The characterization of extent at SWMU 211-B required 19 DPT soil borings (Figure 10.2). Sampling activities at SWMU 211-A are continuing into 2013. Through 2012, the characterization of extent at SWMU 211-A had required 34 DPT soil borings (Figure 10.3). Additional characterization is required to define the extent of VOC-contaminated UCRS soil to the west of the existing SWMU boundary. Results from the FC/RDSI will be reported in a Field Characterization Report in 2013.

As required by the ROD, the ROD was made available to the organization responsible for implementing the Excavation/Penetration Permit Program within 30 days of the ROD signatures. Warning signs also were posted for the Southwest Plume source areas before beginning RDSI field activities. Signs were removed once RDSI fieldwork was completed. Subsequently, DOE has reposted the areas to warn site workers of potential exposure to contaminated groundwater or soil.

10.3 SYSTEMS OPERATIONS/OPERATIONS AND MAINTENANCE

O&M cannot be assessed at this time.

10.4 PROGRESS SINCE LAST FIVE-YEAR REVIEW

The remedial action for Southwest Plume VOC sources was not included in the 2008 Five-Year Review. The only site remedial activity during the period of this Five-Year Review at each of the SWMUs has been performance of the FC/RDSI. The draft RDSI report was submitted to the regulatory agencies in February 2012, and the final RDSI report was issued in December 2013. A decision regarding the selection of remedy for SWMUs 211-A and 211-B awaits review of the RDSI report.

10.5 SITE INSPECTION

Site inspections of the areas of the Southwest Plume source zone remedial actions were made on August 14, 2013, by a member of the Five-Year Review Team. The inspection revealed no changes to physical site conditions or changes to land use or expected land use at any of the three SWMUs. Interim LUCs consisting of placement of warning signs and the sites' excavation/penetration permit program are in place to prevent exposure to the site contaminants.

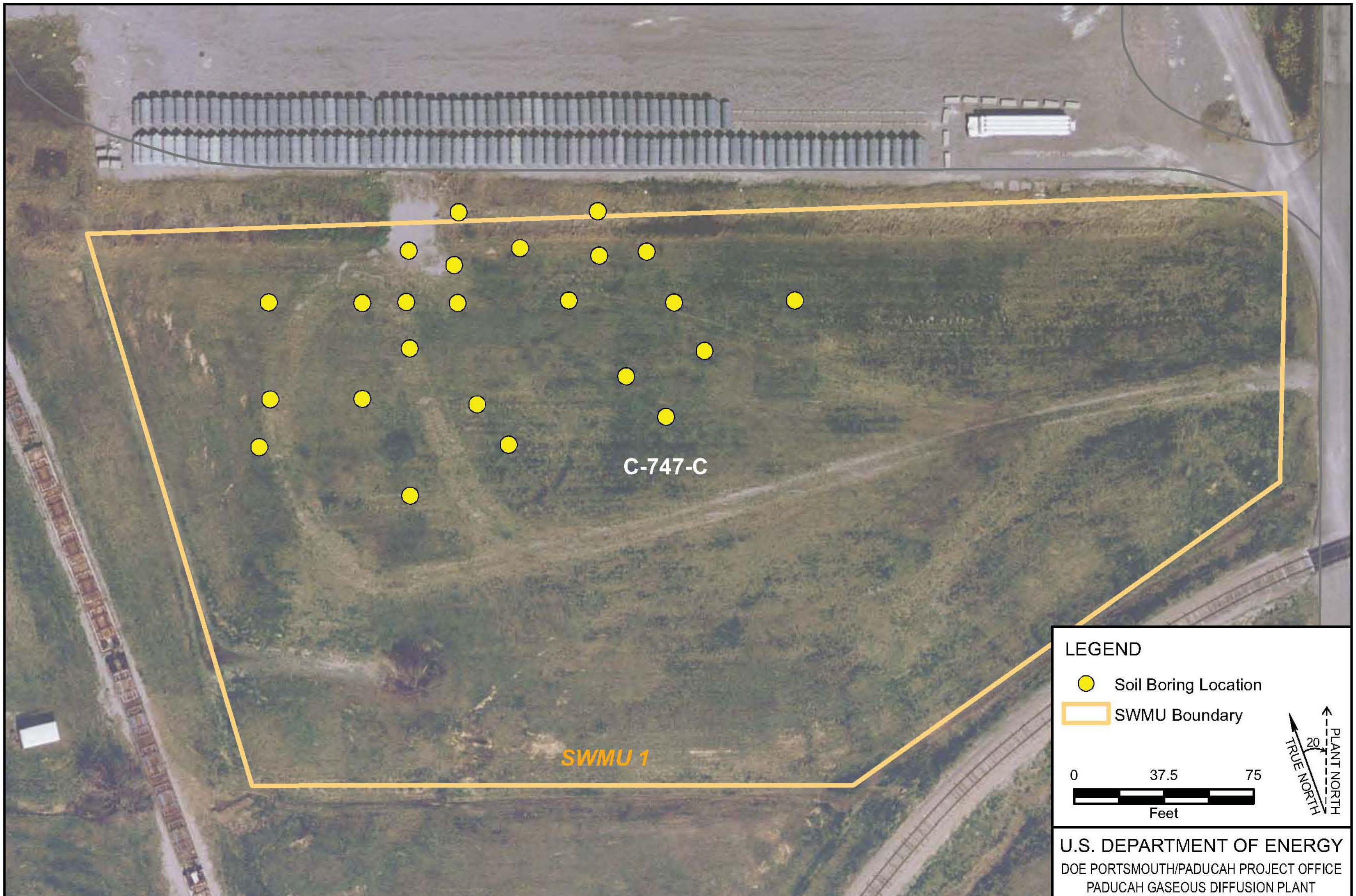

Figure 10.1. 2012 RDSI Sample Locations at the C-747-C Oil Landfarm

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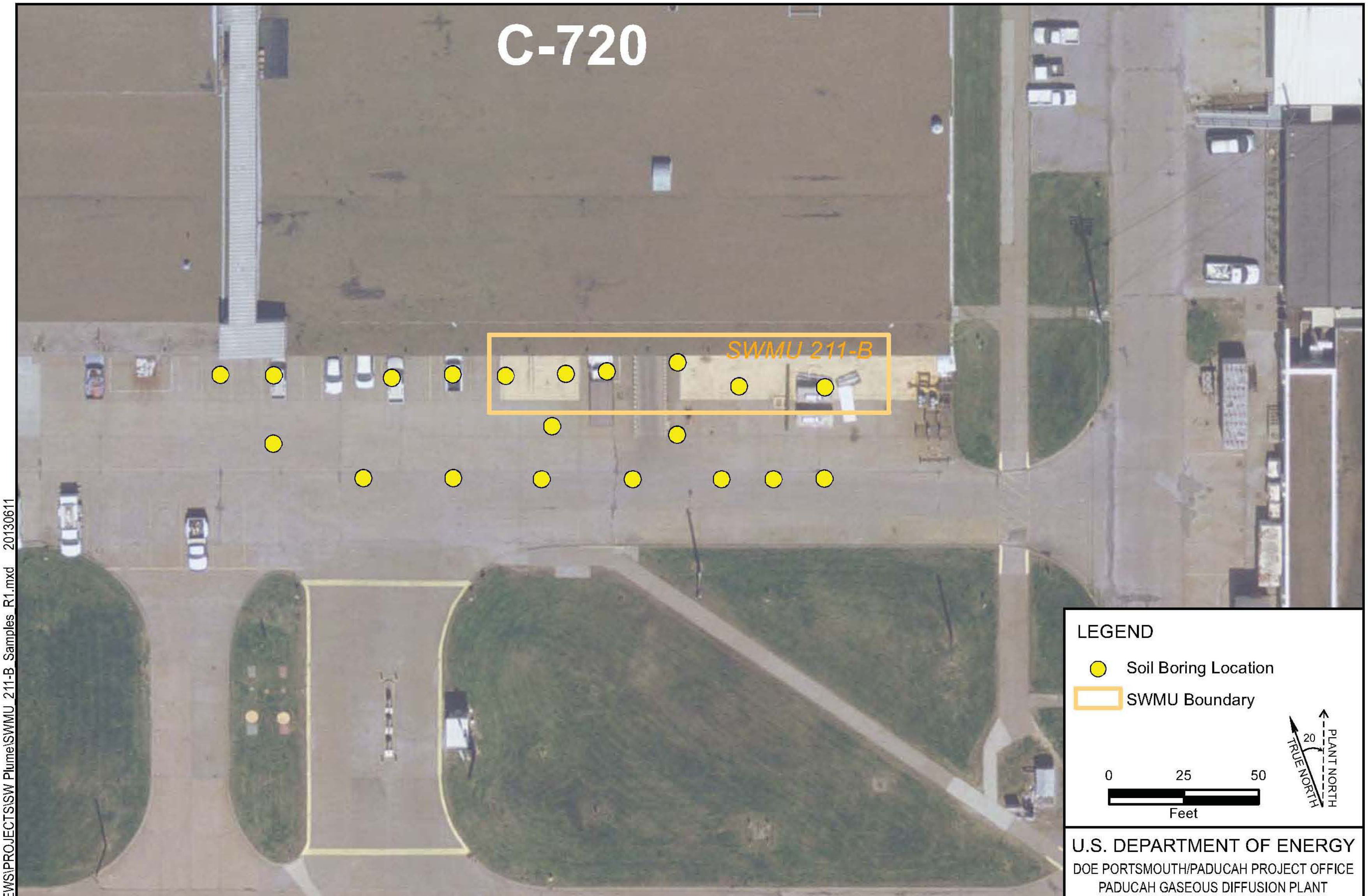

Figure 10.2. 2012 RDSI Sample Locations at SWMU 211-B

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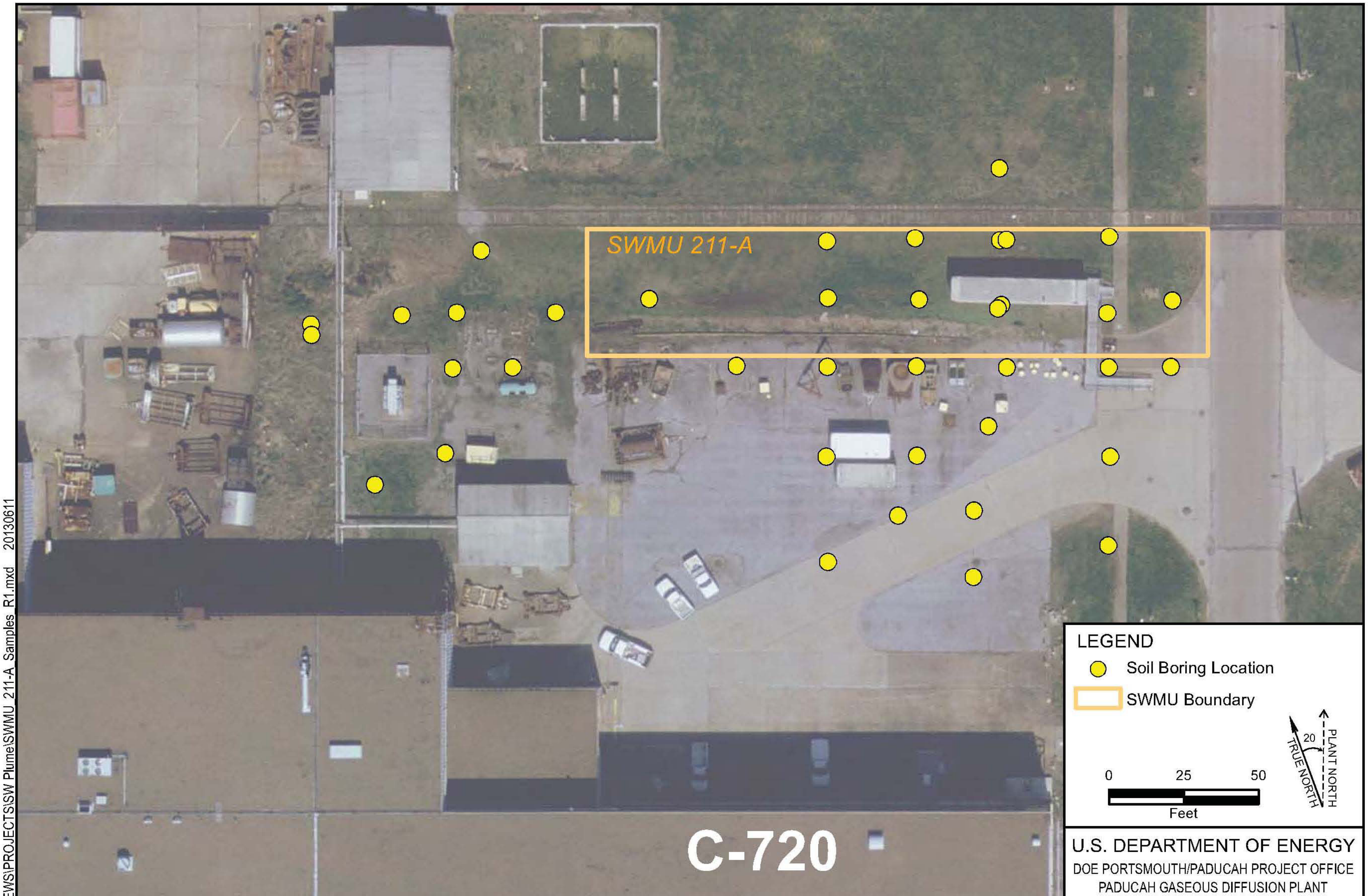

Figure 10.3. 2012 RDSI Sample Locations at SWMU 211-A

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10.6 TECHNICAL ASSESSMENT

The only site remedial activity during the period of this Five-Year Review at each of the SWMUs has been performance of the FC/RDSI.

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

The remedial action for the Southwest Plume VOC sources is under construction. The function of the remedies cannot be assessed at this time.

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?

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 they were during the original remedy selection. The basis and the numerical cleanup levels established in the Southwest Plume ROD are included in Table 10.1.

Table 10.1. Changes in Chemical-Specific Standards for the Southwest Plume

Contaminant*	Media	Cleanup Level-SWMU 1	Cleanup Level-SWMUs 211-A and B	Basis
Trichloroethene	Soil	73 µg/kg	75 µg/kg	Calculated soil cleanup levels protective of GW at the POE
1,1-Dichloroethene	Soil	130 µg/kg	137 µg/kg	Calculated soil cleanup levels protective of GW at the POE
cis-1,2-Dichloroethene	Soil	600 µg/kg	619 µg/kg	Calculated soil cleanup levels protective of GW at the POE
trans-1,2-Dichloroethene	Soil	1,080 µg/kg	5,290 µg/kg	Calculated soil cleanup levels protective of GW at the POE
Vinyl chloride	Soil	34 µg/kg	570 µg/kg	Calculated soil cleanup levels protective of GW at the POE

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

The goals identified for the Southwest Plume VOC sources ROD remain valid:

- To treat and/or remove principal threat waste;
- To prevent unacceptable exposure to VOCs by the excavation worker and to non-VOC contamination; and
- To reduce VOC migration from the source zones such that contaminants migrating from the treatment areas do not result in an 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 PGDP, within security, 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. There have been no new contaminants or new understanding of geologic conditions identified.

10.6.3 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.

10.6.4 Technical Assessment Summary

The area of UCRS soil contamination at the C-720 Building Southeast Site is near the outlet to one of the storm drains for the east end of the C-720 Building. There also is a storm sewer inlet for the southeast parking lot in the vicinity. The northern edge of the this parking lot where the contamination occurs, also is the location of one of the loading docks for the C-720 Building, an area where chemicals, including solvents, may have been loaded or unloaded. The VOCs associated with this site, which are beneath the southeast parking lot, may be the result of activities within the building that resulted in VOCs entering the storm drains for the southeast corner of the building or from spills or leaks of activities on the loading dock or in the southeast parking lot. The subsurface soil contamination found to the northeast of the C-720 Building is believed to have been a result of routine equipment cleaning and rinsing with solvents.

The C-747-C Oil Landfarm was used for landfarming of waste oils contaminated with TCE, uranium, PCBs, and 1,1,1-trichlorethane between 1973 and 1979. These waste oils are believed to have been derived from a variety of plant processes. The Landfarm consisted of two 1,125 ft^2 plots that were plowed to a depth of 1 to 2 ft. Waste oils were spread on the surface every 3 to 4 months, then the area was limed and fertilized. The VOC contamination in the soils at C-747-C is thought to be the residual of the waste oils.

These activities, or other unknown spills, have resulted in VOC-contamination. PGDP's contractor excavation/penetration permit program and the DOE Water Policy limit the exposure pathways to the SWMU 1 and C-720 area source zones.

It is anticipated that the upcoming Southwest Plume source actions will be protective.

10.7 ISSUES

The Southwest Plume project is a remedial action under construction. The remedial action is designed to address VOC releases to groundwater. A follow-up evaluation is needed to ensure long-term protection.

11. NSDD SOURCE CONTROL

The NSDD originates within the north central portion of PGDP and joins with Little Bayou Creek to the north of the plant. Figure 11.1 illustrates the location of the NSDD Source Control. 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 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 at PGDP 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 (i.e., outside the existing security fence) migration of on-site contaminant sources (CH2M HILL 1992). The PHEA also recommended action to eliminate the off-site (i.e., outside the existing security fence) migration of these contaminants to the outside of the Paducah Gaseous Diffusion Plant’s boundaries (i.e., outside the existing security fence) and recommended remedial action to eliminate this off-site (i.e., outside the existing security fence) movement. The NSDD ROD also stated there was potential for exposure of plant maintenance personnel to the contaminants within the ditch through routine maintenance activities. The personnel were potentially 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 remedial action, discussed in this section, and the response actions for Sections 1 and 2, 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 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.

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;

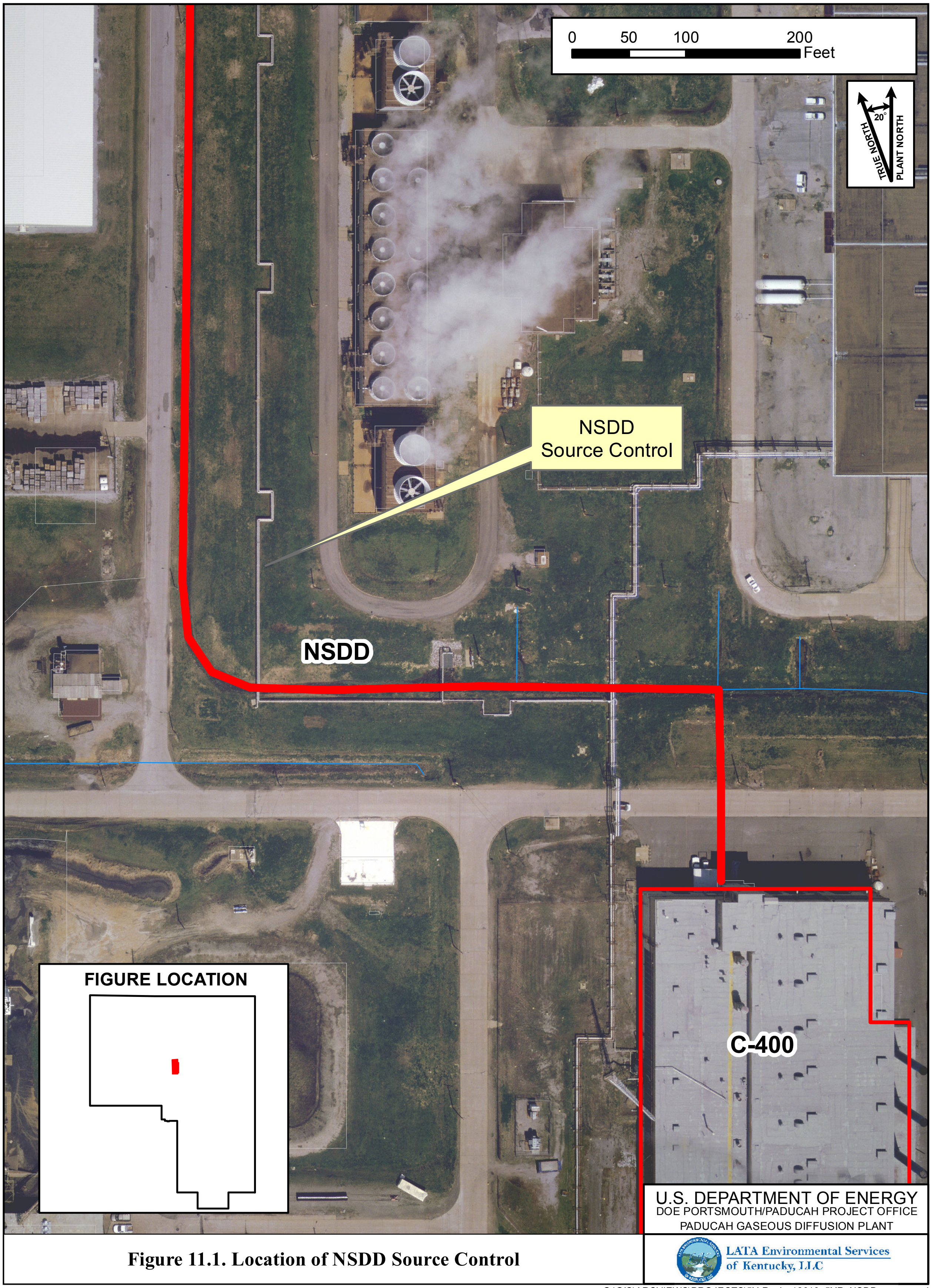

Figure 11.1. Location of NSDD Source Control

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- 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-616-H Lift Station;

- Removing fly ash from the C-600 Steam Plant ash pile runoff by constructing settling lagoons 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 (i.e., outside the existing security fence) 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). Once construction was completed, two components of the actions, the C-400 Ion Exchange and C-600 Fly Ash Lagoons, were incorporated into the daily operations of PGDP by USEC. 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 stormwater 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 stormwater drain. The discharge water will be transferred through the stormwater drainage system to Outfall 008.[5]

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

The 1994 NSDD ROD identified ARARs pertinent to the remedial action (DOE 1994a). The 1998 Five-Year Review found that jurisdictional wetlands have been identified in the NSDD after the ROD had been signed. The 1994 ROD for the NSDD was signed prior to DOE's Secretarial Policy requiring that National Environmental Policy Act values be incorporated in CERCLA documents (DOE 1994a). DOE

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

complied with all requirements during implementation of the remedial action and continues to comply with identified requirements during operation of the action. Because the wetlands were not identified prior to signing the 1994 ROD, ARARs for the protection of wetlands were not identified. They were added in 2003 during the five-year review period and are being complied with.

11.3 SYSTEMS OPERATIONS/OPERATIONS AND MAINTENANCE

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

The operations of the C-400 Ion Exchange unit and discharges from it are conducted according to a memorandum of understanding between USEC and DOE.

The C-400-L Lift Station is located on the north side of the NSDD near its upper reach near 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 were some cattails and 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 2009, extensive re-wiring was completed for the lift station to accommodate new level probes and relays that were installed. The previous level probes had begun to malfunction, which resulted in the occasional need for manual pumping of the lift station.

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 is under the control and operation of USEC. 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-C 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; however, several small pieces of covering were damaged, partially attached, or missing.

A gabion with a nonwoven, geotextile filter was installed at the existing C-616-H 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 plantwide, long-term surveillance and maintenance, and environmental monitoring programs.

11.4 PROGRESS SINCE LAST FIVE-YEAR REVIEW

The 2008 Five-Year Review determined that the exposure pathways for the NSDD Control Source that could result in unacceptable risk are being controlled and therefore are protective of human health and the environment. The following is from the 2008 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 was not a final action and was not designed to return the area to unrestricted use (DOE 2009a).

There have been no previous issues or recommendations for the NSDD Source Control. The site remains unchanged as described in the 2008 Five-Year Review, and no new actions have occurred.

11.5 SITE INSPECTION

On February 19, 2013, a site inspection by the SWOU Project Manager of the following facilities associated with the NSDD IRA was conducted: (1) the C-400-L Lift Station and associated piping, (2) the C-616-L Lift Station and associated piping, and (3) the gabion installed at the C-616-H Lift Station. Additionally, 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; however, several small pieces of the covering were damaged, partially attached, or missing. The lift stations appear to be functioning properly. After the site inspection, maintenance on the aboveground pipeline metal jacket covering was completed. The facility manager and the site inspector also were consulted concerning this facility and did not have any concerns.

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 is routed to the USEC-operated C-400 Cleaning Building collection tank, where it is stored until the treatment levels are assessed. The wastewater is repeatedly processed through the uranium precipitation and ion exchange systems until a point of diminishing return is reached (i.e., until the percentage of reduction becomes insignificant with subsequent treatments). The final concentration in the treated water is contingent upon the initial concentrations. After treatment, the water either is recycled in C-400 Building processes or is discharged via Outfall 008. Because the effluent discharge from the C-400 Building is treated until a point of diminishing return is reached and was rerouted to Outfall 008 during the design phase, the introduction of contaminants into the NSDD from the C-400 Building has been eliminated completely.

The discharges of Outfall 008 are the responsibility of USEC. The wastewater from the C-400 Building is treated and DOE monitors surface water at Outfall 008 quarterly as a part of its Environmental Monitoring Program. From 2005 to 2010, this location was monitored for volatiles, PCBs, metals, anions/cations, and radionuclides. Since 2011, this location has been monitored for volatiles and PCBs. The maximum Tc-99 detection during this review period is 20.1 pCi/L, which is considerably less than the accepted standards.

Two concrete settling lagoons were constructed to reduce fly ash from the C-600 Steam Plant ash pile runoff prior to discharge. The C-600 Fly Ash Lagoons continue to be used to keep coal-pile water runoff out of the NSDD, thereby lowering the levels of sediment being deposited in the NSDD. With the installation of the two lift stations, C-400-L and C-616-L, and associated aboveground and underground pipelines to bypass coal-pile water runoff and fly ash settling basin water to the NSDD, the introduction of contaminants into the NSDD from the C-600 Steam Plant has been eliminated completely.

To minimize sediment transport off-site (i.e., outside the existing security fence) from the NSDD, a gabion with a nonwoven, geotextile filter was installed. 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 at a minimum of twice 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 remains valid.

Changes in risk assessment methodology subsequent to approval of the ROD have been significant; these changes, however, 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.

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, 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.
- 401 *KAR* 5:029(2) and 401 *KAR* 5:031(4) were moved 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 to ensure that the screen of the Ditch 001 lift station remains 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 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. The interim action is functioning as designed and therefore is protective of human health and the environment.

11.7 ISSUES

None.

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12. NSDD SECTIONS 1 AND 2

The NSDD originates within the north central portion of PGDP and joins with Little Bayou Creek to the north of the plant. 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 at PGDP.

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 remedial action (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 plant 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).

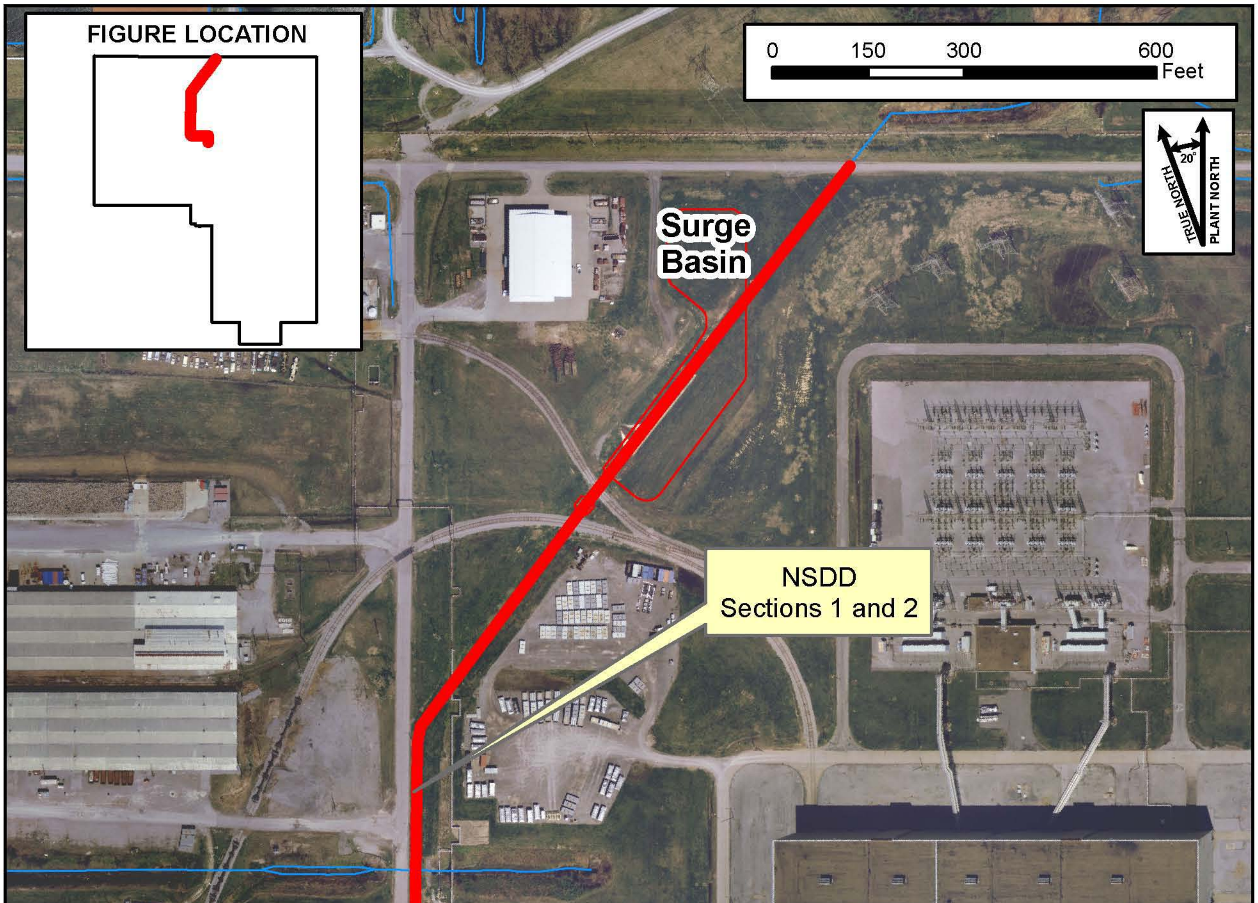

Figure 12.1. Location of NSDD Sections 1 and 2

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3/12/2013

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 Kentucky Division of Waste Management (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 for the C-746-U Landfill.

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

The C-746-U Landfill is a contained landfill as defined in Kentucky regulations of 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 remediation contractor has procedures in place to ensure that no wastes are disposed of in the landfill that do not meet the waste acceptance criteria for this facility. This includes soil waste from the NSDD and other areas of PGDP. One aspect of the waste acceptance criteria are 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 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 (TSCA)-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 Paducah/Portsmouth project health physicist. This is done through documentation prepared for all waste disposed 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 is 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 the maximally exposed individual. 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 disposing 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 2005d).

Figure 12.2. NSDD Sections 1 and 2 before Remedial Action

Figure 12.3. NSDD Sections 1 and 2 after Remedial Action

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 can be optimized (e.g., risks are at a level that would support modification of institutional controls and/or cessation of five-year reviews). This evaluation shows 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 newly excavated and lined ditch is maintained as part of PGDP's ongoing grounds maintenance program, and the cost is not tracked separately.

12.4 PROGRESS SINCE LAST FIVE-YEAR REVIEW

The summation of the 2008 Five-Year Review protectiveness statement follows: The remedy for the NSDD Sections 1 and 2 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 (DOE 2009a).

The 2008 Five-Year Review had the following recommendation:

> Perform a residual risk calculation to determine if the remedy can be optimized (e.g., risks are at a level that would support modification of institutional controls and/or cessation of five-year reviews).

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 EPA risk range (EPA 1999); therefore, monitoring of LUCs can be reduced to once every five years in conjunction with the Five-Year Reviews to ensure that the assumption of industrial land use continues until a final remedy is selected. A request for modification of the NSDD LUCIP for reduced monitoring of institutional controls is recommended. The residual risk evaluation is provided in Appendix B.

The site remains unchanged as described in the 2008 Five-Year Review, and no new actions have occurred.

12.5 SITE INSPECTION

The NSDD site inspection was conducted on February 19, 2013, by the SWOU Project Manager, as part of this Five-Year Review. 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, although there were some cattails in the concrete lining of the basin entry point. There was no standing water in the surge basin. The grass cover is well established and was mowed. There were no visible signs of erosion along the banks of the surge basin. NSDD inspections are ongoing as part of the current remediation contractor’s scope. The facility manager and the site inspector also were consulted concerning this facility and did not have any concerns.

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, TSCA-regulated, or greater than authorized limits for the on-site C-746-U Landfill. The waste acceptance criteria 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. The plugged culverts and detention basin prevent rainfall from inside the plant from flowing beyond the 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 2012b). Current exposure assumptions and toxicity data were used to prepare the residual risk evaluation.

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 EPA risk range (EPA 1999); therefore, monitoring of LUCs can be reduced to once every five years in conjunction with the Five-Year Reviews to ensure that the assumption of industrial land use continues to be the current and reasonably anticipated future land use until a final remedy is selected.

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 clean-up 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 a new standard using similar risk-based exposures and current risk methodology (DOE 2002d; DOE 2013). For technetium-99, thorium-230, and uranium-234, the new standards 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 standard (i.e., an ELCR of 1E-04). The cleanup levels still are protective. Verification sampling showed the results for these contaminants were well below both the cleanup level and the new standard. 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, but do not impact the protectiveness of the remedy:

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

- 401 *KAR* 5:029(2) and 5:031 references 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.

12.6.4 Technical Assessment Summary

The remedial action 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.

Table 12.1. Changes in Chemical-Specific Standards for the NSDD Sections 1 and 2

Contaminant	Media	Cleanup Level[a]	Standard[b]	Citation/Year
Aluminum	Sediment	139,200 mg/kg		DOE 2002d
			100,000 mg/kg	DOE 2013
Antimony	Sediment	11.37 mg/kg		DOE 2002d
			2,450 mg/kg	DOE 2013
Arsenic	Sediment	52.3 mg/kg		DOE 2002d
			381 mg/kg	DOE 2013
Barium	Sediment	6,870 mg/kg		DOE 2002d
			100,000 mg/kg	DOE 2013
Beryllium	Sediment	28.44 mg/kg		DOE 2002d
			11,900 mg/kg	DOE 2013
Cadmium	Sediment	639 mg/kg		DOE 2002d
			5,940 mg/kg	DOE 2013
Chromium	Sediment	85.2 mg/kg		DOE 2002d
			19,800 mg/kg	DOE 2013
Copper	Sediment	14,790 mg/kg		DOE 2002d
			100,000 mg/kg	DOE 2013
Iron	Sediment	62,100 mg/kg		DOE 2002d
			100,000 mg/kg	DOE 2013
Lead	Sediment	50 mg/kg		DOE 2002d
			800 mg/kg	DOE 2013
Manganese	Sediment	2,598 mg/kg		DOE 2002d
			100,000 mg/kg	DOE 2013
Mercury	Sediment	29.46 mg/kg		DOE 2002d
			1,840 mg/kg	DOE 2013
Nickel	Sediment	7,260 mg/kg		DOE 2002d
			100,000 mg/kg	DOE 2013
Selenium	Sediment	2,847 mg/kg		DOE 2002d
			30,600 mg/kg	DOE 2013
Silver	Sediment	1,233 mg/kg		DOE 2002d
			30,600 mg/kg	DOE 2013
Thallium	Sediment	2.2 mg/kg		DOE 2002d
			61.2 mg/kg	DOE 2013
Uranium	Sediment	3,030 mg/kg		DOE 2002d
			17,900 mg/kg	DOE 2013
Vanadium	Sediment	99.6 mg/kg		DOE 2002d
			30,900 mg/kg	DOE 2013
Total PCBs	Sediment	19.9 mg/kg		DOE 2002d
			286 mg/kg	DOE 2013
Total PAHs	Sediment	2.12 mg/kg		DOE 2002d
			78.4 mg/kg	DOE 2013
Americium-241	Sediment	467 pCi/g		DOE 2002d
			1,550 pCi/g	DOE 2013
Cesium-137	Sediment	13.3 pCi/g		DOE 2002d
			40.5 pCi/g	DOE 2013
Neptunium-237	Sediment	45.4 pCi/g		DOE 2002d
			121 pCi/g	DOE 2013

Table 12.1. Changes in Chemical-Specific Standards for the NSDD Sections 1 and 2 (Continued)

Contaminant	Media	Cleanup Level[a]	Standard[b]	Citation/Year
Plutonium-239	Sediment	563 pCi/g		DOE 2002d
			2,140 pCi/g	DOE 2013
Technetium-99	Sediment	227,000 pCi/g		DOE 2002d
			100,000 pCi/g	DOE 2013
Thorium-230	Sediment	3,510 pCi/g		DOE 2002d
			2,510 pCi/g	DOE 2013
Uranium-234	Sediment	6,880 pCi/g		DOE 2002d
			6,110 pCi/g	DOE 2013
Uranium-235	Sediment	81.6 pCi/g		DOE 2002d
			161 pCi/g	DOE 2013
Uranium-238	Sediment	313 pCi/g		DOE 2002d
			748 pCi/g	DOE 2013

[a] Previous standards 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 standards 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 2013 Risk Methods Document (DOE 2013).

The maintenance of the clay cover to prevent exposure is not required because the samples collected from the open excavation indicated that the clean-up criteria 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 PGDP. Based on the recommendation of the 2008 Five-Year Review, a residual risk evaluation was performed. The evaluation showed that the residual risk to the outdoor and industrial worker falls within EPA risk range (EPA 1999). Based on the residual risk evaluation, a modification to the LUCIP is recommended that calls for the monitoring of 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 NSDD Sections 1 and 2.

12.7 ISSUES

The 2008 Five-Year Review recommended that a residual risk evaluation be performed to determine if the remedy could be optimized, leading to the removal of institutional controls and/or cessation of the five-year reviews. 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.

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13. C-746-K LANDFILL

The C-746-K Sanitary Landfill, SWMU 8, is located southwest of the PGDP fenced security area and approximately 200 m (656 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 C-746-K.

Records indicate that PGDP used the landfill between 1951 and 1981 for disposal of fly ash from the plant's coal combustion boilers, uncontaminated combustible plant waste, and potential radiologically contaminated plant 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 indicates that up to 28 ft of fly ash and trash was 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, PGDP 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. The 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 (KDOW) 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 the 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 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. Location of C-746-K Landfill

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13.2 REMEDY IMPLEMENTATION

The ROD defined and identified the following components of the remedial action for the C-746-K 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 PGDP MOA and LUCAP, there is no LUCIP for the LUCs at the C-746-K 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*, documents the remedial actions taken at the C-746-K Landfill ROD (DOE 1999b). The O&M requirements were then revised in the document, *Operation and Maintenance Plan for the Surface Water Operable Unit at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 2000c).

The action implemented at the C-746-K 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 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* and developed the monitoring program that was used until October 1998 (DOE 1992). Four stations made up the surface water monitoring network. Two stations, 746KTB1 and 746KTB2 (Figure 13.2), located on the adjacent unnamed tributary and Bayou Creek, respectively, 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 746K3A was impacted by the leachate from the C-746-K Sanitary Landfill, while monitoring station 746K-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).

As stipulated in the ROD, the surface water monitoring requirements for C-746-K 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 effective date of December 1, 2009 for PGDP. The 2009 KPDES permit allowed for the 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 requires only that surface

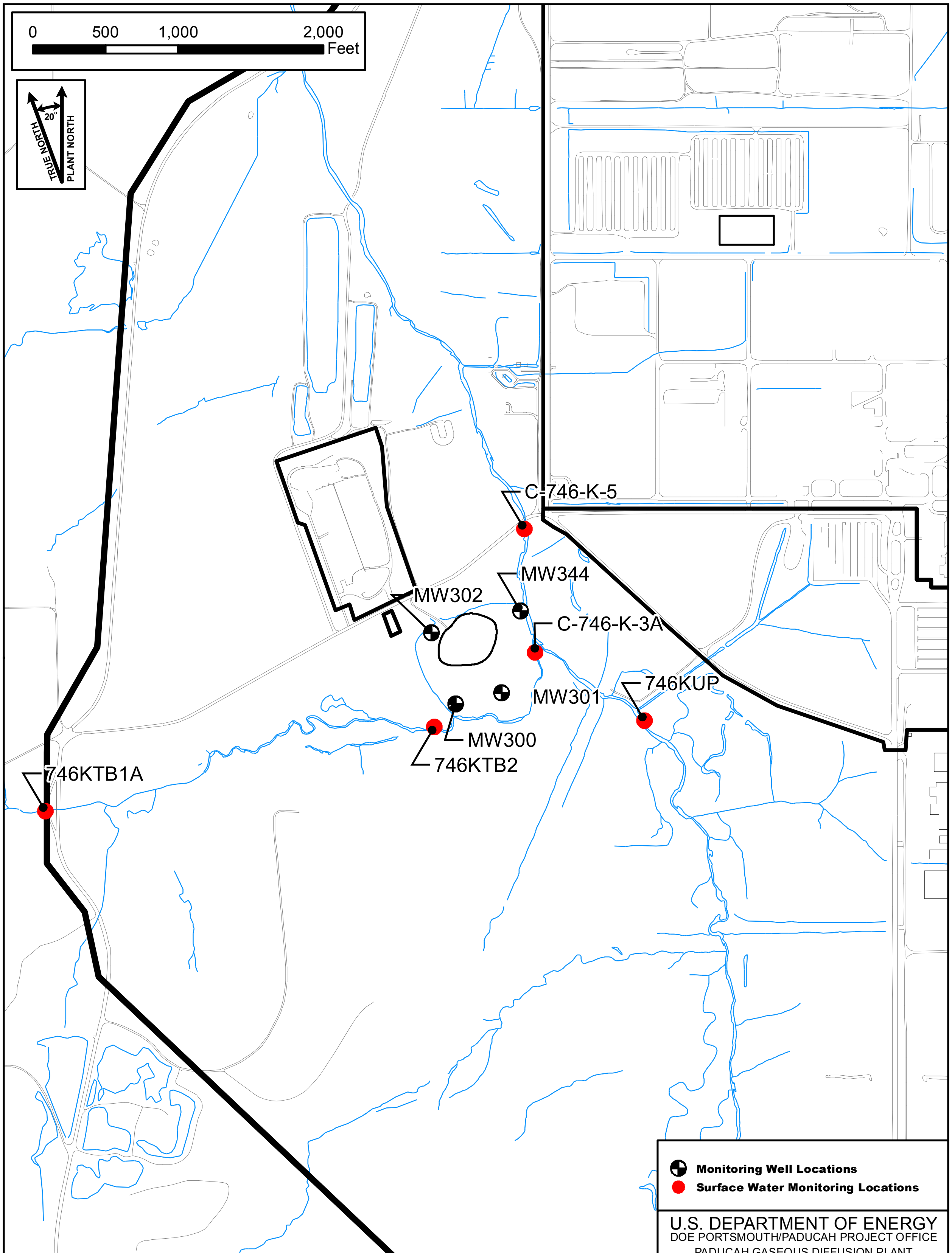

Figure 13.2. Sampling Locations at C-746-K Landfill

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water be sampled quarterly for PCBs and TCE in Bayou Creek. After additional evaluations of the plan and historical data sets, the metals analysis and aquatic organism sampling was removed from the plan in a revised Watershed Monitoring Plan, which was submitted to KDOW on September 27, 2011. Water was last 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 was last collected for chemical analyses from these stations in 1999.

The remedy identified in the C-746-K Landfill ROD included the placement of riprap on visible leachate seep locations to prevent direct 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 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. Three leachate seep sites were covered to minimize the potential for human and animal exposure. 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.

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 Court Clerk.

13.3 SYSTEMS OPERATIONS/OPERATIONS AND MAINTENANCE

Two locations in the unnamed tributary and Bayou Creek in the vicinity of SWMU 8 are sampled quarterly.

Figure 13.2 shows the four monitoring well locations and the two surface water monitoring locations. The 2011 through the current CY 2013 Environmental Monitoring Plan (EMP) analytical suite for surface water monitoring includes PCBs, TCE, pH, and other field measurements at these two locations. Of note, the shaft of MW301 has buckled so that pump repair/replacement would not be possible. MW301 is installed in a position comparable to MW300, which typically has higher concentrations. The data from MW300 would represent the worst case scenario for monitoring purposes, which makes the abandonment of MW301 acceptable. Both MW300 and MW301 are Terrace Gravel wells and both are downgradient of the C-746-K Landfill according to the interpreted southeast groundwater flow through the Terrace Gravel. Based on the location and sampling results of MW301, it is recommended that this well be abandoned.

Table 13.1 summarizes relevant data for COCs since the last Five-Year Review. The surface water monitoring requirements at the C-746-K Landfill have been incorporated into the Watershed Monitoring Plan required by the KPDES permit of December 1, 2009. The modification of the Groundwater

Table 13.1. Summary of Surface Water Quality Analyses for the C-746-K Landfill COCs–2008 through 2012

Analyte	Unit	Bayou Creek (surface water) C-746-K-5 (downstream)	Unnamed Tributary (surface water) 746KTB1A (upstream)
Aluminum [a]	mg/L	ND-2.67	ND-1.04
Iron [a]	mg/L	0.22-1.82	ND-0.805
Manganese [a]	mg/L	0.024-0.121	0.0245-0.0425
Zinc [a]	mg/L	ND	ND
TCE[b]	µg/L	ND	ND

[a] For years 2008–2010
[b] For years 2008–2012
ND = nondetect

Monitoring Program in support of the remedy implementation was to generate groundwater data that could be used for future decision-making purposes involving groundwater remediation. Groundwater monitoring continues under the PGDP Groundwater Monitoring Program and is included in the FFA semiannual reports.

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

13.4 PROGRESS SINCE LAST FIVE-YEAR REVIEW

The summation of the 2008 Five-Year Review protectiveness statement follows: The remedy for the C-746-K 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 2009a).

There have been no previous issues or recommendations for the C-746-K Landfill. The site remains unchanged as described in the 2008 Five-Year Review, and no new actions have occurred. Surface water is monitored in accordance with the KPDES Permit.

13.5 SITE INSPECTION

The C-746-K Sanitary Landfill and its immediate surroundings were inspected on February 4, 2013, by a member of the Five-Year Review team, to determine if the required remedial actions for the C-746-K Landfill ROD are being met (DOE 1998b). The facility manager also was consulted concerning this facility and did not have any concerns.

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 C-746-K Landfill and along the north bank of the unnamed tributary to the south of C-746-K Landfill. The signs are in good condition and clearly legible. Additionally, the C-746-K Landfill falls within the boundaries of an extended security buffer zone around PGDP that was established by DOE immediately following September 11, 2001. This buffer zone severely restricts access to the area by the general public.

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 were 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

The overall objectives of this project were to control the release of COCs from the unit, reducing the ecological risks, and limiting human contact. The risk assessment for the C-746-K Landfill determined that the unit posed unacceptable risk to industrial workers and animals via direct contact with leachate and contaminated sediments.

The current remedy for the C-746-K area includes institutional controls (LUCs and engineering barriers to prevent exposure), along with groundwater monitoring for potential migration of contaminants off-site. The concentrations of metals detected in surface water that are listed in Table 13.1 were compared to the surface water preliminary remediation goals (PRGs) (i.e., cleanup goals) generated for the PGDP human health Risk Methods Document (DOE 2011d). For metals, the lowest PRGs associated with surface water are for the child swimming scenario. The PRGs for that scenario are 82.8 mg/L for aluminum, 58 mg/L for iron, 0.529 mg/L for manganese, and 26 mg/L for zinc, and are current for exposure assumptions and toxicity data. All detections in Table 13.1 are below the corresponding lowest PRG for surface water. The results in Table 13.1 were also compared to the Kentucky surface water standards in 401 *KAR* 10:031. The chronic warm water aquatic habitat criteria are 1 mg/L for iron and a function of hardness for zinc; there are no criteria for aluminum and manganese (KY 2013). Results from surface water are below these Kentucky standards, with the exception of the maximum result for iron downstream. The 2010 PGDP ecological risk methods document provides surface water screening levels for aluminum, iron, manganese, and zinc as 0.087 mg/L, 1 mg/L, 0.12 mg/L, and 0.05971 mg/L, respectively (DOE 2010d). Maximum results exceed ecological surface water screening values for aluminum both upstream and downstream and iron and manganese downstream. Results are shown graphically in Figures 13.3–13.5 for iron, aluminum, and manganese.

These comparisons indicate that the remedy continues to be protective of human health and the environment due to restricted direct exposure and because surface water contaminants are near or below applicable surface water standards and screening levels.

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 systems operation or maintenance.

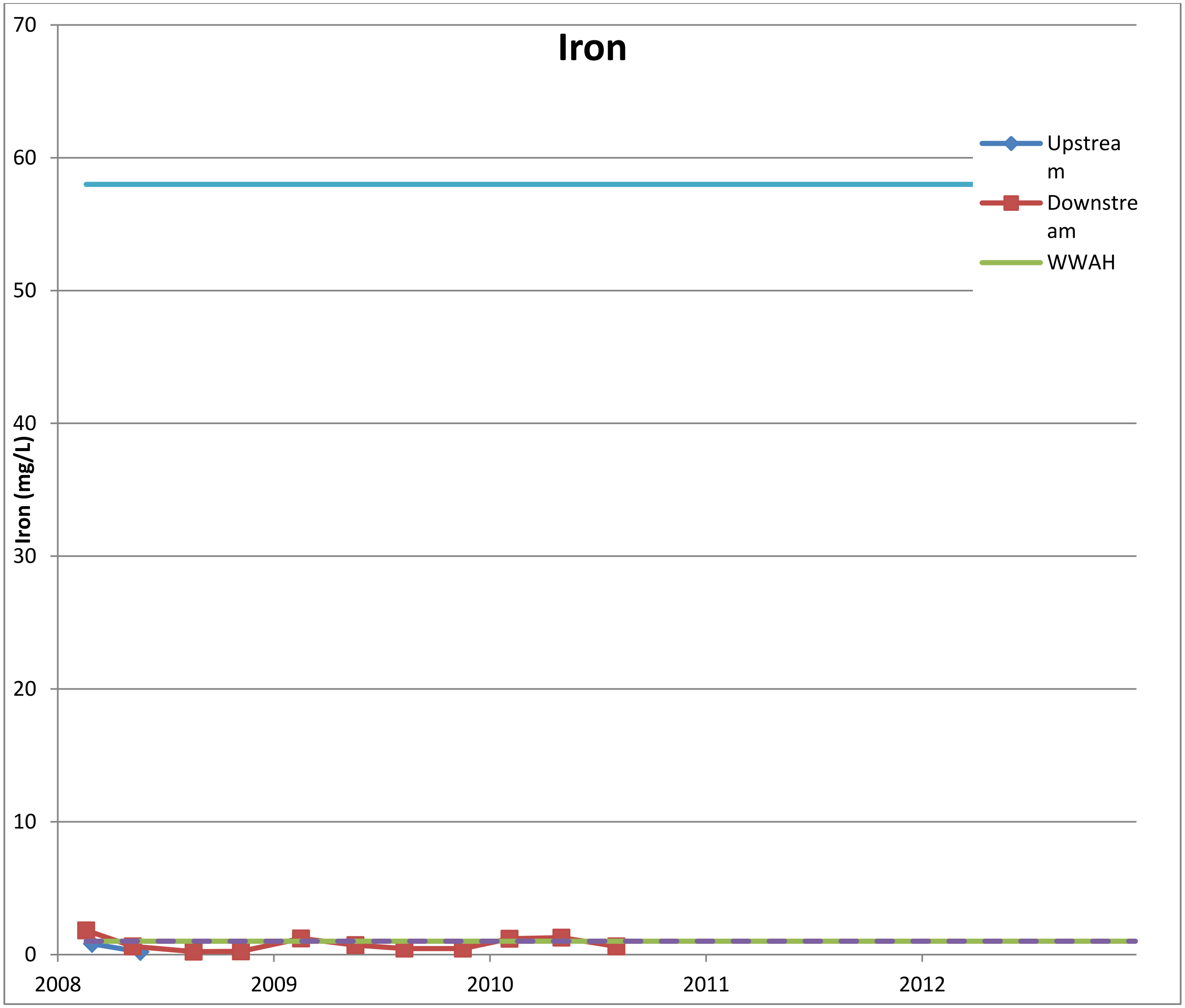

Figure 13.3. Surface Water Results for Iron at C-746-K Landfill

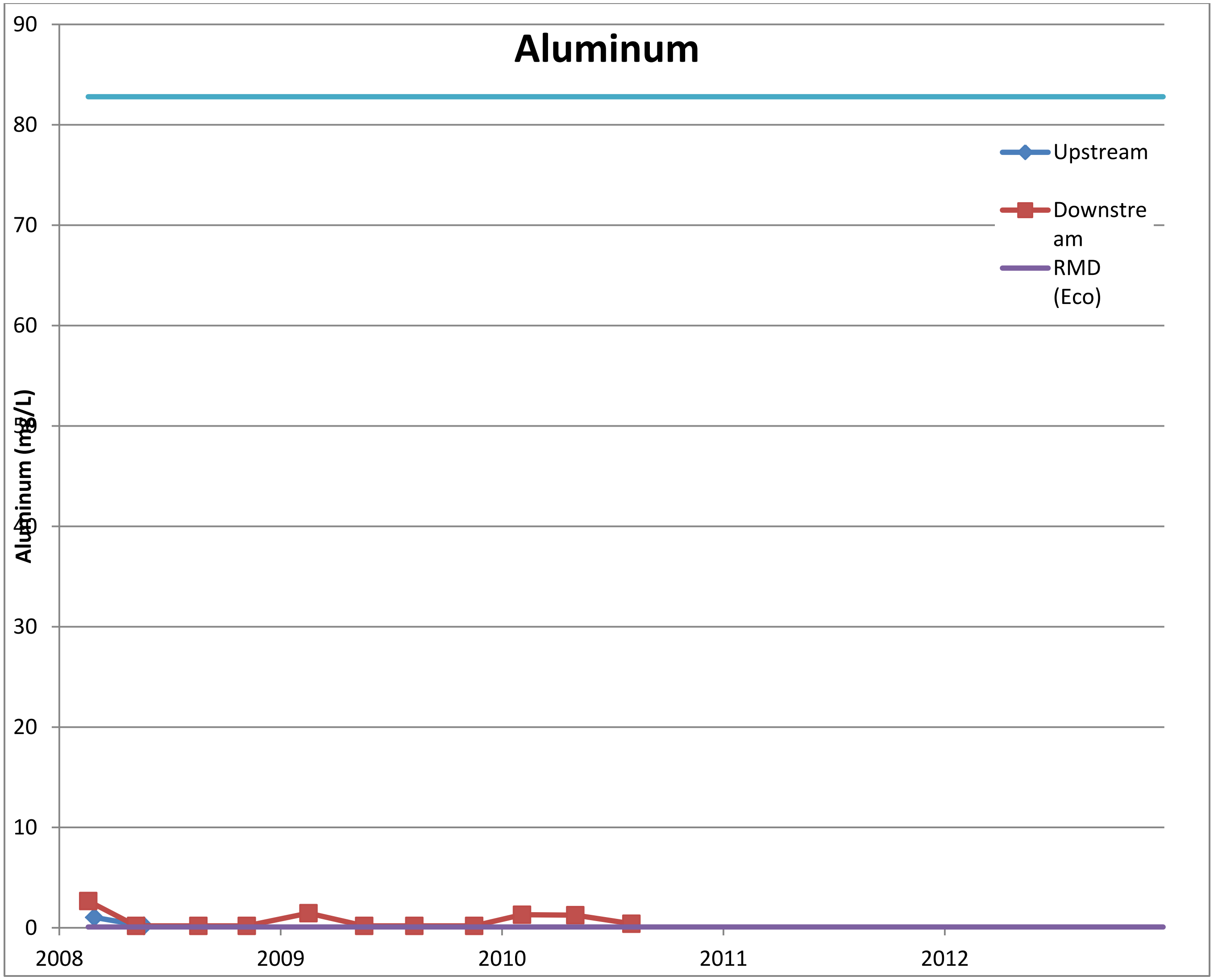

Figure 13.4 Surface Water Results for Aluminum at C-746-K Landfill

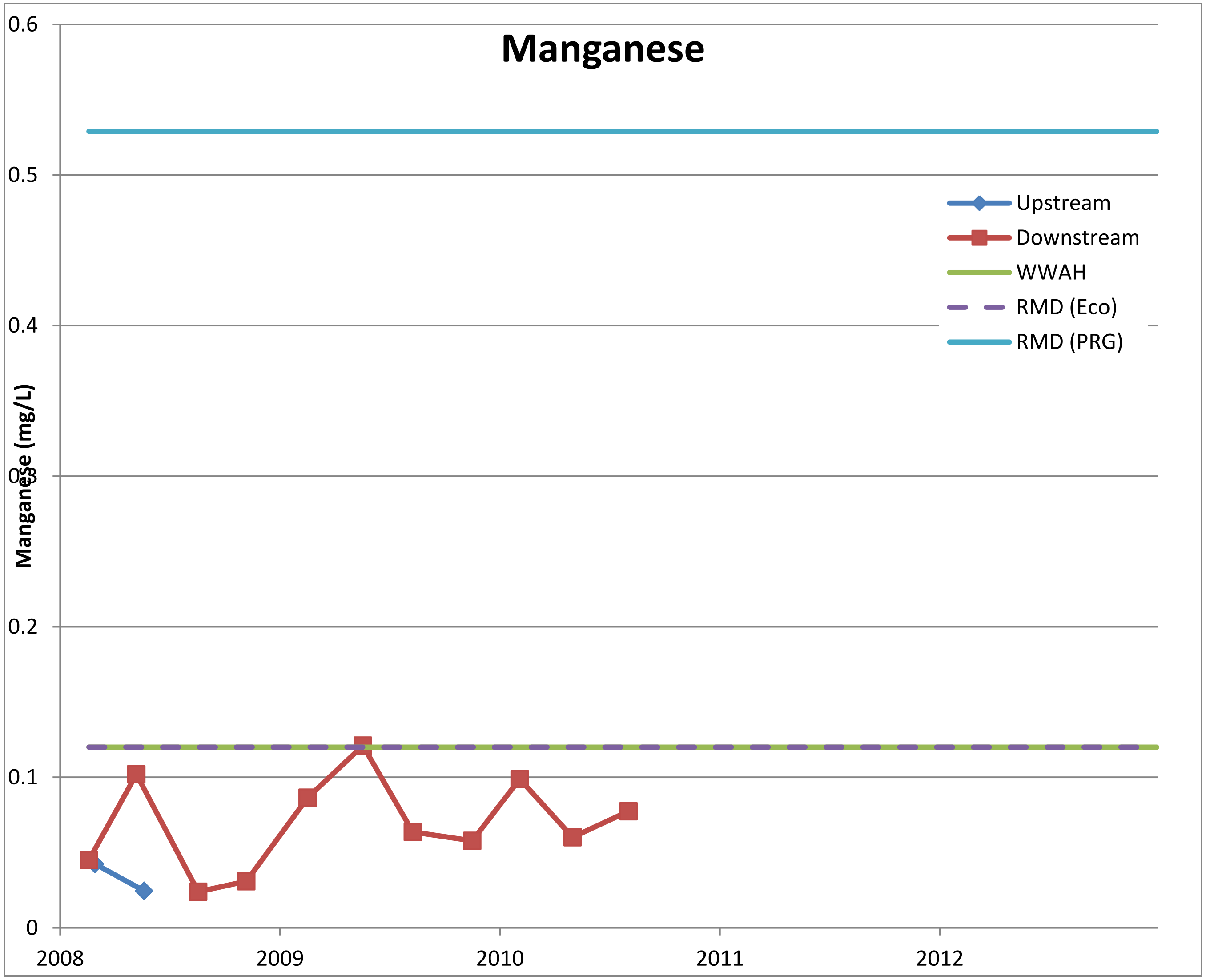

Figure 13.5. Surface Water Results for Manganese at C-746-K Landfill

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 SWMU 8 encompasses and the land use remains industrial. The plant'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, 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 2008- 2012 review period, the remedial action at the C-746-K 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 (DOE 1998b). The potential for direct human contact also is reduced by the placement of riprap along the seeps and by deed notice and restrictions recorded for the C-746-K Landfill, which restrict use of the property.

13.7 ISSUES

The shaft of MW301 has buckled so any repair/replacement of the pump would not be possible.

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14. FIRE TRAINING AREA

The Fire Training Area, SWMU 100, is located in the southwest corner of PGDP. 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 are no longer used. Figure 14.1 illustrates the location of the Fire Training Area.

14.1 REMEDY SELECTION

The selected remedy, which depends on the area remaining industrial, for the Fire Training Area, SWMU 100, was No Further Action (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 SWMU 100 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 plantwide, long-term surveillance and maintenance and environmental monitoring programs.

14.4 PROGRESS SINCE LAST FIVE-YEAR REVIEW

The summation of the 2008 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 2008 Five-Year Review, and no new actions have occurred.

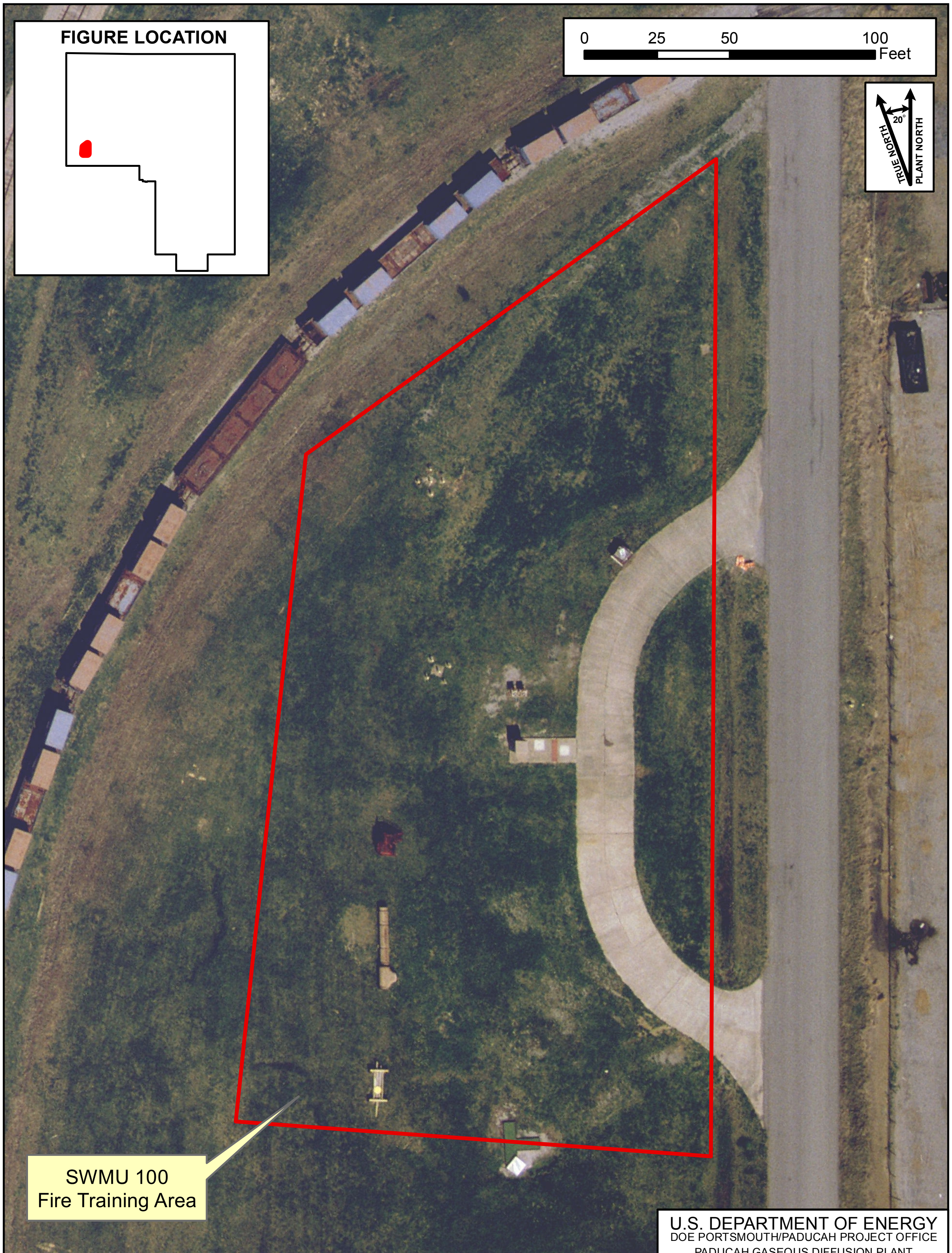

Figure 14.1. Location of Fire Training Area

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14.5 SITE INSPECTION

A site inspection of the Fire Training Area was conducted on February 4, 2013, by a member of the Five-Year Review team. Although it is apparent that the concrete area is used for fire fighters' training, the ground surface features described in the first paragraph of this chapter no longer are apparent. 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.

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. NFA is necessary to protect PGDP 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 SWMU 100 encompasses, and the land use remains industrial. The plant'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 SWMU 100, the WAGs 1 and 7 RI report states that the primary pathway contributing to both the total hazard index (HI) and the total excess lifetime cancer risk (ELCR) is dermal contact with sediment (DOE 1996b).

Updates have been made to dermal toxicity to correct the overly conservative estimation of risk that used dermal absorption factors that exceed oral absorption values (DOE 2013). These updates do not adversely impact the remedy selected. 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, 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 site investigations at PGDP indicated that various units were contributing to off-site surface water contamination. The *Results of the Site Investigation, Phase I* (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* (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 site investigation identified 21 SWMUs which 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 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 PGDP 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 PGDP. 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 1992). 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 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*, 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

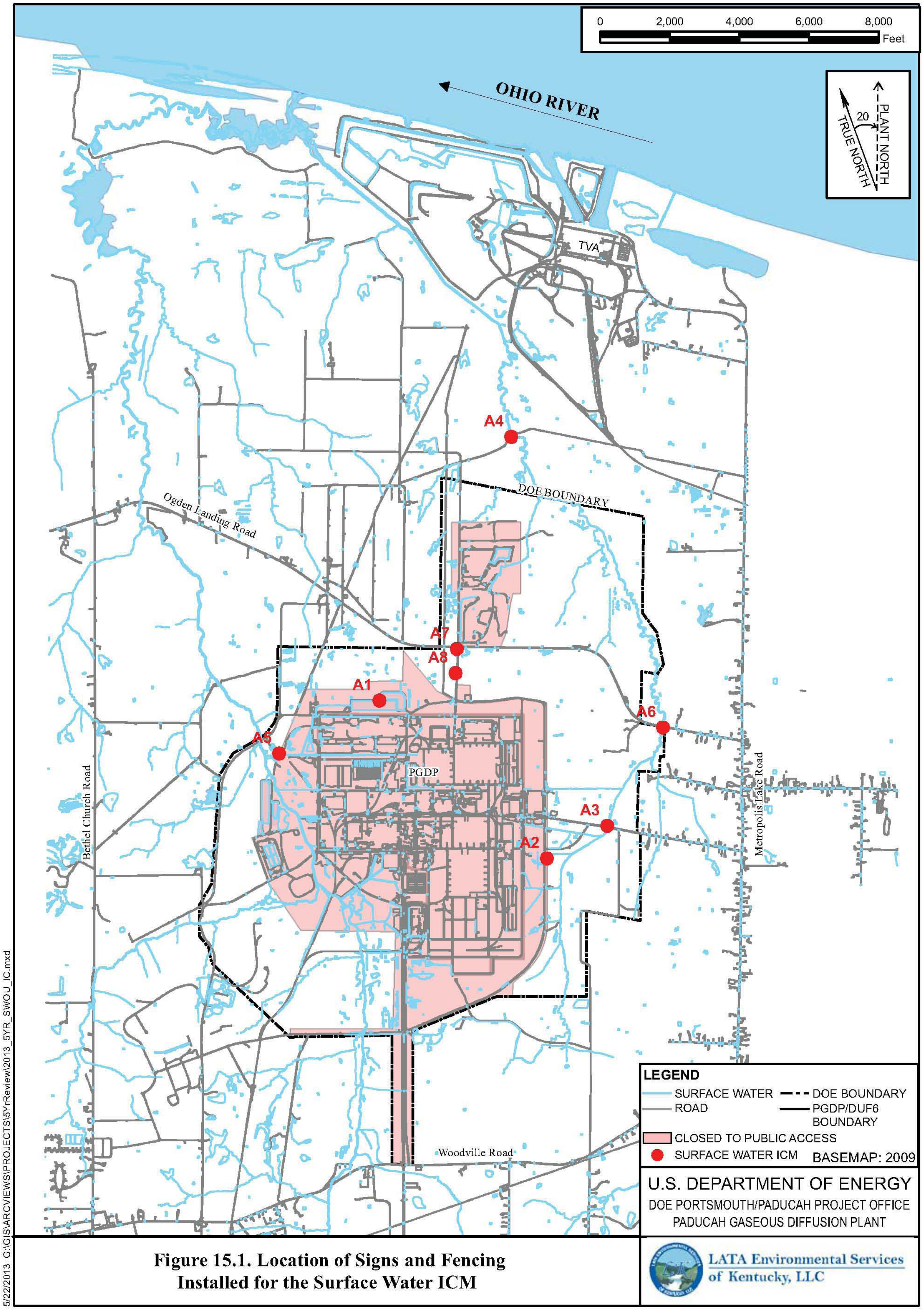

Figure 15.1. Location of Signs and Fencing Installed for the Surface Water ICM

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*, (MMES 1993) 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 2000c). The signs read as follows:

> This waterway is contaminated. Use of this waterway for drinking, fishing, swimming, or other forms of recreation may expose you to unnecessary health risks. Do not eat fish caught in this body of water. Do not cross posted boundaries. Cross only in designated areas. For information, call (270) 441-5023.

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 document *Operation and Maintenance Plan for the Surface Water Operable Unit at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 2000c). Signs are inspected monthly and repaired or replaced, as needed.

Although the sampling and assessment of surface water and sediment data is part of the PGDP 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 PGDP 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 (discussed in Chapter 16) removed areas of contaminated sediment both inside and outside the PGDP fence. After September 11, 2001, PGDP 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.

Following the erection of the fencing and signs in support of the Surface Water ICM Work Plan, another sign program was implemented in 2008. It was implemented through the Government Performance and Results Act (GPRA). The GPRA holds federal agencies accountable for using resources wisely and achieving program results. EPA, under direction from Congress, established two environmental indicators (EIs): (1) groundwater contaminant migration under control and (2) human exposure under control. KDEP had the responsibility for making this determination. The three determination choices were as follows: (1) Yes, contamination under control; (2) No, contamination not under control; or (3) Insufficient information.

In order to help achieve a “Yes” with regard to the GPRA milestone of having Human Health Exposures Under Control, DOE placed EI signs in nine locations along the Bayou and Little Bayou Creeks, as well as in off-site (i.e., outside the existing security fence) portions of Section 5 of the NSDD in the spring of

2008. The placement of these EI signs, along with flowcharts that demonstrated decision making processes that would reduce uncertainty for nonworker exposure associated with PGDP, aided KDEP in achieving a “Yes.” Although these signs were not erected through an FFA party agreement, these EI signs were placed in areas that are managed by FFA decision documents (i.e., *ICM Work Plan*); therefore, after the EI signs were erected, the site was managing signs in the surface water areas using two sign programs: EI signs and the Surface Water ICM signs.

The issue of the management of two sign programs was captured in the following CERCLA Five-Year Review report. The *Five-Year Review for Remedial Actions at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/0117&D2, (DOE 2009a) evaluated the SWOU and identified the following issue: “Signs were erected under the scope of another project. Although the message content between the signs does not conflict with one other, an evaluation of the sign program is needed.” This issue denotes that the EI signs were located in the same areas where the Surface Water ICM signs were located. Though the intent of the signs is the same, subtle differences existed in the wording between the two types of signs, and contact information was inconsistent (i.e., phone numbers). The 2008 Five-Year Review document provided the following recommended action for the issue: “Evaluate whether interim corrective measures signs should be removed or replaced with new signs with language approved for the Environmental Indicator signs.”

An evaluation of both sign programs was finalized in 2010, and a recommendation was made to replace the Surface Water ICM signs with the more current language of the EI signs. This action will remove all Surface Water ICM signs and increase the overall number of EI signs within the program. Implementation of these actions will result in only one sign program. Each sign will be assigned a unique number thereby allowing the ICM locations to be identified separately for the next Five-Year Review. A recommendation also has been made for the fencing to remain down in Section 3 (defined as ICM area number A7 and A8) of the NSDD based on the SWOU On-Site Removal Action Report (RAR) residual risk evaluation (DOE 2011a). The former fencing in areas A7 and A8 add no real value since the areas can be entered from various access points. Table 15.1 is a summary of both recommendations.

Table 15.1. ICM/EI Sign Evaluation Recommendations

ICM Area Number	Description of Area	Is Fencing Present?	Posting Recommendation
A1	C-616 Lagoons	**Yes**	**Remove** ICM signs but leave fencing—area is not readily accessible by the public
A2	KPDES Outfall 011 and Dyke Road	**Yes**	**Remove** ICM signs—**Add** EI signs
A3	Little Bayou Creek and McCaw Road	**Yes**	**Remove** ICM signs—**Leave existing** EI signs
A4	Little Bayou Creek and Anderson Road	**Yes**	**Remove** ICM signs—**Leave existing** EI signs
A5	KPDES Outfall 001 and New Water Line Road	**Yes**	**Remove** ICM signs—**Add** EI signs
A6	Little Bayou Creek and Ogden Landing Road	**Yes**	**Remove** ICM signs—**Leave existing** EI signs
A7	NSDD and Ogden Landing Road	**Yes**	**Remove** ICM signs and fencing—**Add** EI signs
A8	NSDD-PGDP to Ogden Landing Road	**Yes**	**Remove** ICM signs and fencing—**Add** EI signs

Specifically, the evaluation proposes that, where the signs are co-located, 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. Also recommended is that remaining fencing located at areas A7 and A8 be removed, and signs located at A1 will be removed (see Figure 15.1).

15.4 PROGRESS SINCE LAST FIVE-YEAR REVIEW

The 2008 review contained the following protectiveness statement:

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

The 2008 Five-Year Review contained the following Issue and associated Recommendation:

> Signs were erected under the scope of another project. Although the message content between the signs does not conflict with one other, an evaluation of the sign program is needed.
>
> Evaluate whether ICM signs should be removed or replaced with new signs with language approved for the Environmental Indicator signs.

The results of this evaluation made a decision to replace the Surface Water ICM signs with EI signs. Specifically, where the signs are co-located, 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. These actions will remove all Surface Water ICM signs and increase the overall number of EI signs within the program. Implementation of these actions will result in only one sign program. 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 (see Figure ES.1).

Inspections of signs and fences continue along with the monitoring of sediments and surface water per the KPDES permit. The Surface Water On-site Sediment Removal (discussed in Chapter 16) removed areas of contaminated sediment both inside and outside the PGDP fence. This action prevents transport of contaminated sediment off-site (i.e., outside the existing security fence and off DOE property),

15.5 SITE INSPECTION

The locations of the signs and fences were inspected on February 20, 2013, by a member of the Five-Year Review team and the site inspector. The ICM signs were in good condition. 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, with the exception of some of the fencing along the NSDD Section 3 which was subject to the SWOU Removal Action discussed in Chapter 16. A recommendation has been made for the fencing to remain down based on the residual risk evaluation, which was prepared as part of the SWOU On-Site Removal Action Report, and is discussed later in this Chapter and Chapter 16 (DOE 2011a).

15.6 TECHNICAL ASSESSMENT

Outfalls 002, 010, 011, 012, 013, 019, and 020 drain the eastern boundary of PGDP and flow eastward toward Little Bayou Creek. The areas included in the drainage networks for these outfalls are comprised mostly of USEC process equipment 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 PGDP 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 PGDP 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 (Chapter 12), have eliminated this outfall. The stormwater that drained through NSDD to Outfall 003 when the Surface Water ICM was implemented was diverted to the C-616 treatment facility and then 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 PGDP security fence are warned that contact with contaminated water and sediment may pose potential dangers, as detailed in the Section 15.5, Site Inspection. Sediments and water continue to be monitored through the EMP in accordance with the KPDES permit and results are made available through the Annual Site Environmental Report. Since 2008, the KPDES outfalls associated with DOE's permit have exceeded their permit limits a few times, but overall remain compliant. The majority of the exceedances are for zinc and toxicity due to operations at the DUF_6 Conversion Plant. A corrective action plan for these exceedances has been developed. The following summarizes these permit exceedances:

- October 2008, Outfall 017 (oil and grease).
- March 2009, Outfall 015 [total suspended solids (TSS)];
- February 2009, Outfall 017 (zinc);
- January 2010, Outfall 020 (TSS);
- August 2010, Outfall 017 (zinc);
- December 2010, Outfall 017 (zinc);
- January 2011, Outfall 017 (zinc);
- February 2011, Outfall 017 (zinc and toxicity) and Outfall 001 (TSS);
- March 2011, Outfall 001 (TSS);
- April 2011, Outfall 017 (zinc);
- October 2011, Outfall 001 (pH);
- November 2011, Outfall 017 (zinc);
- December 2011, Outfall 017 (toxicity);
- April 2012, Outfall 017 (zinc, 3 exceedances)
- May 2012, Outfall 001 (TSS, 3 exceedances)
- January 2012, Outfall 017 (acute toxicity)

- February 2012, Outfall 017 (chronic toxicity)
- March 2012, Outfall 017 (acute toxicity, 2 exceedances)
- July 2012, Outfall 017 (acute toxicity)
- November 2012, Outfall 017 (acute and chronic toxicity)
- December 2012, Outfall 017 (acute and chronic toxicity)

A recommendation to optimize the sign program has been made. Based on the evaluation, removing of all Surface Water ICM signs and increasing the overall number of EI signs will result in only one sign program. Each sign will be assigned a unique number, thereby allowing the ICM locations to be identified separately for the next Five-Year Review. A recommendation also has been made for the fencing to remain down in Section 3 (defined as ICM area number A7 and A8) of the NSDD based on the SWOU On-Site RAR residual risk evaluation (DOE 2011a). The previous fencing in areas A7 and A8 adds no real value because the areas can be entered from various access points. Table 15.1 is a summary of both recommendations.

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 and 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 1992).

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. As previously stated, some sign locations are now in a restricted access security buffer zone due to responses after September 11, 2001, which prevents most human contact with contaminants in the streams. The access changes have led to greater protectiveness for these areas.

The NSDD, Sections 3, 4, and 5, are part of the Surface Water ICMs. As part of the SWOU On-Site RAR, a residual risk evaluation was prepared (DOE 2011a) that included these sections of the NSDD. 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 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.

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. The remedy protects human health and the environment because the fences prevent recreational users from contacting contaminated sediment and water. This action was not intended to restore the area in which it was implemented to unrestricted use.

15.7 ISSUES

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.

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-PCB Spill
- SWMU 97-C-601 Diesel Spill

The identified contamination was derived from surface water runoff and wastewater from various plant activities conducted at PGDP facilities and 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 SW 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 PGDP and discharges into Little Bayou Creek to the north of the plant.

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 plant ditches that discharge to NSDD and the outfalls were trenched when PGDP was built and became fully operational when the plant 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.

SWMU 92 was designated as a SWMU due to placement of PCB-contaminated soils as fill from a transformer rupture in 1967. SWMU 97 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 SWMUs 92 and 97) 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 remedial investigations, 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 PGDP (DOE 2008b). The investigation involved the 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 having the greatest potential for contaminant discharge to creeks surrounding PGDP.

16.1 REMEDY SELECTION

The Surface Water On-site Sediment Removal was performed as a non-time-critical removal action under the Paducah Federal Facility Agreement. The *Action Memorandum for Contaminated Sediment*

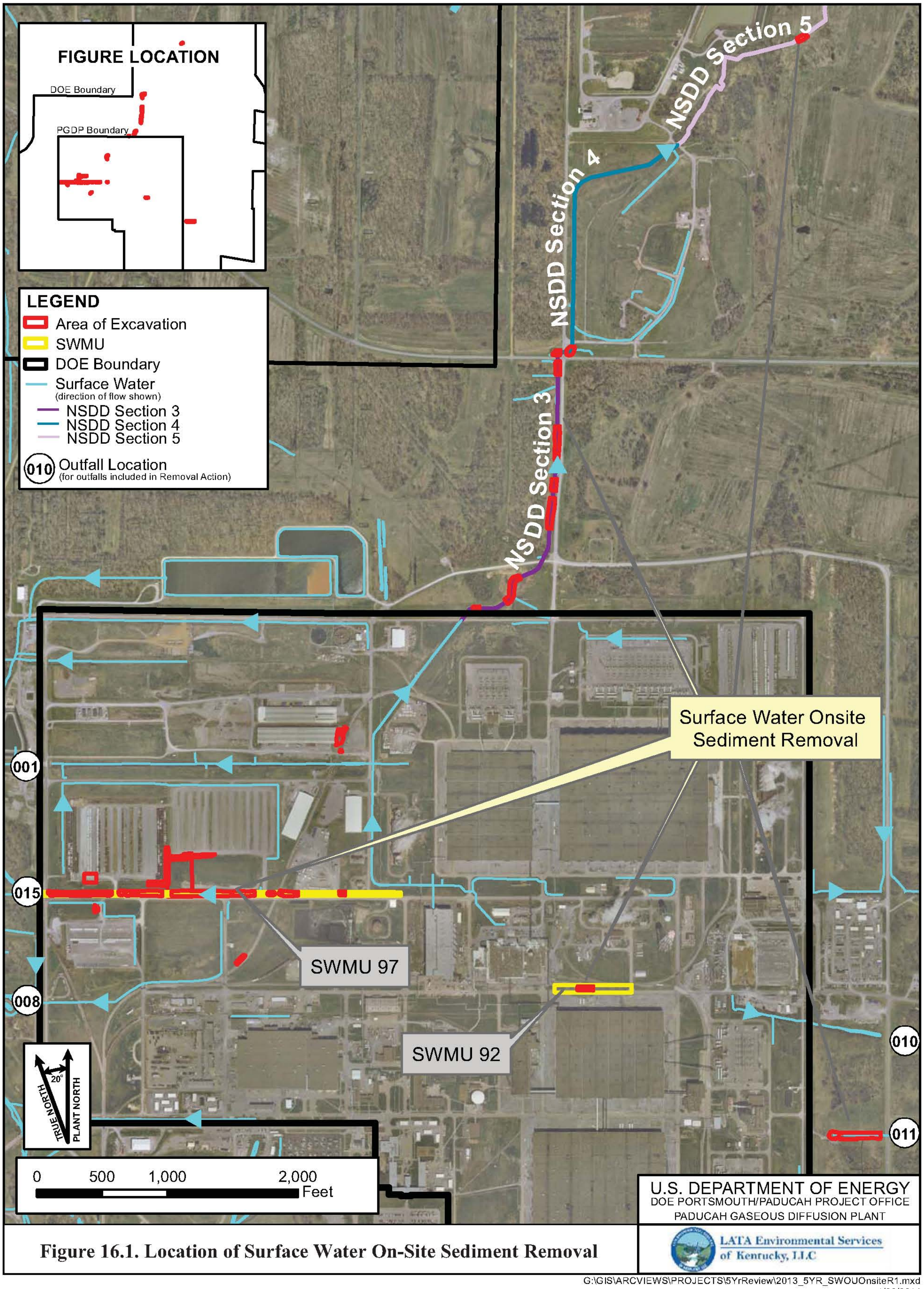

Figure 16.1. Location of Surface Water On-Site Sediment Removal

Associated with the SWOU (On-Site) (DOE 2009c) documents the non-time-critical removal action in specific areas or defined exposure units (EUs) located within PGDP 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 2008c); *Action Memorandum for Contaminated Sediment Associated with the SWOU (On-Site)* (DOE 2009c); 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 2009d).

The RAOs were consistent with the overall RAOs for the SWOU and include the following:

- 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 SWMUs 92 and 97).

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.

- Consistent with the results of the risk-based cost-benefit analysis, verification of 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.

- Methods to validate the achievement of the chemical-specific cleanup levels were implemented similar to the NSDD Sections 1 and 2 remediation.

- Installation of temporary localized engineering controls a small stormwater 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, and until the excavated/restored area was stable.

Figures 16.2 through 16.33 show “before and after” views of NSDD Sections 3 and 5 and KPDES Outfalls 001, 008, 010, 011, 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 2011a).

The RAOs were attained through the 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.

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

A residual risk evaluation was prepared as part of the RAR. 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 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 non-time-critical removal action 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.

16.4 PROGRESS SINCE LAST FIVE-YEAR REVIEW

Actions for the Surface Water On-site Sediment Removal had not begun at the time of the 2008 Five-Year Review; therefore, no previous protectiveness statement is available. Since the 2008 Five-Year Review, the Surface Water On-Site Sediment Removal was initiated and completed.

16.5 SITE INSPECTION

A site inspection was conducted on February 4, 2013, by the SWOU Project Manager and a member of the Five-Year Review team. All areas were grass covered or riprap covered and in good condition. Section 3 of the NSDD did show some signs of erosion on the steep slopes.

16.6 TECHNICAL ASSESSMENT

The remedial action for NSDD Sections 3 and 5 and KPDES Outfalls 001, 008, 010, 011, and 015 and their associated internal ditches and areas (including SWMUs 92 and 97) 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 clean-up 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.

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 standards, compared to the cleanup level established in the AM are lower because the exposure factors are higher for the new standards (Table 16.2). The cleanup levels were based on a current industrial worker accessing the ditches 14 days per year. For simplicity and conformance with the Risk Methods Document, the default industrial worker scenario for which the new standards were derived is based on accessing the ditches 250 days per year (DOE 2013). When comparing the maximum exposure concentration results from verification sampling to the new standards, only one contaminant, uranium-238, is greater. The new standard for uranium-238 is within an order of magnitude of the cleanup level, so the cleanup level would fall within the same risk range as the new standard (i.e., an ELCR of 1E-05). The cleanup levels are protective.

Table 16.2. Changes in Chemical-Specific Standards for the Surface Water On-Site Sediment Removal

Contaminant	Media	Cleanup Level[a]	Standard[b]	Citation/Year
Arsenic	Sediment	27 mg/kg		DOE 2009c
			19.05 mg/kg	DOE 2013
Beryllium	Sediment	50,000 mg/kg		DOE 2009c
			34,750 mg/kg	DOE 2013
Total PCB	Sediment	16 mg/kg		DOE 2009c
			14.3 mg/kg	DOE 2013
Americium-241	Sediment	115 pCi/g		DOE 2009c
			89.5 pCi/g	DOE 2013
Cesium-137	Sediment	8 pCi/g		DOE 2009c
			2.54 pCi/g	DOE 2013
Neptunium-237	Sediment	22 pCi/g		DOE 2009c
			6.05 pCi/g	DOE 2013
Plutonium-239/240	Sediment	108 pCi/g		DOE 2009c
			130 pCi g	DOE 2013
Technetium-99	Sediment	3,825 pCi/g		DOE 2009c
			10,100 pCi/g	DOE 2013
Thorium-230	Sediment	147 pCi/g		DOE 2009c
			197.5 pCi/g	DOE 2013
Thorium-232	Sediment	129 pCi/g		DOE 2009c
			183 pCi/g[c]	DOE 2014
Uranium-234	Sediment	188 pCi/g		DOE 2009c
			305.5 pCi/g	DOE 2013
Uranium-235	Sediment	30 pCi/g		DOE 2009c
			9.2 pCi/g	DOE 2013
Uranium-238	Sediment	94 pCi/g		DOE 2009c
			37.4 pCi/g	DOE 2013
Uranium	Sediment	227 mg/kg		DOE 2009c
			5,980 mg/kg	DOE 2013

[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 for uranium (metal) to achieve cleanup of a cumulative ELCR of 1E-05 and a cumulative HI of 1, see Section 3 and Table 1 of the Action Memorandum (DOE 2009c).
[b] New standards are based on the default industrial worker action levels (Table A.1) presented in the 2013 Risk Methods Document (DOE 2013), calculated to the risk-based set at a target of ELCR = 5E-06 for most COCs and a target of HI = 1 for uranium (metal).
[c] Thorium-232 is not a COPC for PGDP and was not included in the 2013 Risk Methods Document. The new standard was calculated using http://rais.ornl.gov/cgi-bin/prg/PRG_search (accessed January 2014).

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.

Figure 16.2. Outfall 001 11-12-09 (Before)

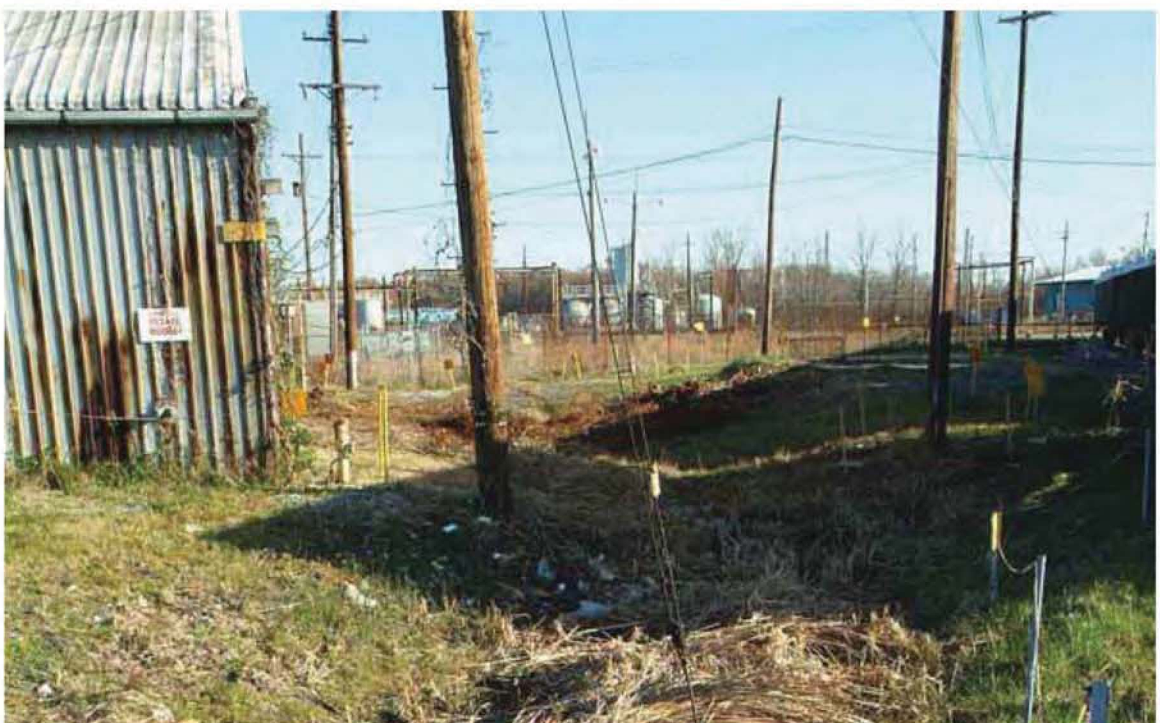

Figure 16.3. Outfall 001 11-12-09 (Before)

Figure 16.4. Outfall 001 07-22-10 (After)

Figure 16.5. Outfall 001 07-22-10 (After)

Figure 16.6. Outfall 010 11-12-09 (Before)

Figure 16.7. Outfall 010 07-12-10 (After)

Figure 16.8. Outfall 011 11-12-09 (Before)

Figure 16.9. Outfall 011 07-12-10 (After)

Figure 16.10. Outfall 015, EU02 11-12-09 (Before)

Figure 16.11. Outfall 015, EU02 11-12-09 (Before)

Figure 16.12. Outfall 015 EU03 11-12-09 (Before)

Figure 16.13. Outfall 015 EU03 11-12-09 (Before)

Figure 16.14. Outfall 015 EU04 11-12-09 (Before)

Figure 16.15. Outfall 015 EU04 11-12-09 (Before)

Figure 16.16. Outfall 015 EU04 11-12-09 (Before)

Figure 16.17. Outfall 015 EU07 1112-09 (Before)

Figure 16.18. Outfall 015 EU08 11-12-09 (Before)

Figure 16.19. Outfall 015, EU 02 07-12-10 (After)

Figure 16.20. Outfall 015, EU 02/03 07-12-10 (After)

Figure 16.21. Outfall 015, EU 03 07-12-10 (After)

Figure 16.22. Outfall 015, Eu 04 07-12-10 (After)

Figure 16.23. North South Diversion Ditch Section 3, EU 01 11-12-09 (Before)

Figure 16.24. North South Diversion Ditch Section 3, E U01 11-12-09 (Before)

Figure 16.25. North South Diversion Ditch Section 3, EU 02 11-12-09 (Before)

Figure 16.26. North South Diversion Ditch Section 3, EU 03 11-12-09 (Before)

Figure 16.27. North South Diversion Ditch Section 3, EU 03 11-12-09 (Before)

Figure 16.28. North South Diversion Ditch Section 3, EU 03 11-12-09 (Before)

Figure 16.29. North South Diversion Ditch Section 5 11-12-09 (Before)

Figure 16.30. North South Diversion Ditch Section 3 EU 01 07-13-10 (After)

Figure 16.31. North South Diversion Ditch Section 3 EU 02 07-13-10 (After)

Figure 16.32. North South Diversion Ditch Section 3 EU 03 07-13-10 (After)

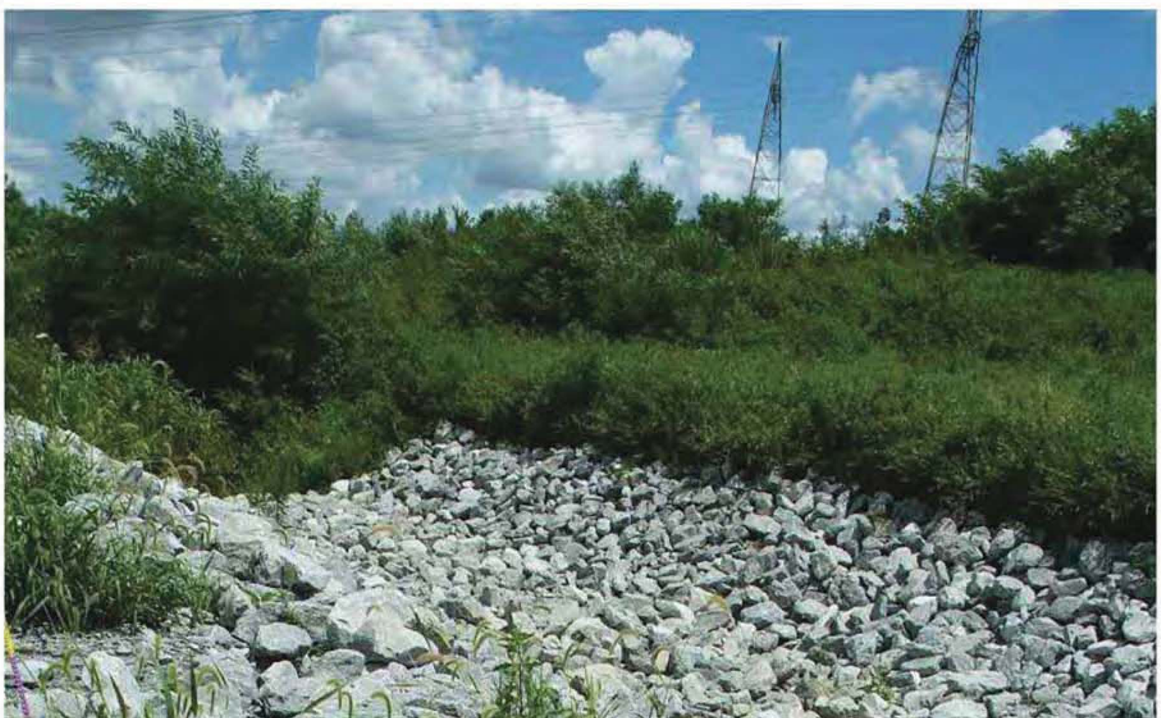

Figure 16.33. North South Diversion Ditch Section 5 07-13-10 (After)

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17. C-749 URANIUM BURIAL GROUND

The C-749 Uranium Burial Ground (SWMU 2) is located in the west-central portion of the plant north of Virginia Avenue and on the western edge of the C-404 Low-Level Radioactive/Hazardous Waste Burial Ground (Figure 17.1). 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*, was signed in 1995 (DOE 1995d). Because SWMU 3, the C-404 Contaminated Burial Ground, is closed with a RCRA cap and is being addressed by RCRA postclosure permit requirements, the 1995 ROD required NFA for it. For SWMU 2, 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. Through agreement by the parties, an impermeable cap was not constructed [WAG 22 Post-ROD Change, October 23, 1996 (Hodges 1996)]. Fieldwork to collect data for the final actions for the BGOU RI was performed in 2007 and the RI report was completed in 2010 (DOE 2010e). An FS is underway to evaluate final remedial actions for SWMUs 2 and 3. Figure 17.1 illustrates the location of SWMU 2.

This IRA in the 1995 ROD leaves waste in place that requires restricted access; therefore, SWMU 2 will be reviewed no less than once every five years. 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 November 2012 report contains a map depicting the SWMU 2 groundwater MWs and a summary of the SWMU 2 trends for TCE and Tc-99 for reporting dates 1996 through July 2012 (DOE 2012a).

DOE conducted an investigation at SWMU 2 to provide information needed before the selected interim action was fully implemented and to provide additional data to evaluate a final remedial action for SWMU 2 (DOE 1997b). One of the goals of this investigation was to determine if the waste within SWMU 2 was saturated with groundwater. The results of the investigation indicated that the waste within SWMU 2 was saturated; therefore, placement of a cap on SWMU 2 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 PGDP boundary in concentrations that exceed both human health risk-based and regulatory (i.e., MCL) PRGs; 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.

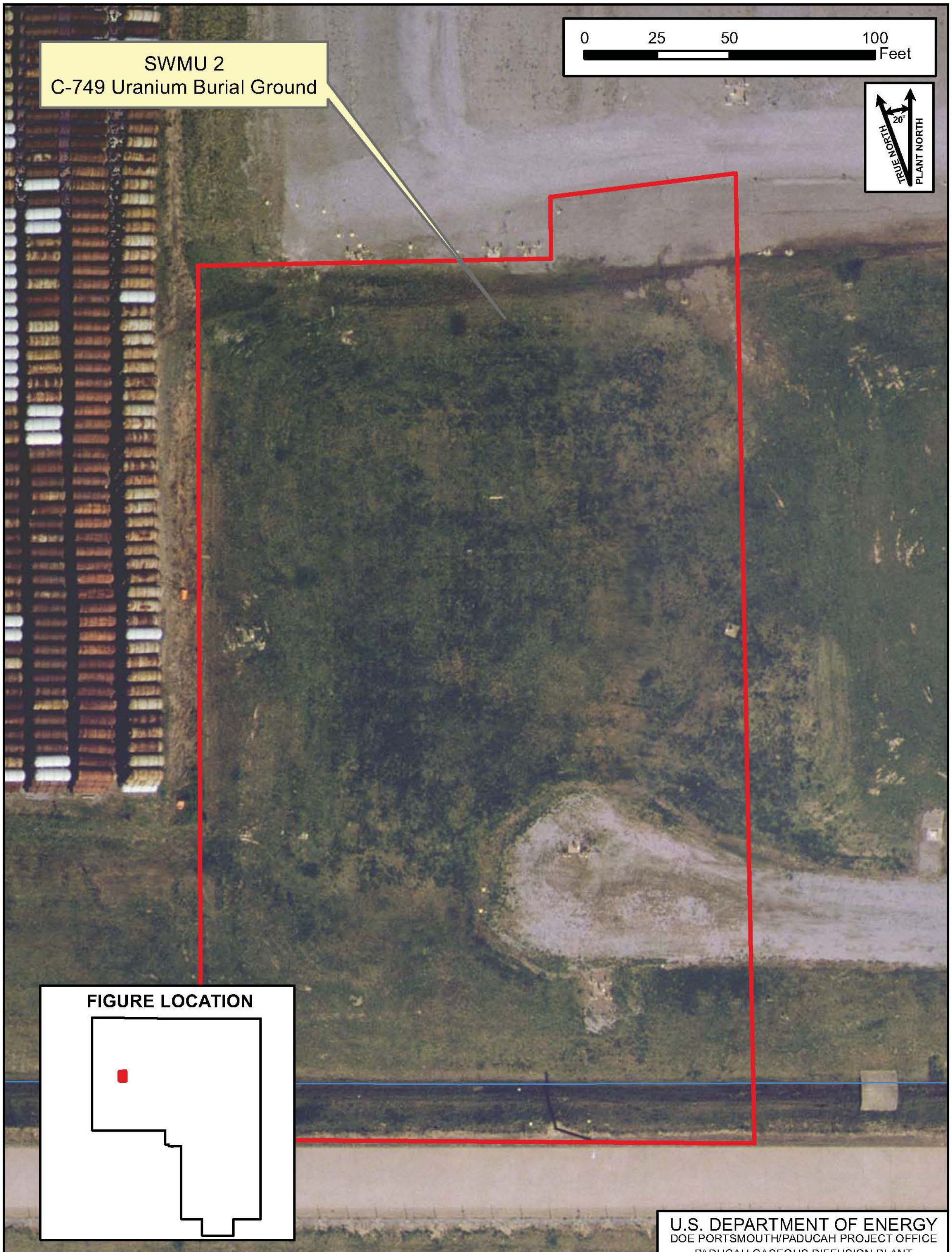

Figure 17.1. Location of C-749 Uranium Burial Ground

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The RAOs for the interim action were to mitigate migration of uranium and TCE from SWMU 2 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 ground water interaction with the buried wastes, a low permeability, multilayered cap may be placed on SWMU 2, the C-749 Uranium Burial Ground, to reduce infiltration of surface water from precipitation events into and through buried wastes. This will also reduce potential leaching of contaminants to ground water. The cap will also 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;

- A ground water monitoring program will be implemented in the uppermost aquifer, the Regional Gravel Aquifer, to detect any release of contaminants from SWMU 2; and

- Institutional controls will be implemented to prevent transferal of the SWMU 2 property and prevent to future intrusive activities at the unit (DOE 1995d).

The low-permeability, multilayered cap would be constructed over SWMU 2 to reduce significantly the infiltration of surface water from precipitation events into the unit.

A groundwater monitoring program would be established in the RGA to detect potential contaminants released from SWMU 2. A monitoring program also would evaluate the cap’s effect(s) on the shallow groundwater level in the UCRS and fill data gaps.

Institutional controls would be implemented to further prevent access to SWMU 2. These institutional controls may include a deed restriction to ensure that DOE retains ownership of the property, which SWMU 2 encompasses. Institutional controls also may prevent inappropriate use of the property and any intrusive activities that could expose buried waste materials.

Additionally, DOE would conduct reviews of the action no less than once every five years.

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 SWMU 2. 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 SWMU 2. MW337 and MW338 were installed downgradient of SWMU 2, and MW333 was installed upgradient of SWMU 2. The wells currently are sampled as part of the PGDP Groundwater Monitoring Program as specified in the EMP (LATA Kentucky 2013).

Since the ROD for this IRA was signed prior to the effective date of the PGDP MOA and LUCAP, a LUCIP does not exist for the institutional controls at SWMU 2.

DOE remains in control of the property that SWMU 2 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 2008 Five-Year Review protectiveness statement follows: The remedy for the C-749 Uranium Burial Ground 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 (DOE 2009a).

There have been no previous issues or recommendations for the C-749 Uranium Burial Ground. The site remains unchanged as described in the 2008 Five-Year Review, and no new actions have occurred.

17.5 SITE INSPECTION

On February 12, 2013, a site inspection of the SWMU 2 was performed by the BGOU Project Manager, and BGOU Project Engineer. This area is located north and west of the C-600 Building within the boundaries of the controlled access area of PGDP. There were no indications of erosion or standing water in the area. An access road is located on the south side of the area outside the radiological boundary. 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 was 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 SWMU 2 to groundwater and to prevent disturbance or contact with the buried waste materials.

The SWMU 2 low-permeability, multilayered cap was intended to mitigate migration of uranium and TCE from SWMU 2 to groundwater; however, this action was cancelled after it was determined that it would be ineffective because of the shallow groundwater found at SWMU 2.

The maximum detected concentrations of TCE in the one upgradient well and the three downgradient RGA wells located at SWMU 2 currently exceed the National Primary Drinking Water Standards and applicable state standards. Tc-99 activity has remained below the MCL, but appears to be rising in SWMU 2 downgradient well, MW337.

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 17.1 and 17.2 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 SWMU 2, based on groundwater sampling conducted between 1996 and 2012. The maximum detected

Table 17.1. Comparison of Initial and Current Contaminant Concentrations in RGA Groundwater, Downgradient of SWMU 2

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	2.3 2.3	MW337 MW67	5/11/2009 8/5/2009	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 17.1. Comparison of Initial and Current Contaminant Concentrations in RGA Groundwater, Downgradient of SWMU 2 (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[h]	pCi/L
U-235/U-236	ND	N/A	ALL	0.11	MW337	10/4/1996	0.3[g]	0.466[h]	pCi/L
U-238	3.3	MW67	3/11/1991	0.67	MW338	10/4/1996	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 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] Background value for U-235.
[h] 2013 Update of the Human Health Risk Methods Document (DOE 2013).

Table 17.2. Comparison of Initial and Current Contaminant Concentrations in RGA Groundwater, Upgradient of SWMU 2

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	7.1	MW333	5/7/2009	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	0.770	MW333	5/7/2009 3/8/2010	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 17.2. Comparison of Initial and Current Contaminant Concentrations in RGA Groundwater, Upgradient of SWMU 2 (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[h]	N/A	ALL	0.03	No Value	pCi/L
Tc-99	33	MW48	8/1/1989	39.9	MW333	5/7/2009	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[i]	pCi/L
U-235/U-236	ND	N/A	ALL	0.35	MW333	10/14/1996	0.3[g]	0.466[i]	pCi/L
U-238	1.3	MW48	4/3/1991	0.14	MW333	10/14/1996	0.7	9.99[i]	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] Background value for U-235.
[h] Value reported below laboratory detection limit, but was not laboratory qualified as a nondetect.
[i] 2013 Update of the Human Health Risk Methods Document (DOE 2013).

concentrations of TCE in the one upgradient well and the three downgradient RGA wells (MW337, MW338, and MW67) located at SWMU 2 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;[6] 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 17.2 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 the downgradient wells. These data indicate that TCE contamination in the RGA at SWMU 2 is coming from an upgradient source and that the net groundwater flow direction is northward. See Figure 17.3 for RGA well locations.

Figure 17.2 illustrates the potentiometric surface in the vicinity of SWMU 3 and SWMU 2 on July 17, 2012. There is a northerly gradient (compare 324.82 ft elevation at upgradient MW333 with 324.45 ft elevation downgradient MW338). The slight easterly vector of groundwater gradient likely is related to the fact that SWMU 3 has an impermeable (RCRA-equivalent) cap that limits infiltration in the vicinity of the unit. This will slightly depress the water table in the vicinity of SWMU 3 and induce some flow to the east, as shown on Figure 17.3, especially during periods of higher infiltration. A review of the shape of the TCE plume 100 µg/L implied contour (See Figure 17.4) supports the finding that the net groundwater flow is to the north, with some seasonal flow to the northwest and some to the northeast.

Because SWMU 2 is located inside the plant secured area and under DOE ownership and control, deed restrictions have not been necessary. SWMU 2 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.

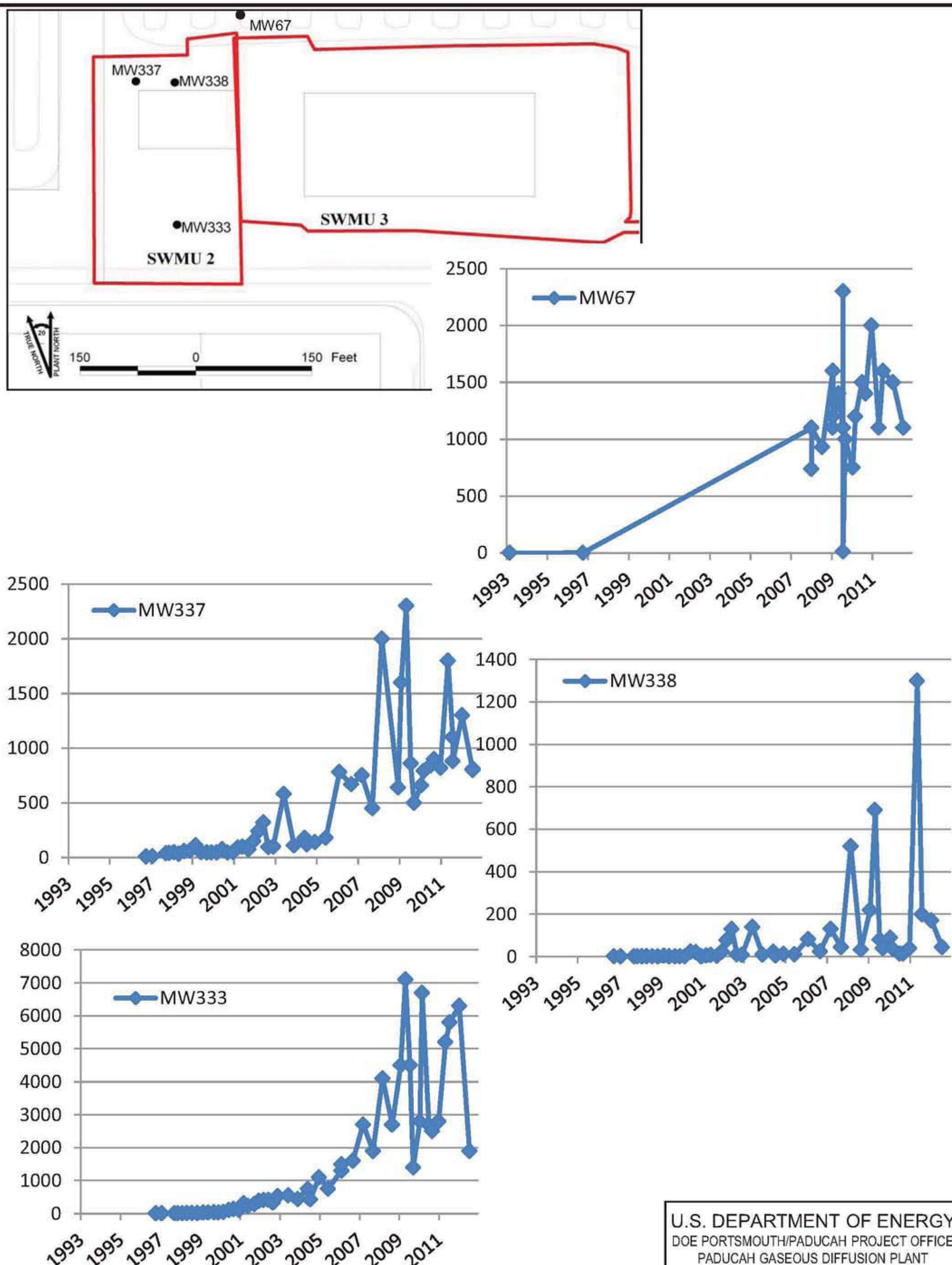
17.6.1 Question A: Is the Remedy Functioning as Intended by the Decision Documents?

The components of the remedy that were implemented are functioning as intended. Groundwater MWs constructed for SWMU 2, consisting of two downgradient wells (MW337 and MW338) and one upgradient well (MW333), are located to monitor the facility. Furthermore, a previously existing RGA well (MW67) provides additional downgradient monitoring.

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?

DOE remains in control of the property that SWMU 2 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.

[6] The laboratory reporting limit for uranium typically is 1 µg/L or less.



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

LATA Environmental Services of Kentucky, LLC

Figure 17.2. TCE Trends in the Upper RGA for SWMU 2

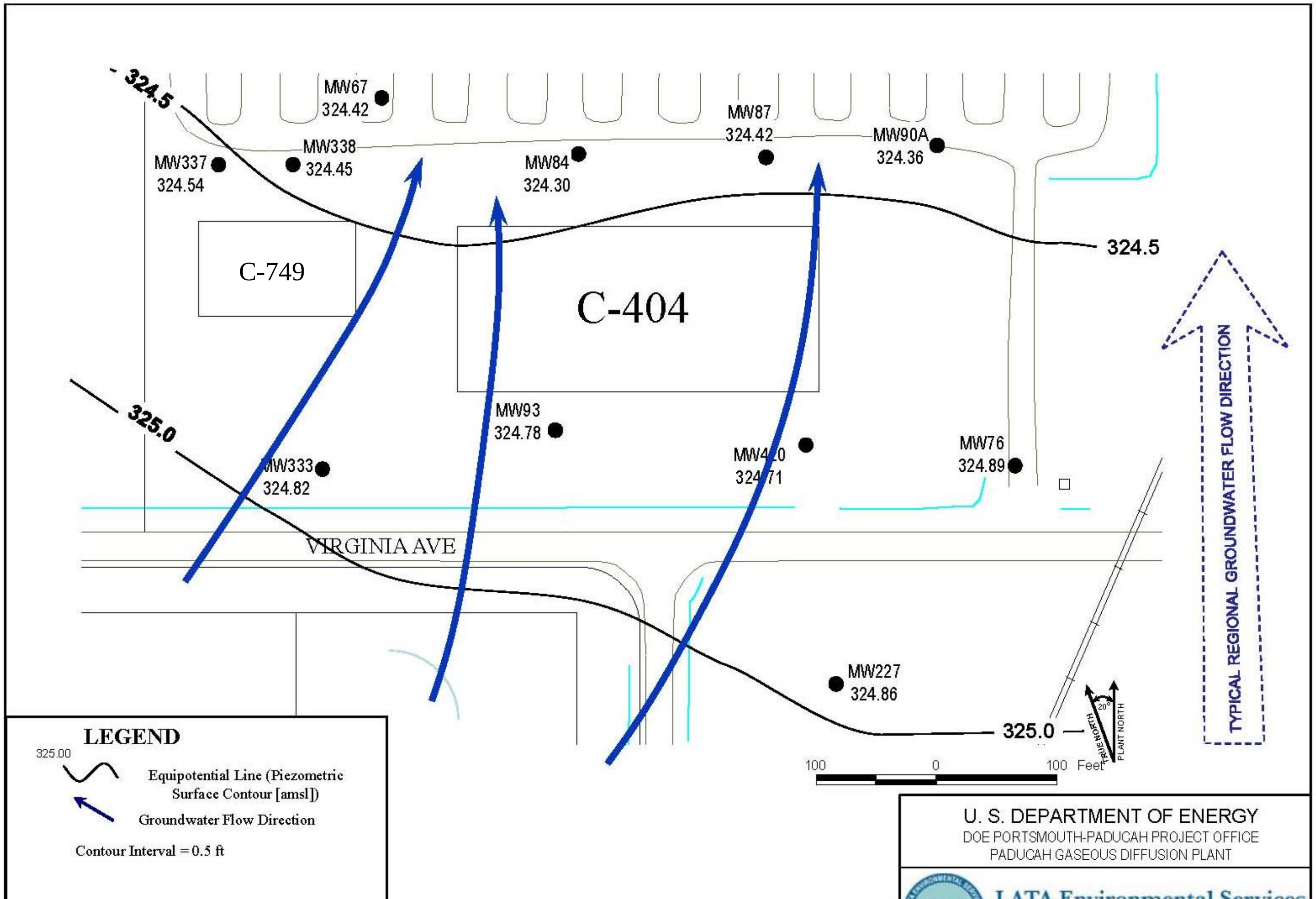


Figure E.2. Potentiometric Surface of the Upper Regional Gravel Aquifer at the C-404 Landfill, July 17, 2012

Figure from LATA Kentucky 2012d

Figure 17.3. Potentiometric Surface of the Upper Regional Gravel Aquifer at the C-404 (SWMU 3) and C-749 (SWMU 2) Landfills, July 17, 2012

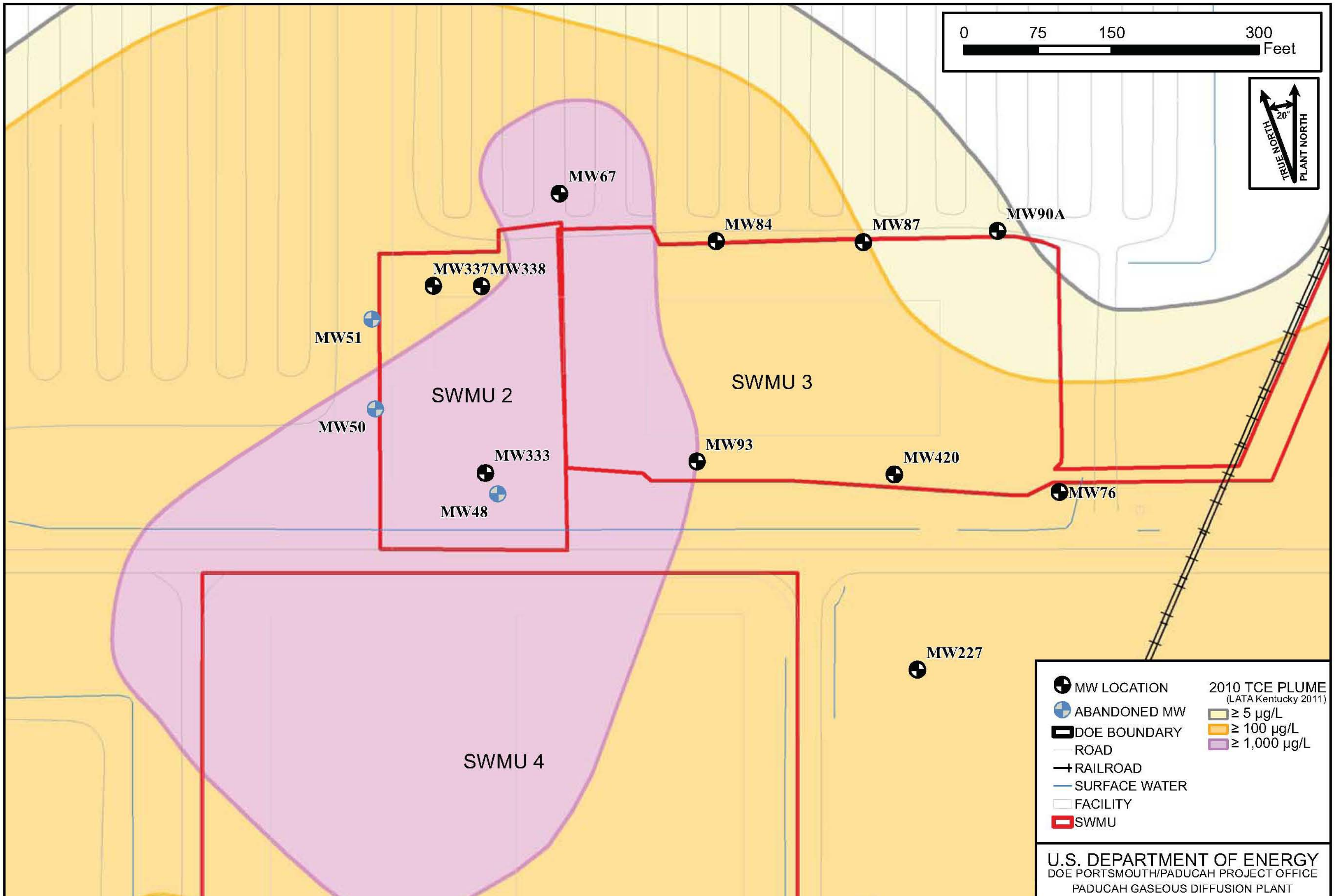


Figure 17.4. Location of C-749 (SWMU 2) and Trichloroethene Groundwater Plume

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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 UCRS water levels in the waste were predominately 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 original remedy was based on the assumption that there is no exposure pathway because institutional controls prevent access to the groundwater at the unit. The changes to the parameters for risk evaluation of TCE, therefore, have no effect on the protectiveness of the remedy because the exposure assumption (no exposure) is still valid. The recent data also indicate that contaminants in groundwater from this unit do 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 changes were identified, but do 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.

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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	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.	DOE	EPA and the Commonwealth of Kentucky	Additional action, if necessary, for long-term protection should be evaluated and documented in the final decision document for the Dissolved-Phase Plume.	09/30/2029	N	Y
Groundwater, Northeast Plume	The Northeast Plume remedial action 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.	DOE	EPA and the Commonwealth of Kentucky	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 PGDP 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.	12/30/2017	N	Y
Groundwater, Northeast Plume	The Northeast Plume is an IRA designed to initiate hydraulic control of the high TCE concentration area within the Northeast Plume and does not achieve final cleanup of the groundwater contamination. A follow-up evaluation is needed to ensure long-term protection.	DOE	EPA and the Commonwealth of Kentucky	Additional action, if necessary, for long-term protection should be evaluated and documented in the final decision document for the Dissolved-Phase Plume.	09/30/2029	N	Y

Operable Unit	Issue	Party Responsible	Oversight Agency	Recommendations and Follow-up Actions	Completion Date	Affects Protectiveness (Y/N)	
						Current	Future
Groundwater, Water Policy	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	EPA and the Commonwealth of Kentucky	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.	12/30/2014	N	Y
Groundwater, C-400 Electrical Resistance Heating (ERH)	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 Upper Continental Recharge System 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.	DOE	EPA and the Commonwealth of Kentucky	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.	TBD	N	Y

Operable Unit	Issue	Party Responsible	Oversight Agency	Recommendations and Follow-up Actions	Completion Date	Affects Protectiveness (Y/N)	
						Current	Future
Groundwater, C-400 Electrical Resistance Heating (ERH)	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. A follow-up evaluation is needed to ensure long-term protection.	DOE	EPA and the Commonwealth of Kentucky	Additional action, if necessary, for long-term protection should be evaluated and documented in the final decision document for the GDP Groundwater Sources OU and the CSOU.	TBD	N	Y
Groundwater, C-400 Electrical Resistance Heating (ERH)	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 and, therefore, 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.	DOE	EPA and the Commonwealth of Kentucky	To ensure that the remedy is protective for vapor intrusion, it is recommended that a vapor intrusion analysis be performed consistent with the PGDP Risk Methods Document as part of any subsequent follow-up C-400 actions (e.g., GDP Groundwater Sources OU, Dissolved-Phase Plume project).	09/30/2029	N	Y
Groundwater, Southwest Plume	The Southwest Plume project is a remedial action under construction. The remedial action is designed to address VOC releases to groundwater. A follow-up evaluation is needed to ensure long-term protection.	DOE	EPA and the Commonwealth of Kentucky	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 Plume project).	09/30/2029	N	Y

Operable Unit	Issue	Party Responsible	Oversight Agency	Recommendations and Follow-up Actions	Completion Date	Affects Protectiveness (Y/N)	
						Current	Future
Surface Water, NSDD Sections 1 and 2	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.	DOE	EPA and the Commonwealth of Kentucky	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 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. In the event there is a major change in land use for the Fire Training Area, an evaluation will be conducted to ensure the remedy is protective consistent with the PGDP LUCAP. Finally, DOE must comply with the requirements of CERCLA Section 120(h) if the property is transferred.	12/30/2014	N	N
Surface Water, C-746-K Landfill	The shaft of MW301 has buckled so that any repair/replacement of the pump would not be possible.	DOE	EPA and the Commonwealth of Kentucky	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.	12/30/2015	N	N
Surface Water, Surface Water Interim Corrective Measures (ICMs)	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.	DOE	EPA and the Commonwealth of Kentucky	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 (see Figure ES.1).	12/30/2014	N	N

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.

19. PROGRESS SINCE THE LAST FIVE-YEAR REVIEW

2008 Issue	2008 Recommendations/ Follow-up Actions	Party Responsible	Milestone Date	Results	Date of Action
Northwest Plume (GWOU)					
Although the remedy remains protective, the action could be optimized by ascertaining whether the high-concentration core of TCE of the Northwest Plume at the North Extraction Wellfield has migrated eastward of the capture zone of the wellfield.	Evaluate the extraction system to determine whether zones of capture of the EW fields can be optimized to control contaminant migration from the source area more effectively. Examples of follow-up actions resulting from this evaluation may include preferential pumping of wells in high concentration areas, termination of the two extraction wells in the North EW Field, and MW/EW installation.	DOE	12/30/2013	In response to recommendations contained in the 2008 CERCLA Five-Year Review, construction activities for the Northwest Plume IRA Optimization commenced in March 2010. The NWPGS previously consisted of two EW fields (north and south with each field having two EWs), for a total of four wells, underground pipeline, treatment facility, and MW network. In August 2010, two new EWs (EW232 and EW233) became operational near the original south wellfield, adjacent to the north security fence of PGDP. The north wellfield EWs (EW228 and EW229) were removed from service in August 2010. EW230 and EW231, located in the original south wellfield, are kept in standby mode and will be returned to service, if needed. The location of the new EWs was optimized to capture the core and the lateral extent of the Northwest Plume in the area of the north plant boundary.	03/18/2010
Northeast Plume (GWOU)					
The objectives of the interim ROD are being met by the IRAs.	Place the system in standby mode following the development of decision criteria that specify the conditions under which the system would be restarted.	DOE	12/30/2013	In 2011, the FFA managers identified optimization of the NEPCS as a priority, consistent with the sitewide strategy that includes a series of sequenced activities consisting of source actions and control of groundwater migration off DOE property followed by a final action for the overall dissolved-phased plume. Optimization activities are ongoing.	4/13/2011

2008 Issue	2008 Recommendations/ Follow-up Actions	Party Responsible	Milestone Date	Results	Date of Action
NSDD Section 1 and 2					
Not Applicable.	Perform a residual risk calculation to determine if the remedy can be optimized (e.g., risks are at a level that would support modification of ICs and/or cessation of five-year reviews).	DOE	12/30/2013	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 EPA risk range (EPA 1999); therefore, monitoring of LUCs can be reduced to once every five years in conjunction with the Five-Year Reviews to ensure that the assumption of industrial land use continues to be the current and reasonably anticipated future land use until a final remedy is selected. A request for modification of the NSDD LUCIP for reduced monitoring of institutional controls is recommended.	12/03/2012
Surface Water Interim Corrective Measures					
Signs were erected under the scope of another project. Although the message content between the signs does not conflict with one other, an evaluation of the sign program is needed.	Evaluate whether ICM signs should be removed or replaced with new signs with language approved for the EI signs.	DOE	12/30/2013	An evaluation of both sign programs was conducted, and a decision was made to replace the Surface Water ICM signs with EI 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. These actions will remove all Surface Water ICM signs and increase the overall number of EI signs within the program. Implementation of these actions will result in only one sign program. 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 (see Figure ES.1).	3/22/2013

20. 2013 PROTECTIVENESS STATEMENTS

Overall, the selected remedies implemented thus far are protective, but PGDP cleanup activities are still ongoing with additional future actions planned. The groundwater exposure pathways for PGDP are being controlled by providing 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 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, 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.

20.1.2 Northeast Plume

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, 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 plant security fence. Optimization of the Northeast Plume is being pursued by the FFA parties. 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 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 remedial action shall be selected and implemented…" as part of the CSOU.

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 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, need to be evaluated for long-term protection.

The objective of this removal action 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 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. However, in order to establish long-term protectiveness, additional remedial actions will be evaluated and selected, as necessary, under the GDP Groundwater Sources OU.

20.1.6 Southwest Plume

The remedial action for VOC sources at Southwest Plume 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.), has addressed adequately known exposure pathways that could result in unacceptable risks originating from the Southwest Plume.

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 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 SWMU 59. 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 Landfill

The remedy for the C-747-K Landfill 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 the reduction of human risks by posting warning signs and other institutional controls, through the 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 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 remedial action shall be selected and implemented…" as part of the CSOU.

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. However, in order to establish long-term protectiveness, additional remedial actions 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 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 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 remedial action 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 currently is being 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 [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)], groundwater monitoring, and institutional controls. 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.

21. NEXT REVIEW

The next Five-Year Review for PGDP is required to be approved by the FFA parties by December 30, 2017. Note: These schedules are estimates for planning and are included for informational purposes only 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. All remedial actions 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 environmental remediation subcontractor performed this Five-Year Review. The reviews were conducted during January through April 2013. 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

22.2 COMMUNITY NOTIFICATION AND INVOLVEMENT

Community involvement at PGDP is handled primarily in conjunction with the CAB. The CAB meets monthly to discuss many aspects of environmental restoration efforts at PGDP. Copies of AR decision documents are kept at the Environmental Information Center (EIC). The EIC is open to the public during regular business hours. DOE published a public notice in the local newspaper on March 17, 2013, announcing the Five-Year Review had been initiated and requested that any suggestions, issues, questions, or concerns regarding this review be provided from March 18 through March 22, 2013. No comments were received.

22.3 DOCUMENT REVIEW

This activity consisted of a review of relevant documents to the remedial action of each of the units and the previous Five-Year Reviews. This was conducted during January through April 2013. These documents are included as references in Chapter 23.

22.4 DATA REVIEW

Groundwater, surface water, and sediment samples are collected routinely at PGDP to assess environmental conditions. These data are stored in Paducah's Oak Ridge Environmental Information System (Paducah OREIS). Data were downloaded for review from Paducah OREIS throughout the review process.

22.5 SITE INSPECTIONS

Inspections were conducted at each of the response action sites during January and February 2013. The DOE 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 February, March, and April 2013 with various personnel connected to some of the response actions. Specifically, the operating engineer 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, CAB, LATA Kentucky subcontractor, and local residents concerning the overall DOE project.

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APPENDIX A

GENERAL PGDP INTERVIEWS

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Name: **Gaye Brewer**
Affiliation: **KDWM, local resident**
Date: **March 12, 2013**

1. What is your overall impression of the project?

Response: I am glad the site is dealing with the tough issues like Burial Grounds and Groundwater and glad to see cleanup efforts moving forward.

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 the purpose and results.

Response: Yes, Bill Clark (KDWM) does oversight of field activities and reports to the KY project manager what he has observed. These are brief write-ups and are mostly positive.

1. 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.

Response: They have received some complaints but whenever they receive one, it is investigated. None have been confirmed, to-date.

2. Do you feel well informed about the site's activities and progress?

Response: Yes.

3. Do you have any comments, suggestions, or recommendations regarding the site's management or operation?

Response: The program is professionally run and is doing a good job. One suggestion is to make sure decisions are made considering the long-term.

4. What effects have site operations had on the surrounding community?

Response: Biggest effects on the community are jobs and an increase in the standard of living. There have been minimal effects environmentally.

5. Are you aware of any community concerns regarding the surrounding community?

Response: Current community concerns are jobs. There also is interest in the Waste Disposal Options (CERCLA Cell) and where it will be located and how it will look.

6. Are you aware of any events, incidents, or activities at the site such as vandalism, trespassing, or emergency responses from local authorities?

Response: No.

Name: **Tim Kreher**
Affiliation: **WKWMA Manager, local resident**
Date: **April 2, 2013**

1. What is your overall impression of the project?

Response: Sometimes it is hard to see where the project is going. For example, on-site disposal facility was investigated and discussed over 10 years ago. Today we are now discussing potential sites for an on-site disposal facility. A large amount of time and money was spent in the past, why are we doing it again now?

1. Have there been routine communications or activities (site visits, inspections, reporting activities, etc.) conducted by your office regarding the site? If so, please give the purpose and results.

Response: No.

2. 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.

Response: Not to my recollection.

3. Do you feel well informed about the site's activities and progress?

Response: Yes on some issues, no on others.

4. Do you have any comments, suggestions, or recommendations regarding the site's management or operation?

Response: I believe that some of the people and entities involved in potential land transfer activities may not be aware of ongoing CERCLA issues with portions of the DOE property. Also, some of the sites that are being suggested for the on-site disposal facility are within the boundaries of the Environmental Assessment for DOE to transfer property to other entities. This makes little sense to me – sites need to be chosen or rejected for potential CERCLA activities before they can be giving away.

5. What effects have site operations had on the surrounding community?

Response: Many of the surrounding residents seem to have lost faith in DOE's ability to accurately convey the importance of cleanup issues at the site. I have heard neighbors say that they have begun throwing away notices of meetings, etc., because the announcements don't make sense to them.

6. Are you aware of any community concerns regarding the surrounding community?

Response: Some people seem to be concerned that cleanup activities will be affected by decreased budget and/or USEC closure. (In effect, close the doors and leave everything like it is.) Others are concerned that the potential re-industrialization of portions of the site may not be well planned out, for example, tracts of land re-industrialized in a disorganized fashion. Many recreational users of the surrounding wildlife management area would choose to see reindustrialization performed in a fashion to minimize impacts on wildlife habitat and historical recreational activities.

7. Are you aware of any events, incidents, or activities at the site such as vandalism, trespassing, or emergency responses from local authorities?

Response: Fish and Wildlife personnel have found evidence of illegal off-road driving taking place on DOE-owned property at the site. These infractions have been investigated and prosecuted by state and county law enforcement agencies, when applicable.

Name: James Tortorelli
Affiliation: Local resident, subcontractor to LATA Kentucky
Date: April 8, 2013

1. What is your overall impression of the project?

Response: I expect for DOE to do the right thing. I feel safe living in the area. I do not believe it is reasonable to expect free release of entire DOE site.

2. Do you feel well informed about the site's activities and progress?

Response: No. I think an email distribution list or website would help keep the community informed of any community meetings and updates as to what is being done.

3. Do you have any comments, suggestions, or recommendations regarding the site's management or operation?

Response: Not really. Every organization needs more discipline in long-term planning. DOE is doing OK.

4. What effects have site operations had on the surrounding community?

Response: Mostly psychological – lots of uncertainty in the economic future, and uncertainty in the level of hazard that exists. This causes fear. It would be nice if DOE would do a workshop on relative risk for the community and the community would attend.

5. Are you aware of any community concerns regarding the surrounding community?

Response: The plume is the biggest health concern. Then there are the economic concerns.

6. Are you aware of any events, incidents, or activities at the site such as vandalism, trespassing, or emergency responses from local authorities?

Response: Not first hand. I have heard that the solar cells installed may have been vandalized but this is not confirmed.

Name: **Mike Kemp**
Affiliation: **Citizen's Advisory Board member**
Date: **April 8, 2013**

1. What is your overall impression of the project?

Response: Complicated and slow.

2. Do you feel well informed about the site's activities and progress?

Response: Yes.

3. Do you have any comments, suggestions, or recommendations regarding the site's management or operation?

Response: The perspective we have in regard to remedial activities is that all is being done. There has been a shift from remedial activities to re-use of the site over the last year. DOE leadership changes to frequently so that we do not know who is in charge from meeting to meeting. There needs to be some consistency in who is doing what.

4. What effects have site operations had on the surrounding community?

Response: Five years ago, no one cared but now, the community is energized. They are concerned about what the condition of the site is going to be left in and how it will be re-developed.

5. Are you aware of any community concerns regarding the surrounding community?

Response: Same as previously stated (Response to question #4). USEC shutting down is of concern.

6. Are you aware of any events, incidents, or activities at the site such as vandalism, trespassing, or emergency responses from local authorities?

Response: No.

Name: Resident
Affiliation: Resident
Date: April 9, 2013

1. What is your overall impression of the project?

Response: It appears that DOE has spent a lot of money and I am not sure they have gotten their money's worth.

2. Do you feel well informed about the site's activities and progress?

Response: Maybe, I feel like DOE is trying but I have little interest as it is not a priority in my life.

3. Do you have any comments, suggestions, or recommendations regarding the site's management or operation?

Response: No.

4. What effects have site operations had on the surrounding community?

Response: I have heard that some people feel that their land has lost value due to the groundwater contamination. For me, it is a personal inconvenience that I cannot water my lawn or garden with my well.

5. Are you aware of any community concerns regarding the surrounding community?

Response: No.

6. Are you aware of any events, incidents, or activities at the site such as vandalism, trespassing, or emergency responses from local authorities?

Response: No.

APPENDIX B

NSDD RESIDUAL RISK ASSESSMENT

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APPENDIX B

NSDD RESIDUAL RISK ASSESSMENT (CD)

Appendix B presents a residual risk assessment performed in response to a recommendation in the 2008 Five-Year Review. This residual risk assessment is presented in the 2013 Five-Year Review to support a recommendation presented in Chapter 18 regarding LUCs for Sections 1 and 2 of the NSDD. Discussions of the need for LUCs presented in this residual risk assessment were made in the context of current DOE ownership of PGDP.

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APPENDIX C

WATER POLICY ADDITIONAL ACTIONS

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WATER POLICY ADDITIONAL ACTIONS

This addendum was prepared to document the additional information that has been collected to support the protectiveness determination of the Water Policy Removal Action (Section 8 of the main text), as requested by the U.S. Environmental Protection Agency (EPA) in letter dated September 30, 2014. 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.

The U.S. Department of Energy (DOE) has completed the following actions:

- The annual Water Policy Educational Fact Sheet, Attachment C1, 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/Kentucky Department for Environmental Protection (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 calendar year, unless another time is agreed to by the Federal Facility Agreement (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 2015. No new landowners were identified. Using this review to supplement current records, the educational mailer was sent in January 2016 to all known addresses (residential and business) within the Water Policy Area; each was addressed to "Current Resident."

DOE intends to repeat this procedure annually and also will include absentee landowners in future mailings.

- The Water Policy Vapor Intrusion Screening Study Report, Attachment C2, was submitted as a secondary document under the FFA to EPA/KDEP on October 21, 2015. Comments were received and a revised report was submitted on February 22, 2016. This addendum contains the revised report that was approved previously by Kentucky on March 8, 2016, but not approved previously by EPA per letter dated March 2, 2016.

- The demonstration that residents located over the 5 µg/L or greater trichloroethene (TCE) plume, which is the Safe Drinking Water Act maximum contaminant level (MCL) for TCE, are not using groundwater is included as Attachment C3 of this Addendum.

Based upon these completed actions, the protectiveness determination for the Water Policy Removal Action is determined to be Short-term Protective as follows:

> 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.

ATTACHMENT C1

WATER POLICY EDUCATIONAL MAILER

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INFORMATIONAL BROCHURE - DOE WATER POLICY RESIDENT

Water Policy Area

Upon discovering residential well contamination in 1988, DOE committed to eliminate residents' exposure to trichloroethene (TCE) and technetium-99 (Tc-99) contamination by providing alternate drinking water to potentially affected residents. This action became known as the DOE Water Policy. To achieve the goal of eliminating residents' exposure to contamination, DOE paid for extending the West McCracken public water supply to the potentially affected area. The potentially affected area is bounded by the Ohio River to the north, DOE property boundary on the south, Metropolis Lake Road to the east, and Bethel Church Road to the west.

DOE also asked property owners in the area to sign a license agreement, in which DOE agreed to pay residents' water bills, allowed DOE representatives access to residential properties to collect samples, and prohibited the property owner from drilling new water supply wells or using existing water supply wells.

DOE continues to implement the Water Policy by renewing license agreements with property owners within the potentially affected area.

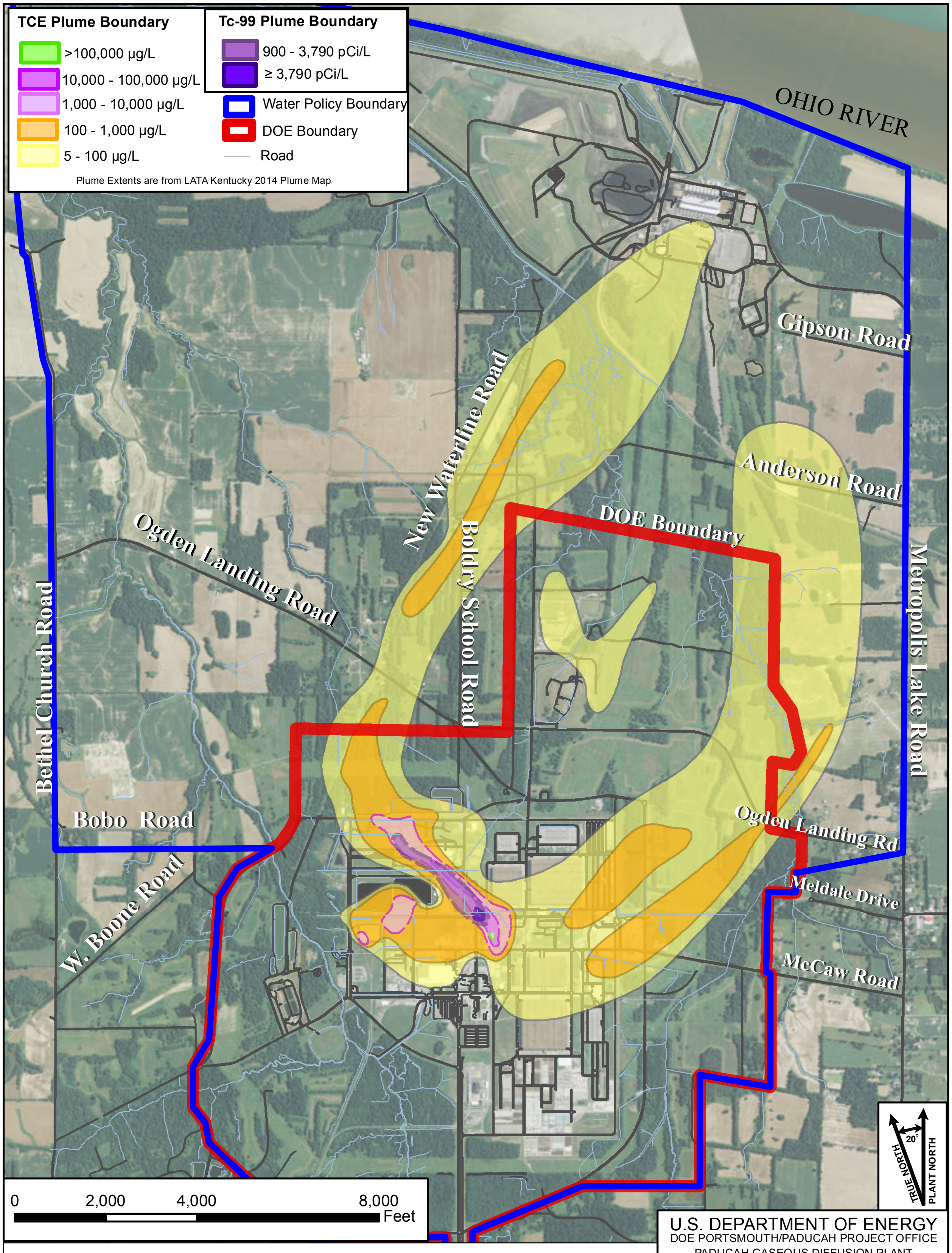
The protectiveness of the Water Policy is required by law to be reviewed every five years. As a result of the most recent review, DOE with agreement from the U.S. Environmental Protection Agency (EPA) and the Kentucky Department for Environmental Protection (KDEP) decided to send this fact sheet to all Water Policy residents to ensure they are educated about the potential contamination in underlying groundwater.

Since discovering the residential well contamination in 1988, DOE has taken actions that have reduced the groundwater concentrations of TCE and Tc-99 in the potentially affected area, including implementing groundwater remedial actions in the northeast and northwest contaminant plumes, which underlie the potentially affected area, and reducing contaminants at the source of those plumes. DOE continues these actions under the oversight of EPA and KDEP.

Resident Need to Know

All residents are asked to not drill a new water supply well or use any existing water wells.

For more information about the Water Policy, please contact: Buz Smith at 270-441-6000



Location of Water Policy Boundary

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ATTACHMENT C2

WATER POLICY VAPOR INTRUSION SCREENING STUDY

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Secondary Document

Water Policy Area Vapor Intrusion Screening Study Report for the Five-Year Review of Remedial Actions Paducah, Kentucky

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DOE/LX/07-1289&D2/R1/A1/R2
Secondary Document

Water Policy Area Vapor Intrusion Screening Study Report for the Five-Year Review of Remedial Actions Paducah, Kentucky

Date Issued—October 2017

U.S. DEPARTMENT OF ENERGY
Office of Environmental Management

Prepared by
FLUOR FEDERAL SERVICES, INC.,
Paducah Deactivation Project
managing the
Deactivation Project at the
Paducah Gaseous Diffusion Plant
under Task Order DE-DT0007774

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PREFACE

This *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/R2, has been prepared as a Secondary Document under the *Federal Facility Agreement for the Paducah Gaseous Diffusion Plant* (EPA 1998). This report has been developed to supplement the *Five-Year Review for Remedial Actions at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/LX/07-1289&D2/R1 (DOE 2014a).

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FIGURES

TABLES

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ACRONYMS

bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
DOE	U.S. Department of Energy
DPT	Direct Push Technology (boring)
EPA	U.S. Environmental Protection Agency
FFA	Federal Facility Agreement
KDFWR	Kentucky Department of Fish and Wildlife Resources
PGDP	Paducah Gaseous Diffusion Plant
Pot	potentiometric surface
RGA	Regional Gravel Aquifer
SAP	sampling and analysis plan
TIC	top of inner casing
TOC	top of casing
UCRS	Upper Continental Recharge System
VISL	Vapor Intrusion Screening Level
VOC	volatile organic compound
WKWMA	West Kentucky Wildlife Management Area
WWR	Well Wizard riser

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EXECUTIVE SUMMARY

This report presents the results of a vapor intrusion screening study performed as an additional action based on determinations made in the *Five-Year Review for Remedial Actions at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/LX/07-1289&D2/R1 (Five-Year Review) (DOE 2014a). The vapor intrusion screening study was conducted at four locations within the Water Policy Area to determine whether volatile organic compound (VOC) [primarily trichloroethene (TCE)] concentrations in groundwater warrant a detailed vapor intrusion study.

This study meets the sampling requirements in *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, as modified by field conditions. During the study, first available water samples were collected, as available, from locations within the Water Policy Area near the residences located near/above the TCE plumes. The Federal Facility Agreement parties agreed that the sampling results provide quality data sufficient to address the study's decision rules.

Direct push technology borings were advanced into the Upper Continental Recharge System (UCRS) matrix in the vicinity of four residences located near/above the Regional Gravel Aquifer (RGA) TCE plumes. Although groundwater was encountered at all four boring locations, only two sets of the borings had sufficient water to allow collection of a water sample. The dearth of water for sample collection at the residences is consistent with the conceptual site model (CSM) for the UCRS and earlier UCRS sampling efforts. The CSM for the UCRS shows the upper UCRS matrix consists of silt and clay that limits water migration and the upward migration of vapor phase VOCs.

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.

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1. INTRODUCTION

This report presents the results of the vapor intrusion screening study performed in accordance with the approved *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&D2 [Sampling and Analysis Plan (SAP)] (DOE 2015a), which was conducted as an additional action subsequent to the *Five-Year Review for Remedial Actions at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-1289&D2/R1 (Five-Year Review) (DOE 2014a). The vapor intrusion screening study was performed to determine whether volatile organic compound (VOC) [primarily trichloroethene (TCE)] concentrations in Upper Continental Recharge System (UCRS) groundwater warrant a detailed vapor intrusion study within the Water Policy Area. TCE plumes in the Regional Gravel Aquifer (RGA) underlie the Water Policy Area, and TCE vapor released from these plumes has the potential to migrate upward. To evaluate this potential for upward migration, a vapor intrusion screening study was designed and a SAP was prepared that described how to collect first-available water samples from locations within the Water Policy Area near the residences located near/above the TCE plumes. The Federal Facility Agreement (FFA) parties agreed that this sampling approach would provide a sufficient basis on which to determine whether a detailed vapor intrusion study is warranted, and the SAP was approved by the U.S. Environmental Protection Agency (EPA) on May 21, 2015, (EPA 2015a) and by the Kentucky Division of Waste Management on May 22, 2015 (KDWM 2015).

1.1 PROJECT SCOPE

The Five-Year Review (DOE 2014a) presented the results of a 2013 review of the Water Policy Removal Action. In a letter dated September 30, 2014, (EPA 2014a) EPA noted the following project-related uncertainty:

> 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.

Three meetings were held to scope the vapor intrusion concern raised by EPA and develop an approach to collecting groundwater data. The meetings were held on August 8, 2014; February 24, 2015; and April 22, 2015. As a result of these meetings, the FFA parties agreed to undertake a vapor intrusion screening study to determine whether a detailed vapor intrusion study is warranted. This study was performed under the provisions of Section XXX, Five-Year Review, of the FFA, as documented in the Record of Conversation letter dated August 1, 2014 (DOE 2014b).

1.2 PROJECT OBJECTIVES

The objective of the field work was to collect first-available water samples from locations within the Water Policy Area near residences located near/above the TCE plumes. Figures 1 and 2 present maps of the RGA TCE plumes and the four boring locations (NW1, NW2, NE1, and NE2) sampled to complete this study. The water samples would be analyzed for selected VOCs per the SAP. Analytical results were compared to the respective default Vapor Intrusion Screening Level (VISL) for groundwater from the VISL Calculator (VISL values) (EPA 2014b). If groundwater data for selected VOCs are less than the

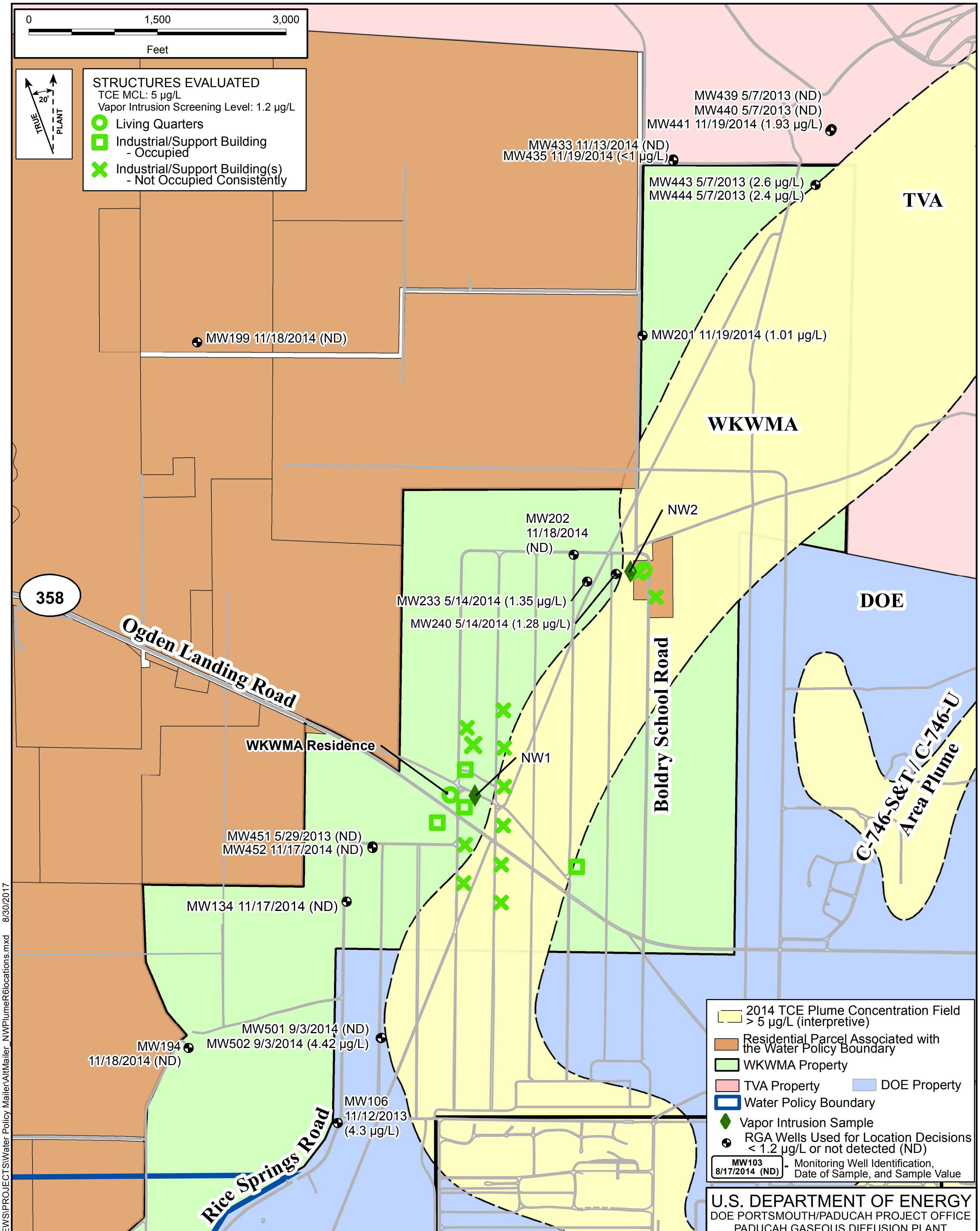

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Figure 1. Northwest Plume Water Policy Area - Vapor Intrusion Screening Sampling Locations

VISL or nondetect, then no additional groundwater sampling is needed and the vapor intrusion pathway does not pose a concern for the residence.

1.3 PROJECT APPROACH

The approach agreed to by the FFA parties to meet the project objective of this vapor intrusion screening study was as follows.

- Advance Direct Push Technology (DPT) rods into the UCRS to allow collection of water from the first-available UCRS depth.

- Sample groundwater from the first available UCRS depth and analyze for VOCs.

- Compare groundwater analytical results to the respective default VISL for groundwater calculated using the VISL Calculator (EPA 2014b).

- Groundwater samples were to be collected from first-available water from four locations within the Water Policy Area near the residences located near/above the TCE Plume. Samples were to be taken within 100 ft. laterally, where possible, and not further than 300 ft. from the residence for the study.

Figure 1 presents a map of the privately-owned parcels located near/above the TCE contamination in groundwater on the west side of the Water Policy Area. A review of the privately-owned parcels indicated there were three parcels located near/over the TCE contamination area and only one of those included a structure with living quarters. Additionally, there was one structure with living quarters on the West Kentucky Wildlife Management Area owned by the Commonwealth of Kentucky over the TCE contamination area. These two structures with living quarters were chosen for locating the two boring locations (NW1 and NW2).

Figure 2 presents a map of the privately-owned parcels located near/above the TCE contamination in groundwater on the east side of the Water Policy Area. A review of the privately-owned parcels indicated there were thirteen parcels (10 owners) located near/over the TCE contamination area. The parcel overlying the TCE contamination contained three structures with living quarters in close proximity to each other. One boring location was utilized to represent all three structures (NE1). A second parcel chosen for evaluation contained one structure with living quarters and a boring was sampled near the structure (NE2). There were seven other parcels with living quarters identified; however, previous groundwater data indicated the contamination was less than the VISL screening level of 1.2 μg/L for groundwater from the VISL values (EPA 2014b). In accordance with the sampling plan, further screening of these properties for vapor intrusion was not necessary. The NE2 boring represented similar conditions for all the other parcels with living quarters.

Consistent with EPA guidance, parcels with TCE trend data below the residential VISL of 1.2 ug/L were not included in the screening study. Figures 1 and 2 include 2014 groundwater sample collection points where results for TCE showed less than 1.2 μg/L and less than 5 ug/L. The figures also illustrate the location of the TCE plume in 2014 based on data above the Maximum Contaminant Level of 5 μg/L for drinking water. Properties with structures located at or beyond the selected vapor intrusion sampling locations (NW1 and NW2 on the west and NE1 and NE2 on the east sides of the Water Policy Area, representing the potential "worse case" scenario for vapor mitigation from groundwater to structures) would not likely overlie areas of the TCE plume that exceed the TCE VISL screening level of 1.2 μg/L; which supports the rationale for not sampling other properties within the Water Policy Area.

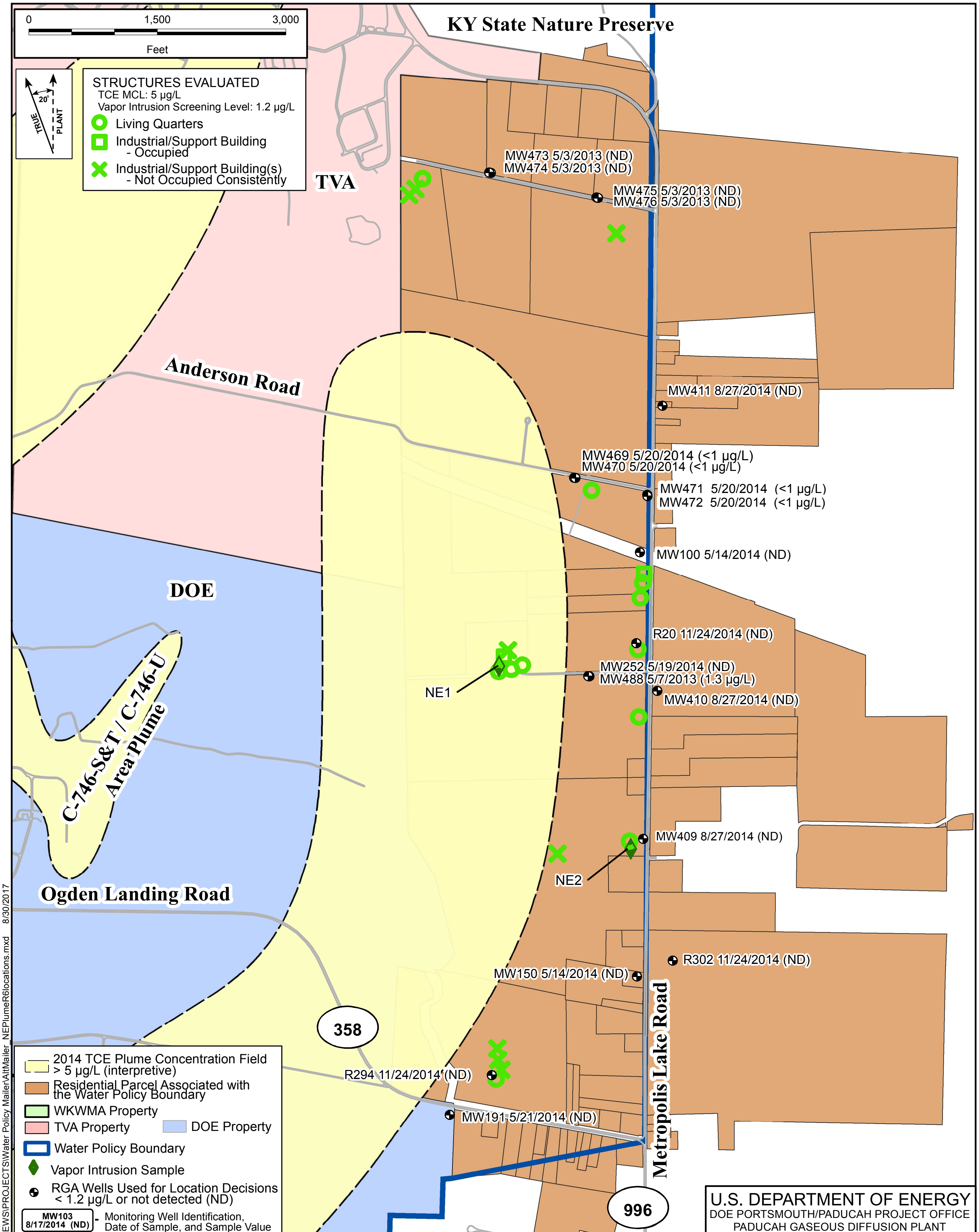

Figure 2. Northeast Plume Water Policy Area - Vapor Intrusion Screening Sampling Locations

The *Trichloroethene and Technetium-99 Groundwater Contamination in the Regional Gravel Aquifer for Calendar Year 2014 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, PAD-ENR-0146, states that all data for the 2014 TCE Plume map were extracted from the Paducah Oak Ridge Environmental Information System database. The map for calendar year 2014 is based on analytical results from the most recent sampling event (primarily January–December 2014). Where collocated monitoring wells (i.e., clustered wells or multiport wells) provide analytical results for the calendar year from screened intervals at multiple elevations within the RGA (e.g., upper, middle, and/or lower RGA), the maps use the value from the interval that has the highest concentration. Data from sampling in 2013 have been used, as necessary, to supplement the 2014 information and aid in plume delineation. This data set, as described, is the source of the TCE data shown on Figures 1 and 2.

1.4 AREA DESCRIPTION

Paducah Gaseous Diffusion Plant (PGDP), located within the Jackson Purchase region of western Kentucky, is an inactive uranium enrichment facility owned by the U.S. Department of Energy (DOE). PGDP first was owned and managed by the Atomic Energy Commission and the Energy Research and Development Administration, DOE's predecessors; DOE then managed PGDP until 1993. On July 1, 1993, the United States Enrichment Corporation assumed management and operation of the PGDP enrichment facility under a lease agreement with DOE that continued until October 2014 when the facility was returned to DOE. DOE retains ownership of the enrichment complex.

Of the 3,556 acres owned by DOE, approximately 650 acres of this parcel are inside the PGDP fenced area. Most of the facilities used to support enrichment operations are located inside the PGDP fenced area. Outside the fenced area, several support facilities for DOE projects can be found. The support facilities include landfills (both active and closed), modular office complexes, a water treatment facility, groundwater remediation systems, decontamination facilities, storage areas, a storm water retention basin, and liquid effluent treatment facilities. Of the remaining DOE land, approximately 1,986 acres is licensed to the Commonwealth of Kentucky Department of Fish and Wildlife Resources (KDFWR) and serves as a portion of the West Kentucky Wildlife Management Area (WKWMA). The licensed portion of the WKWMA is used by the public for hunting and horse and dog field trials. KDFWR staff work in the licensed area performing wildlife management activities.

The topography of DOE property is level to slightly rolling. It is rural and predominantly open grasslands with scattered wooded areas of mature hardwoods and brush. Approximately 60% of the total area outside PGDP but on DOE-owned property is grasslands; much of this nonwooded area is right-of-way for electrical power lines.

1.5 GEOLOGY AND SOILS

The Jackson Purchase region of western Kentucky, where PGDP is located, represents the northern tip of the Mississippi Embayment portion of the Coastal Plain. The Jackson Purchase region is an area of land that includes all of Kentucky west of the Tennessee River. The stratigraphic sequence in the region consists of Cretaceous, Tertiary, and Quaternary sediments unconformably overlying Paleozoic bedrock. Relative to the shallow groundwater flow system in the vicinity of PGDP, the continental deposits and the overlying loess and alluvium are of key importance. The continental deposits locally consist of an upper silt member, with lesser sand and gravel interbeds, and a thick, basal sand and gravel member, which fills a buried river valley. A subcrop of the Porters Creek Clay, located beneath and immediately south of PGDP marks the southern extent of the buried river valley. Fine sand and clay of the McNairy Formation

directly underlie the continental deposits in the buried river valley. These continental deposits are continuous from beneath PGDP northward beyond the present course of the Ohio River.

The general soil map for Ballard and McCracken Counties indicates that three soil associations are found within the vicinity of PGDP (USDA 1976): the Rosebloom-Wheeling-Dubbs association, the Grenada-Calloway association, and the Calloway-Henry association. The predominant soil association in the vicinity of PGDP is the Calloway-Henry association, which consists of nearly level, somewhat poorly drained, medium-textured soils on upland positions. Many of the characteristics of the original soil have been lost due to industrial activity that has occurred over the past 50-plus years. Activities that have disrupted the original soil classifications include filling, mixing, and grading. The soil type present in these disturbed areas is characterized as urban.

1.6 HYDROGEOLOGY

PGDP is located in the western portion of the Ohio River drainage 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, PGDP is within the drainage areas of the Ohio River, Bayou Creek, and Little Bayou Creek.

PGDP is situated on the divide between the two creeks. Bayou Creek is a perennial stream on the western boundary of the plant that flows generally northward, from approximately 2.5 miles south of the plant site to the Ohio River. Little Bayou Creek becomes a perennial stream at the east outfalls of PGDP. The Little Bayou Creek drainage originates within WKWMA and extends northward and joins Bayou Creek near the Ohio River. The drainage basins for both creeks are located in rural areas; however, they receive surface drainage from numerous swales that drain residential and commercial properties, including WKWMA, PGDP, and Tennessee Valley Authority Shawnee Fossil Plant. The confluence of the two creeks is approximately 3 miles north of the plant site, just upstream of the location at which the combined flow of the creeks discharges into the Ohio River (DOE 2008).

During uranium enrichment operations (1952–2013) and continuing into 2014, most of the flow within Bayou and Little Bayou Creeks was from process effluents or surface water runoff from PGDP. Contributions from PGDP comprised approximately 85% of flow within Bayou Creek and near 100% of flow within Little Bayou Creek. (Process effluents have been significantly reduced during 2015.) A network of ditches discharges effluent and surface water runoff from PGDP to the creeks. Plant discharges are monitored at the Kentucky Pollutant Discharge Elimination System outfalls prior to discharge into the creeks.

The local groundwater flow system at PGDP occurs within the sands of the Cretaceous McNairy Formation, Pliocene Terrace Gravel, Plio-Pleistocene lower continental gravel deposits and upper continental deposits, and Holocene alluvium. The primary local aquifer is the RGA. The RGA consists of the Quaternary sand and gravel facies of the lower continental deposits and Holocene alluvium found adjacent to the Ohio River and is of sufficient thickness and saturation to constitute an aquifer. These deposits have an average thickness of 30 ft. Groundwater flow is predominantly north toward the Ohio River (DOE 2008).

The primary source of groundwater recharge to the RGA derives as downward percolation of infiltrating rainwater and seepage from streams and ponds, through the shallow silt and fine sand units (and lesser clayey units) overlying the RGA. This flow system is termed the UCRS. The top of the saturated zone within the UCRS is the water table, which is poorly known within the Water Policy Area overlying the

TCE plumes. These sediments have low hydraulic conductivity (10^{-7} to 10^{-6} cm/sec); hydraulic gradients often approach -1 ft/ft within the saturated UCRS in response to the downward groundwater flow.

1.7 PROJECT CONCEPTUAL SITE MODEL

There are TCE plumes in RGA groundwater that have migrated off of the DOE property and into the vicinity of four residences (see Figures 1 and 2); therefore, a theoretical potential exists for the TCE to migrate upward from the RGA, through the UCRS groundwater and the UCRS vadose zone (as a vapor) and to the surface. Figure 3, reproduced from the scoping presentations and the SAP, presents an EPA figure (EPA 2013; EPA 2015b) adapted to PGDP conditions to present the conceptual model for how VOCs have the potential to migrate.

The SAP presented the results of historical investigations that indicate that the UCRS soils in the vicinity of PGDP have very low permeability and do not show evidence of vapor migration. Figures 4 and 5, reproduced from the scoping presentations, document trends of soil texture with depth along transects of the two off-site TCE plumes. Figure 6 shows the projected location of the cross sections. Low permeability soils (silts and clays) are continuous to depths of approximately 30 to 50 ft throughout the transects, with the exception of the incised stream valley of Little Bayou Creek. This vapor intrusion screening study was designed to sample UCRS groundwater and confirm that shallow groundwater concentrations do not exceed default VISL values.

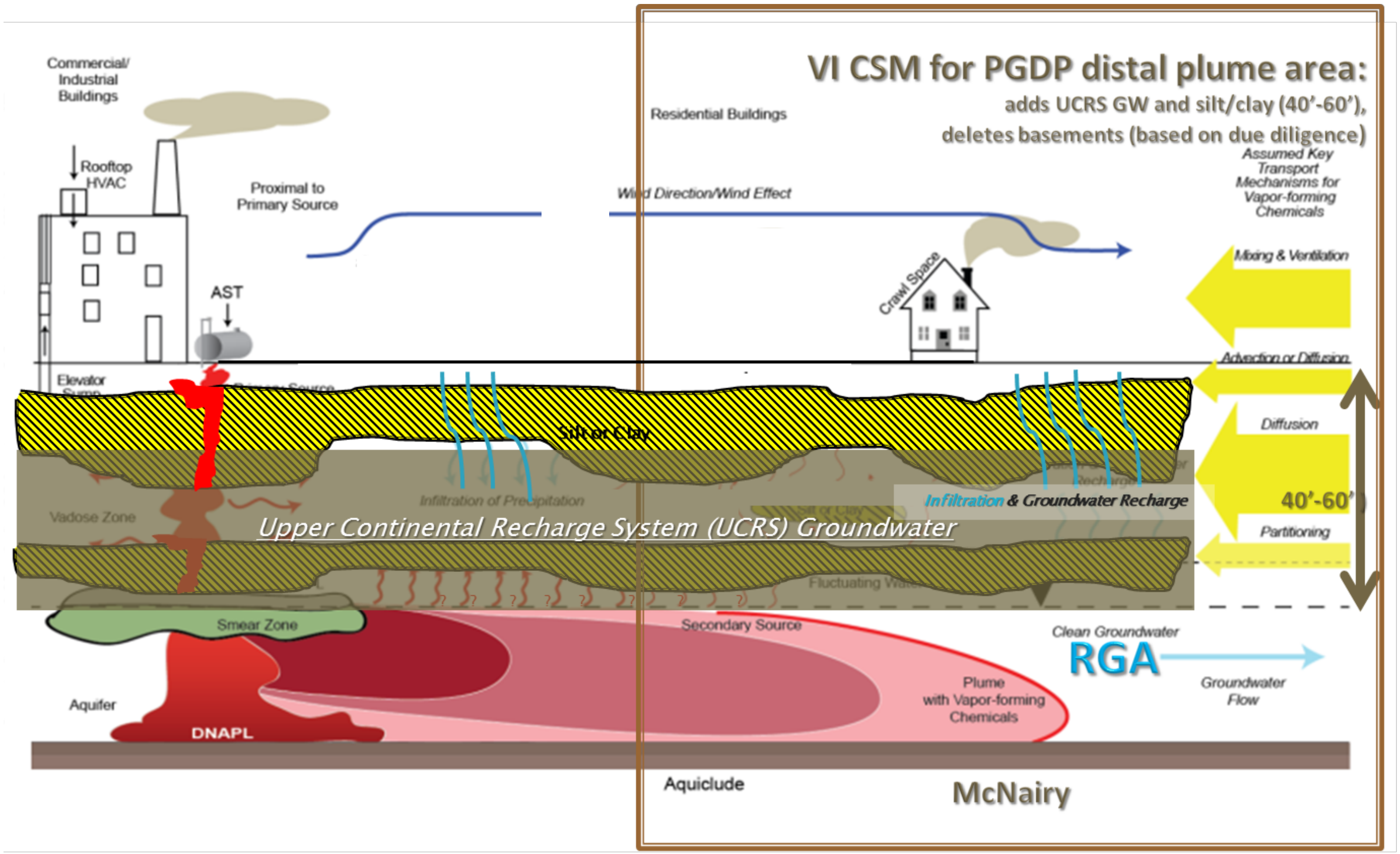

Figure 3. Conceptual Site Model: EPA Figure Adapted to PGDP Conditions

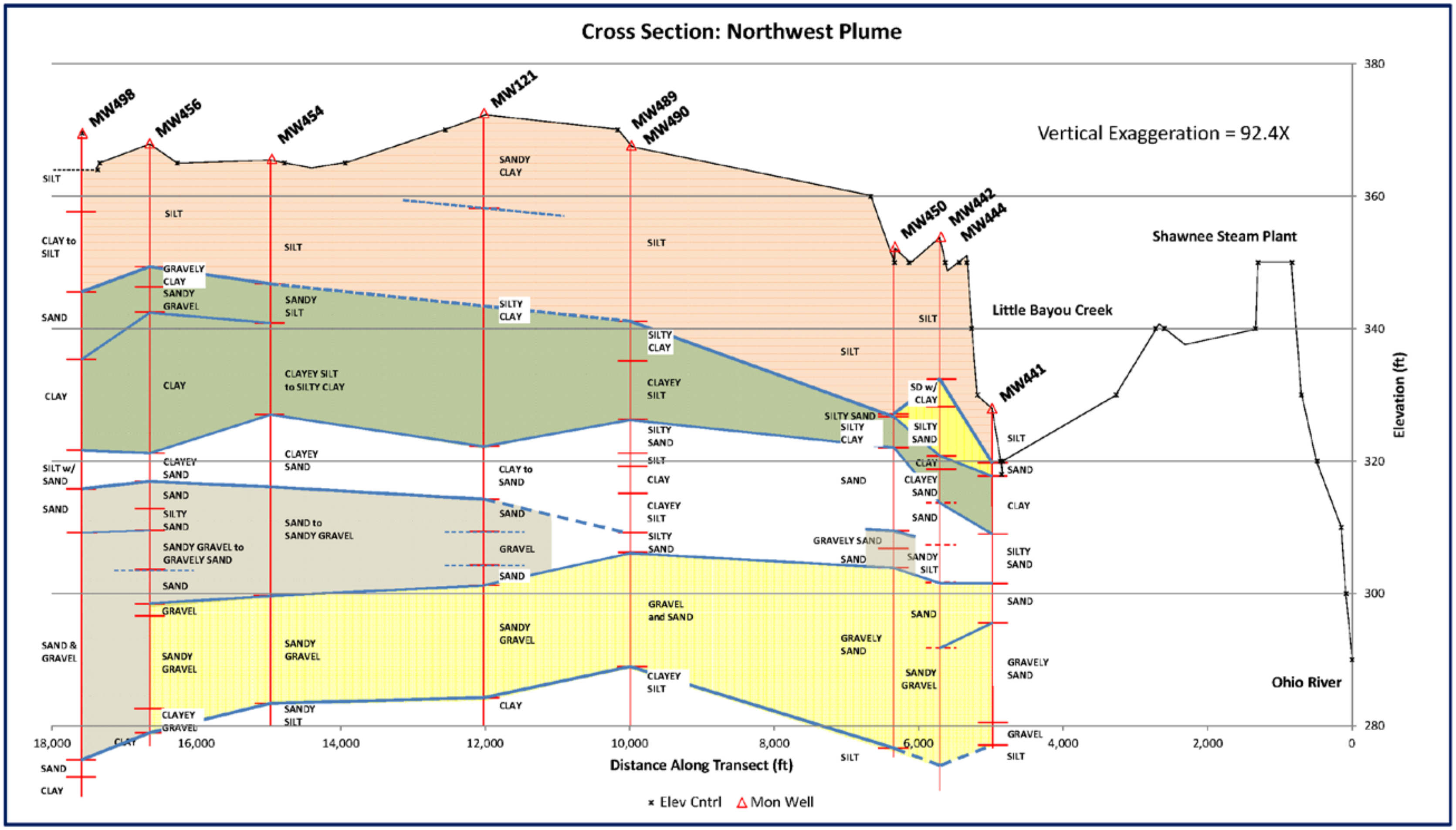

Figure 4. Northwest Plume Cross Section

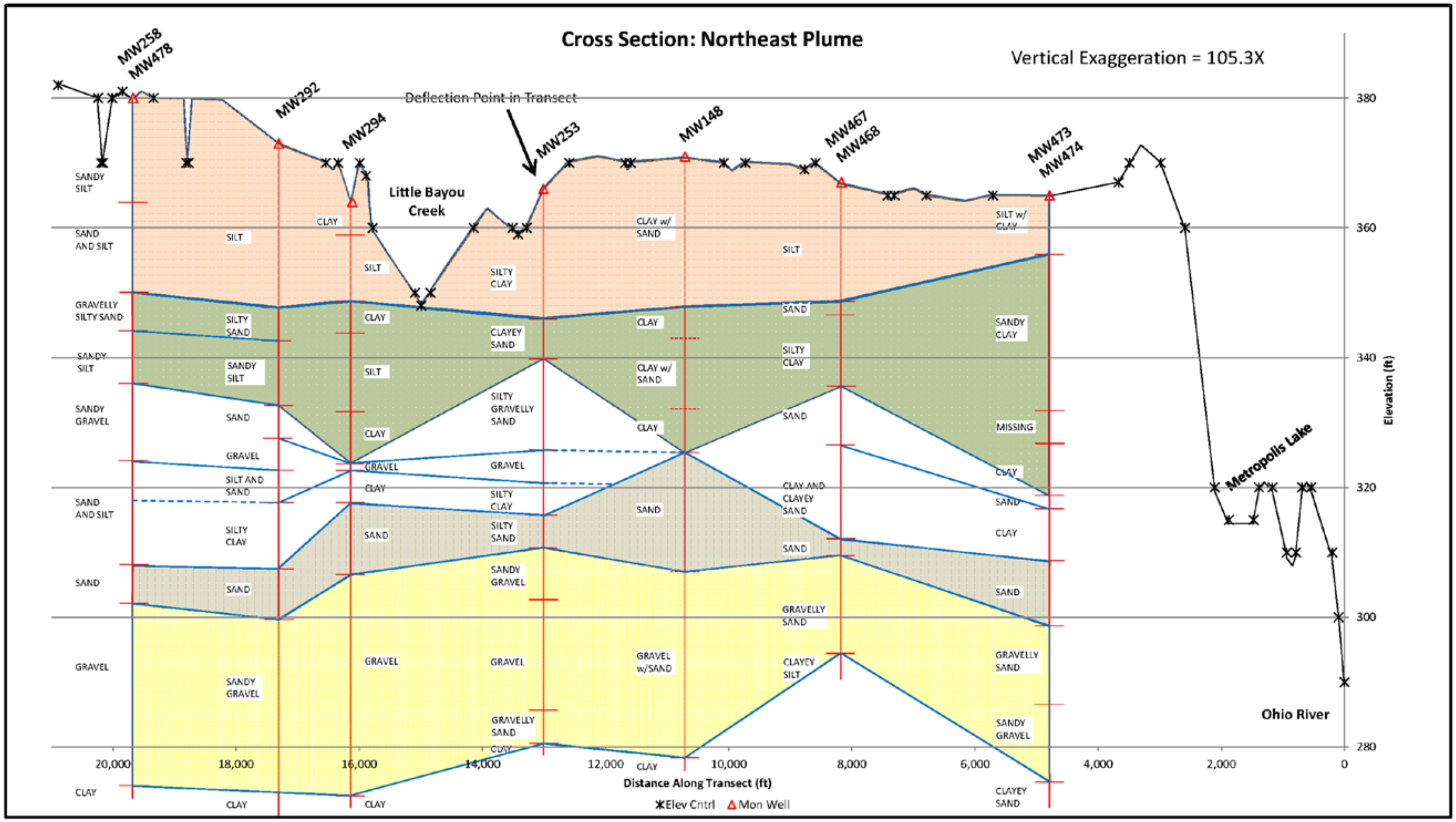

Figure 5. Northeast Plume Cross Section

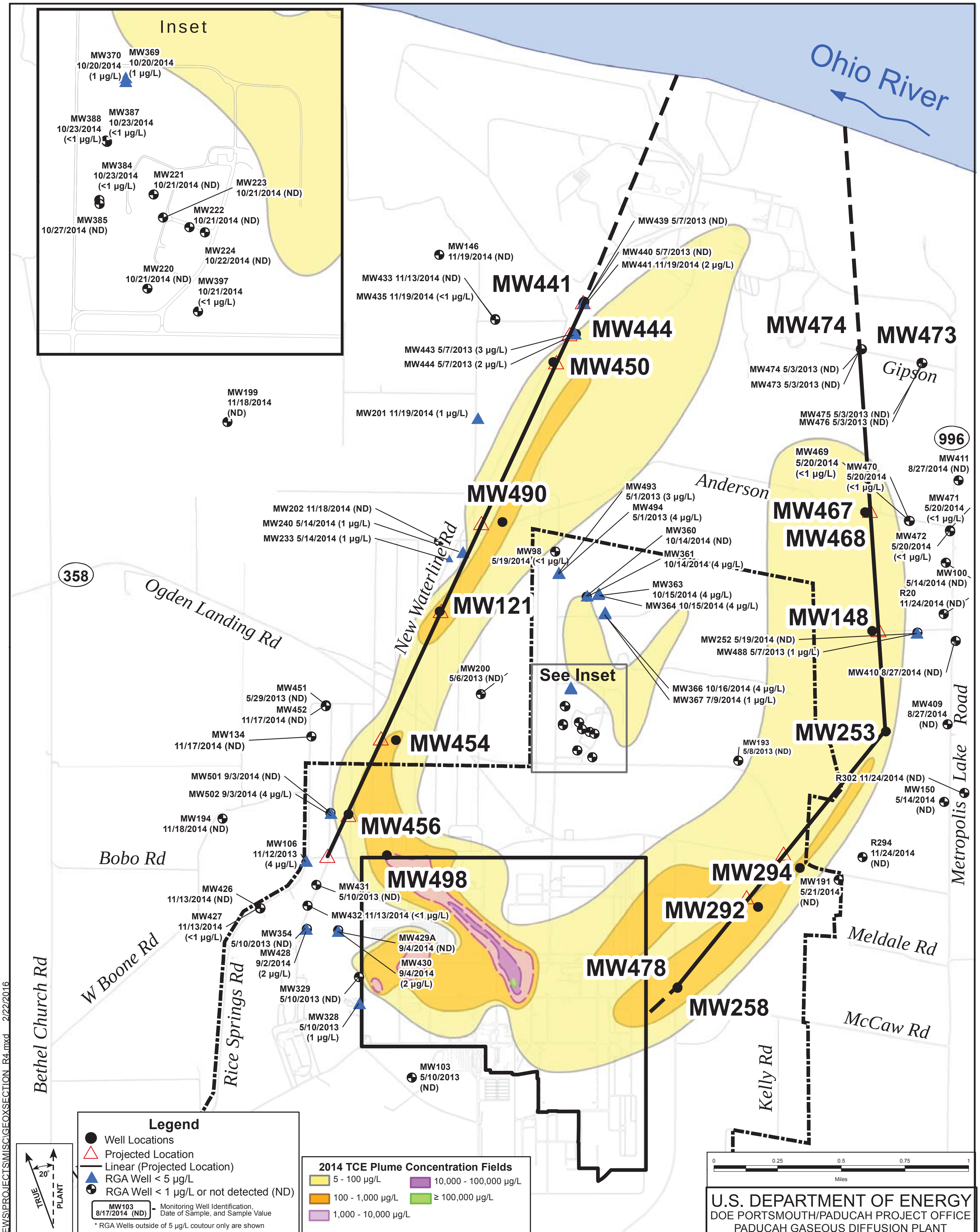

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Figure 6. Northeast and Northwest Plumes Geologic Cross Sections Locations

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2. VAPOR INTRUSION SCREENING STUDY APPROACH

At each of four locations, DPT rods were advanced to three depths [nominally 12 ft below ground surface (bgs), 22 ft bgs, and 32 ft bgs]. The borings were advanced in accordance with the SAP at locations summarized in Table 1 and shown on Figures 7, 8, 9, and 10. When target depth had been reached at each boring, the DPT rod was retracted 0.5 ft to allow for groundwater to enter. The rods remained in that position overnight. The groundwater from the shallowest DPT was sampled the following morning.

The methods used to install the DPTs matched the SAP, except for increasing the sampling depth at one location; however, the groundwater sampling approach was modified from what had been planned in the SAP, after consultation with the FFA parties, due to field conditions. On June 11, 2015, the FFA parties met and discussed the results of NE1 and NE2 borings being found dry. For the NE locations, the FFA parties agreed to the following, which was documented in a record of conversation (DOE 2015b):

- Should no water be available or should the amount of water be insufficient to collect a groundwater sample, water levels will be verified up to three subsequent days, as necessary, in an effort to obtain a groundwater sample.

- Abandon NE1 12 ft and NE2 12 ft and 22 ft borings.

- NE1 22 ft DPT boring will be increased in depth to 5 ft minimum distance of the measured water level in the paired RGA monitoring well, MW148.

If a groundwater sample cannot be obtained from the DPT borings at NE2, then the sample collected at NE1 will be used to extrapolate the conditions at NE2. On June 29, 2015, the FFA parties met and discussed the results of NW1 and NW2 borings having insufficient water to sample. For the NW locations, the FFA parties agreed to the following, which is documented in a record of conversation (DOE 2015c):

- Fieldwork should be considered finished and the borings abandoned.
- The one sample collected from NW2 can be used to extrapolate the condition for NW1.
- The soils have been demonstrated to be sufficiently tight such that water movement is inhibited.

Table 1. Five-Year Review Vapor Intrusion Screening Study DPT Sample Borings Locations

Sample Boring Group	Approximate Location of Boring from Residence	DPT Depths (bgs) Paired RGA well	Approx. Plant Coordinates	
			East	North
NW1	~ 264 ft east (Figure 2)[a]	12 ft, 22 ft, 32 ft MW451	-6837	4808
NW2	~ 117 ft west (Figure 3)	12 ft, 22 ft, 32 ft MW236	-5025	7417
NE1 (three residences—one boring location)	Left Residence ~ 102 ft northeast Middle Residence ~ 54 ft north Right Residence ~ 255 ft west (Figure 4)	12 ft, 22 ft and 42 ft[b], 32 ft MW148	3173	5832
NE2	~ 65 ft south (Figure 5)	12 ft, 22 ft, 32 ft MW253	4707	3708

[a] Location changed from SAP based on resident's request.
[b] NE1 22 ft boring extended to 42 ft in attempt to secure UCRS groundwater sample.

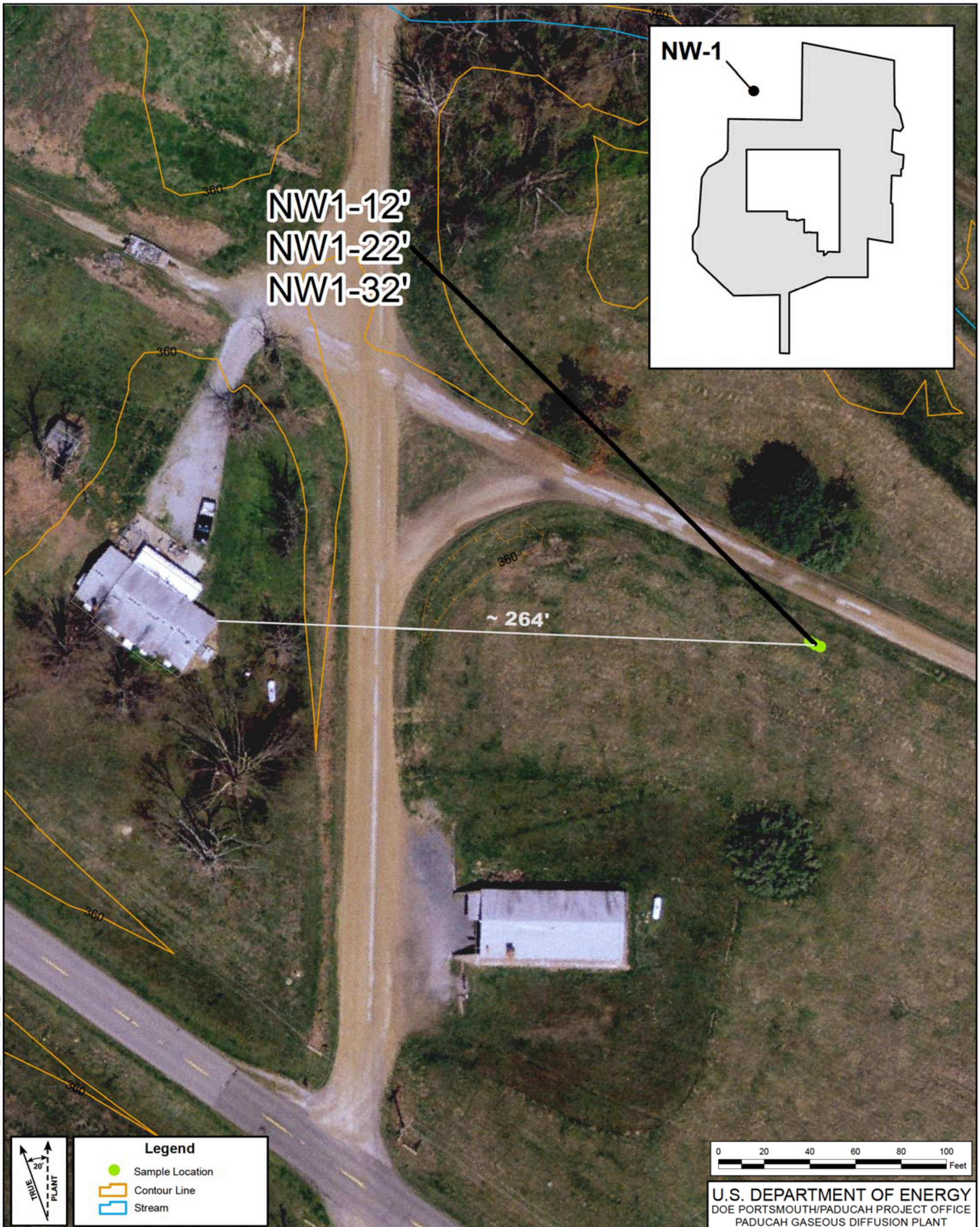

Figure 7. NW1 DPT Sample Boring Locations

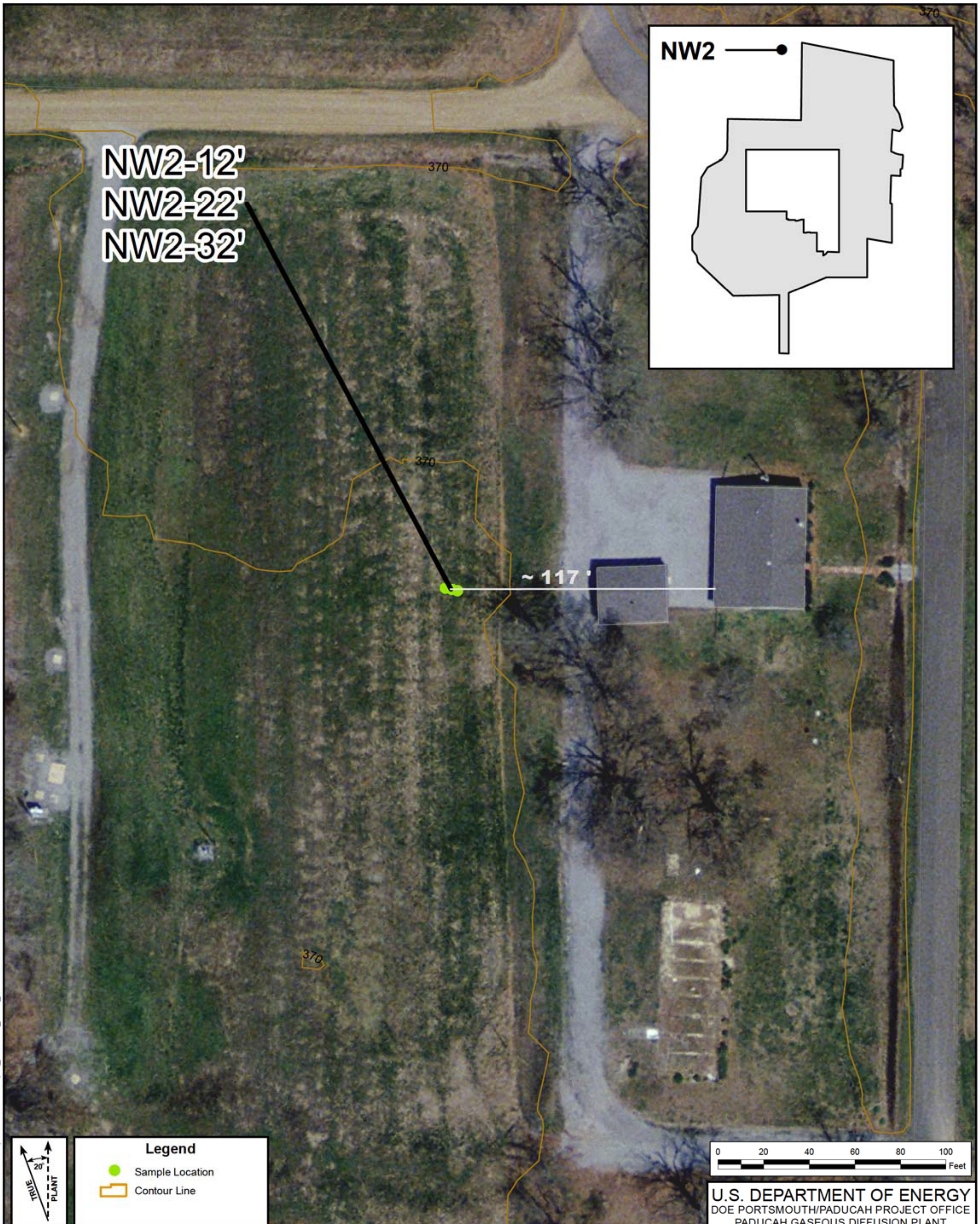

Figure 8. NW2 DPT Sample Boring Locations

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Figure 9. NE1 DPT Sample Boring Locations

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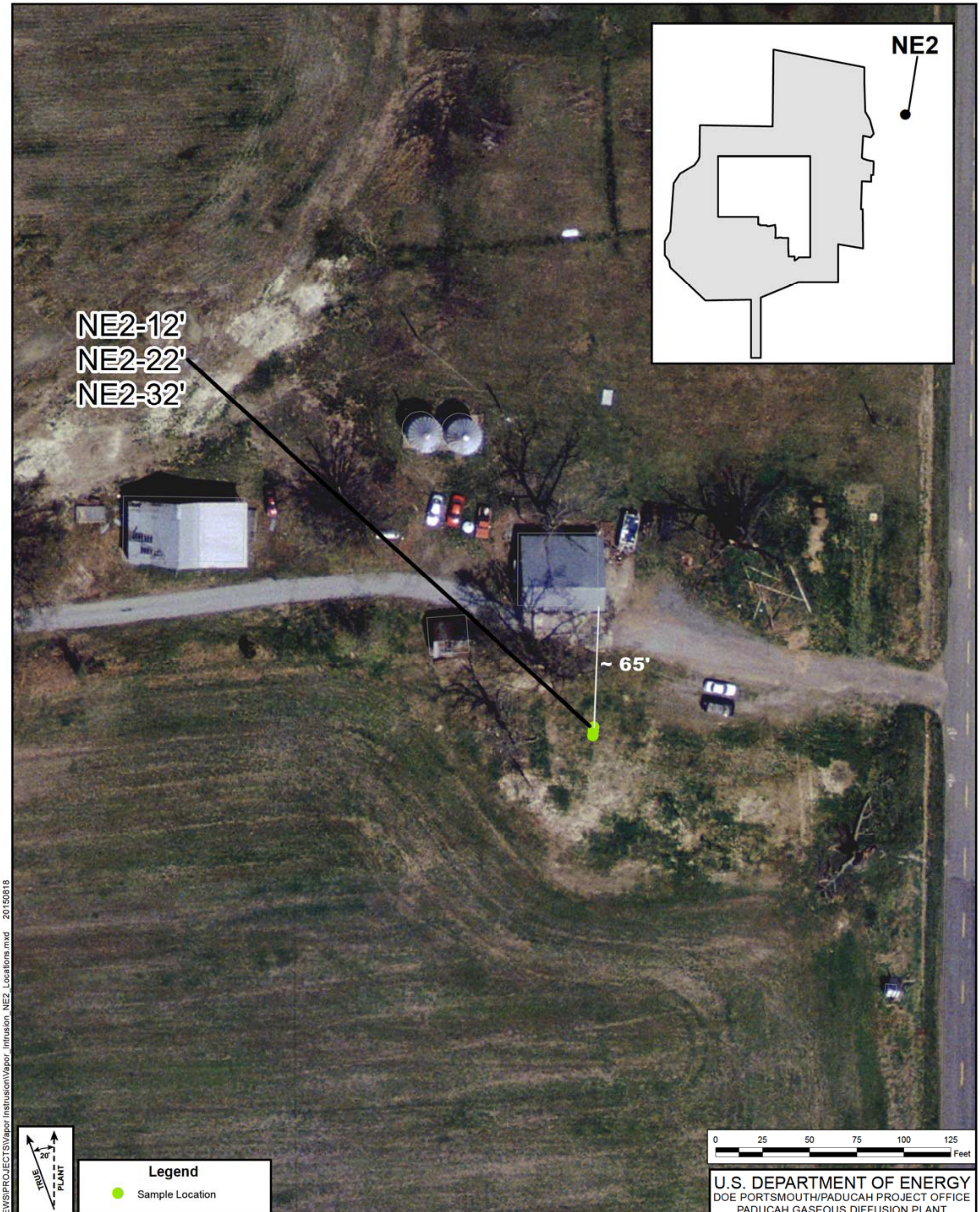

Figure 10. NE2 DPT Sample Boring Locations

2.1 DRILLING METHOD

This vapor intrusion screening study used a DPT rig and dual tube sampling system. The drill crew advanced the sample system with a center rod and drive point assembly to 5 ft short of the target depth (see Section 6) and withdrew the drive point for the bottom 5 ft, allowing the sampler to fill with soil over the bottom 5 ft. This approach was used to minimize the compaction of soils over the bottom 5 ft. Compaction by the DPT rods in the overlying soils provided an effective temporary seal for the DPT rods.

The drill crew extracted the soil core from the bottom of the hole and pulled the outer rods up 0.5 ft to expose the soils and allow groundwater to flow into the interior of the DPT rods. Upon completion of sampling, the DPT boreholes were abandoned by pulling the DPT rods from the ground and filling the boreholes to within 2 ft of ground surface with 3/8-inch particle size bentonite, hydrating the bentonite in 3-ft lifts. The top 2 ft of the borehole was filled with materials consistent with the surrounding ground surface.

2.2 SAMPLING

Three DPT borings were installed at each location, to assure that samples were collected above the potentiometric surface of the underlying RGA (i.e., ~ 32 ft bgs sample above ~ 37 ft bgs RGA potentiometric surface).[1]

Table 2 summarizes the information on each sample boring group including the identification of an RGA monitoring well closest to the boring location. The depth to water in each of these wells was measured to ensure that the greatest boring depth was still nominally 5 ft above the RGA potentiometric surface.

Table 2. RGA Paired Well Information

Sample Boring Group	Paired RGA MW	Approx. Plant Coordinates for Paired RGA Well		Reference Point	Reference Elevation (ft)	Ground Elev. (ft)	Depth to RGA (ft)	~ RGA Pot. Elev.
		X	Y					
NW1	MW451	-8,031.59	4,211.78	TOC	367.22	364.68	42.69	324.53
NW2	MW236	-5,090.64	7,919.36	WWR	369.05	369.28	38.92	330.13
NE1	MW148	3,289.83	5,755.06	TOC	374.00	371.08	47.20	326.80
NE2	MW253	3,572.22	3,669.88	TIC	370.86	368.90	38.52	332.34

TOC = top of casing reference elevation
WWR = Well Wizard riser top reference elevation
TIC = Top Inner Casing
Pot = Potentiometric Surface

When the target depth was reached at each boring, the DPT rod was retracted 0.5 ft to allow groundwater to enter. The rods remained in that position overnight. The next day water levels were measured in each of the DPTs to identify the shallowest DPT with water.

[1] The potentiometric surface of the RGA occurs within the UCRS, above the top of the RGA. The RGA potentiometric surface provides a measurable and reliable reference to assure that the deepest sample depth represents the UCRS and is approximately 10 ft above the top of the RGA.

Table 3 presents a summary timeline of boring installation, sample attempts, and field adjustments to the vapor intrusion screening study.

Table 3. Vapor Intrusion Screening Study Implementation Timeline

Date	Event	Notes
5/28/2015	Initial contact with residents to discuss vapor intrusion screening study borings.	Relocated NW1 borings based upon resident's request and in accordance with the SAP.
6/08/2015	Mobilized to northeast locations. Measured depth to water at MW253 and MW148. Installed NE1 and NE2 borings at 12 ft, 22 ft, and 32 ft bgs.	Groundwater in MW148 measured at 47.20 ft bgs. Groundwater in MW253 measured at 38.52 ft bgs.
6/09/2015	NE1 and NE2 borings found dry.	--
6/11/2015	FFA parties met via teleconference and agreed to path forward: • Abandon NE1 12 ft and NE2 12 ft and 22 ft borings. • NE1 22 ft DPT boring will be increased in depth to 5 ft minimum distance of the measured water level in the paired RGA monitoring well, MW148. • If a groundwater sample cannot be obtained from the DPT borings at NE2, then the sample collected at NE1 will be used to extrapolate the conditions at NE2. • Should no water be available or should the amount of water be insufficient to collect a groundwater sample, water levels will be verified up to three subsequent days, as necessary, in an effort to obtain a groundwater sample.	--
6/15/2015	Collected sample from NE1 32 ft boring. NE2 borings had insufficient water for a sample to be collected. NE1 12 ft boring abandoned per the SAP. NE1 22 ft boring advanced to 42 ft bgs. NE2 12 ft and 22 ft borings abandoned per SAP.	Sample collected at NE1 32 ft boring had heavy sediment; uncertain if enough water for lab to run analysis. Laboratory was able to analyze the sample.
6/16/2015	Collected sample from NE1 32 ft boring. Insufficient water in both NE1 42 ft and NE2 32 ft borings to allow sample to be collected.	Sample collected at NE1 32 ft had heavy sediment. Laboratory was able to analyze the sample.
6/17/2015	Water present in both NE1 32 ft and NE2 32 ft borings but too much sediment to allow sample to be collected. Insufficient water in the NE1 42 ft boring to collect a sample.	--
6/22/2015	DOE issued Record of Conversation for 6/11/2015 teleconference.	--

Table 3. Vapor Intrusion Screening Study Implementation Timeline (Continued)

Date	Event	Notes
6/23/2015	NE1 22 ft and 42 ft and NE2 32 ft borings abandoned per the SAP. Mobilized to northwest locations. Measured depth to water at MW 236 and MW451. Installed NW1 and NW2 borings at 12 ft, 22 ft, and 32 ft bgs.	Groundwater in MW236 measured at 42.69 ft bgs. Groundwater in MW451 measured at 38.92 ft bgs.
6/24/2015	Insufficient water to sample NW1 or NW2.	--
6/25/2015	Insufficient water to sample NW1 or NW2.	--
6/29/2015	Water sample collected from NW2 22 ft boring. Remaining borings were either dry or had insufficient water to collect a sample. FFA parties met via teleconference and agreed to the following: • Fieldwork should be considered finished and the borings abandoned. • The one sample collected from NW2 can be used to extrapolate the condition for NW1. • The soils have been demonstrated to be sufficiently tight that water movement is inhibited.	--
6/30/2015	NW1 and NW2 borings abandoned in accordance with approved work plan.	--
7/16/2015	DOE issued Record of Conversation for 6/29/2015 teleconference.	--

3. DATA EVALUATION

3.1 RESULTS

Three samples were submitted for laboratory analysis for VOCs, one sample from NW2 and two samples from NE1. The results of the analysis for TCE, *cis*-1,2-dichloroethene, *trans*-1,2-dichloroethene, and vinyl chloride were nondetect for each sample with a reporting limit of 1 µg/L. Table 4 presents a summary of the results including the recorded field temperature of the water sample.

Table 4. DPT Boring Water Sample Results

Boring Sampled	Date Sampled	*cis*-1,2-Dichloroethene[1]	*trans*-1,2-Dichloroethene[1]	Trichloroethene[1]	Vinyl Chloride[1]	Field Temperature (F)
NE1-32 ft	15-Jun-15	ND	ND	ND	ND	75.5
NE1-32 ft	16-Jun-15	ND	ND	ND	ND	81.2
NW2-22 ft	29-Jun-15	ND	ND	ND	ND	72.7

[1] Results were all nondetect at a reporting limit of 1µg/L.
ND = nondetect

Table 5 contains the default VISL values from EPA VISL Calculator, v3.4.2, September 3, 2015.

Table 5. Default VISL Values for Selected VOCs

Selected VOC	Default VISL Value[a]
cis-1,2-Dichloroethene	No Inhalation Toxicity Information
trans-1,2-Dichloroethene	No Inhalation Toxicity Information
Trichloroethene	1.2 µg/L
Vinyl Chloride	0.15 µg/L[b]

[a] http://www.epa.gov/oswer/vaporintrusion/documents/VISL-Calculator.xlsm.
[b] During scoping, the FFA parties agreed 1 µg/L detection limit was sufficient.

3.2 CONCLUSION

The intent of this vapor intrusion screening study was to compare TCE (and other selected chlorinated VOCs) concentrations in the first available water against VISLs developed using default parameter assumptions. VOCs of concern for this vapor intrusion screening study are TCE, *cis*-1,2-dichloroethene, *trans*-1,2-dichloroethene, and vinyl chloride. The Decision Rules presented in the SAP (DOE 2015a) are as follows:

- **IF** groundwater data for selected VOCs are less than the associated VISL or nondetect, **THEN** no additional groundwater sampling is needed and the vapor intrusion pathway does not pose a concern for the residence.

- **IF** groundwater data for selected VOCs are greater than or equal to the associated VISL, **THEN** reevaluate and scope the next step to address the potential for a vapor intrusion concern.

The groundwater data for all the selected VOCs was nondetect at a reporting limit of 1µg/L; therefore, according to the Decision Rules presented in the SAP (DOE 2015a), no additional groundwater sampling is needed, and the vapor intrusion pathway does not pose a concern for the residences. This study is consistent with historical investigations and the conceptual site model, which demonstrated limited potential for vapor intrusion. Based on the results of this vapor intrusion screening study (see Figures 11 and 12), historical information provided/referenced in the SAP, and the vapor intrusion guidance (EPA 2015b), an additional vapor intrusion study (i.e., a detailed investigation) is not warranted in the Water Policy Area at the time of this study. Because this study was designed to investigate the residences with the greatest potential for vapor intrusion, it is not likely that other residences in the water policy area currently have vapor intrusion concerns.

DOE will continue to evaluate groundwater conditions in the Water Policy Area in a manner consistent with five-year reviews for remedial actions required under Section 121(c) of Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and final remedial actions required under Section XXX of the FFA. Results of these periodic evaluations will be used to determine if a detailed vapor intrusion study is warranted.

4. REFERENCES

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DOE 2014b. J. Woodard letter to J. Tufts and T. Mullins, "Transmittal of the Record of Conversation Concerning the U.S. Environmental Protection Agency Recommendation for Modification and Additional Action to the Five-Year Review," Paducah, KY, August 1.

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DOE 2015c. J. Woodard letter to J. Corkran and A. Webb, "Transmittal of the Record of Conversation Concerning the Additional Action for the Five-Year Review Fieldwork," Paducah, KY, July 16.

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EPA 2013. *OSWER Final Guidance for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Sources to Indoor Air (External Review Draft*), U.S. Environmental Protection Agency, Washington, DC, April.

EPA 2014a. R. Chaffins letter to J. Woodard, Paducah, KY, September 30.

EPA 2014b. OSWER Vapor Intrusion Screening Level (VISL) Calculator, U.S. Environmental Protection Agency, accessed at http://www.epa.gov/oswer/vaporintrusion/documents/VISL-Calculator.xlsm.

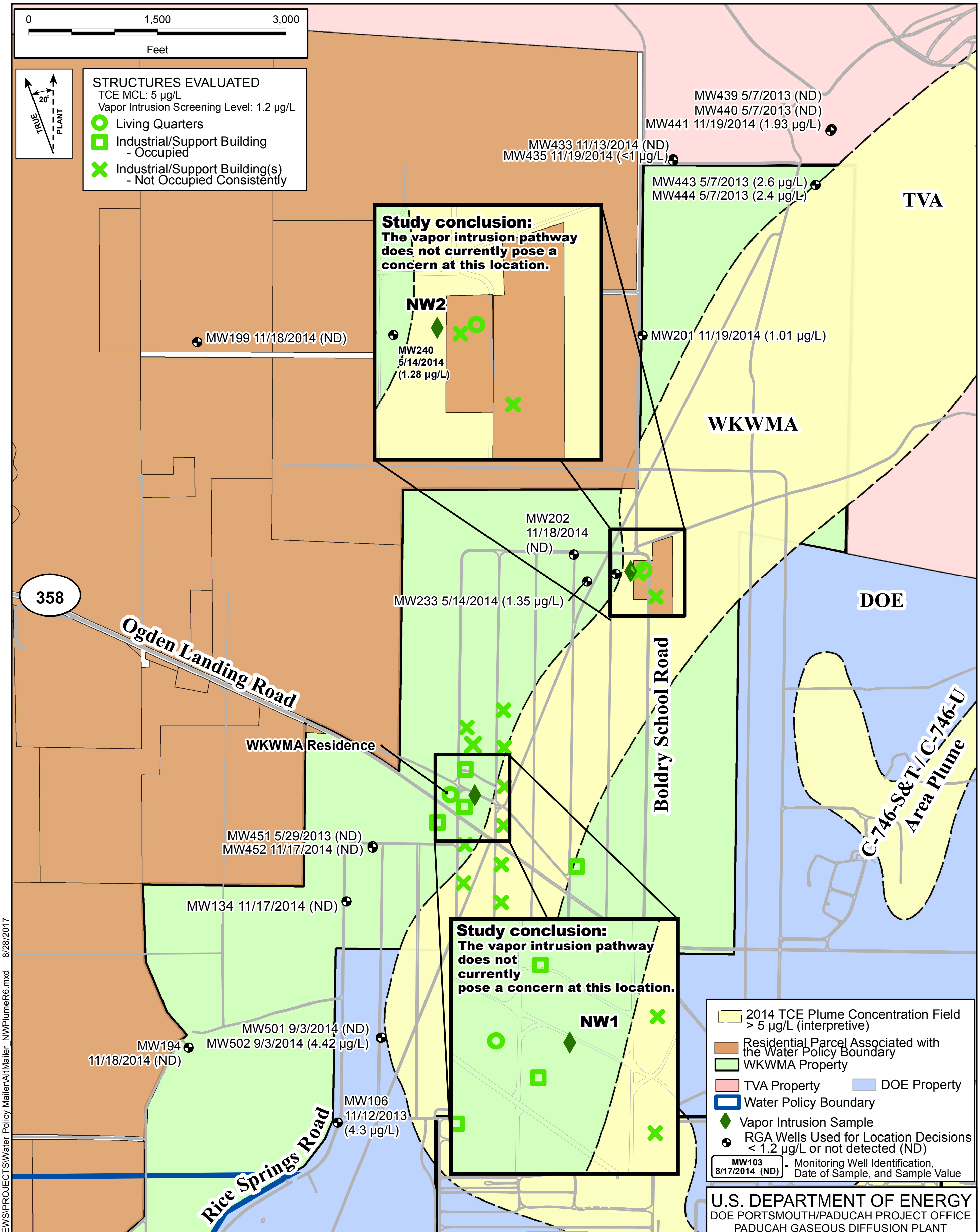

Figure 11. Northwest Plume Water Policy Area - Vapor Intrusion Screening Results

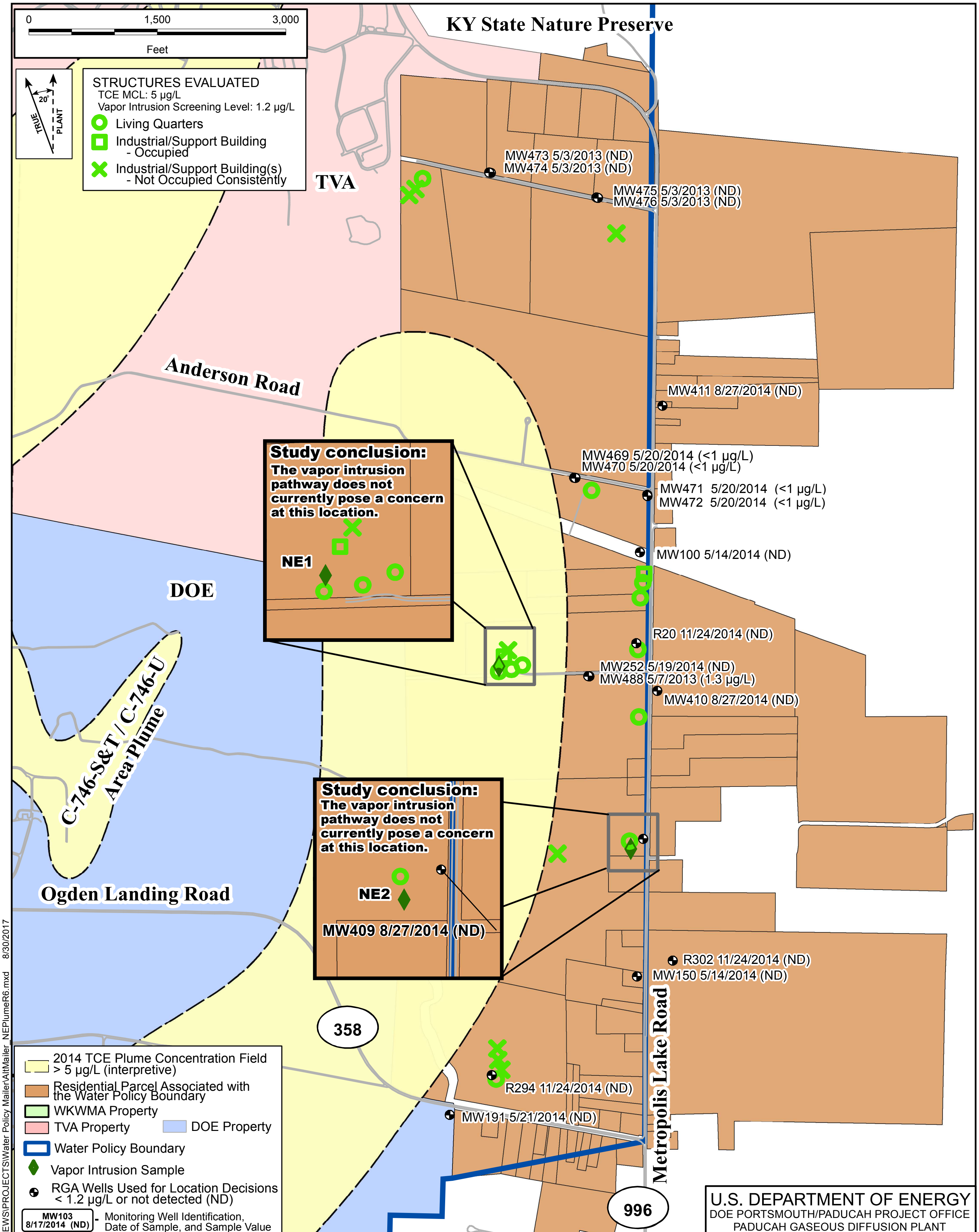

Figure 12. Northeast Plume Water Policy Area - Vapor Intrusion Screening Results

EPA 2015a. J. Corkran letter to J. Woodard, “EPA Concurrence: Replacement Pages for the *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&D2, U.S. Environmental Protection Agency, Atlanta GA, May.

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APPENDIX

RESIDENT CONTACT SUMMARY

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RESIDENT CONTACT SUMMARY

Called NE1 resident on May 28, 2015, and scheduled a visit for May 29, 2015. Met with resident and provided information about the needed sampling on May 29, 2015. Resident reviewed a map of the proposed sampling and agreed to the proposed location. The resident called and left a voice mail on June 1, 2015, regarding a buried fiber optic line in the area. Spoke to the resident on June 11, 2015, and discussed that a groundwater sample had not been obtained and would like to leave the rods in longer. Resident agreed.

Called NE2 resident on May 28, 2015, but no one answered and no answering machine picked up. On May 29, 2015, met with resident on their property and discussed the sampling project. The resident reviewed a map of proposed sampling location and agreed to the location. On June 4, 2015, utilities were scheduled to be marked, but the resident refused to let that be done. Resident stated that he would not allow this to happen and wanted a change to his license agreement. On June 5, 2015, met with resident and he agreed to the sampling event. The change he wants is to add a word to the license agreement. He was told that the requested change would be presented to DOE for their approval. He also wants two separate agreements: one for this water and the other for the monitoring wells. Spoke to the resident on June 11, 2015, and discussed that a groundwater sample had not been obtained and would like to leave the rods in longer. Resident agreed.

Called NW1 and NW2 resident/property owner and left a voice mail on May 28, 2015. Called again on June 1, 2015, and spoke to resident and scheduled a meeting to discuss the project on June 2, 2015. The resident reviewed a map of the proposed sampling location and agreed to the NW2 location on June 2, 2015. The resident requested a different location for the NW1 location. The resident did not want sampling that close to the home and wanted it to be at least 150 yards away. Resident stated that a previous sampling event had rattled objects on the walls of the club house and did not want that to happen to the home. With further discussion and a new map, the resident agreed to a location that was approximately 260 ft away from the house.

Called NW1 and NW2 resident/property owner on June 11, 2015, and left message on office phone. Called again on June 12, 2015, both cell and office phones, no answer. Called on June 15, 2015, and left voice mail on cell phone. Called office on June 16, 2015, and left message for resident to call. Sent e-mail on June 16, 2015, and received response e-mail on June 17, 2015, stating that sampling event could not happen on June 17, 2015. Spoke on phone with resident about the sampling event on June 17, 2015. Resident was having a meeting on the June 17, 2015, date and needed to reschedule because the resident wanted to be present for the sampling event. Sent e-mail, per the resident's request, with new proposed date of June 23, 2015, for sampling event and received e-mail from resident stating that the sampling event could begin on that date.

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ATTACHMENT C3

DEMOSTRATE NO GROUNDWATER USAGE

(The following has been reprinted in its original format. Pagination and formatting from original document retained.)

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Demonstration that Residents Located over the Contaminated Groundwater Plume Are Not Using Groundwater at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky

Demonstration that Residents Located over the Contaminated Groundwater Plume Are Not Using Groundwater at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky

Date Issued—October 2017

U.S. DEPARTMENT OF ENERGY
Office of Environmental Management

Prepared by
FLUOR FEDERAL SERVICES, INC.,
Paducah Deactivation Project
managing the
Deactivation Project at the
Paducah Gaseous Diffusion Plant
under Task Order DE-DT0007774

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CONTENTS

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FIGURES

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TABLES

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ACRONYMS

AKGWA	Assembled Kentucky Ground Water Database
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
ND	nondetectable
PGDP	Paducah Gaseous Diffusion Plant

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1. INTRODUCTION

This document describes actions taken by the U.S. Department of Energy (DOE) in response to comments on the *Five-Year Review for Remedial Actions at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-1289&D2/R1 (DOE 2014). In a letter dated September 30, 2014, (EPA 2014) the U.S. Environmental Protection Agency (EPA) stated the following:

> 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"…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…

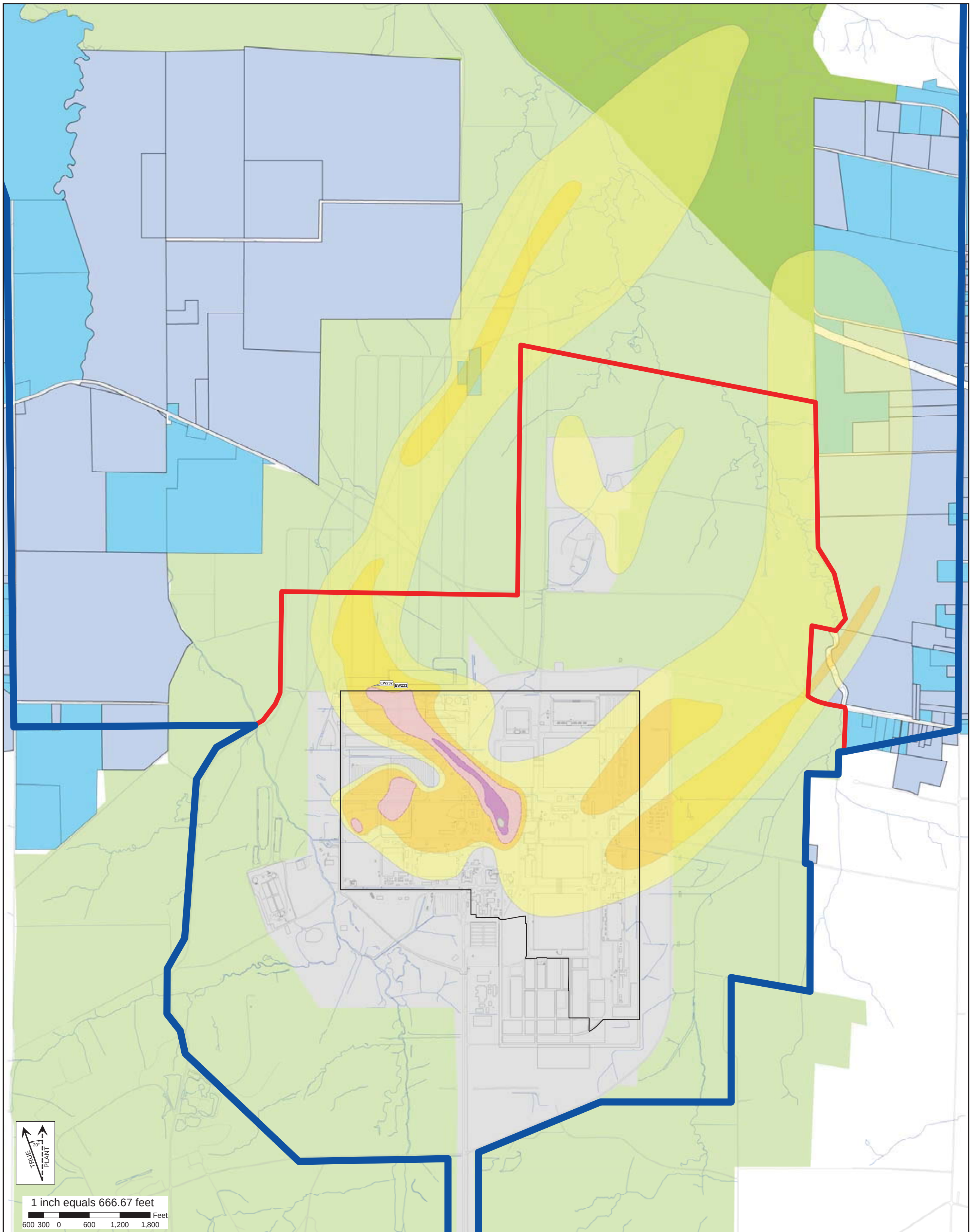
This document has been developed to address EPA's requirement that DOE demonstrate that all residents located above the contaminated groundwater plume are not using groundwater from their wells. To further protect the health of residents living north of the PGDP in the area commonly referred to as the "Water Policy Area" (Figure 1), DOE conducted a vapor intrusion screening study (DOE 2016) and determined that vapor intrusion is not occurring into residential properties.

DOE also developed and mailed an educational flyer to all residents within the Water Policy Area. This flyer was designed to educate landowners about the presence of groundwater contamination in the area.

To demonstrate that all residents located above the contaminated groundwater plume are not using groundwater from their wells, DOE has evaluated which parcels currently are located over the 5 µg/L or greater trichloroethene (TCE) plume. The 5 µg/L is the Safe Drinking Water Act maximum contaminant level (MCL) for TCE. DOE has identified 16 parcels overlying or immediately downgradient of the 5 µg/L or greater TCE-contaminant plume (Figure 2). Each of the 16 parcels was researched to identify the landowner(s), the presence of a residence, the presence of a license agreement, the presence of groundwater wells, and current integrity of DOE caps and locks. DOE then assessed the current uses of each parcel by reviewing applicable state groundwater well databases, examining aerial photographs for evidence of disturbances potentially related to wells, and physically assessing the conditions of the property, either by driving past the property where no license agreement was in place or through a sight check from the existing well location where license agreements were in place. Through these surveillance actions, DOE has examined all reasonably available lines of evidence and has concluded that no owners or occupants of any of the parcels located above the contaminated groundwater plume (i.e., overlying or immediately downgradient of the 5 µg/L or greater TCE plume) are using groundwater. As such, this study meets the requirements set forth in EPA's September 30, 2014, letter requesting that DOE demonstrate that all residents located above the contaminated groundwater plume are not using groundwater from their wells.

2. BACKGROUND

Upon detecting TCE and technetium-99 in private wells located north of Paducah Gaseous Diffusion Plant (PGDP) in August 1988, the U.S. Department of Energy (DOE) placed affected residences/businesses on alternate water supplies and began a monitoring and investigation program to define the extent and temporal variations of the groundwater contaminant plumes. DOE developed the current PGDP Water Policy in accordance with the *Engineering Evaluation/Cost Analysis for the Water Policy at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* (DOE 1993) and the *Action*



2014 TCE Plume Concentration Fields

- 5 - 100 µg/L
- 100 - 1,000 µg/L
- 1,000 - 10,000 µg/L
- 10,000 - 100,000 µg/L
- ≥ 100,000 µg/L

LEGEND

- Water Policy Area
- Parcels w/o Current Agreements
- Parcels w/Current Agreements
- Wildlife Management Area
- TVA Boundary
- DOE Boundary
- DOE Property Boundary
- Roadways
- Streams
- PGDP Boundary

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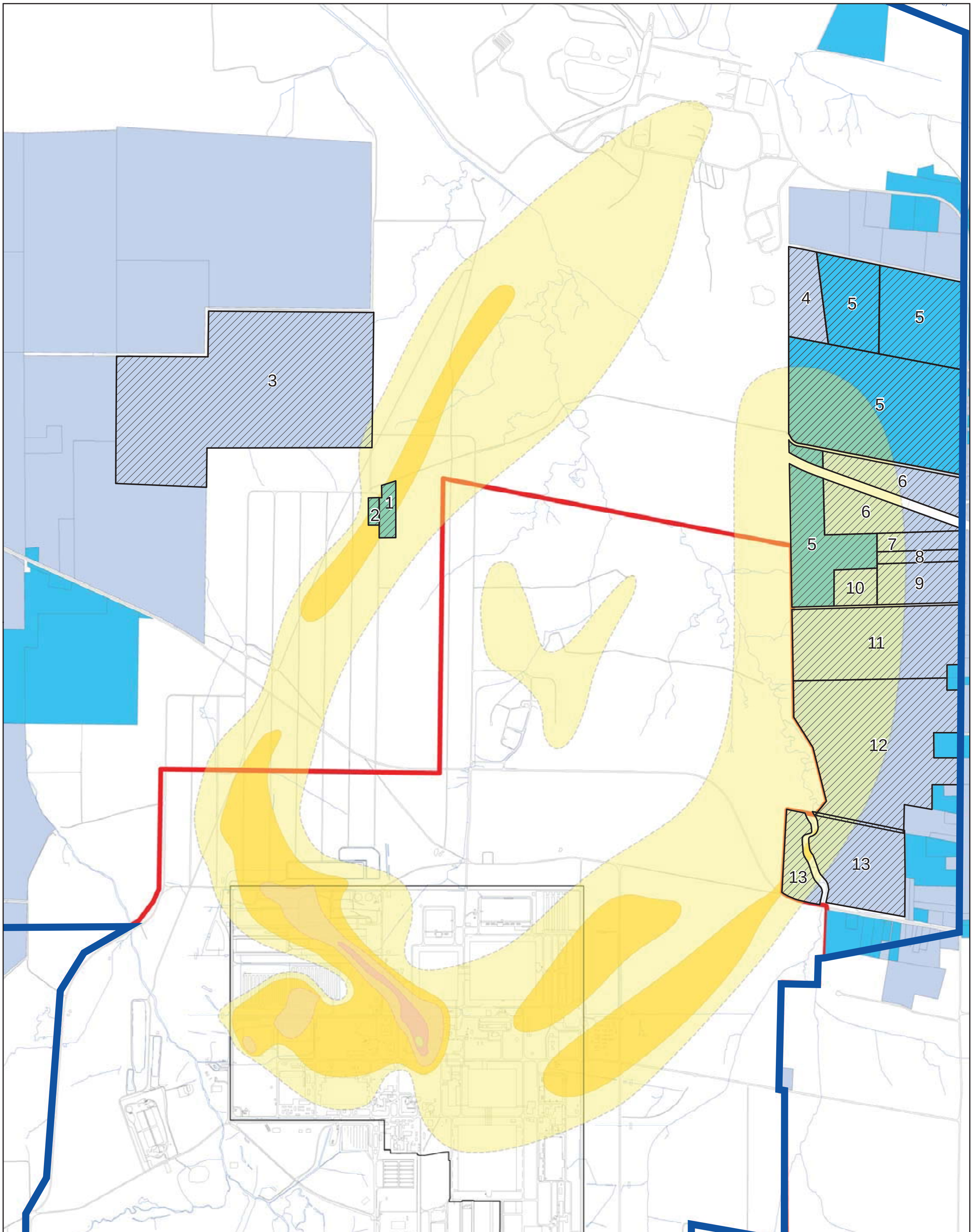
PORTSMOUTH / PADUCAH PROJECT OFFICE
PADUCAH GASEOUS DIFFUSION PLANT

Figure 1. 2014 Plume Map with Parcels

FILE NAME:	PROJECT #:	SCALE:	DATE:
Fig 1 WP_2014Plumes_Parcels R2	EM	AS NOTED	3/3/2016



LEGEND

2014 TCE Plume Concentration Fields

- 5 - 100 μg/L
- 100 - 1,000 μg/L
- 1,000 - 10,000 μg/L
- 10,000 - 100,000 μg/L
- ≥ 100,000 μg/L

- Water Policy Area
- Parcels w/o Current Agreement
- Parcels Overlying Plume 16 parcels with 13 landowners
- Parcels w/Current Agreements
- DOE Property Boundary
- Roadways
- Streams
- PGDP Boundary

TRUE 20° PLANT

1 inch = 565.62 feet

0 287.5 575 1,150 1,725 2,300 Feet

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PADUCAH GASEOUS DIFFUSION PLANT

Figure 2. Privately-Owned Parcels Over or Immediately Downgradient of the TCE Contamination at or above 5 μg/L

FILE NAME:	PROJECT #:	SCALE:	DATE:
Figure 2 WP_2014Plumes_TCER_Parcels	EM	AS NOTED	3/23/2016

Memorandum for the Water Policy at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, (DOE 1994) for the Water Policy removal action.

The PGDP 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 Paducah Gaseous Diffusion Plant (affected area)."

In June 1994, DOE signed the Action Memorandum for the Water Policy (DOE 1994). The Action Memorandum 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.

Management activities of the Water Policy include the following:

- Water bills are reviewed monthly looking for abnormal bills; residents whose bills are outside the range of historical usage are notified by mail and/or a site visit.
- A due diligence is conducted yearly at the McCracken County Property Valuation Office for new owners of land parcels within the Water Policy Box.
- As License Agreements are set to expire, property owners are contacted prior to the expiration date to request a renewal.
- Caps and locks installed on residential wells are inspected to verify the wells are nonoperational.

3. DEMONSTRATION OF NO WATER USAGE OVER THE GROUNDWATER PLUMES

3.1 EVALUATION PROCESS

The following approach was developed and implemented to evaluate groundwater usage above the 5 µg/L or greater TCE plume.

1. Determined locations of land parcels overlying or immediately downgradient of the 5 µg/L or greater TCE plume by overlaying property boundaries on the 2014 TCE Plume map.
2. Reaffirmed land ownership of land parcels overlying or immediately downgradient of the 5 µg/L or greater TCE plume by reviewing relevant records in the McCracken County Property Valuation office.
3. Reviewed records for land parcels situated overlying or immediately downgradient of the 5 µg/L or greater TCE plume to determine whether those parcels had residential wells, DOE caps and locks, and/or license agreements.

4. Reviewed the Kentucky water well database to ensure no additional groundwater wells have been installed overlying or immediately downgradient of the 5 µg/L or greater TCE plume.

5. Conducted visual assessment of properties overlying or immediately downgradient of the 5 µg/L or greater TCE plume. For properties with a current Water Policy license agreement, contacted the landowner, accessed the site, confirmed no residential well is being used, and checked well cap and lock, if applicable. For properties without a current Water Policy license agreement, conducted a drive-by assessment and documented any evidence of water well usage.

6. Examined aerial images of properties overlying or immediately downgradient of the 5 µg/L or greater TCE plume for signs of groundwater well usage.

There are 13 landowners associated with 16 parcels. Figure 2 groups the parcels by landowner and provides a unique identifier for each property owner and each individual parcel (1–13).

3.1.1 Property 1 Evaluation

Table 1 presents the evaluation results and additional comments concerning Property 1, and Figures 3 and 4 present the overall aerial view of the property along with an example of the aerial examination.

Table 1. Property 1 Evaluation

Evaluation Process	Evaluation Results	Comments
Property overlying or immediately downgradient of the 5 µg/L or greater TCE Plume?	Yes.	Northwest Plume.
Land ownership of property	No change from previous year.	--
Municipal water usage	Historically consistent.	--
Known existing wells (residential or monitoring)	No.	--
Historical capping and locking information	None.	--
License Agreement Status	No current agreement in place.	Last agreement expired September 30, 2015, attempts to contact for renewal have not been successful.
Property has a residence	No.	The structure (repurposed Kentucky Ordinance Works bunker) is used as a hunting club.
Review of the Kentucky Database for Water Wells	No new wells have been installed/reported to Kentucky.	The Water Well & Spring Records Database, Kentucky Groundwater Data Repository was reviewed in August 2015 and was current on the Web as of June 2014.
Visual assessment of property*	Visual was conducted by drive-by and aerial photograph and noted no visible sign of groundwater usage.	--

*See Appendix A for Assessment Forms

Figure 3. Property 1 Aerial View—Overall

Figure 4. Property 1 Street View—Club House

3.1.2 Property 2 Evaluation

Table 2 presents the evaluation results and additional comments concerning Property 2, and Figures 5, 6, and 7 present the overall aerial view of the property along with examples of the aerial examination.

Table 2. Property 2 Evaluation

Evaluation Process	Evaluation Results	Comments
Property overlying or immediately downgradient of the 5 µg/L or greater TCE Plume?	Yes.	Northwest Plume.
Land ownership of property	No change from previous year.	--
Municipal water usage	Historically consistent.	--
Known existing wells (residential or monitoring)	Record of residential well on-site that was abandoned by resident.	The Kentucky database for water wells (see Section 3.1.5) reports the status of the well as "Inactive" and lists the well as "unused" on a 1992 inspection record.
Historical capping and locking information	DOE capping and locking notes from 1994 state that the resident abandoned the well [Assembled Kentucky Ground Water Database (AKGWA) # 0003-0205] and capped it below grade.	--
License Agreement Status	No current agreement in place.	Original landowner and current landowner have both refused to sign a license agreement.
Property has a residence	Yes.	Modular home.
Review of the Kentucky Database for Water Wells	No new wells have been installed/reported to Kentucky.	The Water Well & Spring Records Database, Kentucky Groundwater Data Repository was reviewed and was current on the Web as of June 2014.
Visual assessment of property*	Visual conducted as drive-by and aerial photograph and noted no visible sign of groundwater usage.	--

*See Appendix A for Assessment Forms

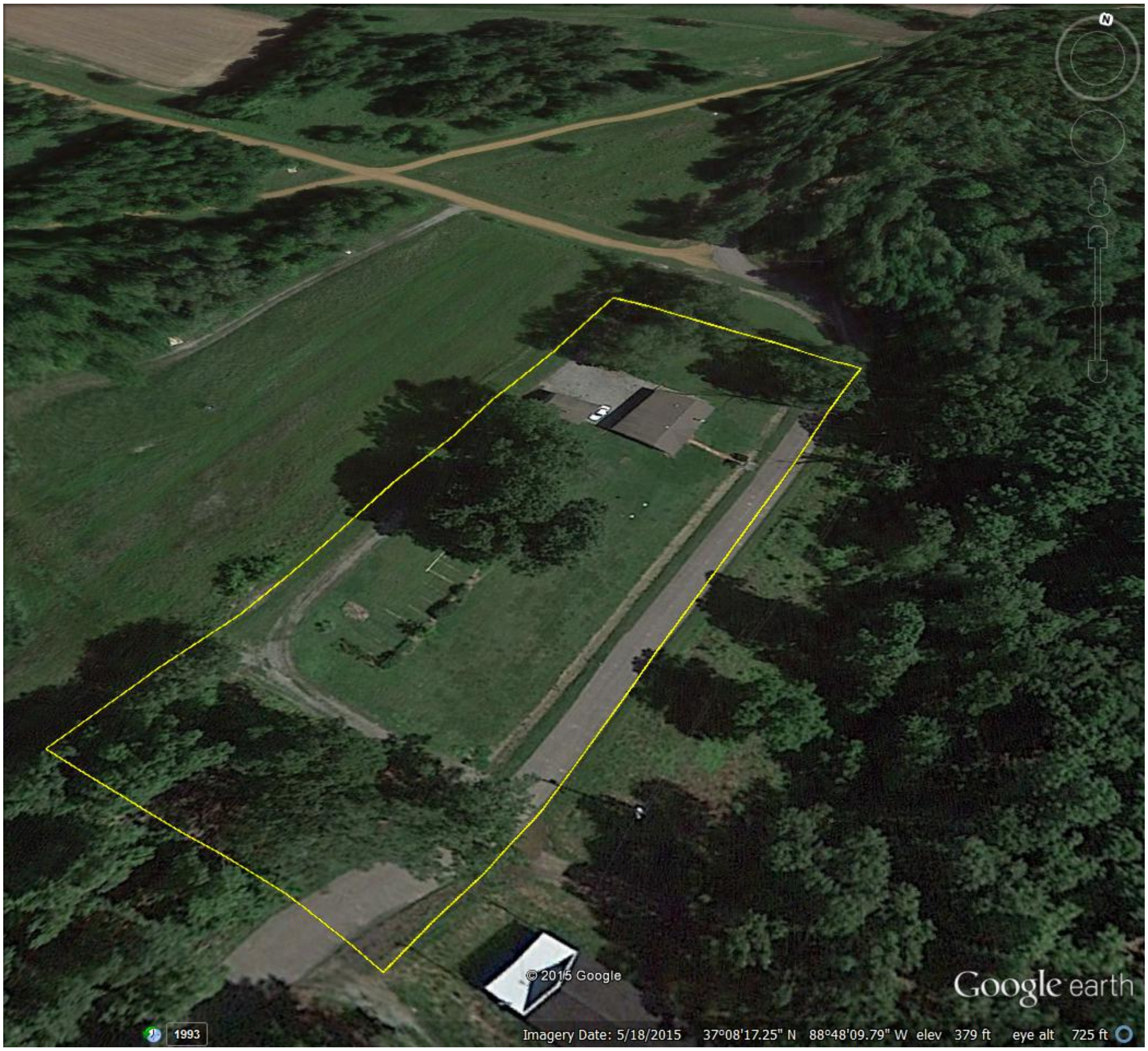

Figure 5. Property 2 Aerial View—Overall

Figure 6. Property 2 Street View—Residence

Figure 7. Property 2 Street View—Former Residence Footprint

3.1.3 Property 3 Evaluation

Table 3 presents the evaluation results and additional comments concerning Property 3, and Figures 8 and 9 present the overall aerial view of the property along with an example of the aerial examination.

Table 3. Property 3 Evaluation

Evaluation Process	Evaluation Results	Comments
Property overlying or immediately downgradient of the 5 µg/L or greater TCE Plume?	Yes.	Northwest Plume.
Land ownership of property	No change from previous year.	--
Municipal water usage	Historically consistent.	--
Known existing wells (residential or monitoring)	No.	Farmland with no known groundwater well on parcel. The adjoining property to the north, which is owned by the same landowner, has two capped and locked residential wells, R16 and R245, and a monitoring well, MW199.
Historical capping and locking information	None.	--
License Agreement Status	Current agreement in place.	--
Property has a residence	No.	Adjoining property to the north has a residence.
Review of the Kentucky Database for Water Wells	No new wells have been installed/reported to Kentucky.	The Water Well & Spring Records Database, Kentucky Groundwater Data Repository was reviewed and was current on the Web as of June 2014.
Visual assessment of property*	Visual from location of existing wells on adjoining parcels and drive-by and aerial photograph, noted no visible sign of groundwater usage.	Resident confirmed not using existing wells on adjoining parcels and has not drilled a new well. It was noted that the cap was broken and the lock missing on the R245. The resident was informed that the cap and lock would be replaced, but did not express any concern or ask any additional questions. Cap and lock were replaced as of March 3, 2016.

*See Appendix A for Assessment Forms

Figure 8. Property 3 Aerial View—Overall

Figure 9. Property 3 Aerial View—Monitoring Well on Adjoining Property

3.1.4 Property 4 Evaluation

Table 4 presents the evaluation results and additional comments concerning Property 4, and Figures 10, 11, 12, and 13 present the overall aerial view of the property along with an example of the aerial examination.

Table 4. Property 4 Evaluation

Evaluation Process	Evaluation Results	Comments
Property overlying or immediately downgradient of the 5 µg/L or greater TCE Plume?	Yes.	Northeast Plume.
Land ownership of property	No change from previous year.	--
Municipal water usage	Historically consistent.	--
Known existing wells (residential or monitoring)	No.	Farmland with no known groundwater well.
Historical capping and locking information	None.	--
License Agreement Status	Current agreement in place.	--
Property has a residence	Yes.	Residence was built in 1998.
Review of the Kentucky Database for Water Wells	No new wells have been installed/reported to Kentucky.	The Water Well & Spring Records Database, Kentucky Groundwater Data Repository was reviewed and was current on the Web as of June 2014.
Visual assessment of property*	Visual from driveway, drive-by, and aerial photograph noted no visible sign of groundwater usage.	Resident confirmed no new water well has been installed. Resident also indicated that there was a residential well on the property in the 1950s, but it was filled in many years ago.

*See Appendix A for Assessment Forms

Figure 10. Property 4 Aerial View—Overall

Figure 11. Property 4 Street View—Residence

Figure 12. Property 4 Street View—Barns

Figure 13. Property 4 Aerial View—Barns

3.1.5 Property 5 Evaluation

Table 5 presents the evaluation results and additional comments concerning Property 5, and Figures 14 and 15 present the overall aerial view of the property along with an example of the aerial examination.

Table 5. Property 5 Evaluation

Evaluation Process	Evaluation Results	Comments
Property overlying or immediately downgradient of the 5 µg/L or greater TCE Plume?	Yes.	Northeast Plume.
Land ownership of property	No change from previous year.	It should be noted that this property has been purchased by Tennessee Valley Authority since the D1 version was written.
Municipal water usage	N/A.	This property is farmland with no municipal hookup.
Known existing wells (residential or monitoring)	No.	--
Historical capping and locking information	None.	--
License Agreement Status	No current agreement in place.	Original landowner had refused to sign a license agreement.
Property has a residence	No.	Farmland with no known groundwater well.
Review of the Kentucky Database for Water Wells	No new wells have been installed/reported to Kentucky.	The Water Well & Spring Records Database, Kentucky Groundwater Data Repository was reviewed and was current on the Web as of June 2014.
Visual assessment of property*	Visual conducted as drive-by and aerial photograph and noted no visible sign of groundwater usage.	No indications were seen during drive-by or on aerial photograph of a new well.

*See Appendix A for Assessment Forms

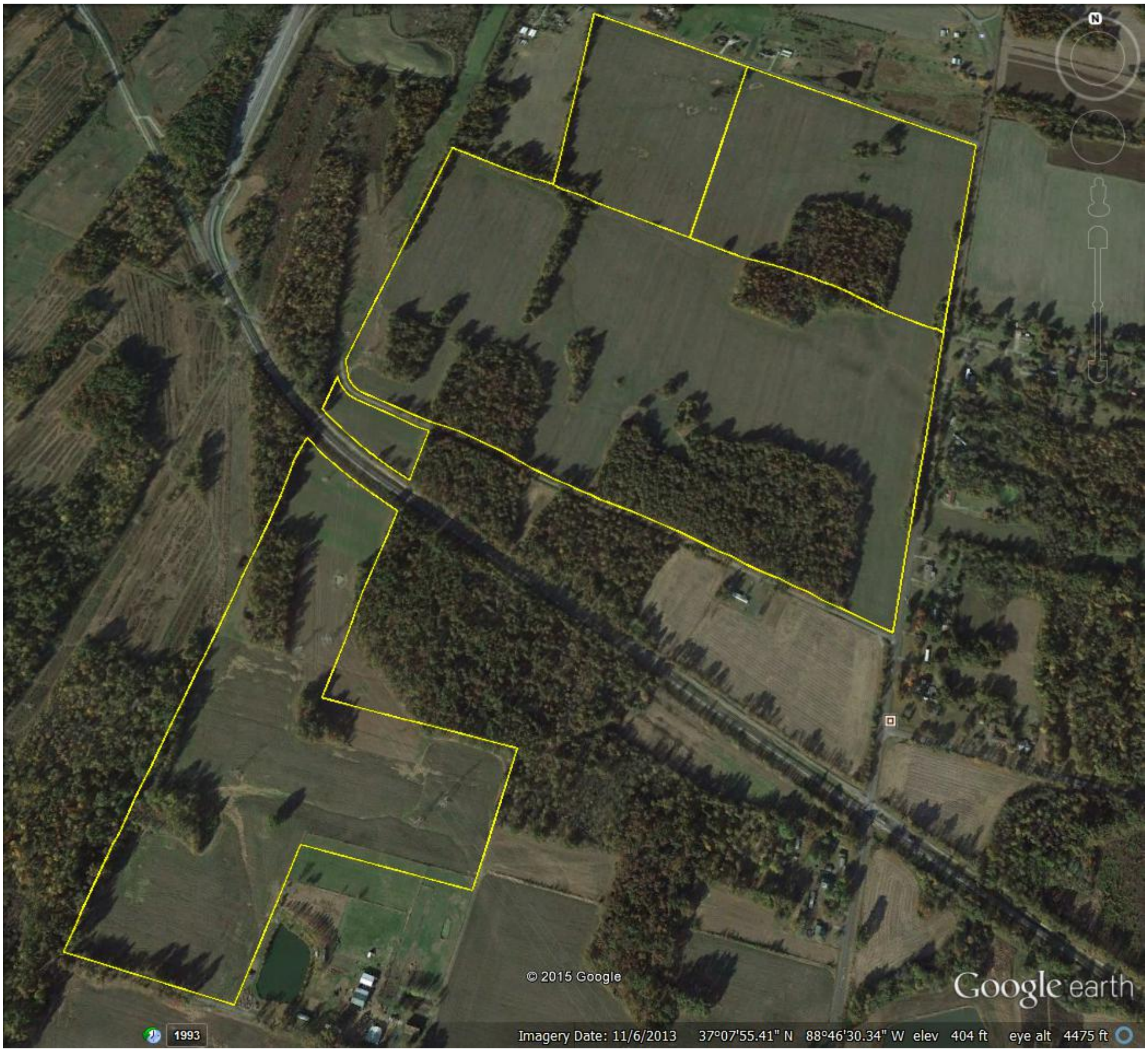

Figure 14. Property 5 Aerial View—Overall

Figure 15. Property 5 Aerial View—Old Barn

3.1.6 Property 6 Evaluation

Table 6 presents the evaluation results and additional comments concerning Property 6, and Figures 16 and 17 present the overall aerial view of the property along with an example of the aerial examination.

Table 6. Property 6 Evaluation

Evaluation Process	Evaluation Results	Comments
Property overlying or immediately downgradient of the 5 µg/L or greater TCE Plume?	Yes.	Northeast Plume.
Land ownership of property	No change from previous year.	Please note that Tennessee Valley Authority is in the process of purchasing this property.
Municipal water usage	Historically consistent.	
Known existing wells (residential or monitoring)	Yes, monitoring well.	Monitoring wells 465-472 are located on this property and are sampled annually with the exception of 468, 473, and 474, which are samples biennially. All monitoring wells are inspected annually.
Historical capping and locking information	None.	--
License Agreement Status	Current agreement in place.	--
Property has a residence	Yes.	Residence was built in approximately 2006. Owner of property lives out of state and the residence is rented.
Review of the Kentucky Database for Water Wells	No new wells have been installed/reported to Kentucky.	The Water Well & Spring Records Database, Kentucky Groundwater Data Repository was reviewed and was current on the Web as of June 2014.
Visual assessment of property*	Visual from driveway, drive-by, and aerial photograph noted no visible sign of groundwater usage.	Resident confirmed not using existing wells. Resident confirmed no new water well has been installed. Property is forested with areas used for row crops. Property also has the Tennessee Valley Authority railroad running diagonally through it.

*See Appendix A for Assessment Forms

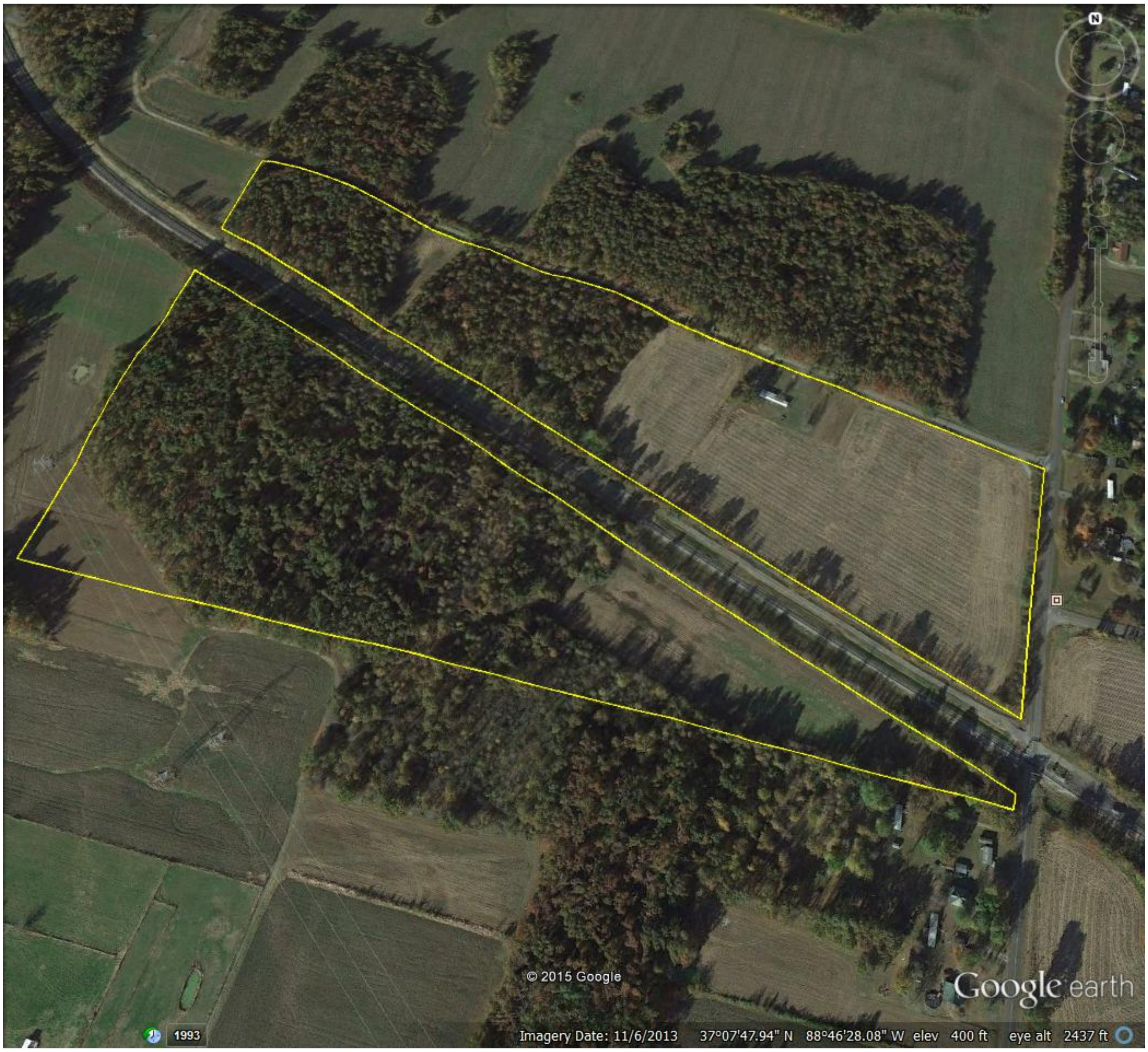

Figure 16. Property 6 Aerial View—Overall

Figure 17. Property 6 Aerial View—Flush Mounted Monitoring Wells

3.1.7 Property 7 Evaluation

Table 7 presents the evaluation results and additional comments concerning Property 7, and Figures 18 and 19 present the overall aerial view of the property along with an example of the aerial examination.

Table 7. Property 7 Evaluation

Evaluation Process	Evaluation Results	Comments
Property overlying or immediately downgradient of the 5 µg/L or greater TCE Plume?	Yes.	Northeast Plume.
Land ownership of property	No change.	--
Municipal water usage	Historically consistent.	--
Known existing wells (residential or monitoring)	Yes, residential well.	R530, AKGWA 0004-2844, is not inspected; please see comment below.
Historical capping and locking information	None.	Well is under residence, with no access to the well without removing flooring. It was removed from the capping and locking project.
License Agreement Status	Current agreement in place.	--
Property has a residence	Yes.	--
Review of the Kentucky Database for Water Wells	No new wells have been installed/reported to Kentucky.	The Water Well & Spring Records Database, Kentucky Groundwater Data Repository was reviewed and was current on the Web as of June 2014.
Visual assessment of property*	Visual from driveway, drive-by, and aerial photograph noted no visible sign of groundwater usage.	Resident confirmed they are not using existing wells. Resident confirmed no new water well has been installed. Resident confirmed the existing well is located under an addition to the house and is not accessible.

*See Appendix A for Assessment Forms

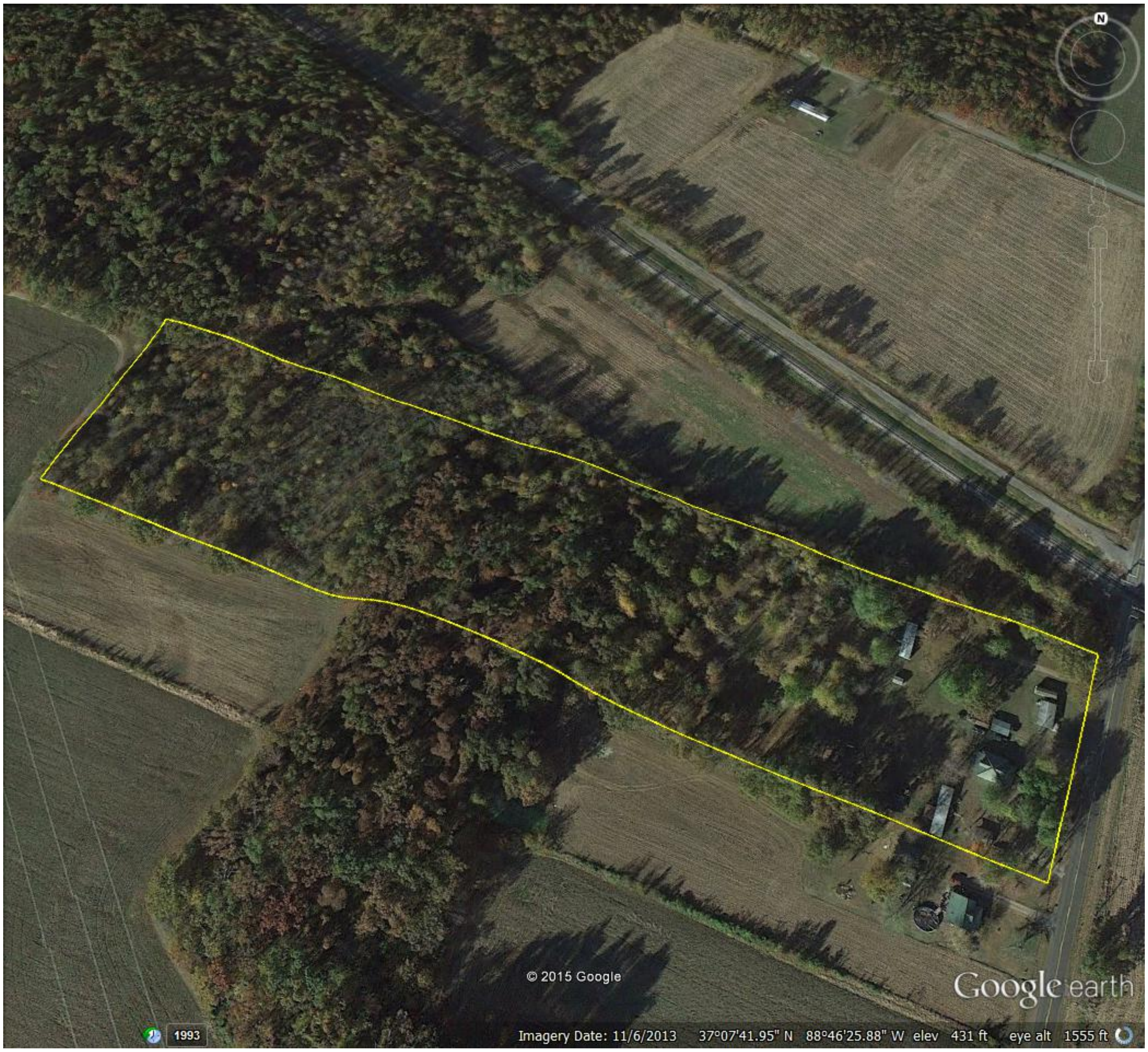

Figure 18. Property 7 Aerial View—Overall

Figure 19. Property 7 Street View—Business and Residence

3.1.8 Property 8 Evaluation

Table 8 presents the evaluation results and additional comments concerning Property 8, and Figures 20 and 21 present the overall aerial view of the property along with an example of the aerial examination.

Table 8. Property 8 Evaluation

Evaluation Process	Evaluation Results	Comments
Property overlying or immediately downgradient of the 5 µg/L or greater TCE Plume?	Yes.	Northeast Plume.
Land ownership of property	No change from previous year.	--
Municipal water usage	Historically consistent.	--
Known existing wells (residential or monitoring)	No.	--
Historical capping and locking information	None.	--
License Agreement Status	Current agreement in place.	--
Property has a residence	Yes.	--
Review of the Kentucky Database for Water Wells	No new wells have been installed/reported to Kentucky.	The Water Well & Spring Records Database, Kentucky Groundwater Data Repository was reviewed and was current on the Web as of June 2014.
Visual assessment of property*	Visual from driveway, drive-by, and aerial photograph noted no visible sign of groundwater usage.	--

*See Appendix A for Assessment Forms

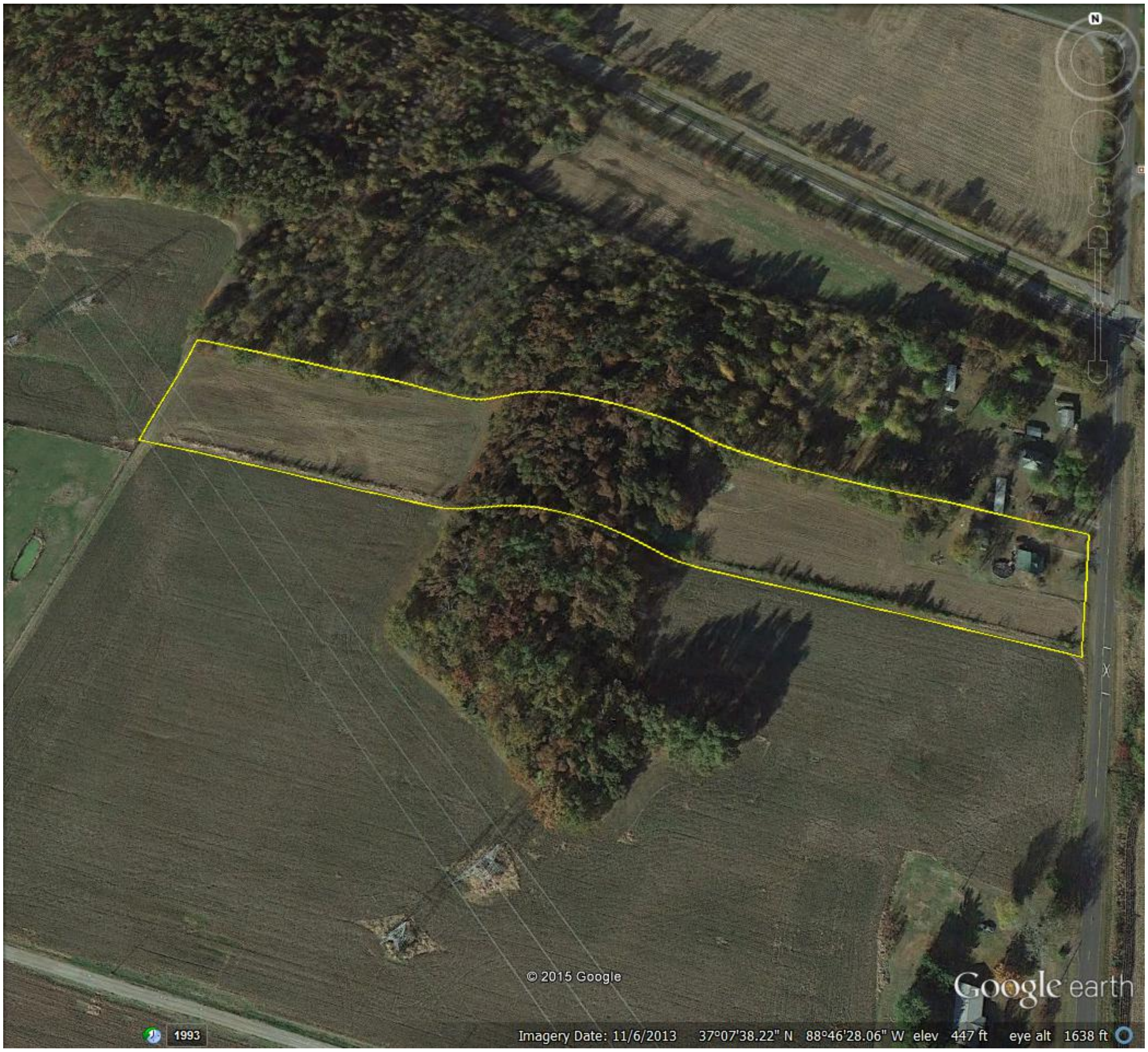

Figure 20. Property 8 Aerial View—Overall

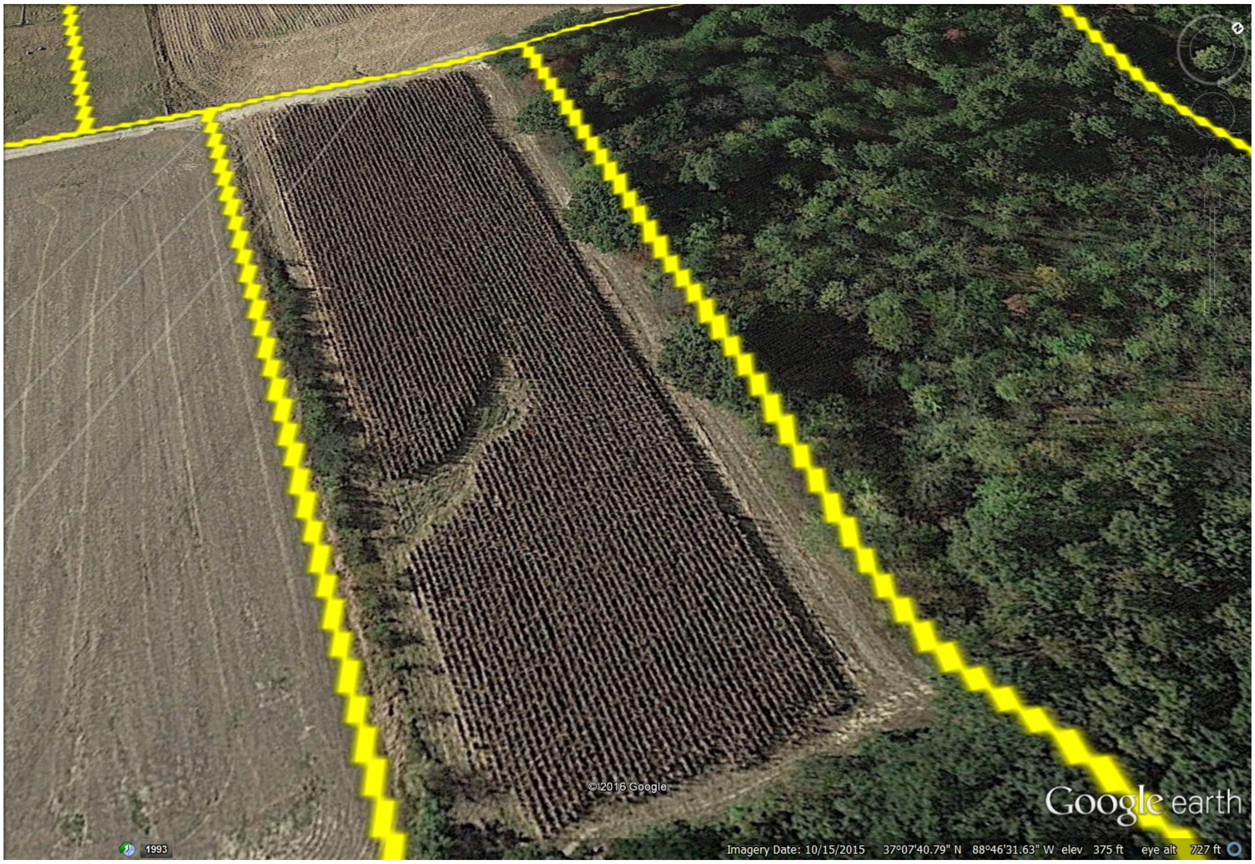

Figure 21. Property 8 Aerial View—Row Crop

3.1.9 Property 9 Evaluation

Table 9 presents the evaluation results and additional comments concerning Property 9, and Figures 22 and 23 present the overall aerial view of the property along with an example of the aerial examination.

Table 9. Property 9 Evaluation

Evaluation Process	Evaluation Results	Comments
Property overlying or immediately downgradient of the 5 µg/L or greater TCE Plume?	Yes.	Northeast Plume.
Land ownership of property	No change from previous year.	--
Municipal water usage	Historically consistent.	--
Known existing wells (residential or monitoring)	Yes, residential well.	R20, AKGWA 0003-5007, is sampled annually and is inspected in conjunction with the Five-Year Reviews.
Historical capping and locking information	Capped and Locked on June 22, 1995.	--
License Agreement Status	Current agreement in place.	--
Property has a residence	Yes.	--
Review of the Kentucky Database for Water Wells	No new wells have been installed/reported to Kentucky.	The Water Well & Spring Records Database, Kentucky Groundwater Data Repository was reviewed and was current on the Web as of June 2014.
Visual assessment of property*	Visual from well, drive-by, and aerial photograph noted no visible sign of groundwater usage.	Resident confirmed not using existing wells. Resident confirmed no new water well has been installed.

*See Appendix A for Assessment Forms

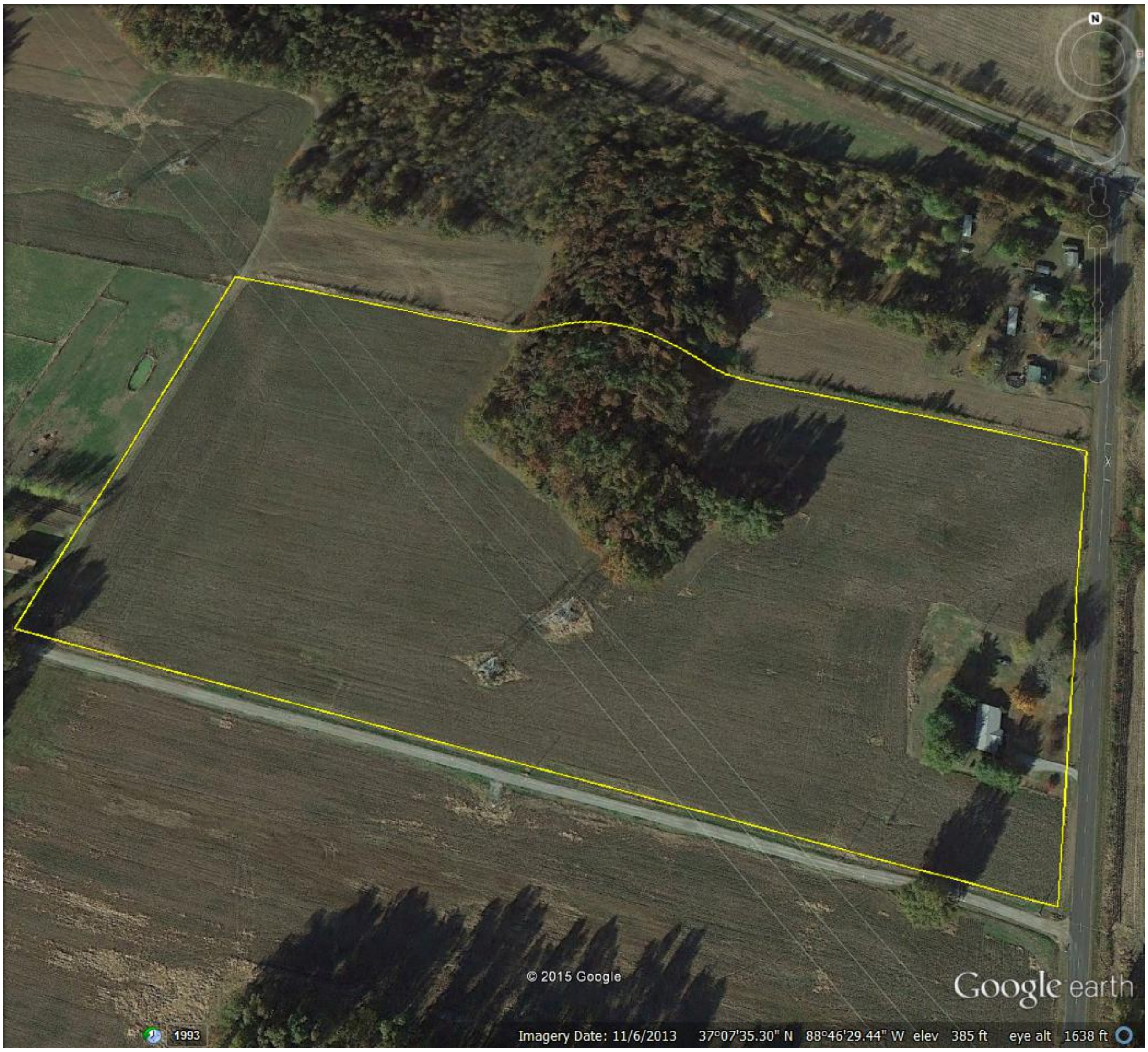

Figure 22. Property 9 Aerial View—Overall

Figure 23. Property 9 Street View—Drive Used for Sampling Residential Well

3.1.10 Property 10 Evaluation

Table 10 presents the evaluation results and additional comments concerning Property 10, and Figures 24 and 25 present the overall aerial view of the property along with an example of the aerial examination.

Table 10. Property 10 Evaluation

Evaluation Process	Evaluation Results	Comments
Property overlying or immediately downgradient of the 5 µg/L or greater TCE Plume?	Yes.	Northeast Plume.
Land ownership of property	No change from previous year.	--
Municipal water usage	Historically consistent.	--
Known existing wells (residential or monitoring)	Yes, residential and monitoring wells.	R31, AKGWA 0003-5008, is inspected in conjunction with the Five-Year Reviews. Two MWs are located on the property, MW148 and MW149, which are sampled biennially.
Historical capping and locking information	Capped and Locked on June 22, 1995.	--
License Agreement Status	Current agreement in place.	--
Property has a residence	Yes.	--
Review of the Kentucky Database for Water Wells	No new wells have been installed/reported to Kentucky.	The Water Well & Spring Records Database, Kentucky Groundwater Data Repository was reviewed and was current on the Web as of June 2014.
Visual assessment of property*	Visual from well, drive-by, and aerial photograph noted no visible sign of groundwater usage.	Resident confirmed not using existing wells. Resident confirmed no new water well has been installed. It was noted that the lock was missing on R31. The resident was informed that the lock would be replaced, but did not express any concern or asked any additional questions. Lock was replaced as of February 19, 2016.

*See Appendix A for Assessment Forms

Figure 24. Property 10 Aerial View—Overall

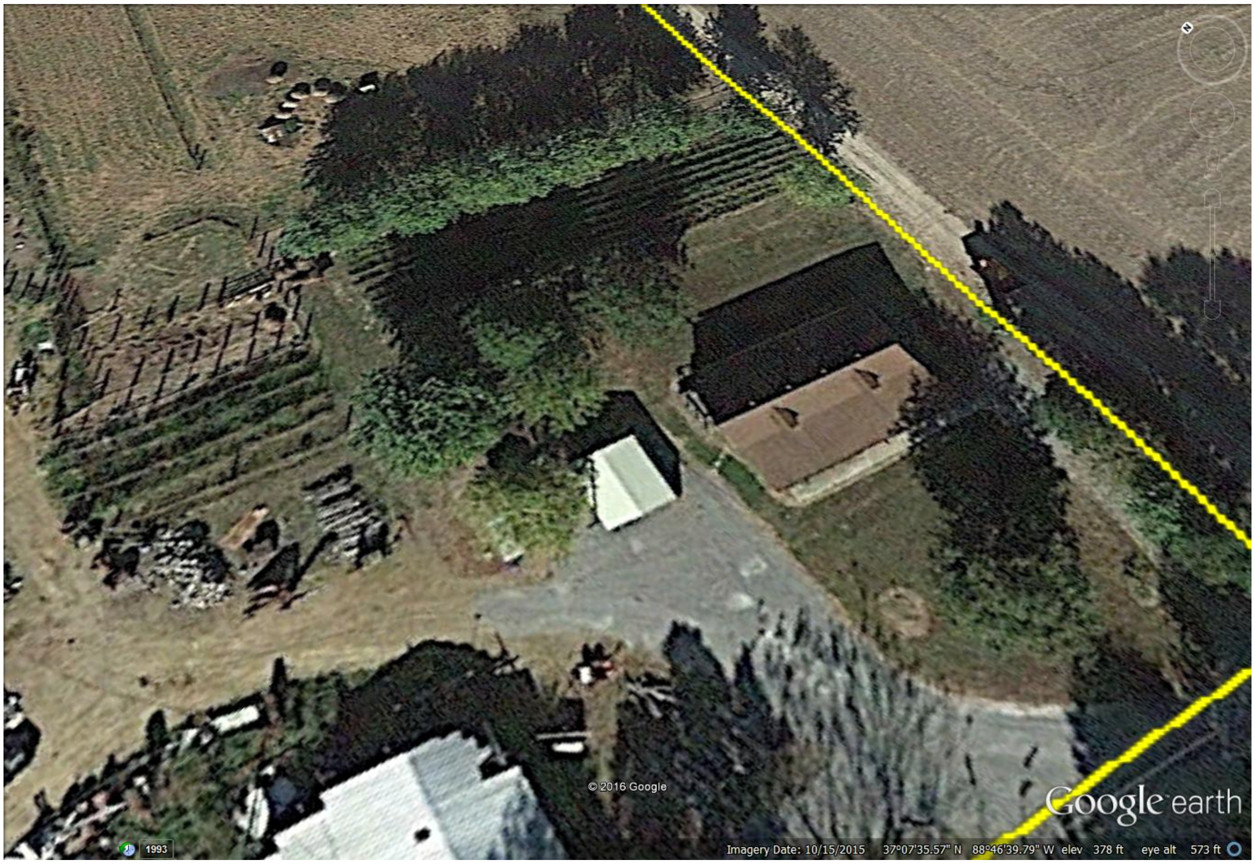

Figure 25. Property 10 Aerial View—Residence with Well Pad

3.1.11 Property 11 Evaluation

Table 11 presents the evaluation results and additional comments concerning Property 11, and Figures 26 and 27 present the overall aerial view of the property along with an example of the aerial examination.

Table 11. Property 11 Evaluation

Evaluation Process	Evaluation Results	Comments
Property overlying or immediately downgradient of the 5 µg/L or greater TCE Plume?	Yes.	Northeast Plume
Land ownership of property	No change from previous year.	--
Municipal water usage	Historically consistent.	--
Known existing wells (residential or monitoring)	Monitoring wells 252, 483-488.	MW252 is sampled annually; MWs 483-488 are sampled biennially.
Historical capping and locking information	None.	--
License Agreement Status	Current agreement in place.	--
Property has a residence	Yes.	Property purchased by parents in 1973.
Review of the Kentucky Database for Water Wells	No new wells have been installed/reported to Kentucky.	The Water Well & Spring Records Database, Kentucky Groundwater Data Repository was reviewed and was current on the Web as of June 2014.
Visual assessment of property*	Visual conducted from driveway, MWs, drive-by, and aerial photograph and noted no visible sign of groundwater usage.	Landowner confirmed not using existing wells. Landowner confirmed no new water well has been installed.

*See Appendix A for Assessment Forms

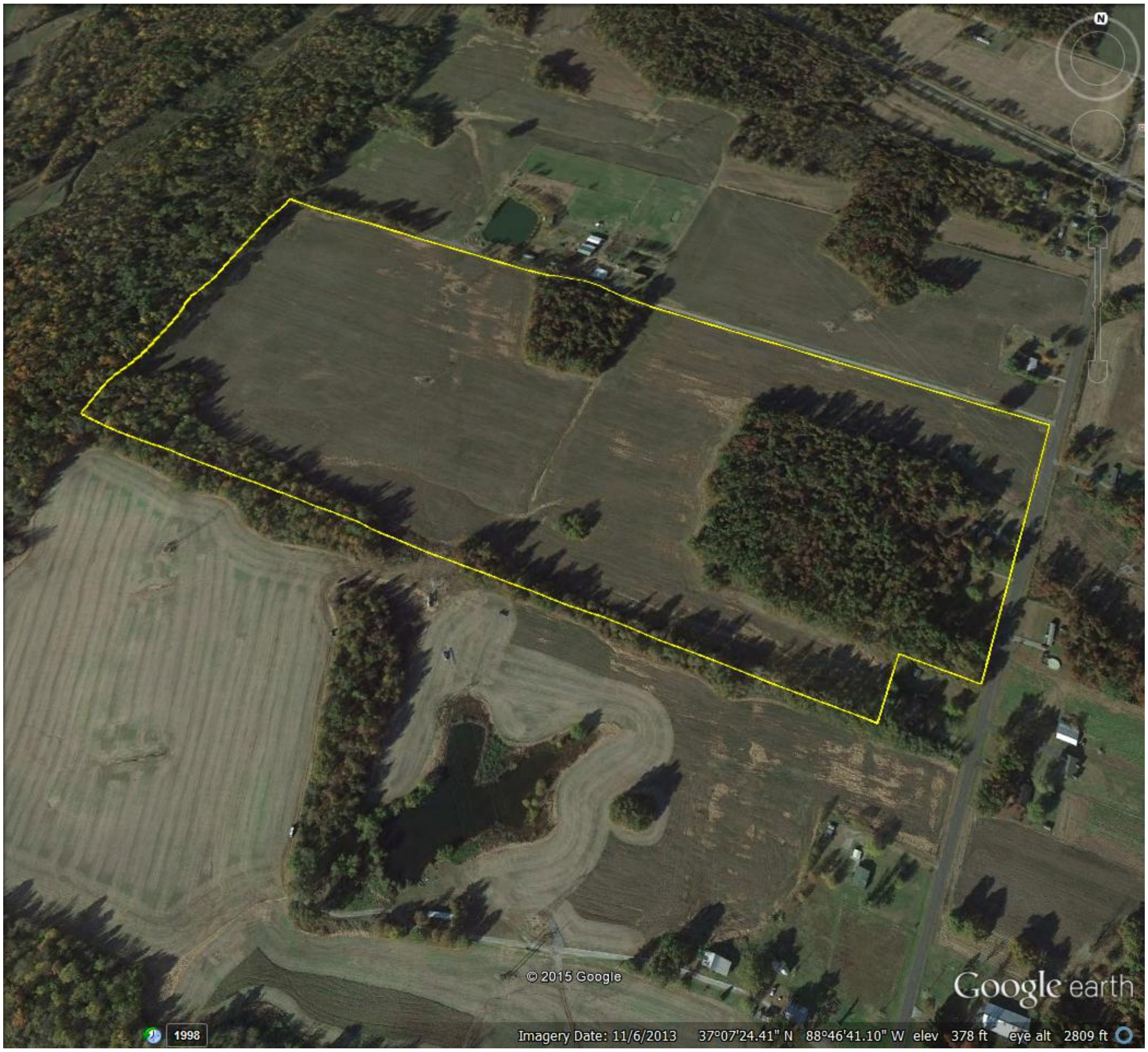

Figure 26. Property 11 Aerial View—Overall

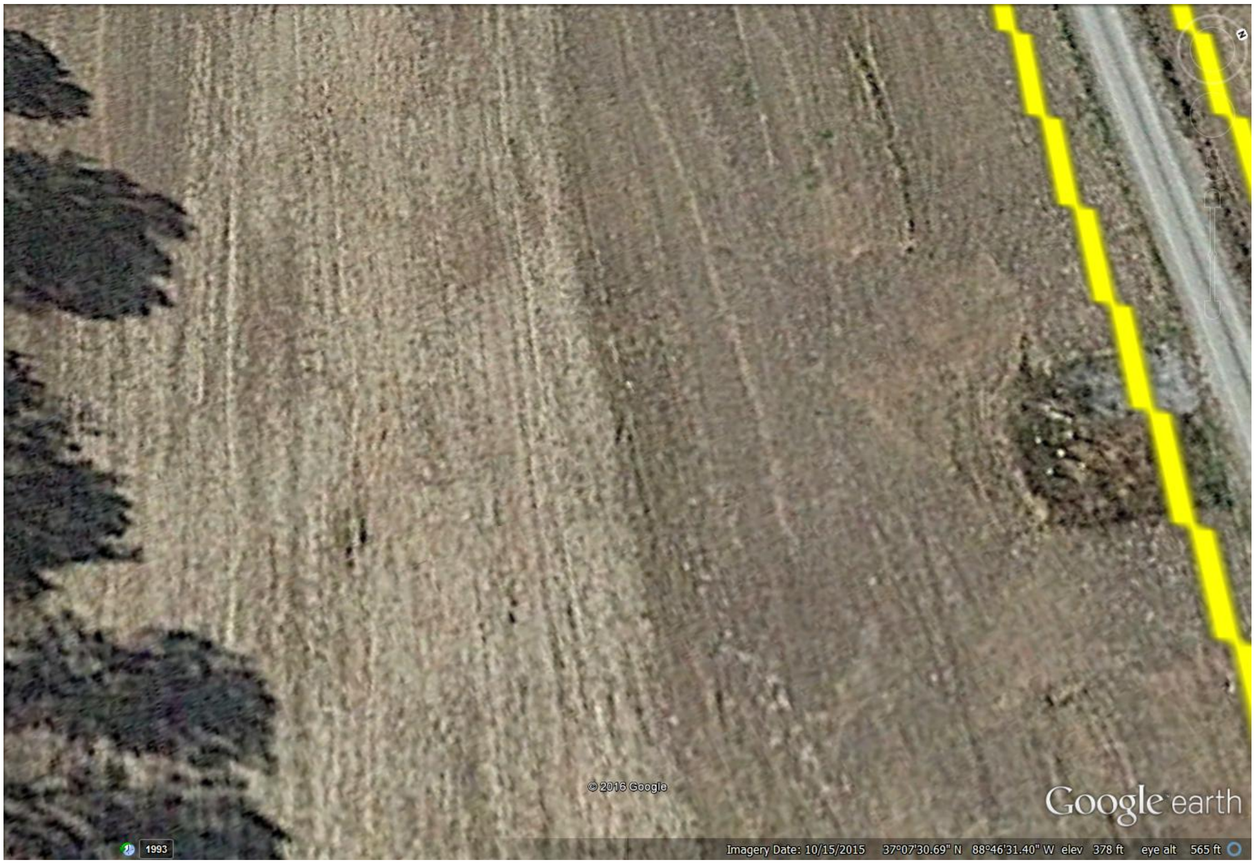

Figure 27. Property 11 Aerial View—Existing Monitoring Well

3.1.12 Property 12 Evaluation

Table 12 presents the evaluation results and additional comments concerning Property 12, and Figures 28 and 29 present the overall aerial view of the property along with an example of the aerial examination.

Table 12. Property 12 Evaluation

Evaluation Process	Evaluation Results	Comments
Property overlying or immediately downgradient of the 5 μg/L or greater TCE Plume?	Yes.	Northeast Plume
Land ownership of property	No change from previous year.	--
Municipal water usage	Historically consistent.	--
Known existing wells (residential or monitoring)	Yes, residential and two monitoring wells (253 and 409).	R528, AKGWA 0003-5132, is inspected in conjunction with the Five-Year Reviews. MW253 and MW409 are sampled annually.
Historical capping and locking information	DOE capping and locking notes state owner reported that the well was buried. Therefore, there is no cap and lock on well.	--
License Agreement Status	Current agreement in place.	--
Property has a residence	Yes.	--
Review of the Kentucky Database for Water Wells	No new wells have been installed/reported to Kentucky.	The Water Well & Spring Records Database, Kentucky Groundwater Data Repository was reviewed and was current on the Web as of June 2014. The Kentucky database reports this well as plugged.
Visual assessment of property*	Visual from approximate location of buried well, drive-by, and aerial photograph noted no visible sign of groundwater usage.	Resident confirmed not using existing wells. Resident confirmed no new water well has been installed.

*See Appendix A for Assessment Forms

Figure 28. Property 12 Aerial View—Overall

Figure 29. Property 12 Aerial View—Farmland

3.1.13 Property 13 Evaluation

Table 13 presents the evaluation results and additional comments concerning Property 13, and Figures 30 and 31 present the overall aerial view of the property along with an example of the aerial examination.

Table 13. Property 13 Evaluation

Evaluation Process	Evaluation Results	Comments
Property overlying or immediately downgradient of the 5 µg/L or greater TCE Plume?	Yes.	Northeast Plume.
Land ownership of property	Property is in estate. Landowner's sister is executor. No change was made to existing information database.	--
Municipal water usage	Historically consistent.	--
Known existing wells (residential or monitoring)	Yes, Residential.	R294, AKGWA 0003-5035, is inspected in conjunction with the Five-Year Reviews and has been sampled annually through 2015. Due to failing pump, R294 has been removed from the annual sampling program.
Historical capping and locking information	Capped and Locked on June 21, 1995.	--
License Agreement Status	Current agreement in place.	--
Property has a residence	Yes.	--
Review of the Kentucky Database for Water Wells	No new wells have been installed/reported to Kentucky.	The Water Well & Spring Records Database, Kentucky Groundwater Data Repository was reviewed and was current on the Web as of June 2014.
Visual assessment of property*	Visual from well, drive-by, and aerial photograph noted no visible sign of groundwater usage.	Executor confirmed not using existing wells. Executor confirmed no new water well has been installed.

*See Appendix A for Assessment Forms

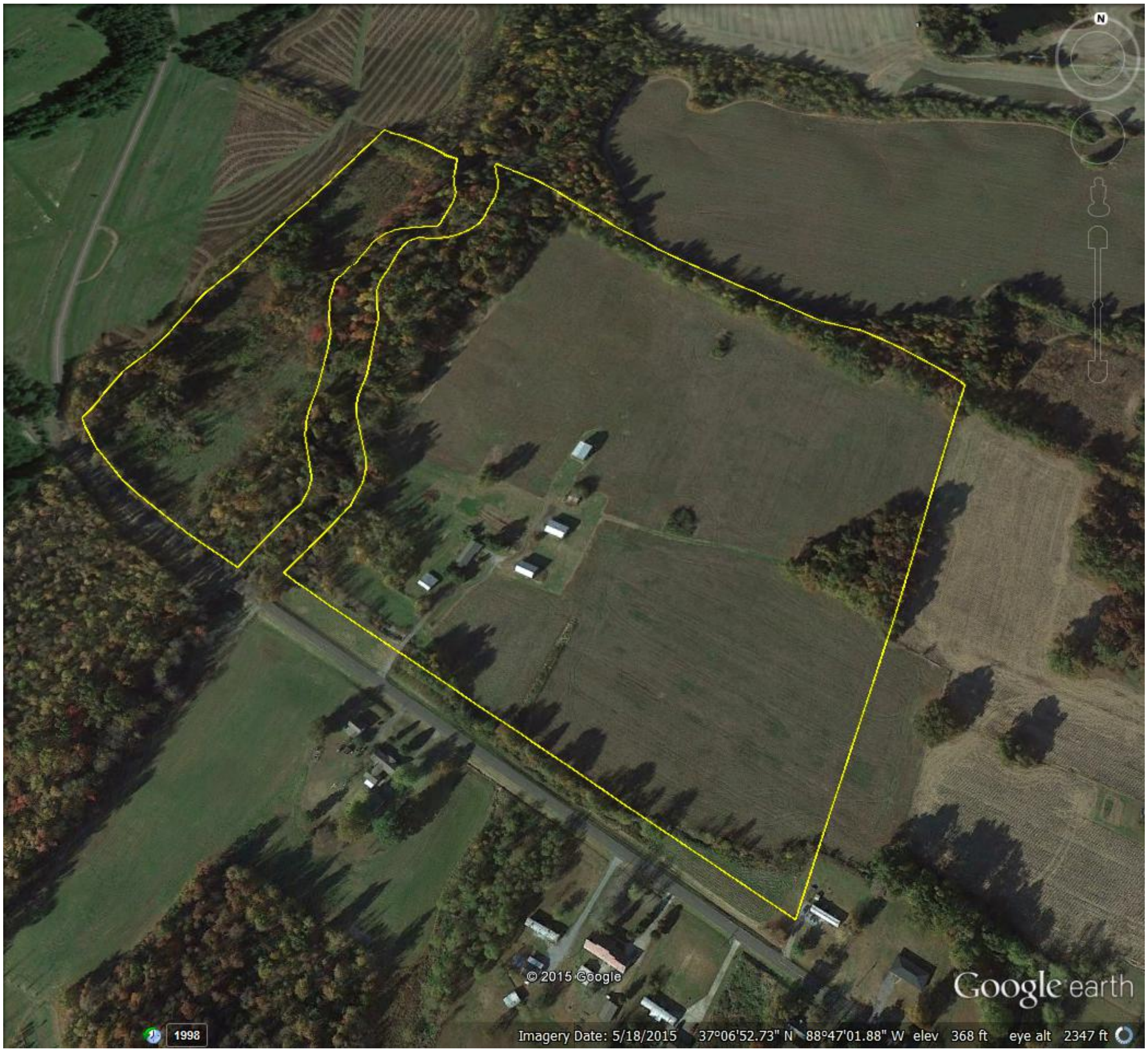

Figure 30. Property 13 Aerial View—Overall

Figure 31. Property 13 Aerial View—Well House near Residence

3.2 SUMMARY OF EVALUATION PROCESS

3.2.1 Determination of Property Overlying or Immediately Downgradient of the 5 µg/L or Greater TCE Plume

The lateral extent of the plume, shown on Figures 1 and 2, is defined by the 5 µg/L TCE contour, which is the Safe Drinking Water Act MCL for TCE. Figure 1 shows a total of 16 parcels situated overlying or immediately downgradient of the 5 µg/L or greater TCE plume.

3.2.2 Review of Land Ownership of Properties Overlying or Immediately Downgradient of the 5 µg/L or Greater TCE Plume

Land ownership was verified for these 16 parcels with the McCracken County Property Valuation Office. There are 13 landowners associated with these 16 parcels. Figure 2 groups the parcels by landowner and provides a unique identifier for each property owner and each individual parcel (1–13). No new landowners were identified by this review.

3.2.3 Review of Municipal Water Usage of Properties 1 through 13

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 Properties 1 through 13.

3.2.4 Review of Known Existing Wells (Residential or Monitoring) and Historical Capping and Locking Information for Properties 1 through 13

DOE contractors periodically inspect residential wells where access is available and a License Agreement is in place to ensure that they remain nonoperational. Residential wells with a License Agreement that are not sampled are inspected in conjunction with the Five-Year Review. When a well is sampled, any signs of use or other issues are noted and reported to the Environmental Monitoring Manager.

3.2.5 Review of the Kentucky Database for Water Wells

The Kentucky database for water wells was reviewed (current on the Web as of June 2014), and the installation of any new wells has not been reported in the Water Policy Area. The database may be accessed using the following link: http://kgs.uky.edu/kgsweb/DataSearching/Water/WaterWellSearch.asp. The following are the parameters for the database search.

Five locations were selected north of PGDP and within the Northeast and Northwest Plumes.

Northwest Plume

— Location 1: latitude 37° 08' 44"; longitude 88° 47' 14"
— Location 2: latitude 37° 08' 21"; longitude 88° 48' 02"
— Location 3: latitude 37° 07' 46"; longitude 88° 48' 35"

Northeast Plume

— Location 4: latitude 37° 08' 01"; longitude 88° 46' 45"
— Location 2: latitude 37° 07' 08"; longitude 88° 47' 11"

A search was conducted for wells within a radius of 4,000 ft.

3.2.6 Visual Assessment of Properties 1 through 13

DOE has attempted to execute license agreements with property owners within the Water Policy area. In the license agreements, DOE agrees to provide and pay for the owner's reasonable municipal water usage in exchange for the property owner's commitment to forego the use of groundwater from the property. In addition, the license agreements grant DOE access to the property to collect samples and to check the status of caps and locks placed on residential wells. DOE has executed license agreements with owners of ten of the thirteen owners of properties situated above the 5 µg/L or greater TCE plume and immediately downgradient. The three properties without a license agreement (Properties 1, 2, and 5) had a visual inspection by drive-by only.

Of the three properties for which there are no license agreements:

- Property 1 has no residence, but has a hunt club; municipal water is paid by DOE;
- Property 2 has a residence, but municipal water is paid by DOE; and
- Property 5 is farmland, has no residence, no water bill, and no known well.

A checklist was developed for the property assessment that includes the following:

- Background (e.g., current license agreement);
- Results of any on-site assessment (e.g., confirming that owner does not use groundwater);
- Results of any off-site assessment where access is not granted; and
- Results of examination of aerial images.

For the aerial images of Properties 1 through 13, existing well locations were examined, looking for disturbed soil around the well. Then the remaining portion of each property was examined in a systematic manner (e.g., Southeastern corner clockwise) for disturbed soil (e.g., mounded in one small location indicating a well could have been installed or in a line indicating a new line could have been installed) and for the presence of new well houses/casings.

Appendix A contains forms from the assessment of each property that overlies or is immediately downgradient of the 5 µg/L or greater TCE plume.

None of the assessments revealed any sign of groundwater use at any of the properties. Of note, two properties (IDs 3 and 10) were found to need replacement locks, and one of the two needed a replacement cap. DOE did not explicitly ask the resident why the locks were missing or why the cap was broken, but DOE confirmed with the residents that they were not using the existing water wells(s) and that neither had drilled a new water well. As noted on the forms, DOE verified that a license agreement is in place with both residents that prohibits using groundwater and that DOE continues to pay both residents' water bills. Each resident was informed that the cap and lock, as necessary, would be replaced. Neither resident expressed any concern or asked any additional questions. Additionally, both of these wells contain a low-flow bladder pump for sampling purposes; this type pump can be used only when attached to an air compressor.

4. CONCLUSION

DOE has examined all reasonably available lines of evidence and has concluded that no owners or occupants of any of the parcels located above the contaminated groundwater plume (i.e., overlying or immediately downgradient of the 5 µg/L or greater TCE plume) are using groundwater. As such, this study meets the requirements set forth in EPA's September 30, 2014, letter requesting that DOE demonstrate that all residents located above the contaminated groundwater plume are not using groundwater from their wells.

5. REFERENCES

DOE (U.S. Department of Energy) 1993. *Engineering Evaluation/Cost Analysis for the Water Policy at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/06-1142&D2, U.S. Department of Energy, Paducah, KY, May.

DOE 1994. *Action Memorandum for the Water Policy at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/OR/06-1201&D2, U.S. Department of Energy, Paducah, KY, June.

DOE 2014. The *Five-Year Review for Remedial Actions at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-1289&D2/R1, U.S. Department of Energy, Paducah, KY, May.

DOE 2016. *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, U.S. Department of Energy, Paducah, KY, February.

EPA (U.S. Environmental Protection Agency) 2014. R. Chaffins, U.S. Environmental Protection Agency, Region 4, Atlanta, GA, letter to J. Woodard, U.S. Department of Energy, Paducah, KY, September 30.

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APPENDIX

ASSESSMENT FORMS

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Assessment of Selected Property within the Water Policy Box

Property ID: 1

1. Background
   a. Current License Agreement expiration date: N/A

   b. Known existing wells: None

2. Onsite Assessment
   a. Means by which consent to enter property is provided (e.g., in person/telephone):

      N/A

   b. Are cap and lock in good condition: N/A

   c. Is well in good condition: N/A

   d. Confirm with occupant that they are not using existing water wells? N/A

   e. Confirm with occupant that they have not drilled a new water well? N/A

   f. From location of existing well, are there signs of additional wells? NO

   g. Other observations related to possible groundwater usage?

      There is no sign of groundwater usage. The property appears to be abandoned.

3. Aerial Observations

   No signs of groundwater well was seen on property.

Completed by: Justin Riley [signature] 2-4-16 Print/Sign/Date

Teresa Overby/[signature] 2-4-16 Print/Sign/Date

Assessment of Selected Property within the Water Policy Box

Property ID: 2

1. Background
   a. Current License Agreement expiration date: N\A

   b. Known existing wells: 1 well capped below grade. AKGWA # 0003-0205

2. Onsite Assessment
   a. Means by which consent to enter property is provided (e.g., in person/telephone):

      N\A

   b. Are cap and lock in good condition: N\A

   c. Is well in good condition: N\A

   d. Confirm with occupant that they are not using existing water wells? N\A

   e. Confirm with occupant that they have not drilled a new water well? N\A

   f. From location of existing well, are there signs of additional wells? NO

   g. Other observations related to possible groundwater usage?

      Drive by observation indicates no groundwater usage and no visible residential wells.

3. Aerial Observations

   No signs of groundwater well being present on property.

Completed by: Justin Riley / Justin Riley 2-4-16 Print/Sign/Date   Teresa Overby / Teresa Overby 2/4/2016 Print/Sign/Date

Assessment of Selected Property within the Water Policy Box

Property ID: 3

1. Background
   a. Current License Agreement expiration date: 12-31-18
   b. Known existing wells: R16 - Located under existing house
      R245
2. Onsite Assessment
   a. Means by which consent to enter property is provided (e.g., in person/telephone):

      Telephone

   b. Are cap and lock in good condition: R-245 No (cap is broken, Lock is missing)
   c. Is well in good condition: yes
   d. Confirm with occupant that they are not using existing water wells? yes
   e. Confirm with occupant that they have not drilled a new water well? yes
   f. From location of existing well, are there signs of additional wells? NO
   g. Other observations related to possible groundwater usage?

      No observations of possible ground water usage.

3. Aerial Observations

   No visable sign of water wells being installed on property other than existing well.

Completed by: Justin Riley [signature] 2-4-16 Print/Sign/Date

Teresa Overley [signature] 2-4-2016 Print/Sign/Date

* Replacement parts order as of 2/8/2016. TO 2/12/2016

** cap and lock were fixed on 2/25/2016. TO 3/3/2016

Assessment of Selected Property within the Water Policy Box

Property ID: 4

1. Background
   a. Current License Agreement expiration date: 12-31-18

   b. Known existing wells: None

2. Onsite Assessment
   a. Means by which consent to enter property is provided (e.g., in person/telephone):

      Telephone

   b. Are cap and lock in good condition: N/A

   c. Is well in good condition: N/A

   d. Confirm with occupant that they are not using existing water wells? N/A

   e. Confirm with occupant that they have not drilled a new water well? Yes

   f. From location of existing well, are there signs of additional wells? NO

   g. Other observations related to possible groundwater usage?

      No indication of possible groundwater usage. Owner indicated there was a residential well on the property in the 1950's but it was filled many years ago.

3. Aerial Observations

   No signs of new groundwater well installed on property.

Completed by: Justin Riley / [signature] Print/Sign/Date 2-4-16

Teresa Overby / [signature] Print/Sign/Date 2/4/2016

Assessment of Selected Property within the Water Policy Box

Property ID: 5

1. Background
   a. Current License Agreement expiration date: N\A

   b. Known existing wells: NONE

2. Onsite Assessment
   a. Means by which consent to enter property is provided (e.g., in person/telephone):

      N\A

   b. Are cap and lock in good condition: N\A

   c. Is well in good condition: N\A

   d. Confirm with occupant that they are not using existing water wells? N\A

   e. Confirm with occupant that they have not drilled a new water well? N\A

   f. From location of existing well, are there signs of additional wells? NO

   g. Other observations related to possible groundwater usage?

      Drive by observation of property revealed no evidence of new or existing groundwater wells.

3. Aerial Observations

   No signs of groundwater well on property.

Completed by: Justin Riley [signature]
Print/Sign/Date 2-4-16

Teresa Ownby [signature]
Print/Sign/Date 2-4-16

Assessment of Selected Property within the Water Policy Box

Property ID: 6

1. Background
   a. Current License Agreement expiration date: 9-30-19

   b. Known existing wells: None

2. Onsite Assessment
   a. Means by which consent to enter property is provided (e.g., in person/telephone):

      Telephone

   b. Are cap and lock in good condition: N\A

   c. Is well in good condition: N\A

   d. Confirm with occupant that they are not using existing water wells? Yes

   e. Confirm with occupant that they have not drilled a new water well? Yes

   f. From location of existing well, are there signs of additional wells? No

   g. Other observations related to possible groundwater usage?

      Observations do not indicate any groundwater usage.

3. Aerial Observations

   No signs of groundwater well on property.

Completed by: Justin Riley / [signature] Print/Sign/Date 2-4-16

Teresa Overby / [signature] Print/Sign/Date 2-4-16

Assessment of Selected Property within the Water Policy Box

Property ID: 7

1. Background
   a. Current License Agreement expiration date: 12-31-18

   b. Known existing wells: R530, AKGWA 0004-2844

2. Onsite Assessment
   a. Means by which consent to enter property is provided (e.g., in person/telephone):

      Person

   b. Are cap and lock in good condition: N/A*

   c. Is well in good condition: N/A*

   d. Confirm with occupant that they are not using existing water wells? Yes

   e. Confirm with occupant that they have not drilled a new water well? Yes

   f. From location of existing well, are there signs of additional wells? NO

   g. Other observations related to possible groundwater usage?

      *The existing residential well is located under an addition To The house. IT is NOT accessible.
      There is no evidence of groundwater usage.

3. Aerial Observations

   No sign of groundwater well on property.

Completed by: Justin Riley / [signature]
Print/Sign/Date 2-5-16

Teresa Overby / [signature]
Print/Sign/Date 2-5-16

Assessment of Selected Property within the Water Policy Box

Property ID: 8

1. Background
   a. Current License Agreement expiration date: 12-14-17

   b. Known existing wells: None

2. Onsite Assessment
   a. Means by which consent to enter property is provided (e.g., in person/telephone):

      Occupants could not be reached after several attempts in person.

   b. Are cap and lock in good condition: N/A

   c. Is well in good condition: N/A

   d. Confirm with occupant that they are not using existing water wells? N/A

   e. Confirm with occupant that they have not drilled a new water well? NO

   f. From location of existing well, are there signs of additional wells? NO

   g. Other observations related to possible groundwater usage?

      Property surrounding the house was inspected and there is no evidence of possible groundwater usage.

3. Aerial Observations

   No signs of groundwater well on property.

Completed by: Justin Riley / Justin Riley
Print/Sign/Date 2-5-16

Teresa Overby / Teresa Overby
Print/Sign/Date 2-5-16

Assessment of Selected Property within the Water Policy Box

Property ID: 9

1. Background
   a. Current License Agreement expiration date: 6-30-17

   b. Known existing wells: R20 - AKGWA 0003-5077

2. Onsite Assessment
   a. Means by which consent to enter property is provided (e.g., in person/telephone):

      Telephone

   b. Are cap and lock in good condition: yes

   c. Is well in good condition: yes

   d. Confirm with occupant that they are not using existing water wells? yes

   e. Confirm with occupant that they have not drilled a new water well? yes

   f. From location of existing well, are there signs of additional wells? NO

   g. Other observations related to possible groundwater usage?

      No observations of possible groundwater usage.

3. Aerial Observations

   No signs of additional groundwater well on property.

Completed by: Justin Riley / Justin Riley
Print/Sign/Date 2-4-16

Teresa Roberts / Teresa Roberts
Print/Sign/Date 2-4-16

Assessment of Selected Property within the Water Policy Box

Property ID: 10

1. Background
   a. Current License Agreement expiration date: 7-21-20

   b. Known existing wells: R31 AKGWA 0003-5008

2. Onsite Assessment
   a. Means by which consent to enter property is provided (e.g., in person/telephone):

      Telephone

   b. Are cap and lock in good condition: Cap is present, Lock is missing.

   c. Is well in good condition: yes

   d. Confirm with occupant that they are not using existing water wells? yes

   e. Confirm with occupant that they have not drilled a new water well? yes

   f. From location of existing well, are there signs of additional wells? NO

   g. Other observations related to possible groundwater usage?

      There are no indications of possible groundwater usage. Owner was notified the lock will be replaced on the well cap.

3. Aerial Observations

   No signs of additional groundwater well on property.

Completed by: Justin Riley [signature] Print/Sign/Date 2-4-16 — Teresa Oberby [signature] Print/Sign/Date 2-4-16

*Lock replacement has been obtained and scheduled for 2/18/2016. TO 2/16/2016

**Lock was replaced on 2/19/2016. TO 3/3/2016

Assessment of Selected Property within the Water Policy Box

Property ID: 11

1. Background
   a. Current License Agreement expiration date: 9-30-19

   b. Known existing wells: None

2. Onsite Assessment
   a. Means by which consent to enter property is provided (e.g., in person/telephone):

      Telephone

   b. Are cap and lock in good condition: N/A

   c. Is well in good condition: N/A

   d. Confirm with occupant that they are not using existing water wells? yes

   e. Confirm with occupant that they have not drilled a new water well? yes

   f. From location of existing well, are there signs of additional wells? NO

   g. Other observations related to possible groundwater usage?

      There is no evidence of possible groundwater usage.

3. Aerial Observations

   No signs of groundwater well on property.

Completed by: Justin Riley [signature] Print/Sign/Date 2-4-16

Teresa Alverby [signature] Print/Sign/Date 2-4-16

Assessment of Selected Property within the Water Policy Box

Property ID: 12

1. Background
   a. Current License Agreement expiration date: 12-31-17

   b. Known existing wells: R528 (buried)

2. Onsite Assessment
   a. Means by which consent to enter property is provided (e.g., in person/telephone):

      Telephone

   b. Are cap and lock in good condition: N\A

   c. Is well in good condition: N\A

   d. Confirm with occupant that they are not using existing water wells? yes

   e. Confirm with occupant that they have not drilled a new water well? yes

   f. From location of existing well, are there signs of additional wells? NO

   g. Other observations related to possible groundwater usage?

      Owner confirmed previous well R528 was buried years ago. There is no evidence to suggest possible groundwater usage.

3. Aerial Observations

   No sign of groundwater well on property

Completed by: Justin Riley [signature] 2-4-16
Print/Sign/Date

Teresa Overby / [signature] 2-4-16
Print/Sign/Date

Assessment of Selected Property within the Water Policy Box

Property ID: 13

1. Background
   a. Current License Agreement expiration date: 12-31-2018

   b. Known existing wells: R294, AKGWA 0003-5035

2. Onsite Assessment
   a. Means by which consent to enter property is provided (e.g., in person/telephone):

      Telephone

   b. Are cap and lock in good condition: Yes

   c. Is well in good condition: yes

   d. Confirm with occupant that they are not using existing water wells? yes*

   e. Confirm with occupant that they have not drilled a new water well? yes*

   f. From location of existing well, are there signs of additional wells? No

   g. Other observations related to possible groundwater usage?

      *Currenty not occupied. Confirmation made with Owner's Sister.
      No evidence of possible groundwater usage.

3. Aerial Observations

   No signs of new groundwater well was seen on property.

Completed by: Justin Riley [signature] Print/Sign/Date 2-4-16   Teresa [signature] Print/Sign/Date 2-4-16

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APPENDIX D

C-400 VAPOR INTRUSION ADDITIONAL ACTIONS

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Addendum to the
Five-Year Review for Remedial Actions at the Paducah Gaseous Diffusion Plant, Paducah Kentucky, DOE/LX/07-1289&D2/R1/A2/R2, Dated October 2017

A Five-Year Review addendum generally is completed for remedies where the protectiveness determination is deferred until further information is obtained. This Addendum provides progress since the 2013 Five-Year Review for the C-400 Cleaning Building electrical resistance heating (ERH) interim remedial action because the 2013 protectiveness determination was deferred by the U.S. Environmental Protection Agency (EPA). It also includes a revised protectiveness determination based on information obtained since the 2013 Five-Year Review.

The 2013 Five-Year Review report (Report) for the Paducah Gaseous Diffusion Plant in Paducah, Kentucky, outlined the following protectiveness statement(s).

GROUNDWATER OPERABLE UNIT

Northwest Plume

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 plume need to be evaluated for long-term protection.

Northeast Plume

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 need to be evaluated for long-term protection.

Cylinder Drop Test Area

The remedy for the Cylinder Drop Test Area is protective of human health and the environment in the short-term. Exposure pathways that could result in unacceptable risk are being controlled through U.S. Department of Energy (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 trichloroethene (TCE) cleanup level providing long-term protection of groundwater has not been established yet. In order to establish long-term protectiveness, per the Federal Facility Agreement (FFA), "…any necessary remedial action shall be selected and implemented…." as part of the Comprehensive Site Operable Unit (CSOU).

Water Policy

2013 Five-Year Review Original Protectiveness Statement:

> 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 need to be evaluated for long-term protection.

EPA Deferred Protectiveness Statement (September 30, 2014):

> 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.

2013 Five-Year Review Appendix C Revised Protectiveness Statement (October 2017):

> 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.

C-400 Cleaning Building ERH[1]

2013 Five-Year Review Original 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, 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. However, in order to establish long-term protectiveness, additional remedial actions will be evaluated and selected, as necessary, under the GDP Groundwater Sources OU.

EPA Deferred Protectiveness Statement (September 30, 2014):

> The protectiveness determination of the remedy for the C-400 Building cannot be made at this time until further information is obtained. Further information will be obtained by taking the following actions: a vapor intrusion study will be conducted that is consistent with EPA protocol and based on current toxicity values and risk assessment methodology. 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.

2013 Five-Year Review Appendix C Revised Protectiveness Statement (May 2018):

> The Interim Remedial Action (IRA) for volatile organic compound (VOC) contamination at C-400 Cleaning Building is protective of human health and the environment upon completion 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

[1] This addendum addresses the Protectiveness Statement(s) for Groundwater OU, C-400 Cleaning Building ERH.

Response, Compensation, and Liability Act (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 C-400 Cleaning Building. In order to establish long-term protectiveness, however, additional remedial actions will be evaluated and selected, as necessary, under the C-400 Complex Operable Unit (OU).

Southwest Plume

The remedial action for VOC sources at the Southwest Plume is expected to be protective of human health and the environment upon completion. Interim LUCs, consisting of placement of warning signs and the DOE 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.

SURFACE WATER OPERABLE UNIT

North-South Diversion Ditch (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.

NSDD Sections 1 and 2

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 currently are being controlled. This project is not a comprehensive final action for Solid Waste Management Unit 59. In order to establish long-term protectiveness, additional action will be evaluated and selected, as necessary, under the Surface Water OU (SWOU).[2]

C-746-K Landfill

The remedy for the C-746-K Landfill 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.

Fire Training Area

The remedy for the Fire Training Area 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 remedial action shall be selected and implemented…." as part of the CSOU.

[2] The 2018 Five-Year Review will reflect changes to NSDD Sections 1 and 2 strategy that were made and agreed to by the FFA parties for the FY 2018 Site Management Plan. NSDD Sections 1 and 2 changes will be evaluated as necessary under the CSOU.

Surface Water Interim Corrective Measures

The remedy for the surface water interim corrective measures (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.

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, however, additional remedial actions will be evaluated and selected, as necessary, under the SWOU.

BURIAL GROUNDS OPERABLE UNIT

C-749 Uranium Burial Ground

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 remedial action and was not designed to address fully the risks to human health and the environment from the buried wastes or 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 currently is being evaluated under the Burial Grounds OU to ensure long-term protectiveness.

The 2013 Five-Year Review deferred protectiveness determinations for two of the preceding remedies (Water Policy Removal Action and C-400 Cleaning Building ERH Interim Remedial Action). Appendix C (dated October 2017) of the 2013 Five-Year Review contains the necessary information and the revised protectiveness statement for the Water Policy Removal Action (dated October 2017). The necessary information and the revised protectiveness statement for the C-400 Cleaning Building ERH are contained in this document, Appendix D, for the 2013 Five-Year Review.

PROGRESS SINCE THE FIVE-YEAR REVIEW COMPLETION DATE

This addendum was prepared to document the additional information that has been collected to support the protectiveness determination of the C-400 Cleaning Building ERH (Section 9 of the main text), as requested by EPA in a letter dated September 30, 2014. EPA's letter stated the following:

> The FYR protectiveness determination for Building C-400 remedy is currently "short-term protective". Given the magnitude of high concentration volatile organic compounds (VOC) contamination including TCE DNAPL present in surrounding subsurface soils and below the building, the potential for vapor intrusion is likely. Vapor intrusion into building C-400 is identified as an issue in the FYR with the recommendation that a vapor intrusion analysis be performed as part of any subsequent C-400 action. The vapor intrusion study should not be delayed until a subsequent action and should be conducted in the near term to determine whether this potential pathway presents an unacceptable risk to human health such as workers that work in and around the C-400 Building. Until a vapor intrusion study is conducted that is consistent with EPA protocol and based on current toxicity values and risk assessment methodology, the

protectiveness statement should be "deferred" until the protectiveness of the remedy can be determined.

Based on the information provided in the subject document and additional data provided by DOE, EPA has made the following determination for the C-400 Building remedy: The protectiveness determination of the remedy for the C-400 Building cannot be made at this time until further information is obtained. Further information will be obtained by taking the following actions: a vapor intrusion study will be conducted that is consistent with EPA protocol and based on current toxicity values and risk assessment methodology. 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 action:

DOE conducted a vapor intrusion study, consistent with EPA protocol based on current toxicity values and risk assessment methodology (DOE 2018a), in accordance with the approved *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. The results are documented in this Addendum.

Based on the decision rules, the VI study results show that the VI pathway for TCE is complete and exceeded Project Action Levels (PALs) in indoor air at Locations 5, 6, and 8. Based on the sub-slab concentrations in these areas, TCE concentrations in indoor air greater than the screening level continue to be possible, particularly under closed door conditions. However, cumulative excess lifetime cancer risk assuming chronic exposure by unprotected industrial workers was less than 6.0E-06 at all locations, and cumulative hazard index assuming chronic exposure by unprotected industrial workers was less than 1.0 at all but one location. Periodic air monitoring, worker access restriction or both, and/or increased ventilation may be appropriate steps to take if it is anticipated remediation workers will spend substantial time in the building in the vicinity of Locations 5, 6, and 8, until the building is decommissioned or the source is remediated.

The VI pathway is either incomplete (i.e., indoor air sampling result is nondetect) or is complete with a sampling result below the PAL, at all other sampled locations. While sub-slab soil gas concentrations are above PALs at some of the other locations (1, 4, and 7), indoor air concentrations either do not exceed their respective indoor air PALs, or they are nondetect under all tested scenarios.

Considering that the groundwater under C-400 Cleaning Building contains the highest concentrations of TCE and geologic conditions most favorable for vapor transport, it is unlikely that indoor air in other PGDP structures of similar construction with groundwater as the primary potential source of vapors would have VOC concentrations above a level that could pose an unacceptable risk to current protected workers.

It should be noted that this building is undergoing deactivation, and it is not occupied by nonremediation workers.

ISSUES AND RECOMMENDATIONS

None.

PROTECTIVENESS STATEMENTS

Based on new information obtained since the 2013 Five-Year Review, the following is the revised protectiveness statement(s) for the Groundwater OU, C-400 Cleaning Building ERH.

The IRA for the VOC contamination at C-400 Cleaning Building is protective of human health and the environment in the short-term. 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 addressed adequately the known exposure pathways that could result in unacceptable risks originating from C-400 Cleaning Building. In order to establish long-term protectiveness, however, additional remedial actions will be evaluated and selected, as necessary, under the C-400 Complex OU.

NEXT FIVE-YEAR REVIEW

The next five-year review will be completed for the period of January 2013 through December 2017, five years after the last five-year review report.

CONTENTS

FIGURES

TABLES

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ACRONYMS

CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CSM	conceptual site model
CSOU	Comprehensive Site Operable Unit
DNAPL	dense nonaqueous-phase liquid
DOE	U.S. Department of Energy
ELCR	excess lifetime cancer risk
EPA	U.S. Environmental Protection Agency
EPCC	exposure point concentration
FFA	Federal Facility Agreement
FYR	five-year review
HI	hazard index
HQ	hazard quotient
ICM	interim corrective measure
IRA	interim remedial action
KDEP	Kentucky Department for Environmental Protection
KDFWR	Kentucky Department of Fish and Wildlife Resources
LUC	land use control
NSDD	North-South Diversion Ditch
OU	operable unit
OREIS	Oak Ridge Environmental Information System
PAL	Project Action Level
PGDP	Paducah Gaseous Diffusion Plant
QAPP	quality assurance project plan
RGA	Regional Gravel Aquifer
RL	reporting limit
RPD	relative percent difference
SAP	sampling and analysis plan
SWOU	Surface Water Operable Unit
UCRS	Upper Continental Recharge System
VI	vapor intrusion
VISL	Vapor Intrusion Screening Level
VOC	volatile organic compound
WKWMA	West Kentucky Wildlife Management Area
WP	work plan

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D.1. INTRODUCTION

This report presents the results of the vapor intrusion (VI) study performed in accordance with the approved *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 Work Plan (WP) (DOE 2017), which was conducted as an additional action subsequent to the *Five-Year Review for Remedial Actions at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, DOE/LX/07-1289&D2/R1 (DOE 2014a). The WP was developed to document the site-specific VI conceptual site model (CSM) for the C-400 Cleaning Building at the U.S. Department of Energy (DOE) Paducah Gaseous Diffusion Plant (PGDP) and to provide a sampling and analysis plan (SAP) guiding the collection of vapor samples within and around C-400 Cleaning Building. This VI study was conducted under the provisions of Section XXX, Five-Year Review, of the PGDP Federal Facility Agreement (FFA) (EPA 1998), as documented in the Record of Conversation letter dated August 1, 2014 (DOE 2014b).

Consistent with the U.S. Environmental Protection Agency's (EPA) *Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air* (EPA 2015), the WP included the following:

1. Provided a compilation and summary of existing information and data relevant to the VI pathway at C-400 Cleaning Building;

2. Documented the preliminary and detailed VI evaluations for C-400 Cleaning Building;

3. Summarized the C-400 Cleaning Building site-specific VI CSM, analyzed the completeness of the VI pathway in the context of the VI CSM, and identified data gaps;

4. Presented the rationale for additional sampling at C-400 Cleaning Building;

5. Recommended screening levels based on toxicity values from the EPA's Regional Screening Levels—Generic Tables (November 2017) (EPA 2017a);

6. Described the sampling and analysis needed to determine whether volatile organic compound (VOC) [primarily trichloroethene (TCE)] concentrations present an unacceptable risk to human health due to VI in C-400 Cleaning Building; and

7. Provided decision rules for evaluating the data collected as part of this VI study.

The WP was approved by the EPA and the Kentucky Division of Waste Management (KDWM) on August 11, 2017 (EPA 2017b; KDWM 2017, respectively). Previous inspection of C-400 Cleaning Building identified historical releases of TCE to the subsurface around and beneath the building and the presence of cracks and other openings in the concrete flooring in areas. Together, these items suggest that there is potential for vapor migration from the subsurface to indoor air. The goal of this VI study is to determine whether the VI pathway is complete and presents unacceptable risks to humans working in and around C-400 Cleaning Building.

D.1.1 PROJECT OBJECTIVE

The objective of the VI study is to evaluate whether the subsurface-to-indoor air VI pathway is complete and presents an unacceptable risk to workers in and around C-400 Cleaning Building.

D.1.2 PROJECT SCOPE

The C-400 Cleaning Building VI study was completed using three scenarios representative of current and possible future working conditions for C-400 Cleaning Building workers. Each scenario was maintained for 24 hours prior to initiation of sampling. The three sampled scenarios included the following in the order performed:

- Exhaust fan off and large bay doors closed;
- Exhaust fan on and large bay doors open; and
- Exhaust fan on and large bay doors closed.

As part of the VI study, vapor samples were collected at eight indoor and four ambient (outdoor) locations during each scenario. Seven of the eight indoor sampling locations were co-located with sub-slab sampling locations that were collected concurrently to the indoor and ambient vapor samples. One of the indoor air sampling locations was accessed via a sample port installed within an operational exhaust fan and had no corresponding sub-slab sampling. SUMMA® canister samples were collected as 10-hour integrated samples during normal work hours to mirror the exposure duration of a typical worker within C-400 Cleaning Building. Temperature and differential pressure (indoor air to ambient air) were measured in the vicinity of the indoor air SUMMA® canisters, six times per each sampling scenario (i.e., start of the sampling event, end of sampling event, and every two hours during sampling event). Differential pressure also was measured at the sub-slab locations (split manometer) and at the exhaust fan location six times per each sampling event (i.e., start of the sampling event, end of sampling event, and every two hours during sampling event).

D.1.3 PROJECT APPROACH

The following approach was agreed to by the FFA parties to meet the project objective of this VI study.

- Advance seven sub-slab monitoring points through the concrete slab of C-400 Cleaning Building using a hammer drill with a 5/8-inch drill bit to the top of the gravel underlying the slab; record the thickness of the concrete at each location and set the sub-slab probe.

- Set up each sampling scenario (i.e., exhaust fan on and large bay doors open, exhaust fan on and large bay doors closed, and exhaust fan off and large bay doors closed) a minimum of 24 hours prior to the start of the sampling event.

- Collect vapor samples using SUMMA® canisters over a 10-hour integrated sampling period during normal work hours to mirror the exposure duration of a typical worker within C-400 Cleaning Building from eight indoor air, seven sub-slab, and four ambient air vapor samples and analyze for volatile organic compounds (VOCs).

- Collect temperature and differential pressure (relative to ambient air) readings at each of the indoor air and exhaust fan SUMMA® canisters, six times per each sampling scenario.

- Collect differential pressure readings at the sub-slab locations (split manometer) six times per each sampling event (i.e., start of the sampling event, end of sampling event, and every two hours during sampling).

- Set up a weather station outside of C-400 Cleaning Building to record the temperature, barometric pressure, wind direction and speed, and relative humidity from the weather station every two hours for a total of six readings during the sampling period of ten hours.

Figure D.1 presents a map of C-400 Cleaning Building depicting indoor air and co-located sub-slab sampling Locations 1 through 7, and exhaust fan Location 8. Figure D.2 presents a map of C-400 Cleaning Building depicting ambient air sampling Locations 1 through 4, and weather station Location 5.

D.1.4 AREA DESCRIPTION

PGDP, located within the Jackson Purchase region of western Kentucky, is an inactive uranium enrichment facility owned by the DOE. PGDP first was owned and managed by the Atomic Energy Commission and the Energy Research and Development Administration, DOE's predecessors; DOE then managed PGDP until 1993. On July 1, 1993, the United States Enrichment Corporation assumed management and operation of the PGDP enrichment facility under a lease agreement with DOE that continued until October 2014, when the facility was returned to DOE. DOE retains ownership of the enrichment complex.

Of the 3,556 acres owned by DOE, approximately 628 acres of this parcel are inside the PGDP fenced area. Most of the facilities used to support enrichment operations are located inside the PGDP fenced area. Outside the fenced area, several support facilities for DOE projects can be found. The support facilities include landfills (both active and closed), modular office complexes, a water treatment facility, groundwater remediation systems, decontamination facilities, storage areas, and a storm water retention basin. Of the remaining DOE land, approximately 1,986 acres is licensed to the Commonwealth of Kentucky Department of Fish and Wildlife Resources (KDFWR) and serves as a portion of the West Kentucky Wildlife Management Area (WKWMA). The licensed portion of the WKWMA is used by the public for hunting and horse and dog field trials. KDFWR staff work in the licensed area performing wildlife management activities.

The topography of DOE property is level to slightly rolling. It is rural and predominantly open grasslands with scattered wooded areas of mature hardwoods and brush. Approximately 60% of the total area outside PGDP, but on DOE-owned property, is grasslands; much of this non-wooded area is right-of-way for electrical power lines.

D.1.5 GEOLOGY AND SOILS

The Jackson Purchase region of western Kentucky, where PGDP is located, represents the northern tip of the Mississippi Embayment portion of the Coastal Plain. The Jackson Purchase region is an area of land that includes all of Kentucky west of the Tennessee River. The stratigraphic sequence in the region consists of Cretaceous, Tertiary, and Quaternary sediments unconformably overlying Paleozoic bedrock. Relative to the shallow groundwater flow system in the vicinity of PGDP, the continental deposits and the overlying loess and alluvium are of key importance. The continental deposits locally consist of an upper silt member, with lesser sand and gravel interbeds, and a thick, basal sand and gravel member, which fills a buried river valley. A subcrop of the Porters Creek Clay, located beneath and immediately south of PGDP marks the southern extent of the buried river valley. Fine sand and clay of the McNairy Formation

Figure D.1. Indoor Sampling Locations for C-400 Cleaning Building Vapor Intrusion Study

Figure D.2. Ambient Air Sampling Locations for C-400 Cleaning Building Vapor Intrusion Study

directly underlie the continental deposits in the buried river valley. These continental deposits are continuous from beneath PGDP northward beyond the present course of the Ohio River.

The general soil map for Ballard and McCracken Counties indicates that three soil associations are found within the vicinity of PGDP (USDA 1976): the Rosebloom-Wheeling-Dubbs association, the Grenada-Calloway association, and the Calloway-Henry association. The predominant soil association in the vicinity of PGDP is the Calloway-Henry association, which consists of nearly level, somewhat poorly drained, medium-textured soils on upland positions. Many of the characteristics of the original soil have been lost due to industrial activity that has occurred over the past 50-plus years. Activities that have disrupted the original soil classifications include filling, mixing, and grading. The soil type present in these disturbed areas is characterized as urban.

D.1.6 HYDROGEOLOGY

PGDP is located in the western portion of the Ohio River drainage 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, PGDP is within the drainage areas of the Ohio River, Bayou Creek, and Little Bayou Creek.

PGDP is situated on the divide between the two creeks. Bayou Creek is a perennial stream on the western boundary of the plant that flows generally northward, from approximately 2.5 miles south of the plant site to the Ohio River. Little Bayou Creek becomes a perennial stream at the east outfalls of PGDP. Little Bayou Creek drainage originates within WKWMA and extends northward and joins Bayou Creek near the Ohio River. The drainage basins for both creeks are located in rural areas; however, they receive surface drainage from numerous swales that drain residential and commercial properties, including WKWMA, PGDP, and Tennessee Valley Authority Shawnee Fossil Plant. The confluence of the two creeks is approximately 3 miles north of the plant site, just upstream of the location at which the combined flow of the creeks discharges into the Ohio River (DOE 2008).

During uranium enrichment operations (1952–2013) and continuing into 2014, most of the flow within Bayou and Little Bayou Creeks was from process effluents or surface water runoff from PGDP. Contributions from PGDP comprised approximately 85% of flow within Bayou Creek and near 100% of flow within Little Bayou Creek. (Process effluents were reduced significantly during 2015.) A network of ditches discharges effluent and surface water runoff from PGDP to the creeks. Plant discharges are monitored at the Kentucky Pollutant Discharge Elimination System outfalls prior to discharge into the creeks.

The local groundwater flow system at PGDP occurs within the sands of the Cretaceous McNairy Formation, Pliocene Terrace Gravel, Plio-Pleistocene lower continental gravel deposits and upper continental deposits, and Holocene alluvium. The primary local aquifer is the Regional Gravel Aquifer (RGA). The RGA consists of the Quaternary sand and gravel facies of the lower continental deposits and Holocene alluvium found adjacent to the Ohio River and is of sufficient thickness and saturation to constitute an aquifer. These deposits have an average thickness of 30 ft. Groundwater flow is predominantly north toward the Ohio River (DOE 2008).

The primary source of groundwater recharge to the RGA derives as downward percolation of infiltrating rainwater and seepage from streams and ponds, through the shallow silt and fine sand units (and lesser clayey units) overlying the RGA. This flow system is termed the Upper Continental Recharge System (UCRS). The top of the saturated zone within the UCRS is the water table, which is poorly known within the Paducah Site overlying the TCE plumes. These sediments have low hydraulic conductivity

(10^{-7} to 10^{-6} cm/sec); hydraulic gradients often approach -1 ft/ft within the saturated UCRS in response to the downward groundwater flow. In the C-400 Cleaning Building area, groundwater is encountered at approximately 30 to 35 ft below ground surface in the UCRS. Figure D.3 presents the hydrogeology of the C-400 Cleaning Building area.

D.1.7 VAPOR INTRUSION CONCEPTUAL SITE MODEL

Section 6 of the WP presents a site-specific VI CSM for C-400 Cleaning Building. The VI CSM detailed in the WP used site-specific information collected during characterization studies and interim remedial actions to describe the nature, location, spatial extent of the vapor sources in the subsurface, as well as the uses (including those that could have the potential to serve as indoor vapor sources), occupancy, and construction of C-400 Cleaning Building. The VI CSM also portrays the hydrologic, hydrogeologic, and geologic setting and its influence on vapor migration and attenuation in the vadose zone.

As described in the WP, TCE contaminated groundwater and soil adjacent to and under C-400 Cleaning Building are considered sources of vapors that may migrate to indoor air in C-400 Cleaning Building. Subsurface conditions in the C-400 Cleaning Building area are considered to allow vapor transport toward the building. Although TCE concentrations in the RGA near C-400 Cleaning Building have decreased, groundwater concentrations still exceed EPA's groundwater Vapor Intrusion Screening Level (VISL). Similarly, while remedial actions have achieved greater than 95% reduction in soil concentrations in areas addressed by a remedial action, vapor concentrations associated with the remaining TCE-contaminated soil are expected to be orders of magnitude higher than the commercial soil gas and sub-slab TCE VISL screening level of 100 (micrograms per cubic meter) $\mu g/m^3$. Therefore, according to the EPA VI Guide, further investigation is appropriate to evaluate the completeness of the VI pathway in C-400 Cleaning Building.

Vapor migration from subsurface groundwater and soil sources through the vadose zone is promoted by the presence of sand in the UCRS in the vicinity of C-400 Cleaning Building, as well as the presence of gravel immediately beneath the building. The large number of utilities present in the vicinity of the building also may serve as preferential pathways for vapor migration. The presence of cracked concrete in the building slab and other potential, but unidentified VI conduits may provide potential pathways for vapor migration into the building. Figure D.4 depicts the TCE plume in the RGA in 2014.

The building includes an exhaust system (plenum with fans) constructed to induce intake of fresh air into the building and exhaust building air from C-400 Cleaning Building to limit the potential for worker exposure to vapors. At least one fan continues to operate. The plenum is below grade level and is designed to enable air flow downward through gratings and other openings in the floor from the main portion of the building and exhaust it through the stack. The plenum also may induce flow of soil gas through conduits or other potential pathways and exhaust this induced flow.

Evaluation of VI Pathway Completeness

The VI CSM describes sources of TCE immediately under and adjacent to C-400 in the form of dissolved-phase groundwater contamination and residual or adsorbed TCE in soil. Additionally, leaks from building drains and sewers are known to have historically contaminated utility trenches and adjacent soils with TCE dense nonaqueous-phase liquid (DNAPL). TCE concentrations in groundwater underlying C-400 Cleaning Building exceed the groundwater screening levels for TCE in EPA's VISL calculator (updated by EPA February 2018). Where TCE DNAPL may be present (e.g., in abandoned drain lines and utility bedding material) under C-400 Cleaning Building due to past practices, the associated vapor concentrations are expected to be orders of magnitude greater than the sub-slab VISLs.

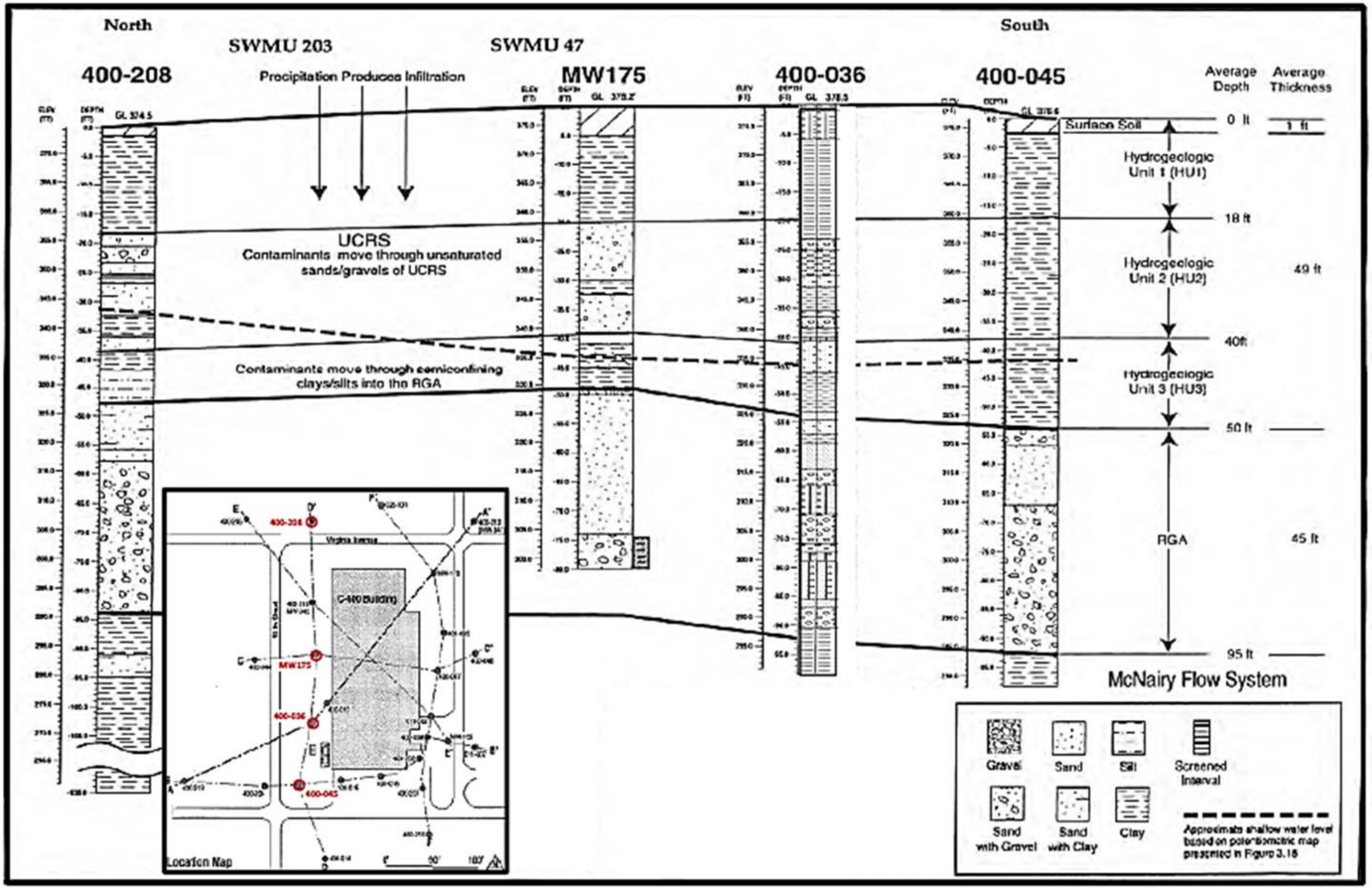

Figure D.3. C-400 Cleaning Building Area Hydrogeology (DOE 1999)

Figure D.4. 2014 TCE Plume Regional Gravel Aquifer in the Area of C-400 Cleaning Building (DOE 2015a)

Known subsurface conditions, including the presence of sandy material in the vadose zone and gravel under the slab, favor vapor migration. There are no impediments (e.g., no laterally continuous clay layers) considered to inhibit vapor transport between the sources and the building sufficient to limit to below VISL levels. The presence of cracked concrete flooring in the building and potentially unidentified VI conduits in the building may provide pathways for vapor migration into the building. As illustrated in Figure D.5, TCE partitions to gas phase from the source(s) and then diffuses away from the source(s) in response to a concentration gradient. When gas-phase TCE diffuses close to the building's foundation, the TCE can be drawn (advected) into the building's interior and mixed with the indoor air through the combined effects of fans, stack effects, and wind loading.

Based on the information presented in the WP and summarized here, DOE determined that vapors may be migrating from the documented source materials under and adjacent to C-400 Cleaning Building and through the sand and gravel into the building. Openings exist in the building's foundation (openings such as perimeter cracks, stress relief seams, and perforations for utility conduits and structural supports) that could serve as a pathway for vapor entry into the building.

DOE concluded that four of EPA's five conditions that can lead to a complete VI pathway are present and documented with site-specific data, including the following:

1. Subsurface sources of vapor are present in soil and groundwater underneath or near C-400 Cleaning Building;

2. Routes exist for vapor transport to the underside of C-400 Cleaning Building and vapor sources are immediately adjacent to the building slab;

3. C-400 Cleaning Building is susceptible to VI; and

4. C-400 Cleaning Building had been occupied by non-remediation workers.

DOE has completed the indoor air sampling to evaluate the remaining EPA condition regarding completeness of the VI pathway (i.e., one or more of the chemicals in the sub-slab soil gas also are present in the indoor environment and, if present, pose an unacceptable health risk), and the results are discussed in this report.

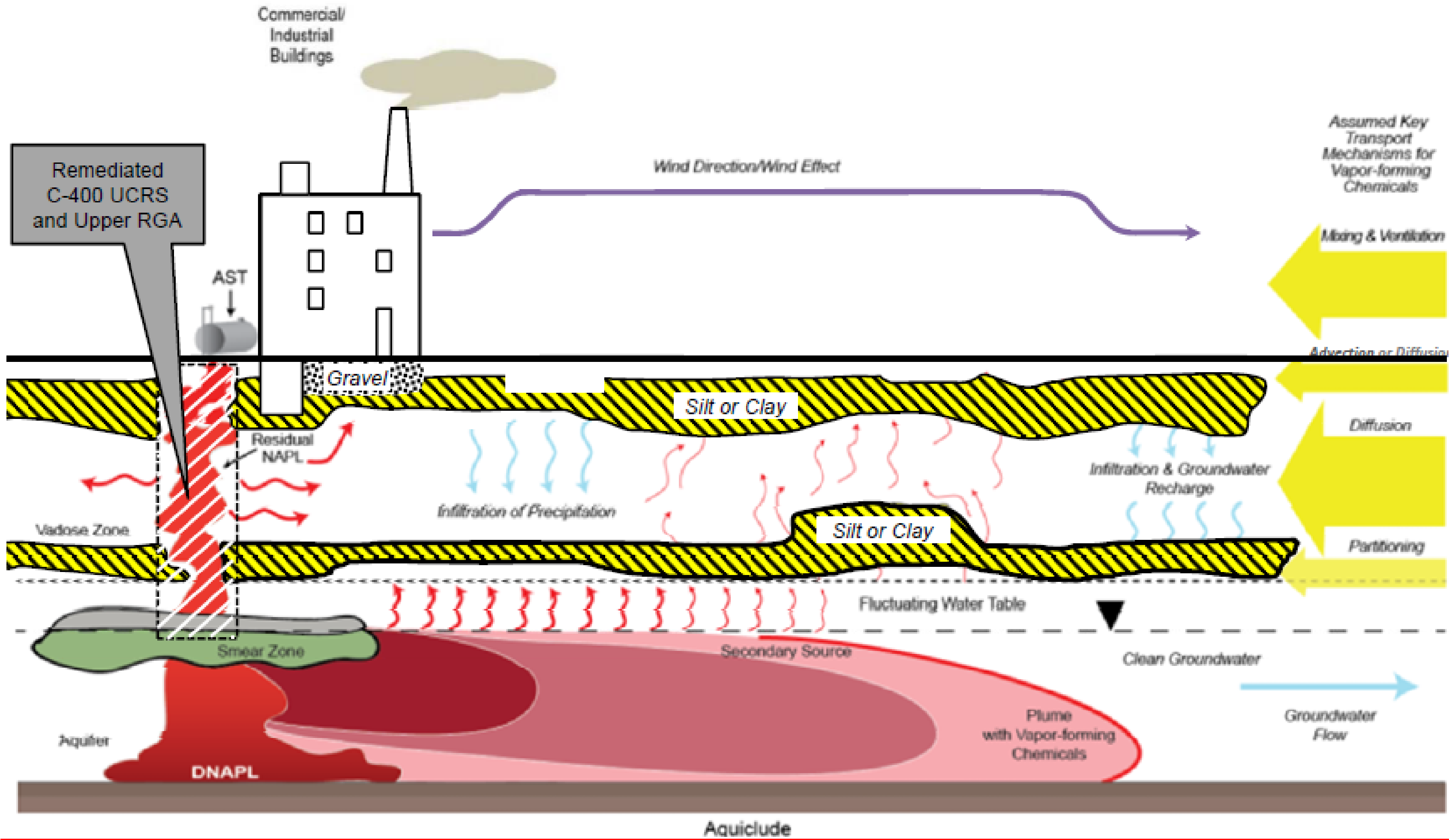

Figure D.5. C-400 Cleaning Building CSM (Approximate Perspective from Northeast Building Corner) Adapted from June 2015 EPA VI Guidance

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D.2. VAPOR INTRUSION STUDY APPROACH

This section describes the methodology used to collect indoor air; sub-slab soil gas, and ambient air samples; and auxiliary data (e.g., 10-second interval differential pressure readings) to support the VI study at C-400 Cleaning Building. All field activities were completed in accordance with the approved WP, except as described below (DOE 2017). Select photographs taken during the sampling events are included in Attachment D1.

D.2.1 SUB-SLAB SOIL GAS SAMPLING FIELD METHODS

Sampling locations were selected based on the areas identified in the WP and areas identified during the walkdown to be away from exterior walls.

Sub-slab Soil Gas Monitoring Probe Installation, Setup, and Leak Checks

On September 14, 18, 19, and 21, 2017, the sub-slab soil gas monitoring probes were installed using a hammer drill with a 5/8-inch drill bit to drill though the concrete to the top of the gravel underlying the slab. The top 2 inches of each monitoring point was enlarged using a 1-inch drill bit to facilitate placement of sub-slab soil gas monitoring probes and surface ports. The sub-slab soil gas monitoring probes were installed after each hole was drilled. The probes consisted of a ¼-inch brass pipe capped with a stainless-steel ball valve and compression fitting, secured, and sealed into the slab using hydraulic anchoring cement. Each probe location was subjected to a helium tracer check to ensure that the annular seal for the probe was not leaking. Nylaflow® tubing and a lung box equipped with a Tedlar® bag were connected to the probe. A plastic shroud was placed over the probe and tubing, then the interior of the shroud was enriched with helium gas. The contents of the Tedlar® bag then were screened for the presence of helium using an electronic helium meter. The helium tracer checks are described and illustrated in a photograph and a diagram in the "Seal Check Procedure for Soil Gas Sampling Operating Procedure" developed by Geosyntec Consultants, included in Attachment D2. The checks include a shut-in vacuum check and a helium tracer check; the results of these leak checks are recorded in the field notes included in Attachment D3. If the leak check failed to meet the guidance, then the hydraulic cement seal was chipped away partially and reset, and the leak check was conducted again to ensure the leak check passed. All locations passed the helium tracer checks that were conducted.

On January 25, 2018, the helium tracer check was conducted again on individual sub-slab soil gas monitoring probes, and all probes passed the leak checks. On January 26, February 9, and 11, 2018, the day prior to each sampling event, 6-liter, individually certified SUMMA® canisters used to collect the gas samples were connected to the seven sub-slab soil gas monitoring probes, and leak checks were conducted to ensure that samples would not be diluted with indoor air.

On January 26, 2018, Locations 3 and 7 failed the initial helium tracer check. The hydraulic cement seal surrounding the probes at both locations was partially chipped out, reset, and allowed to set prior to conducting the leak check again. Both locations passed the second helium tracer check. Locations 3 and 4 failed the initial helium tracer check on February 9, 2018. The hydraulic cement seal surrounding the probe at Location 4 was chipped out partially, reset, and allowed to set; Location 4 passed the second leak check. The hydraulic cement seal surrounding the probe at Location 3 was inspected carefully and found to be intact. Because the probe passed the helium leak test in September 2017, and on January 25 and January 26, 2018, and the analytical results from the January 26 and February 10, 2018, sampling events are similar, the probe location is not suspected of introducing indoor air into the subsurface. A possible explanation for difficulty with the seal check at Location 3 is that material beneath the slab is clay, rather than the anticipated gravel that was present at the other probe locations. Drawing a sub-slab sample was more difficult and required a longer time than at the other probe locations. Sub-slab SUMMA® canisters at Locations 1 through 7 passed the shut-in vacuum check prior to each sampling event.

Helium tracer checks were not completed on February 11, 2018, because the checks had been completed on February 9, 2018, and the probes were not disturbed. Sub-slab SUMMA® canisters at Locations 1 through 7 passed the shut-in vacuum check prior to each sampling event.

After installing the sub-slab soil gas monitoring probes, a ¼-inch tubing was laid from each location to the nearest exterior door. The tubing allowed monitoring of the differential pressure between the indoor air at the sampling location and the ambient air, as required by the WP. Measurement of the differential pressure between sub-slab soil gas and indoor air was enabled by a tee fitting connected to the monitoring probe, the SUMMA® canister, and ¼-inch tubing that was connected to the pressure gauge. The tee fitting on the SUMMA® was equipped with two ball valves, one on either side of the tee fitting, to allow switching between the SUMMA® canister and the pressure gauge and vice versa while collecting pressure readings (see Attachment D2).

D.2.1.1 Sub-slab Soil Gas Sampling

On January 27, February 10, and 12, 2018, the sampling events were conducted under the three scenarios described in the WP. At the start of each sampling event, the SUMMA® canisters were opened at the sub-slab soil gas probes, and the canister vacuum, air temperature at the sampling location, and the differential pressure between the sub-slab soil gas and indoor air was recorded. These measurements were recorded at the start and end of sampling and at two-hour intervals during the sampling event, for a total of six readings per event. Field notes are included in Attachment D3. After 10 hours, the SUMMA® canisters were closed, and final canister vacuums were recorded. The differential pressures were measured using a TEC DG-700 pressure and flow gauge, and the temperature was measured using a TSI 8330 VelociCalc® Plus Multi-Parameter Ventilation Meter.

D.2.1.2 Deviations from the Work Plan

An eighth soil gas monitoring probe was installed near Location 7 to be used for continuous differential pressure logging during each sampling event. The point was drilled and installed following the same methodology described in Section D.2.1.1. No sub-slab soil gas sample was collected from this probe. Differential pressures between sub-slab soil gas and indoor air and between indoor and ambient air were recorded every 10 seconds at this location for each 10-hour sampling event using a 2-channel datalogging micromanometer.[1] Ambient air pressure was measured by running an extra length of ¼-inch tubing from the differential pressure meter located near Location 7 to the nearest exterior door.

No other deviations from the WP were noted during sub-slab soil gas sampling events.

[1] The TEC DG-700 pressure and flow gauge installed near Location 7 stopped collecting continuous pressure readings approximately 1.5 hours after the start of sampling on January 27, 2018. However, differential pressure readings were still collected at the start, at 2-hour intervals, and at the end of the sampling event as outlined in the WP. The continuous pressure readings were collected for the entire sampling period during the February 10 and 12, 2018, sampling dates.

D.2.2 INDOOR AND AMBIENT FIELD METHODS

D.2.2.1 Indoor and Ambient Air Sample Setup

The indoor and ambient air samples were collected using 6-liter, individually certified SUMMA® canisters. The indoor air canisters were set up on January 26, February 9, and 11, 2018, at Locations 1 through 7 and Location 8 (exhaust fan), concurrent with the sub-slab soil gas canister setup. Seven indoor air sample locations were co-located with sub-slab soil gas monitoring locations. On January 27, February 10, and 12, 2018, the ambient air SUMMA® canisters were set up just prior to the start of each sampling event. Four ambient air sample canisters were positioned around C-400 Cleaning Building at locations required by the WP. The position of ambient air Location 3 was selected in the morning from two predetermined locations, depending on the wind direction to avoid emissions from the operating stack on the east side of the building. The southeast location, Location 3SE, was selected for ambient air sample Location 3 during all three sampling events based on the prevailing wind direction at the start of each sampling event. The indoor air and ambient air canisters were positioned such that the intake was in the "breathing zone," considered to be between 5 and 6-ft above the ground.

The Location 8 indoor air sample was collected from the air plenum fan exhaust by inserting a 3/4-inch, schedule 40 PVC pipe through a canvas joint of the duct work. The PVC pipe was secured such that it did not touch the walls of the duct work. Then the ¼-inch Nylaflow® tubing was inserted into the PVC piping and connected the other end to a SUMMA® canister to collect the sample. Immediately prior to opening the SUMMA® canister at the beginning of each sampling event, a minimum of 3-liters of local air was purged through the tubing leading from the sample port using a lung box.

D.2.2.2 Indoor and Ambient Air Sampling

On January 27, February 10, and 12, 2018, the sampling events were conducted under the three scenarios described in the WP. At the start of each sampling event, the SUMMA® canisters were opened at indoor and ambient air sampling locations and the canister vacuums were recorded. The canister vacuum was recorded every 2-hours after opening the canisters and at the closing of the canisters for a total of 6 readings per event. Duplicate samples were connected by ¼-inch Nylaflow® tubing to a duplicate tee fitting using compression fittings. Field notes are included in Attachment D3. After 10 hours, the SUMMA® canisters were closed and final canister vacuum recorded.

At the Ambient Location 5, a Vantage Pro2 W weather station was set up. The weather station continuously logged measurements of wind speed and direction, ambient air relative humidity, barometric pressure, and temperature. These measurements also were recorded in field notes at the beginning and end of the sampling event and at 2-hour intervals for a total of 6 readings (Attachment D3). Attachment D4 contains the weather data from the National Weather Service located at the Paducah Airport.

D.2.2.3 Deviations from the Work Plan

While preparing for the second sampling scenario, "Fan On and Doors Open," an issue with Door #6 was encountered. While Door #6 was being raised, the chain hoist mechanism broke when the door was approximately one ft off the floor. C-400 Cleaning Building has a total of nine large bay doors. Five doors are on the north end, and four doors are on the south end. Door #6 is located on the south end of C-400 Cleaning Building. EPA and Kentucky Department for Environmental Protection (KDEP) agreed that, with all the other doors open, the partial opening of Door #6 was not seen as an issue for the second sampling scenario, "Doors Open and Fan On." Based upon this agreement, the sampling scenario scheduled for February 10, 2018, would occur.

Additionally, it was discussed that for Sunday, February 11, 2018, the setup for the third sampling scenario, "Doors Closed and Fan On," was potentially impacted by the operation of Door #6. The parties discussed that if Door #6 could not be closed safely, then plastic, similar to what currently is in use in the C-400 Cleaning Building, would be used to seal the door with duct tape and sandbags, as necessary. The plastic would be placed on the inside of Door #6 and on the outside of Door #6 for added protection. EPA and KDEP agreed that the modification to Door #6, should it remain inoperable, would be satisfactory and that the third sampling scenario scheduled for February 12, 2018, would continue.

The door remained inoperable, and the plastic and sandbags were necessary to seal Door #6. On March 2, 2018, DOE provided a record of conversation documenting the February 9, 2018, teleconference (DOE 2018b).

No other deviations from the WP were noted for the indoor air and ambient air canister installation and sampling.

D.2.3 POST-SAMPLING EVENT ACTIVITIES

After 10 hours, the SUMMA® canisters were closed and collected. Labels were affixed to each SUMMA® canister and then released for shipment to the laboratory under chain of custody control for analysis by EPA method TO-15. Stands for indoor and ambient air canisters were removed and tubing was rolled, placed in a Ziploc bag and stored next to the respective sub-slab soil gas monitoring probe for subsequent use. Following the final sampling event, all tubing used within C-400 Cleaning Building was collected and dispositioned appropriately.

D.3. RESULTS

The analytical results, field data, and field observations are summarized below. Attachment D5 contains the Excel files for the analytical results and pressure differential readings.

D.3.1 ANALYTICAL RESULTS

Concentrations of TCE, *cis*-1,2-dichloroethene (*cis*-1,2-DCE), *trans*-1,2-dichloroethene (*trans*-1,2-DCE) and 1,1-Dichloroethene (1,1-DCE) were detected in the air samples. TCE was the most commonly detected compound at 46 out of 62 samples, and it was detected in all three media. *cis*-1,2-DCE was detected in only seven sub-slab soil gas air samples. *trans*-1,2-DCE was detected in only six indoor air samples. 1,1-DCE was detected in only one sub-slab soil gas sample. Tables D.1 through D.3 present the results. The results by medium are summarized in the following subsections.

D.3.1.1 Indoor Air Analytical Results

Indoor air samples were collected from Locations 1 through 7, and from Location 8 (exhaust fan) within C-400 Cleaning Building on January 27, 2018, under the fan off, doors closed scenario. A second round of indoor air samples was collected from the same locations on February 10, 2018, under the fan on, doors open scenario. The last round of indoor air samples was collected from the same locations on February 12, 2018, under the fan on, doors closed scenario. These samples were collected concurrently with the sub-slab and ambient samples.

TCE and *trans*-1,2-DCE were the only compounds detected in the indoor air samples. During the first sampling event on January 27, 2018, (fan off, doors closed scenario) a final vacuum of 2-inches of mercury was recorded for the indoor air SUMMA® canister collected at Location 7. The laboratory reported a vacuum of 0-inches of mercury upon receipt of the canister. The indoor air sample for Location 7 under the fan off, doors closed scenario could not be analyzed.

During the January 27, 2018, sampling event, TCE was detected in all the indoor air samples at concentrations ranging from 0.22J μg/m^3 at Location 2, with J indicating an estimated TCE concentration because the compound was detected below the method quantitation limit, to 17 μg/m^3 in the duplicate sample collected at Location 5.

During the February 10, 2018, sampling event, TCE was below the reporting limit (RL) of 0.19 μg/m^3 at Locations 1, 2, 3, 4, and 7 and detected at concentrations ranging from 1.4 μg/m^3 at Location 6 to 2.9 μg/m^3 in the duplicate sample collected at Location 5. *trans*-1,2-DCE was below the RL of 0.2 μg/m^3 in all locations, except Location 7, where it was detected at a concentration of 1.3 μg/m^3.

During the final sampling event on February 12, 2018, TCE was below the RL of 0.19 μg/m^3 at Locations 2, 3, and 4, and detected at concentrations ranging from 0.23J μg/m^3 at Location 7 to 7.1 μg/m^3 in the duplicate sample collected at Location 5. *trans*-1,2-DCE was below the RL of 0.2 μg/m^3 at Locations 1, 2, 3, and 6, and detected at concentrations ranging from 0.2J μg/m^3 at Location 5 to 0.43J μg/m^3 at Location 7.

Indoor air analytical results are summarized in Table D.1, including indoor worker Project Action Levels (PALs) for comparison, and illustrated on Figure D.6. Over the three sampling events, the measured

Table D.1. Indoor Air Analytical Results

Table D.1 page 2 of 3

Table D.1 page 3 of 3

Figure D.6. Summary of Indoor Air Sampling Detections for C-400 Cleaning Building Vapor Intrusion Study

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concentrations of TCE varied by a factor of 3.5 or less at all locations, except Location 5, where it varied by a factor of 8.5. The missing Location 7 indoor air sample from the January 27, 2018, sampling event likely would have been within the same range and, therefore, well below the PALs identified in Table D.1.

As indicated in the Quality Assurance Project Plan (QAPP) contained in Appendix B of the WP, data are placed into and reported from the Paducah Oak Ridge Environmental Information System (OREIS) following verification assessment and validation.

All data were found to be usable during validation, and no data were rejected. TCE results were "J" qualified 6 times, indicating that the compound was detected below the method quantitation limit, resulting in an estimated value. *trans*-1,2-DCE results were similarly qualified 5 times. The requisite number of duplicate indoor air samples identified in the WP were successfully collected from Locations 5 and 6 and analyzed during all the sampling events. Individual RLs for nondetect samples were all below screening levels. QAPP criteria established a relative percent difference (RPD) of ≤ 50% for the field duplicates. Of note, the RPD for 4 samples and their duplicates were above the QAPP criteria and were "J" qualified during validation. These samples were for Location 5 and 6 on February 10 and February 12, 2018.

D.3.1.2 Sub-Slab Soil Gas Analytical Results

Sub-slab soil gas samples were collected from Locations 1 through 7 on January 27, 2018, under the fan off, doors closed scenario, on February 10, 2018, under the fan on, doors open scenario, and on February 12, 2018, under the fan on, doors closed scenario. These samples were collected concurrently with the indoor and ambient samples. TCE, *cis*-1,2-DCE, and 1,1-DCE were the only compounds detected in the sub-slab soil gas samples, although 1,1-DCE was detected only once, at a level only slightly above the RL.

During the January 27, 2018, sampling event, TCE was detected at all sampling locations at concentrations ranging from 14 $\mu g/m^3$ at Location 3 to 9,500,000 $\mu g/m^3$ at Location 5. *cis*-1,2-DCE was below the RL of 0.24 $\mu g/m^3$ at Locations 2, 3, and 4 and below an elevated RL of 30,000 $\mu g/m^3$ due to the high TCE concentration at that location. *cis*-1,2-DCE was detected at Locations 1, 6, and 7 at concentrations of 120, 2.2, and 180J $\mu g/m^3$, respectively.

During the February 10, 2018, sampling event, TCE was detected at all sampling locations at concentrations ranging from 14 $\mu g/m^3$ at Location 3 to 10,000,000 $\mu g/m^3$ at Location 5. *cis*-1,2-DCE was below the RL of 0.24 $\mu g/m^3$ at Locations 2, 3, and 4, and below elevated RLs of 9,500 and 200 $\mu g/m^3$ at Locations 5 and 7, respectively, due to the high TCE concentrations at those locations. *cis*-1,2-DCE was detected at Locations 1 and 6 at concentrations of 140 and 0.69J $\mu g/m^3$, respectively.

During the final sampling event on February 12, 2018, TCE was detected at all sampling locations at concentrations ranging from 16 $\mu g/m^3$ at Location 3 to 12,000,000 $\mu g/m^3$ at Location 5. *cis*-1,2-DCE was below the RL of 0.24 $\mu g/m^3$ at Locations 2, 3, and 4 and below an elevated RL of 10,000 $\mu g/m^3$ at Locations 5 due to the high TCE concentrations at that location. *cis*-1,2-DCE was detected at Locations 1, 6, and 7 at concentrations of 150, 2.3, and 220J $\mu g/m^3$, respectively. 1,1-DCE was detected at 0.15J $\mu g/m^3$ at Location 4 and was non-detect at all other locations

The measured concentrations of TCE varied by less than 25% from one sampling event to the next, with the exception of Location 6, where a J-valued concentration for the second sampling event was a factor of three less than the concentrations reported for the other two events. Sub-slab soil gas analytical results are

Table D.2. Sub-slab Soil Gas Air Analytical Results

Table D.2 page 2 of 3

Table D.2 page 3 of 3

Figure D.7. Summary of Sub-slab Sampling Detections for C-400 Cleaning Building Vapor Intrusion Study

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summarized in Table D.2, including EPA VISLs for comparison, and illustrated on Figure D.7. As indicated in the QAPP contained in Appendix B of the WP, data are placed into and reported from OREIS following verification assessment and validation.

All data was found to be usable during validation, and no data was rejected. *cis*-1,2-DCE results were "J" qualified 3 times and 1,2 DCE was "J" qualified once, indicating that the compound was detected below the method quantitation limit, resulting in an estimated value. Individual RLs for nondetect samples at Locations 1, 5, and 7 were above screening levels identified in Table D.2 due to the concentrations of TCE in the samples.

D.3.1.3 Ambient Air Analytical Results

Ambient air samples were collected from Locations 1 through 4 surrounding C-400 Cleaning Building on January 27, 2018, under the fan off, doors closed scenario. A second round of ambient air samples was collected from the same locations on February 10, 2018, under the fan on, doors open scenario. The last ambient air samples were collected from the same locations on February 12, 2018, under the fan on, doors closed scenario.

TCE was the only compound detected in the ambient air samples. These samples were collected concurrently with the indoor and sub-slab samples.

During the January 27, 2018, sampling event, TCE was below the RL of 0.19 $\mu g/m^3$ at ambient Locations 1 and 4 and detected at ambient Locations 2 and 3 at concentrations of 0.21J $\mu g/m^3$ and 0.36J $\mu g/m^3$, respectively.

During the February 10 and 12, 2018, sampling events, TCE was below the RL of 0.19 $\mu g/m^3$ at ambient Locations 1, 2, and 4 and detected only at ambient Location 3 at concentrations of 0.2J $\mu g/m^3$ and 0.28J $\mu g/m^3$, respectively.

Ambient air analytical results are summarized in Table D.3, including PALs for comparison, and illustrated in Figure D.8. All TCE results from the three sampling events were "J" qualified, indicating that the compound was detected below the method quantitation limit, resulting in an estimated value. As indicated in the QAPP contained in Appendix B of the WP, data are placed into and reported from OREIS following verification assessment and validation.

All data were found to be usable during validation, and no data were rejected. Individual RLs for nondetect samples all were below the PALs identified in Table D.3.

D.3.2 OTHER DATA

D.3.2.1 Pressure Monitoring Data

On February 10 and 12, 2018, at the additional sub-slab soil gas monitoring probe installed near Location 7, the differential pressures between sub-slab soil gas and indoor air and between the indoor air and ambient air were logged at 10-second intervals during the 10-hour sampling events. During the January 27, 2018, field event (fan off, doors closed scenario) the logging micromanometer at the additional sub-slab soil gas monitoring probe near Location 7 ceased to function after 1.5 hours. The 2-hour interval differential pressure was collected at all locations in accordance with the approved WP (Locations 1 through 8), and those data are included in Attachment D3.

Table D.3. Ambient Air Analytical Results

Table D.3 page 2 of 3

Table D.3 page 3 of 3

Figure D.8. Summary of Ambient Air Sampling Detections for C-400 Cleaning Building Vapor Intrusion Study

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Fan Off, Doors Closed Scenario (January 27, 2018)

2-hour Interval Summary: The differential pressure between sub-slab soil gas and indoor air varied at sample Locations 1 through 7 during the course of the sampling event as indicated on the Differential Pressure and Ambient Temperature Monitoring Records included in Attachment D3. Average differential pressures between sub-slab soil gas and indoor air varied between -5.4 Pascals (Pa) (Location 3) to +2.2 Pa (Location 2). The average differential pressure between indoor air and ambient air ranged between -3.4 Pa (Location 7) and +0.1 Pa (Location 1). The differential pressure between Location 8 and ambient air ranged between -2 and -0.2 Pa and averaged -0.7 Pa.

10-second Interval Summary: The sub-slab to indoor air and indoor air to ambient air differential pressures measured during the first 1.5 hours near Location 7 ranged between approximately +0.04 and -0.07 Pa. These variations around a zero pressure differential are consistent with the expectation of near neutral pressure conditions for a closed building without mechanical ventilation, particularly under the moderate temperatures and calm winds recorded during the test period.

Fan On, Doors Open Scenario (February 10, 2018)

2-hour Interval Summary: The differential pressure between sub-slab soil gas and indoor air varied at sample Locations 1 through 7 during the course of the sampling event, as indicated on the Differential Pressure and Ambient Temperature Monitoring Records included in Attachment D3. Average differential pressures between sub-slab soil gas and indoor air varied between -1.4 Pa (Location 3) to +1.7 Pa (Location 4). The average differential pressure between indoor air and ambient air ranged between -4.3 Pa (Location 4) and +1 Pa (Location 7). The differential pressure between the exhaust fan (Location 8) and ambient air ranged between -0.2 and +2 Pa and averaged +0.7 Pa. These observations are consistent with the observations described above, based on the continuous pressure differential monitoring.

10-second Interval Summary: The differential pressure between sub-slab soil gas and indoor air varied between approximately -8 and +8 Pa and averaged +0.14 Pa, which indicates the building interior was, on average, slightly depressurized relative to the sub-slab. The largest variability in differential pressure measurements also occurred in the middle of the day. The measurements of differential pressure between indoor air and ambient air ranged between -0.25 and +2.69 Pa with a consistent average of +0.8 Pa throughout the day, as illustrated in Figure D.9, indicating the building interior was, on average, slightly pressurized relative to the ambient. Vapor entry would be expected to be slightly enhanced under these conditions, but any vapors entering through the slab would have been expected to be diluted by the additional ventilation provided by operating the exhaust fan and keeping the doors open, particularly considering the consistent breeze from the south blowing into the building's southern bay doors.

The average differential pressure +0.14 Pa between sub-slab soil gas and indoor air indicates a higher pressure in the sub-slab than the building interior; therefore, the building was depressurized relative to the subsurface during the sampling event. The average differential pressure of +0.8 Pa between indoor air and ambient also indicates that the building was depressurized. The differential pressure indicates that samples were collected under conditions that foster VI.

Fan On, Doors Closed Scenario (February 12, 2018)

2-hour Interval Summary: The differential pressure between sub-slab soil gas and indoor air varied at sampling Locations 1 through 7 during the course of the sampling event, as indicated on the Differential Pressure and Ambient Temperature Monitoring Records included in Attachment D3. Average differential pressures between sub-slab soil gas and indoor air varied between -3 Pa (Location 4) to +0.1 Pa

Figure D.9. Differential Pressure between Sub-slab Soil Gas and Indoor Air—Fan On, Doors Open Scenario, February 10, 2018

(Location 6). The average differential pressure between indoor air and ambient air ranged between -10 Pa (Location 3) and -0.5 Pa (Location 7). The differential pressure between Location 8 and ambient air ranged between -2.4 and +5.1 Pa and averaged -2.9 Pa.

10-second Interval Summary: The differential pressure between sub-slab soil gas and indoor air varied between approximately -4.2 and +1.5 Pa and averaged -2.9 Pa, which indicates the sub-slab was, on average, depressurized relative to the building interior at Location 7. The data shows an increasing trend, with pressure differentials starting at about -3 Pa and rising to approximately 0 Pa around 14:00 and thereafter appearing relatively stable as illustrated in Figure D.10, as measured at the eighth sub-slab soil gas monitoring probe near Location 7. The differential pressure between indoor air and ambient air varied between -4.6 and +7.4 Pa and averaged -3.7 Pa, indicating the building was, on average, depressurized relative to the ambient. The time trend plot shows an overall increasing trend with pressure differentials starting around -3 Pa, reaching zero around noon, and rising to levels above +3 Pa in the afternoon. Variability increased throughout the sampling event, as illustrated in Figure D.10.

The sub-slab depressurized condition relative to the building suggests that operating the exhaust fan, which is designed to draw building air through a subgrade plenum, also draws subsurface vapors into the plenum. The building depressurization relative to the ambient suggests that VI will be enhanced in areas more distal from the plenum.

D.3.2.2 Weather Data

On January 27, February 10 and 12, 2018, weather data (temperature, relatively humidity, barometric pressure, wind direction, and wind speed) were collected every 2 hours during the sampling events (Attachment D3).

January 27, 2018, (Fan Off, Doors Closed Scenario): Ambient temperature at the weather station was relatively stable, ranging from 50 to 53 degrees Fahrenheit (°F) throughout the day. Relative humidity started at 76% and rose to 90% within 2 hours of the start of sampling. Barometric pressure was steady, around 30.20 inches of mercury (inHg). Conditions were calm with wind speed recorded as 0 miles per hour (mph) during every reading, except the first hour, which recorded a speed of 4 mph blowing from the south-southeast.

February 10, 2018, (Fan On, Doors Open Scenario): Ambient temperature at the weather station was relatively stable, ranging from 38 to 40°F throughout the day. Relative humidity started at 41% and rose to around 50% within 2 hours of the start of sampling. Barometric pressure decreased slightly throughout the sampling event starting at around 30.04 inHg and finishing at 29.97 inHg. The wind was relatively consistent, blowing at around 5 mph in a northerly direction for most of the sampling event.

February 12, 2018, (Fan On, Doors Closed Scenario): Ambient temperature at the weather station increased throughout the field event, starting at 22°F and ending around 40°F. The relative humidity started at 75% and decreased to around 60%. The barometric pressure started at 30.51 inHg and increased to 30.57 inHg in the first 2 hours of sampling where it remained with little fluctuation for the rest of the event. The wind was recorded consistently as blowing in a northerly direction at speeds around 6 mph, except for a reading in the middle of the day where the wind speed dropped to 1 mph.

Figure D.10. Differential Pressure between Sub-slab Soil Gas and Indoor Air—Fan On, Doors Closed Scenario, February 12, 2018

D.4. DISCUSSION

This section compares the indoor air analytical results to PALs for indoor workers and discusses the findings from individual building interior samples (Locations 1–7) relative to the integrated fan exhaust results (Location 8) and ambient air concentrations. These results are evaluated in context of the VI CSM to determine whether the VI pathway is complete and if a completed pathway would present an unacceptable risk to unprotected workers in C-400 Cleaning Building, using the decision rules presented in the WP.

D.4.1 PROJECT ACTION LEVEL COMPARISON

The PALs for indoor workers are included in Tables D.1 and D.3 for comparison to analytical results. The PALs are the same as the EPA commercial scenario VISLs for a cancer risk of 1E-6 or hazard quotient (HQ) of 1.0 for all chemicals, except *cis*- and *trans*-1,2-DCE. The PALs for *cis*- and *trans*-1,2-DCE are the VISLs provided by EPA Region 4, which are based on the Agency for Toxic Substances and Disease Registry's Inhalation Minimal Risk Level of 0.2 ppm (0.8 mg/m^3). As of May 14, 2018, there has been no change in EPA's VISLs since the WP was developed.

Indoor Air

TCE is the only detected compound that exceeded indoor air PALs at any location. The RLs for all compounds were below their respective PALs.

During the January 27, 2018, sampling event (fan off, doors closed), the measured TCE concentration in indoor air exceeded the indoor air PAL of 3.0 μg/m^3 in samples collected at Locations 5, 6, and 8, with the highest indoor air concentrations occurring at Location 5 (12–17 μg/m^3). No other compound was detected during this event.

During the February 10, 2018, sampling event (fan on, doors open), the measured TCE concentration in indoor air did not exceed the indoor air PAL of 3.0 μg/m^3 at any location, suggesting an open door scenario may supply sufficient ventilation to ensure indoor air concentrations are below PALs. TCE was detected at Locations 5, 6, and 8 at concentrations ranging from 1.4 to 2.9 μg/m^3; the highest indoor air concentrations occurred at Location 5 (2.5–2.9 μg/m^3). The only other compound detected in indoor air was *trans*-1,2-DCE at Location 7, at a concentration (1.3 μg/m^3) several orders of magnitude below its PAL of 3,500 μg/m^3. The concentration of the integrated fan exhaust (2.1 μg/m^3 at Location 8) was within the range of concentrations reported at the other building interior locations (1–7), indicating the fan exhaust concentration serves as integrated measure of indoor air concentrations in this scenario.

During the February 12, 2018, sampling event (fan on, doors closed), the measured TCE concentration in indoor air exceeded the indoor air PAL of 3.0 μg/m^3 in samples collected at Locations 5 and 6, with the highest indoor air concentration occurring at Location 5 (7.1 μg/m^3). The only other compound detected in indoor air was *trans*-1,2-DCE at Locations 4, 5, 7, and 8, with estimated concentrations (ranging from 0.2J to 0.43J μg/m^3) several orders of magnitude below the PAL of 3,500 μg/m^3. The concentration of the integrated fan exhaust (2.0 μg/m^3 at Location 8) was within the range of concentrations reported at the other building interior locations (1–7), indicating the fan exhaust concentration serves as integrated measure of indoor air concentrations in this scenario.

Over the three sampling events, the measured concentrations of TCE varied by a factor of 3.5 or less at all locations, except Location 5, where it varied by a factor of 8.5. Exceedances of the TCE PAL were observed only under the doors closed scenarios.

A preliminary risk evaluation was conducted because indoor air TCE concentrations exceeded the PAL at some locations. Cumulative excess lifetime cancer risks (ELCR) and non-cancer hazard indices (HIs) for the indoor worker scenario were calculated and are presented in Table D.4. Location 8 is included in the risk evaluation because concentrations at that location fall within the range of indoor air concentrations measured at the building interior locations. Chemicals that were not detected in any indoor air or sub-slab soil gas samples were not included in the risk evaluation. The chemicals included in the risk evaluation are 1,1-DCE, *cis*-1,2-DCE, *trans*-1,2-DCE, and TCE, which were detected at least once in either indoor air or sub-slab soil gas.

The exposure point concentrations (EPCs) for chemicals at individual locations are the laboratory reported concentrations at those locations. Where duplicate samples were taken, the highest of reported results was used in the calculations. Spatially aggregated EPCs for the building were derived from the results reported for Locations 1–8 for each sampling event. Spatially and temporally aggregated EPCs were derived by combining the data for the three sampling events. The building EPCs are reasonable maximum exposure concentrations derived as the 95% upper confidence level recommended by the latest version of ProUCL (Version 5.1, October 2015) when sufficient data were available or where the maximum reported concentration when insufficient data were available. As recommended by ProUCL, the RL was used for nondetect values, and ProUCL accounted for the nondetects in performing the calculations.

The exposure parameters used to perform the risk evaluation for the Paducah indoor worker scenario were ET = 8 hr/d; EF = 250 d/yr; ED = 25 yrs; AT(nc) = 25 yrs × 365 d/yr; and AT(c) = 70 yrs × 365 d/yr. These exposure parameters are the same as the default commercial scenario exposure parameters EPA uses to calculate VISLs. Thus, for this preliminary risk evaluation, ELCR were derived as the ratio of the EPC to the EPA Cancer VISL at CR = 1E-06. Likewise, the HQs were derived from the ratio of the EPC to the EPA Non-cancer VISL at HQ = 1.0. Cumulative ELCRs and HIs were calculated for each location, for the building during each sampling event, and for the aggregate of sampling events in the building.

The risk evaluation presented in Table D.4 shows the calculated risks are driven by the observed TCE concentrations. The cumulative ELCRs for individual locations, for the building during each sampling event, and for the building over the three sampling events are all well within EPA's acceptable ELCR range of 1.0E-6 to 1.0E-4. The cumulative building ELCR for the fan off, doors closed scenario is 5.6E-6. For the fan on, doors open scenario, all ELCRs are below 1.0E-6; for the fan on, doors closed scenario, the cumulative building ELCR is 1.3E-6. Considering all the data, the cumulative ELCR is 1.6E-6. The building HI for the fan off, doors closed scenario is 1.9, due to the measured concentration at Location 5. For the fan on, doors open and fan on, doors closed scenarios, all HIs are less than 1.0. Considering all the data, the cumulative HI is 0.53. Actual exposures and, therefore, risks likely are lower than assumed, based on the default commercial exposure parameters used in this preliminary risk evaluation because DOE has relocated all office workers and laundry workers from C-400 Cleaning Building. Remediation workers (and/or deactivation workers) currently enter the building only to conduct deactivation activities and have a health and safety plan that covers their activities. Cumulative risks for the building as a whole are within or below acceptable levels. Site-specific exposure times, frequencies, durations, or averaging times that are less than the assumed values would result in even lower risks.

Table D.4. Risk Evaluation—Cumulative Excess Lifetime Cancer Risks and Non-cancer Hazard Indices

Table D.4 page 2 of 4

Table D.4 page 3 of 4

Table D.4 page 4 of 4

Sub-slab Soil Gas

The measured TCE concentrations in sub-slab soil gas exceeded EPA's commercial VISL of 100 $\mu g/m^3$ in samples collected from Locations 1, 4, 5, 6, and 7. The only other detected compounds in the sub-slab soil air were *cis*-1,2-DCE and 1,1-DCE, but were detected at concentrations that are orders of magnitude below their respective screening levels. The TCE concentrations typically did not vary by more than 25% from one sampling event to the next. The analytical RLs for six compounds (1,1,2-trichloroethane, 1,1-dichloroethane, 1,1-DCE, 1,2-dichloroethane, 1,4-dioxane, and vinyl chloride) exceeded their respective screening levels, but only at sample Locations 1, 5, and 7 where sub-slab TCE concentrations were the highest.

Outdoor Air

There were no PAL exceedances in outdoor air. TCE was the only compound detected in the outdoor air samples, with concentrations ranging from 0.2J to 0.36J $\mu g/m^3$. These concentration levels would not constitute a significant source of TCE to indoor air and would not contribute substantially to indoor air risks.

D.4.2 COMPARISON OF INDOOR AIR AND SUB-SLAB SOIL GAS RESULTS

TCE concentrations in indoor air samples were less than 1 $\mu g/m^3$ where TCE was less than approximately 80,000 $\mu g/m^3$ in sub-slab soil gas (Locations 1, 2, 3, 4, and 7), and TCE concentrations were greater than 1 $\mu g/m^3$ in indoor air where the concentration in sub-slab soil gas was greater than 80,000 $\mu g/m^3$ (Location 5). This spatial association is consistent with TCE entering indoor air in the southern portion of C-400 Cleaning Building; that is, the VI pathway is complete. The exception to the spatial association was the Southeast Office (Location 6) where concentrations in indoor air ranged from 1.7 to 4.9 $\mu g/m^3$ and in sub-slab soil gas from 75 to 180 $\mu g/m^3$. Concentrations measured in the exhaust fan (Location 8) also were above 1 $\mu g/m^3$. Sampling Locations 6 and 8 (Southeast Office and exhaust fan, respectively) are relatively close to Location 5 (basement degreaser tanks) and may receive some TCE as it circulates and dilutes in that portion of the building.

The presence of *cis*-1,2-DCE in sub-slab vapor shows there is an underlying groundwater source of TCE. *cis*-1,2-DCE is a common breakdown product of TCE dissolved in groundwater, where groundwater conditions support reductive dechlorination. It is rarely present in commercial products, and it generally is not associated with TCE off-gassing from contaminated vadose zone soil because soils typically are sufficiently oxygenated to preclude reductive dechlorination of TCE (Rivett et al. 2011). In the northern portion of C-400 Cleaning Building, at Locations 2, 3, and 4, *cis*-1,2-DCE was not detected in sub-slab soil gas, and TCE concentrations in sub-slab soil gas ranged from 14 to 200 $\mu g/m^3$, which is consistent with an absence of subsurface sources of TCE that are significant to the VI pathway. In the southern portion of C-400 Cleaning Building, near Locations 1, 6, and 7, TCE concentrations in sub-slab soil gas ranged from 75 to 77,000 $\mu g/m^3$, and *cis*-1,2-DCE was detected in sub-slab soil gas, consistent with a groundwater source of TCE (see Figure D.4) and a complete VI pathway. It also is possible residual TCE in soil is contributing to the TCE in indoor air. In the southern portion of C-400 Cleaning Building near Location 5, high TCE concentrations (ranging from 9,500,000 to 12,000,000 $\mu g/m^3$) were observed in both sub-slab and indoor air, but no *cis*-1,2-DCE was detected, indicating a vadose zone soil source of TCE likely is responsible for the elevated sub-slab and indoor air TCE concentrations in this area.

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D.5. SUMMARY AND CONCLUSIONS

TCE is the only detected compound that exceeded its PAL in indoor air or screening level in sub-slab soil gas at any location (Tables D.1 and D.2). Exceedances of the indoor air PAL were observed only under closed door scenarios. TCE was detected at low concentrations in outdoor air, but only at levels well below its PAL. The detected TCE concentrations in indoor air were greatest at Location 5 (see Figure D.6) coincident the highest detected TCE concentrations in sub-slab soil gas.

A preliminary risk evaluation showed the calculated cumulative ELCRs are within EPA's acceptable cancer risk range of 1.0E-6 to 1.0E-4. All individual location ELCRs are at or below 5.7E-6. The cumulative building ELCR for the fan off, doors closed scenario is 5.7E-6. For the fan on, doors open scenario, all ELCRs are below 1.0E-6 and for the fan on, doors closed scenario, the cumulative building ELCR is 1.3E-6. The cumulative ELCR considering all the data is 1.6E-6. The building HI for the fan off, doors closed scenario is 1.9, due to the measured concentration at Location 5. For the fan on, doors open and fan on, doors closed scenarios, all HIs are less than 1.0. Considering all the data, the cumulative HI is 0.53. The lowest risks are presented by the fan on, doors open scenario. The highest risks are presented by the fan off, doors closed scenario.

Actual exposures and risks likely are lower than calculated based on the default commercial exposure parameters because DOE has relocated all office workers and laundry workers from C-400 Cleaning Building. Remediation workers (and/or deactivation workers) currently enter the building only to conduct deactivation activities and have a health and safety plan that covers their activities. Cumulative risks for the building as a whole currently are within or below acceptable levels. More realistic, site-specific exposure times, frequencies, durations, or averaging times that would be less than the assumed values would result in even lower risks.

The spatial association between elevated indoor air and sub-slab soil gas concentrations is consistent with a conclusion that the VI pathway is complete, particularly in the southern portion of the building. The presence of *cis*-1,2 DCE in sub-slab vapor in some locations shows there is an underlying groundwater source of TCE. The absence of TCE in sub-slab vapor in other locations shows there also are vadose zone soil sources of TCE. The low-level detections of TCE in the outdoor air would not constitute a significant source of TCE to indoor air. These observations are consistent with the preliminary VI CSM presented in the WP.

Based on the decision rules, the VI study results show that the VI pathway for TCE is complete and exceeded PALs in indoor air at Locations 5, 6, and 8. Based on the sub-slab concentrations in these areas, TCE concentrations in indoor air greater than the screening level continue to be possible, particularly under closed door conditions. However, cumulative excess lifetime cancer risk assuming chronic exposure by unprotected industrial workers was less than 6.0E-06 at all locations, and cumulative hazard index assuming chronic exposure by unprotected industrial workers was less than 1.0 at all but one location. Periodic air monitoring, worker access restriction or both, and/or increased ventilation may be appropriate steps to take if it is anticipated remediation workers will spend substantial time in the building in the vicinity of Locations 5, 6, and 8, until the building is decommissioned or the source is remediated.

The VI pathway is either incomplete (i.e., indoor air sampling result is nondetect) or is complete with a sampling result below the PAL, at all other sampled locations. While sub-slab soil gas concentrations are above PALs at some of the other locations (1, 4, and 7), indoor air concentrations either do not exceed their respective indoor air PALs, or they are nondetect under all tested scenarios.

Considering that the groundwater under C-400 Cleaning Building contains the highest concentrations of TCE and geologic conditions most favorable for vapor transport, it is unlikely that indoor air in other PGDP structures of similar construction with groundwater as the primary potential source of vapors would have VOC concentrations above a level that could pose an unacceptable risk to current protected workers.

D.6. REFERENCES

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ATTACHMENT D1

SAMPLING LOCATIONS

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Photographic Record

Client: U.S. Department of Energy	**Project Number:**
Site Name: C-400 Vapor Intrusion Study	**Site Location: Paducah, KY**

Photograph ID: 1 **Date: 1/27/2018** **Direction: NW** **Comments: Ambient 1 sampling location on west side of C-400**	
Photograph ID: 2 **Date: 1/27/2018** **Direction: S** **Comments: Ambient 2 sampling location on north side of C-400**	

Photographic Record

Client: U.S. Department of Energy	**Project Number:**
Site Name: C-400 Vapor Intrusion Study	**Site Location: Paducah, KY**

Photograph ID: 3

Date: 1/27/2018

Direction: W

Comments: Ambient 3SE sampling location on the east side of C-400

Photograph ID: 4

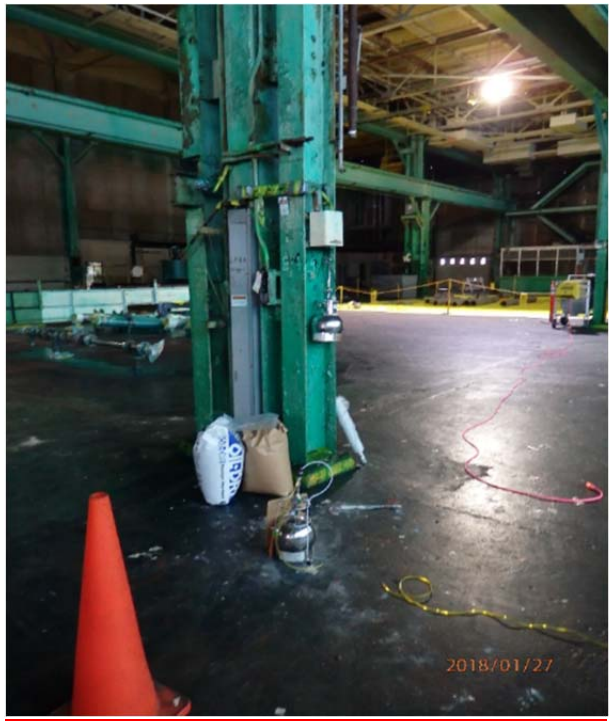
Date: 2/10/2018

Direction: N

Comments: Ambient 4 sampling location on south side of C-400

Photographic Record

Client: U.S. Department of Energy	**Project Number:**
Site Name: C-400 Vapor Intrusion Study	**Site Location: Paducah, KY**

Photograph ID: 5 **Date: 1/27/2018** **Direction: SE** **Comments: Indoor air and subslab soil gas sampling at Location 1**	
Photograph ID: 6 **Date: 2/10/2018** **Direction: W** **Comments: Indoor air and subslab soil gas sampling at Location 2**	

Photographic Record

Client: U.S. Department of Energy	**Project Number:**
Site Name: C-400 Vapor Intrusion Study	**Site Location: Paducah, KY**

Photograph ID: 7

Date: 1/27/2018

Direction: W

Comments: Indoor air and subslab soil gas sampling at Location 3

Photograph ID: 8

Date: 2/10/2018

Direction: W

Comments: Indoor air and subslab soil gas sampling at Location 4

Photographic Record

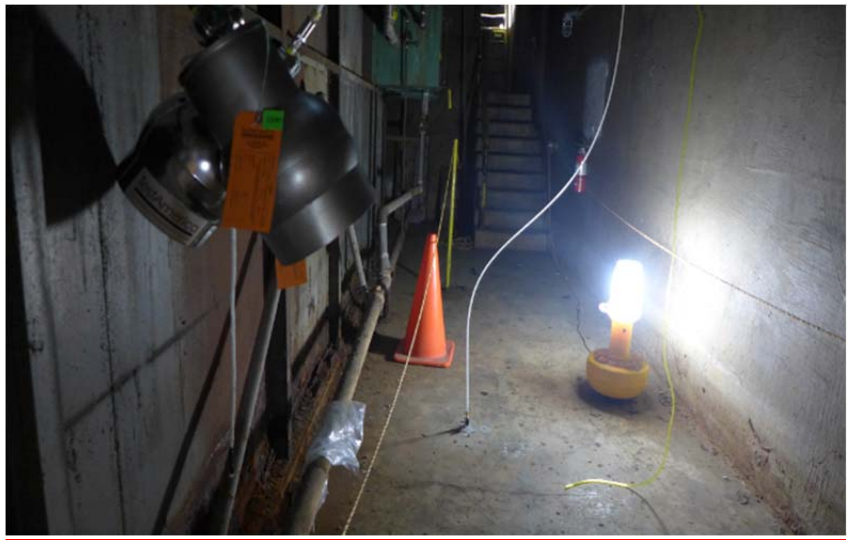
Client: U.S. Department of Energy	**Project Number:**
Site Name: C-400 Vapor Intrusion Study	**Site Location: Paducah, KY**

Photograph ID: 9

Date: 2/10/2018

Direction: E

Comments: Indoor air sampling and subslab soil gas probe at Location 5



Photograph ID: 10

Date: 1/27/2018

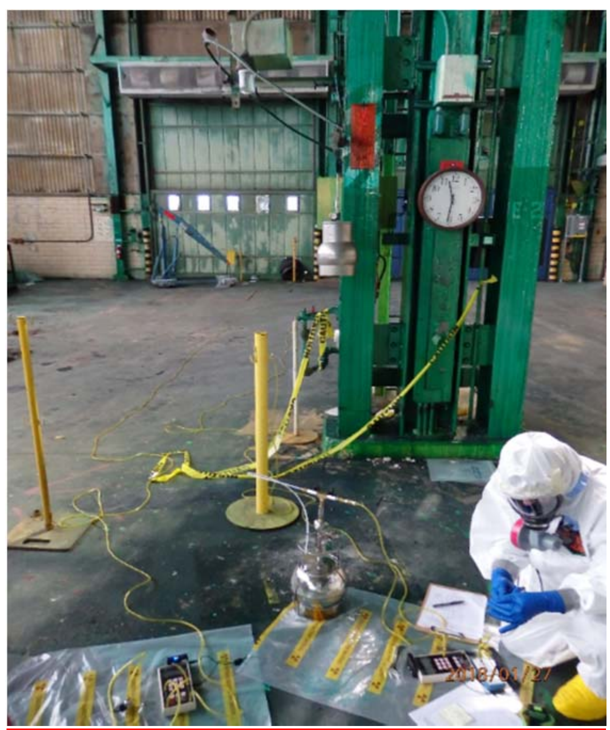
Direction: E

Comments: Subslab soil gas sampling set at Location 5

Photographic Record

Client: U.S. Department of Energy	**Project Number:**
Site Name: C-400 Vapor Intrusion Study	**Site Location: Paducah, KY**

Photograph ID: 11 **Date: 1/27/2018** **Direction: SE** **Comments: Indoor air and subslab soil gas sampling at Location 6**	

Photograph ID: 12 **Date: 1/27/2018** **Direction: S** **Comments: Indoor air and subslab soil gas sampling at Location 7, with continuous differential pressure readings**	

Photographic Record

Client: U.S. Department of Energy	Project Number:
Site Name: C-400 Vapor Intrusion Study	Site Location: Paducah, KY

Photograph ID: 13	
Date: 1/27/2018	
Direction: SE	
Comments: Indoor air sampling from within the exhaust fan at Location 8; port set at the y - junction with tubing advanced to non-radiological contamination area.	

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ATTACHMENT D2

OPERATING PROCEDURE, SOIL GAS SAMPLING

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SEAL CHECK PROCEDURE FOR

SOIL GAS SAMPLING

Geosyntec Consultants, Inc.

Last revision: December 2009

1 INTRODUCTION

This procedure describes the methods for completing seal checks and sampling sub- and soil gas probes to assess potential human health risks due to subsurface vapor intrusion to indoor air and subsequent inhalation exposures.

2 VACUUM SHUT-IN SEAL CHECK

The sampling equipment will be assembled as shown in Figure 2, and will be checked for leaks by conducting a "shut-in" check prior to purging. Valves V-1 and V-3 will be closed (valves V-2 and V-4 open) and then the lung box and Tedlar® bag will be used to exert a vacuum on the sampling train (80 - 100 inches of water [in-H_2O]). Valve V-2 will then be closed and the vacuum observed for at least 60 seconds to ensure it does not dissipate.

If the check indicates a leak, the connections should be disconnected and carefully reconnected one at a time until the leak is fixed. The seal check must be repeated until all leaks have been fixed.

3 HELIUM SEAL CHECK

After the "shut –in" check, a Tedlar bag will be attached to the tubing inside the lung-box and the lid of the lung box will be secured. V-2 will remain closed while the valve under the shroud (V-1 and V-4) will be opened and the shroud filled with helium (10 to 30%). The minimum and maximum concentrations of helium observed in the shroud during the collection of each Tedlar bag sample will be recorded. The lung box will be turned on and V-2 opened to begin purging. The Tedlar bag will fill at flow rate constrained by the flow controller, typically about 200 mL/min. The time to fill the Tedlar bag should be recorded. The Tedlar bag will visibly fill inside the lung box. As it approaches ¾ full, valve V-2 will be closed and the lung box will be turned off.

The lid of the lung box will be opened, the valve on the Tedlar bag closed, and the Tedlar bag removed from the lung box. The Tedlar bag will be connected to the helium meter and the stabilized reading will be recorded.

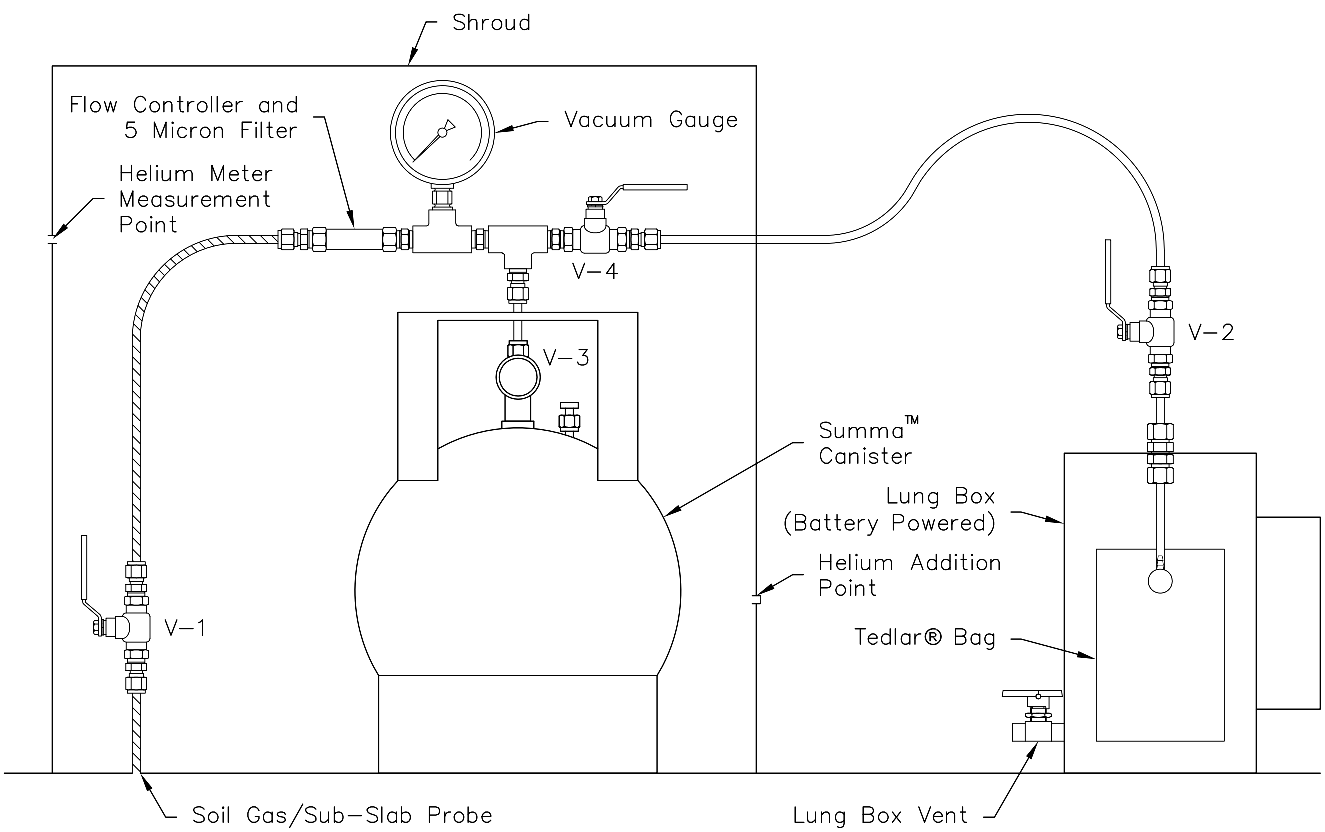
If the concentration of helium in the Tedlar bag is greater than 5% of the concentration in the shroud, the probe seal and fittings should be checked to determine the location of the leak. Once the leak has been fixed, resume purging and field screening. The purging and field screening procedure will be repeated for a minimum of three sets of readings.

4 SUMMA CANISTER SEAL CHECK

Valve V-1 and V-4 will be closed and then valve V-3 (summa canister valve) will be opened to induce a vacuum on the sample train. The vacuum in the sample train will be observed for a short duration (30 seconds) to ensure it does not dissipate as a final check that the sample train does not contain any leaks. Valve V-1 will then be opened and the sample collection time recorded. The vacuum gauge on the Summa canister should be monitored and closed when the residual vacuum in the canister is about 5 in Hg.

5 EQUIPMENT BLANK

The equipment blank is collected by connecting a Summa canister to a fully assembled soil gas probe (screen, tubing, and valve) prior to installation via Swagelok fittings through a 200 milliliter per minute (mL/min) flow controller. The Summa canister valve is opened to draw the contents of the tubing and outdoor air into the canister through the probe tip and Swagelok valve.



Legend

New Nylaflow® Tubing

Non-Dedicated Tubing

Soil Gas Purging and Sampling Assembly

Geosyntec
consultants

Guelph	July 2009	Figure 2

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ATTACHMENT D3

FIELD NOTES

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C-400 Vapor Intrusion Study
Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah
Deactivation Project

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion

LOCATION: PGDP PROJECT NO.: KX5883 TASK NO: 43B

DESCRIPTION: VI SAMPLING DATE: 9/11/2017

CONTRACTOR: FPDP, GEOSYNTEC, GEOCONSULTANTS, LSRS

WEATHER: PARTLY CLOUDY, WARM, BREEZY

12:30 PROJECT MEETING; SAFETY TOPIC: WORK ZONE SAFETY
— SILICA AFFECTED WORKER TRAINING
ATTD: RON HYATTE - H&S LEAD, FPDP; CHAD HOLZER (GEO); S. FOUNTAIN;
JOE TOWORNAKI (FPDP); GAYE BREWER (KDWM); BRANDON TAYLOR (GEO)
JASON BOULTON (GEO); STEPHEN COLLINS; SHAY MITCHELL (LSRS)
GEO TF 4/26/18
— INDUSTRIAL HYGIENE WORK PERMIT
— C-400 HASP, JHA BRIEFING
— JARED COULSON; C-400 MANAGER
1350 GO TO C-400; WALKDOWN SAMPLING LOCATIONS
1500 DEMOB FROM FIELD

~~AF 9/11/2017~~

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C-400 Vapor Intrusion Study
Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah
Deactivation Project

AF 9/11/2017

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C-400 Vapor Intrusion Study
Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah
Deactivation Project

DAILY FIELD REPORT

PROJECT: C-400 VAPOR INTRUSION

LOCATION: PGDP PROJECT NO.: KX5883 TASK NO: 43B

DESCRIPTION: VI SAMPLING DATE: 9/14/17

CONTRACTOR: FPDP, GEOSYNTEC, GEO CONSULTANTS, LSRS

WEATHER: SUNNY, WARM

12:20 MEETING ON C-400 VI DRILLING
— SAFETY TOPIC: STOP WORK AUTHORITY
— EP/P IN PLACE; CONCRETE SCANNER; WORK ORDER;
IHWP; JHA; TASK INSTRUCTION; RWP; DELIBERATE OPERATIONS
— GEOSYNTEC STAFF: Teresa Fischer, Stefanie Fontain,
David Jenson, Kristoffer Henderson
— GME RESPIRATOR CART. CHANGE OUT DAILY BASED ON
MAX 50 ppm
— DRILLING IN CLEAN AREA TODAY (OFFICE ROOM; LOCATION ~~7~~ 6)
~~13~~ 14:00 TF 4/26/18 MOBILIZE TO C-400
SET DRILLING LOCATION FOR LOCATION 6 SCANNED
FOR REBAR. RADCON SCANNED LOCATION.
13:50 START DRILLING LOCATION 6 BY SETTING WORK AREA
BOUNDARIES. DRILL W/ 5/8" BIT. HEPA VACUUM USED
TO COLLECT DUST. 13:52 THROUGH THICKNESS. OVER
DRILLING TOP 2" TO 1" DIA. 1353 DRILLING AT
LOCATION 6. CREWS CLEAN UP DUST. RADCON SCAN
HOLE - OK. PID AT HOLE = 0 ppm; PID AT BZ = 0 ppm
CLEAN OUT BORING DEPTH = 8" TOP OF CONCRETE FLOOR
TO BOTTOM OF CONCRETE.
14:10 INSTALL PROBE
14:25 COMPLETE PROBE INSTALLATION, CONE PLACED IN FRONT

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4/26/18

14:25 CONTINUED. SECURE EQUIPMENT PUT UP CAUTION TAPE

1430 DEMOB

TF 8/14/18

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Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah Deactivation Project

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion

LOCATION: PGDP PROJECT NO.: KX5883 TASK NO: 43B

DESCRIPTION: VI Sampling DATE: 9/18/2017

CONTRACTOR: FPDP, Geosyntec, Geo Consultants

WEATHER: Warm, Overcast

1300 Assemble at C-412 T12 for POD
- Teresa Fischer (Geosyntec), Jason Boulton (Geo), Brandon Taylor (Geo), Shay Mitchell (USRS), Stephen Collins (Rad Con)
- Review Industrial Hygiene Work Permit & RWP
- General safety breifing; STOP WORK authority Regardless of time pressure; STOP WORK as necessary
- 9/19/2017 Meet time is 0630
- Location 3 with Area 14 to be drilled today

1330 Teresa Fischer receives Polar Heat Monitor Training

1400 Mobilize to C400
- Dress out; wait ~~what~~ (TAF 4/26/18) on IH/Safety to arrive. Since working in caustic area w/ potential for silica drillers (Jason & Brandon) don respirators. Others to remain outside of exclusion zone perimeter of 25 ft.

1444 Set up at Location 3. Mark monitoring point to be drilled.
- Start drilling after non-respirator wearers leave zone.

1455 Drilling stopped at 18 inches; concrete still intact.
- Continue drilling to hammer drills extent of 25-inches.
- No breakthrough. 36-inch bit to be used.
- Leave supplies for port in area

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1500 Driller doff PPE
1515 Demobilize from C400

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TAF 4/26/18

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C-400 Vapor Intrusion Study
Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah
Deactivation Project

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study
LOCATION: PGDP PROJECT NO.: KX5883 TASK NO: 43B
DESCRIPTION: VI Sampling DATE: 09/19/2017
CONTRACTOR: Geosyntec Consultants and GEO Consulting
WEATHER: Humid, Warm, Partly Cloudy

0635 Plan of the Day lead by Shay Mitchell at C-412 T12
- Attendance: Shay Mitchell, Teresa Fischer Jason Bolton Brandon Taylor Stephen Collins; Cassidy Mc.
- Safety Topic: Be vigilant about Heat Stress; STOP WORK Authority; Vehicle & Work Area walk arounds; stay times

0700 Mobilize to C-400 to mark locations of monitoring points prior to initaiting drilling

0739 Don PPE to enter C-400

0747 Mark Location 2 in Zone 3; ~~Loc~~ TAF 4/26/18 Location 1 in Zone 4; Location 4 in Zone 12; Location 7 in Zone 10.
- Cannot mark Location 5 in Zone 8 or Location 8 in Zone 13 at this time.

0820 Complete marking monitoring points; doff PPE & scan out of C-400.

0845 Don PPE; IH/Safety has arrived (Cassidy Mc.)
- Set up at Location 2 in Zone 3, establish a 25-ft perimeter for respirable silica
- Drillers in Respirators & Saranac for this location due to caustic surface.

0857 Start drilling Location 2

0902 Finish drilling Location 2; 20-inches deep
- Set probe; barricade area

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0934 Set up at Location 1 in Zone 4, establish a 25 ft ~~perim~~ perimeter for respirable silica

0937 Start drilling Location 1

0949 Complete drilling at Location 1; depth is 18 3/4-inch
- Set probe; barricade area

0958 Set up at Location 7 in Zone 10, establish a 25 ft perimeter for respirable silica.

~~0100~~ TAP 4/26/18

1000 Start drilling Location 7 in Zone 10

1005 Finish drilling Location 7; depth is 20 1/4-inches
- Set probe; barricade area.

1020 Doff PPE; scan out of C-400. Locations 4 (Zone 12) and 5 (Zone 8) to be completed after 1300.

1300 Don PPE to enter C-400.

1307 Set up at Location 4 in Zone 12; establish a 25 ft perimeter.
- Drillers in repirator protection.

1312 Start drilling at Location 4

1315 Finish drilling Location 4; depth in 15 1/2 inches
- Set probe; barricade area

1330 Set up at Location 5 in Zone 8; establish a 25 ft perimeter for respirable silica

1337 Start drilling; rebar encountered. Point moved ~3 inches north of original point. Still within 3 ft circle pictured in Work Plan

1345 Finish drilling Location 5; depth is 20 1/2-inches
- Set probe; barricade area

1400 Leave basement (Location 5) area

1430 Doff PPE; scan out of C-400

1450 Leave C-400

1500 Field activities complete

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C-400 Vapor Intrusion Study
Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah
Deactivation Project

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study

LOCATION: PGDP PROJECT NO.: KX5883 TASK NO: 43B

DESCRIPTION: VI Sampling DATE: 09/21/2017

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Warm & humid; clear

0635 POD in C-412 T12 with TF, JB, BT, SM, SC, CM & CK
- Safety Topic → Pollution Prevention Week
- Use proper lifting technics; caution w/ suspended loads
- Review RWP → Respirator for JB & BT while drilling monitoring points. No respirator for TF but stay outside 25 ft exclusion zone
- Caution with high pH at Location 2. Don't kneel or lay tools in direct contact with ground.

0710 Mobilize to C400. Wait while POD is completed for C400 personnel.

0800 Don PPE. Go to Location 7 to install point for continous differential pressure monitoring
- 3 ft NE of Location 7
- 18 3/4 inches deep.

0824 Set probe for continuous monitoring

0830 Leave CA; Doff PPE & wait for equipment to be scanned.

0930 Arrive at Location 3; set up 25 ft exclusion zone for respirable silica
- Mark 3 ft circle; select ~~20~~ 2 points for drilling within circle. TAP 9/21/2017
- Provide guidance on which direction to drill outside of circle. (To the NE)

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- 1st attempt within circle → no breakthrough @ 25.5 ~~ft~~ in.
- 2nd attempt within circle → obstruction at ~ 14-inches
- 3rd attempt NE of circle → no breakthrough @ 25.5 inches
- 4th attempt NE of circle → break-through at 19 1/4-inches

Silty ~~class~~ clay on drill bit. No gravel encountered. TAP 9/21/2017

1045 Set probe at Location 3.

1100 Leave C400 & LA.

1300 Assemble at ~~C400~~ C412 T12 for afternoon breifing

- JB, BT, TF, DJ, KH, SM & Quality (Nate Ing & Steve Sheeks)
- Safety topic → heat stress. Polar Heart Monitoring for DJ & K completed
- Discuss Helium Shroud Seal Check with personnel from Quality.
  - Information purposes to ensure ambient air in C400 is not entering sub-slab monitoring point.
  - Certification is not necessary.

1400 Mobilize to C400; stage supplies & equipment at CA boundary to conduct Helium Seal Check

- Don PPE; enter C400

1428 Location 5 → Set up equipment & meters

- Fill shroud with Helium → 1st Check
- Pre-tedlar; 26.6 %
- Post-tedar; 20.8 %
- Teldar → 6,600 ppm; less than 1%
- Fill shroud with Helium → 2nd check
- Pre-tedlar; 30.6 %
- Post-tedlar; 28.2 %
- Tedlar → 14,000 ppm; greater than 1%. Add concrete

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Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah
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DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study

LOCATION: PGDP PROJECT NO.: KX5883 TASK NO: 43B

DESCRIPTION: VI Sampling DATE: 09/21/2017

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Afternoon is hot & humid.

1502 Location 7 → Set up Helium Seal Check (Pressure)
- Shroud: 33.9% } 1st Check
- Tedlar: 1500 ppm ; less than 1%
- Shroud: 31.6% } 2nd check
- Tedlar: 1675 ppm ; less than 1%

1512 Location 7 (Probe) → set up Helium Seal Check
- Shroud: 35% } 1st Check
- Tedlar: 2.2% ; too high
- Tighten fittings
- Shroud: Pre 28.2% & Post 21.7% (pre & post)
- Tedlar: 15,200 ppm; greater than 1%. Add concrete.

1542 Location 1 Helium Seal Check
- Shroud: Pre - 27% ; Post 27% } 1st check
- Tedlar: 9750 ppm ; less than 1%
- Shroud: Pre - 25.7% ; Post - 23% } 2nd check
- Tedlar: 11,750 ppm ; less than 1%
- Add concrete

1600 Location 2 Helium Seal Check
- Shroud: Pre - 27.6% ; Post - 27.5% } 1st Check
- Tedlar: 0 ; less than 1%
- Shroud: Pre - 18.1% ; Post - 18% } 2nd cher
- Tedlar: 0 ppm ; less than 1%

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1613 Location 4 Helium Seal Check
- Shroud: Pre - 27.8% ; Post 25% } 1st check
- Tedlar: 0 ppm
- Shroud: Pre - 26.7% ; Post 24.8% } 2nd check
- Tedlar: 0 ppm

1630 Exist CA ; Doff PPE
1643 Location 3 Helium Seal Check
- Shroud: Pre - 23% ; Post 20.7%
- Tedlar: 8.2% ; Add cement.

1703 Location ~~4~~ 6 TAP 9/21/17 Helium Seal Check
- Shroud: Pre - 21.3% ; Post - 20% } 1st Check
- Tedlar: 3575 ppm ; less than 1%
- Shroud: Pre - 20% ; Post - 19.8% } 2nd check
- Tedlar: 50 ppm ; less than 1%

1745 Leave LA
- Unpack at GEO trailer.
- Prepare equipment for Sceanario setup up.

1800 Field activities complete.

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9/21/17

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DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study – Fan Off; Doors Closed

LOCATION: PGDP PROJECT NO.: KX6467 TASK NO: 01/04

DESCRIPTION: VI Sampling DATE: 01/25/2018

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Clear & Cold

0630 Assemble @ C-730-TS for JHA, HASR & RWP briefing

- Meet with Jeff Bennett (Acting FLM), Eric Williams (H&S) Jason Botton & Brandon Taylor (GEO)
- Discuss changed conditions at C-400. West side of C-400 now ARA. Respirators required.

0730 Mobilize to C-400 after loading equipment & materials

- Dress out for CA; TRU with respirators.

0812 Enter C400

- Check probe & tubing at Location 2 → tubing sealed within ziploc bag can be used for differential pressure.
- Chip out seal around probe @ Location 2; reseal
- Location 1 → check probe & tubing → tubing sealed & intact. Chip out seal around probe; reseal

0900 Enter BCS; don additional PPE & monitors for Locations 5 & 8.

0905 Enter C400

- Location 8 → Reset sample intake within Exhaust Fan; Lay out new tubing for differential pressure measurements.
- Location 5 → check probe seal & tubing. Add additional grout. Set tubing up to be able to sample from catwalk

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- Location 7 → Check probe & tubing. Chip out grout & re-seal. Tubing entact & contained within ziploc bag.
- Location 4 → check probe & tubing. Chip out grout & re-seal. Tubing entact & containet within ziploc bag.

1030 Doff PPE; screen out of Radcon.

- Check probes & tubing at Locations 3 & 6.
- Location 6 → probe & tubing entact.
- Location 3 → chip out grout & re-seal. Tubing entact & in good condition.

1100 Mark locations of Ambient samples.

1110 Exit Limited Area. Field activities completed for probe & tubing inspections.

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1/25/2018

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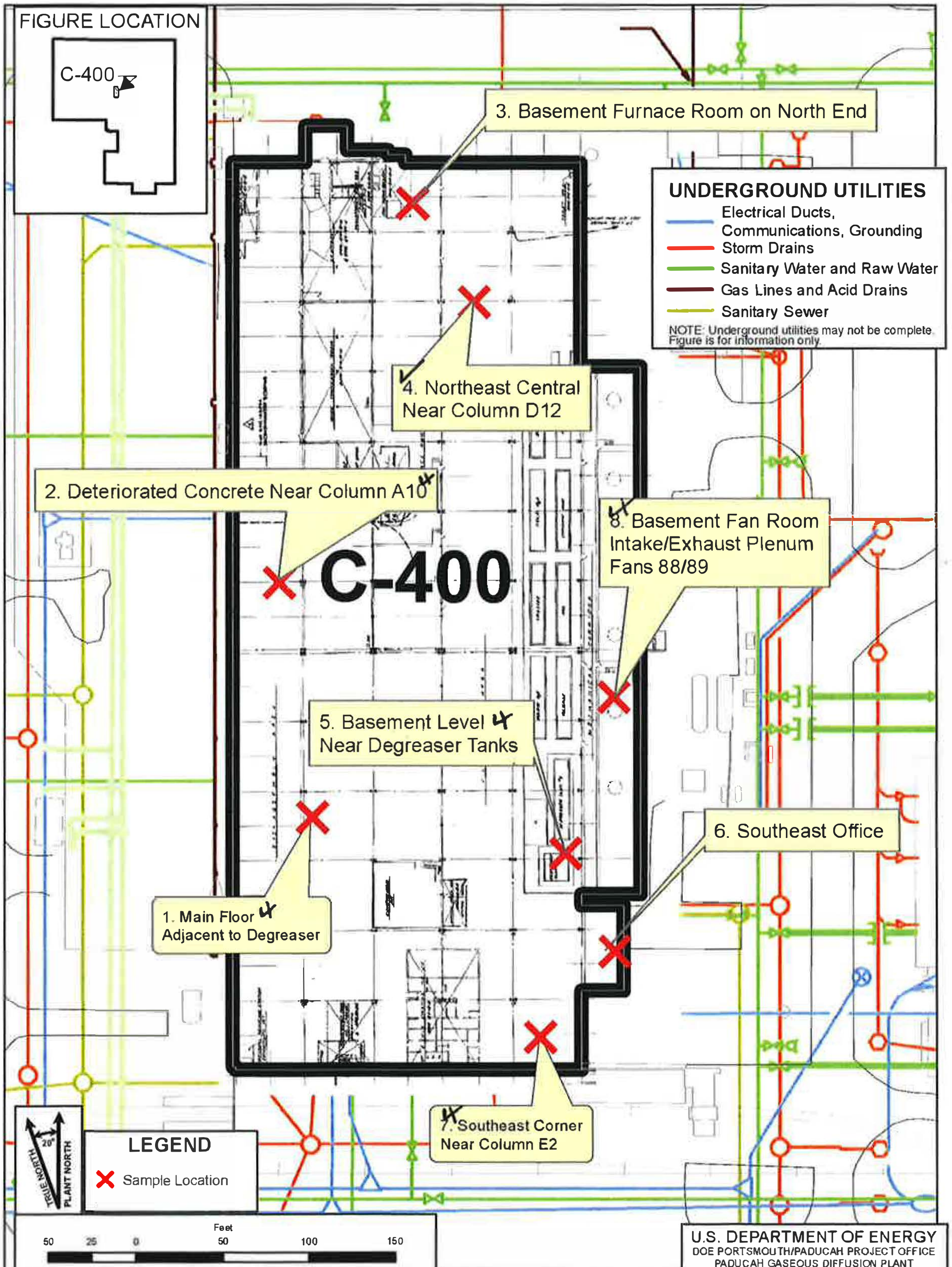

Figure 12. Indoor Sampling Locations for C-400 Building Vapor Intrusion Study

G:\GIS\ARCVIEWS\PROJECTS\Vapor Intrusion\MOA 400\Figure 17. C-400 Map (with Approximate Sampling Locations for VI).mxd
7/25/2017

5/15/2018

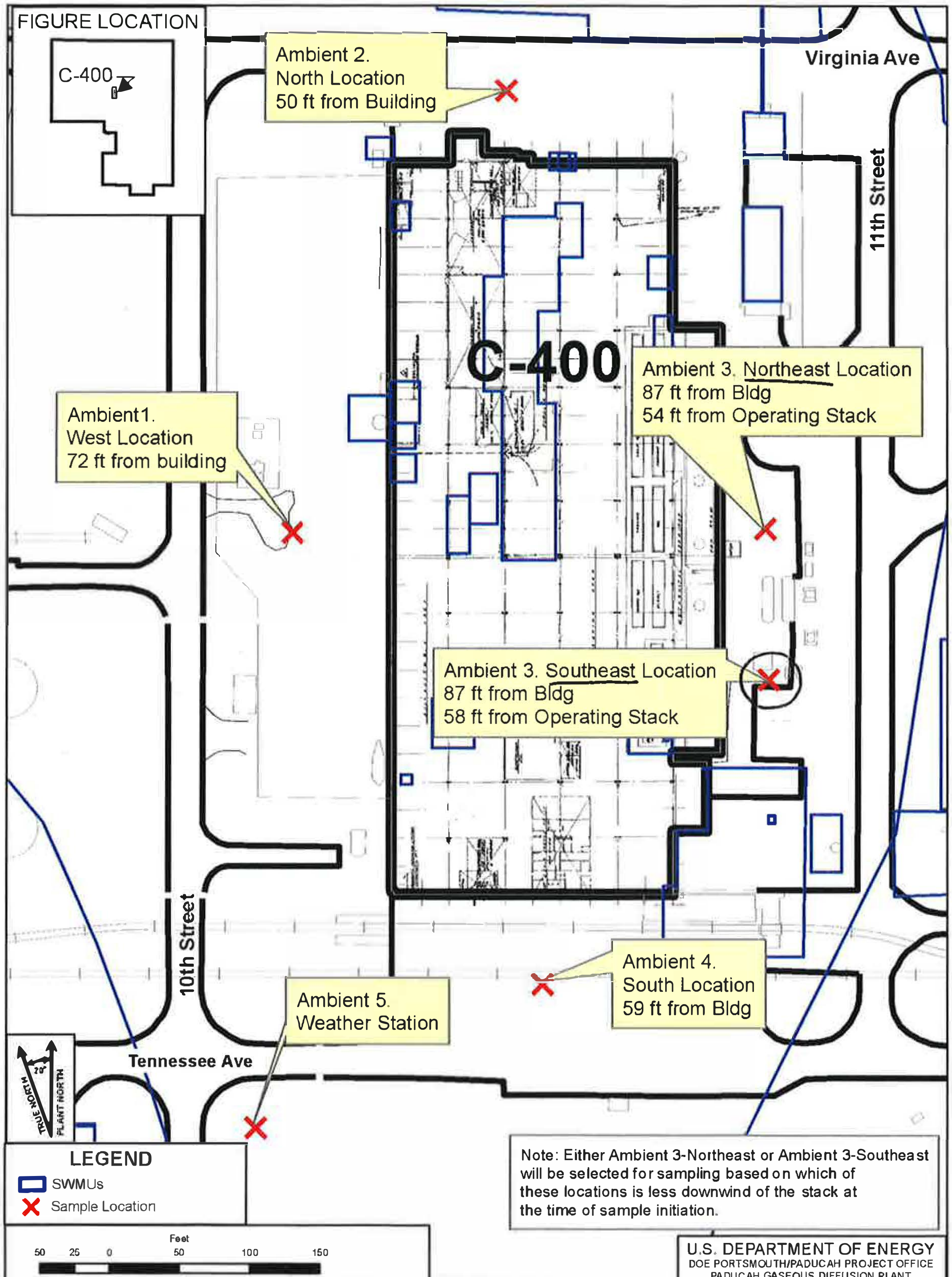

Figure 13. C-400 Map
(with Approximate Ambient Sampling Locations)

FLUOR

G:\GIS\ARCVIEWS\PROJECTS\Vapor Intrusion\MOA 400\Figure 13 C-400 Ambient Sampling Locations.mxd
7/25/2017

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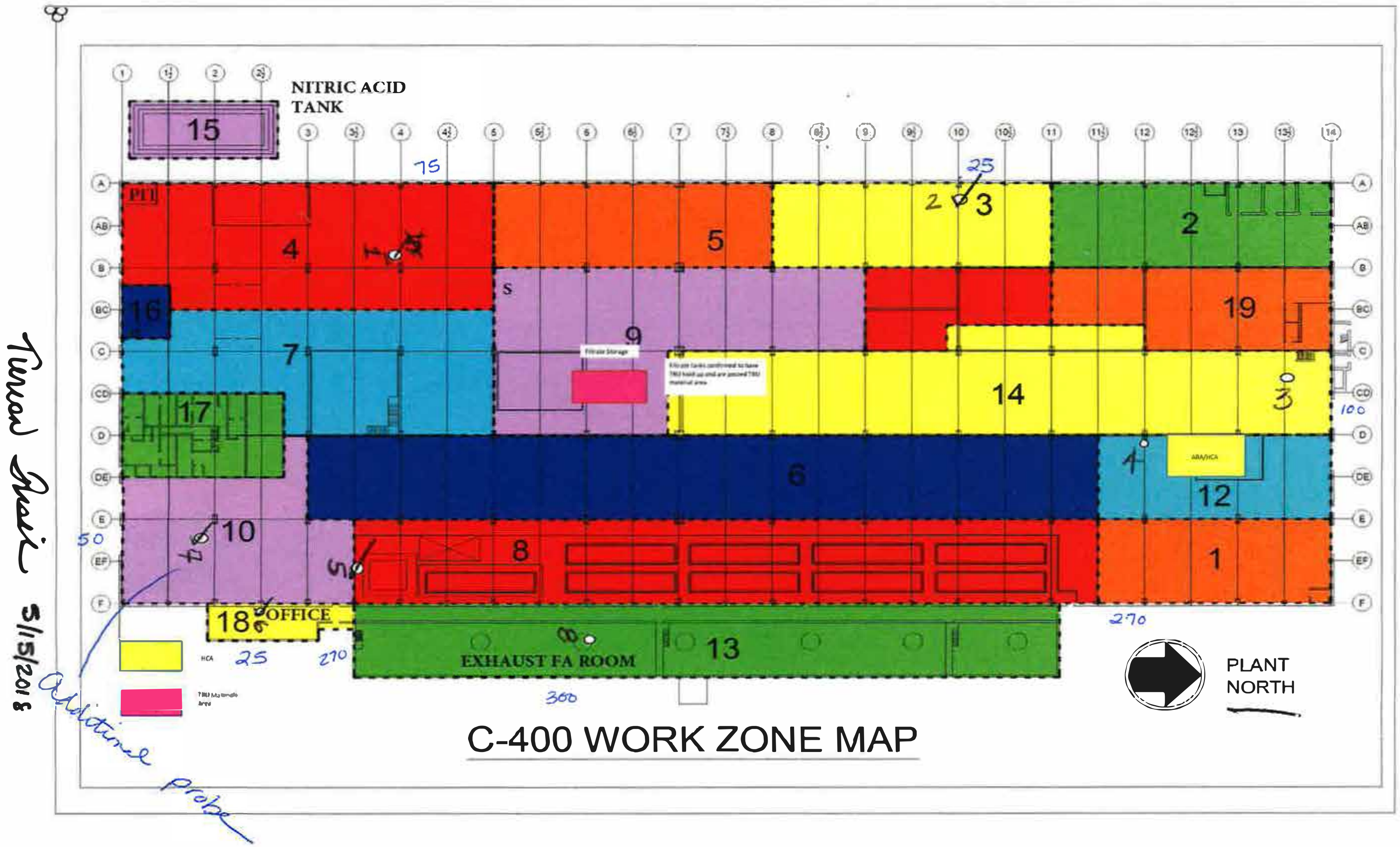

NITRIC ACID TANK
15
PTI
4
5
3
2
16
9
7
19
14
17
6
12
10
8
1
18
OFFICE
EXHAUST FA ROOM
13
HCA
PLANT NORTH
C-400 WORK ZONE MAP
75
25
50
100
270
25
270
300
Additional Probe
3/15/2018

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Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah
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DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study – Fan Off; Doors Closed

LOCATION: PGDP PROJECT NO.: KX6467 TASK NO: 01/04

DESCRIPTION: VI Sampling DATE: 01/26/2018

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Clear & Cold @0545 → 33°F

0545 Arrive at C-730 TOS. Load meters into vehicles.
- Mobilize to C400; Meet at BCS for JHA, HASP briefing.
- Jason Bottom, Brandon Taylor, Kris Henderson, Shay Mitchell, Tucker Gentle (IH), Teresa Fischer present
- Shay Mitchell conducts breifing; wait on RADCON

0650 RADCON arrives; mobilize to Location 6 for Helium Seal Check. after setting up summas

0905 Don PPE to enter C-400
- Conduct Helium Seal Checks & Shut-In tests at Locations 1, 2, 5 after setting up summas

1105 Doff PPE; Break for lunch

1240 Mobilize to C400

1300 Don PPE to enter C400
- Conduct Shut-In & Helium Seal Checks at Locations 4 & 7 after setting up summas
- Location 7 fails seal check; regrout
- Location 4 passes seal check
- Second test after regrout of Location 7 passes seal check

1500 Doff PPE

1605 Set up summas & conduct Shut-In & Helium

1605 Seal Check at Location 3

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- Location 3 seal checks require ~20 minutes per check due to clay subsurface where probe is installed.
- Initial check 2.1% ; second 5.0% → add grout & let set

Location 3 second set of seal checks result in 2.1% & 1.7% → pass

- Do not believe grout or equipment setup is leaking; formation that probe is installed into is clay

1700 Complete Shut-In & Helium Seal Check & Scenario Setup field activities; demobilize

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Geosyntec consultants engineers | scientists | innovators	**C-400 Vapor Intrusion Study** **Paducah Gaseous Diffusion Plant** **Fluor Federal Services, Inc. Paducah** **Deactivation Project**

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study – Fan Off; Doors Closed

LOCATION: PGDP PROJECT NO.: KX6467 TASK NO: 01/04

DESCRIPTION: VI Sampling DATE: 01/27/2018

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Cloudy & cool; Windy w/ intermittent rain

0545 Leave C-730 TOS for C-400.
- Set up weather station & 4 Ambient locations

0726 Don PPE
- Enter C-400 to start summas
- Set DG-700 near Location 7 for continous monitoring

0759 Doff PPE
- All summas opened; see individual forms for details.

1905 All summas collected & released to GEO Consultants
- See attached individual sampling location forms for details

1840 Field activities complete. Leave limited area.

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Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah Deactivation Project

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study – Fan Off; Doors Closed Ambient Locations

LOCATION: PG DP PROJECT NO.: KX6467 TASK NO: 01/04

DESCRIPTION: VI Sampling DATE: 01/27/2018

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Cloudy, Windy, Rain & Cool

0600 Arrive at C-400. Set up Ambient Locations 1-4.
-Ambient 3 set up at SE location → wind coming from the south.
- Start sampling at 0645 → see individual forms for detailed information.
1700 All ambient summa canisters closed & collected
1840 Field activities completed. leave limited area

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Ambient Air Monitoring Record 1

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 01/27/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: T. Fischer / K. Henderson
SUMMA ID# and Regulator ID#: 11562/11463
Weather: Cool & cloudy. Windy with intermittent rain

Location ID: Location 1 - Ambient
Scenario Type: Fan Off; Doors Closed
Sample Start Time: 0658
Sample Initial Vacuum: -29.5 (Certificate)

Time	Summa Canister Vacuum (in Hg)	Comments
0658	-30	NA: Summa opened.
0853	-28	NA
1055	-22	NA
1257	-16	NA
1455	-12	NA
1658	-5	Summa Closed
		Teresa F 1/27/18
—	—	Sample ID - C400V11AMB0FCL-R

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[signature] 5/15/2018

D3-25

Ambient Air Monitoring Record 2

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 01/27/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: T. Fischer
SUMMA ID# and Regulator ID#: 09539 / 10157
Weather: Cool & cloudy; Wind w/ intermittent rain

Location ID: Location 2 - Ambient
Scenario Type: Fan Off; Doors Closed
Sample Start Time: 0645
Sample Initial Vacuum: > -30" Hg (Can)

Time	Summa Canister Vacuum (in Hg)	Comments
0645	> -30	Summa opened
0847	-28	NA
1045	-23	NA
1250	-18	NA
1444	-12	NA
1645	-7	Summa closed
	[illegible] 1/27/18	
—	—	Sample ID - C400V12AMBOFCL-R

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[illegible] 5/15/2018

Ambient Air
Monitoring Record 3SE

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 01/27/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: T. Fischer
SUMMA ID# and Regulator ID#: 10416 / 10666
Weather: Cool & ~~cloudy~~ couldy; windy w/ intermittent rain
TF 1/27/18

Location ID: Location 3 - Ambient
Scenario Type: Fan Off; Doors Closed
Sample Start Time: 0648
Sample Initial Vacuum: -29.3" Hg (certified)

Time	Summa Canister Vacuum (in Hg)	Comments
0648	-25 (can)	Summa opened
0849	-20	NA
1049	-15	Monitor more regularly
1251	-10	NA
1345	-8	NA
1446	-6	NA
1546	-3	NA
1631	-0.5	Summa closed; Sample collected
-	-	over 9 hrs; 43 mins
-	-	Sample ID - C400VI3SEAMBOFCL-R

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D3-26

Ambient Air Monitoring Record 4

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study** Date: 01/27/2018 Page 1 of 1

Project Number: KX6467/01/04 Project Location: **Paducah Gaseous Diffusion Plant**

Recorded By: T. Fischer / K. Henderson SUMMA ID# and Regulator ID#: 11079 / 11245

Weather: Cool & cloudy. Windy with intermittent rain

Location ID: Location 4 - Ambient Scenario Type: Fan Off; Doors Closed

Sample Start Time: 0652 Sample Initial Vacuum: -28 (Certified)

Time	Summa Canister Vacuum (in Hg)	Comments
0652	-28	NA
0850	-25	NA
1051	-21	NA
1254	-16	NA
1447	-12	NA
1652	-5	Summa Closed
	Theresa F[illegible] 1/27/18	
		Sample ID -C400VI4AMB0FCL-R

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[illegible] 5/15/2018

Weather Station
Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 01/27/2018 Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: T. Fischer / K. Henderson

Location ID: Weather Station
Scenario Type: Fan Off; Doors Closed

Time	Ambient Temp. (deg. F)	Relative Humidity (%)	Barometric Pressure (inches Hg)	Wind Direction	Wind Speed (mph)
0649	53	76	30.20	S-SE	4
0851	50	90	30.24	S-SW	0
1052	51	94	30.25	W-NW	0
1253	52	94	30.20	SW	0
1449	52	94	30.20	SW	0
1650	51	94	30.22	W	0

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Teresa Fischer 5/15/2018

[illegible] 5/15/2018

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Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah
Deactivation Project

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study – Fan Off; Doors Closed Location 1

LOCATION: PGDP PROJECT NO.: KX6467 TASK NO: 01/04

DESCRIPTION: VI Sampling DATE: 01/26/2018

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER:

1010 Set up shut in & Helium Seal Check
- Indoor Air Summa 09626; Flow Regulator 1005T → -29.4"
- Sub-slab Summa 10704; Flow Regulator 11310 → -29.1"
- Shut-in & Helium Seal Check passed.

1030 Finish activities at Location 1

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SOIL GAS PROBE MEASUREMENTS

Geosyntec consultants

D3-30

① Project Name: C-400 Vapor Intrusion Study
Date: 01/26/2018 Project Number: KX6467/01
Site Location: Paducah Gaseous Diffusion Plant
Weather: Clear & Cold
Field Personnel: Teresa Fischer, Kris Henderson
Recorded By: T. Fischer

Probe No.: LOCATION 1 ☒ Sub-slab probe ☐ Soil gas probe
Mini Rae 2000 Serial No.: DAQ-248-100-19 Lamp: 10.6 / 11.7 eV
Landtech GEM 2000 Landfill Gas Meter Serial No. M: KAO-399-3
MDG 2002 Helium detector Serial No.: 10702
Tracer Gas: ☒ Helium ☐ Other

② Surface Type: ☐ Asphalt ☒ Concrete ☐ Grass ☐ Other
Surface Thickness (i.e., asphalt or concrete): 10 3/4 inches / centimeters ☐ Unknown

③ 1 Casing Volume
☒ Sub-slab <0.1 L
Soil gas probe ______ (L)

⑤ Field tubing blank reading (ppm$_v$) completed? ☑ Yes ☐ No PID Reading 0 ppm$_v$

⑥ Shut in test prior to purging completed? Yes ☑ No ☐

⑦ Purging

Date	Start Time	End Time	Elapsed Time (min.)	Bag Volume (L)	Purge Rate (LPM)	TAF 4/24/2018 NA	CH_4 (%)	CO_2 (%)	O_2 (%)	Tracer Gas Shroud (%) Min	Tracer Gas Shroud (%) Max	Tracer Gas Sample (ppm$_v$, %) (circle one)	VOCs by PID (ppm$_v$)
1/26/18	1020	1022	2	0.75	0.7	NA	0.2	0.1	20.9	21.7	22.5	0	2.0
1/26/18	1024	1025	1	0.50	0.7	NA	0.2	0.1	20.8	20.1	20.8	0	2.7
1/26/18	1028	1029	1	0.50	0.65	NA	0.1	0.1	20.8	21.1	21.5	0	2.8
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

⑧ Helium concentration in field screened samples is less than 5% of minimum concentration in the shroud? ☑ Yes ☐ No **Note:** 1% helium = 10,000 ppm$_v$

⑨ Shut in test prior to sample collection completed? Yes ☑ No ☐

⑩ Sample Collection

Date	Time	Sample ID	Summa Canister ID	Flow Controller #	Vacuum Gauge #	Initial Vacuum (in. Hg)	Final Vacuum (in. Hg)
1/27/2018	1746	C400VI1SUB0FCL-R	10704	11310	—	-29.1	-2
NA	NA	NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	NA	NA	NA

Comments: NA

Teresa Fischer 5/15/2018 5/15/2018

D3-31

Differential Pressure and Ambient Temperature Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study** Date: 01/27/2018 Page 1 of 1

Project Number: KX6467/01/04 Project Location: **Paducah Gaseous Diffusion Plant**

Recorded By: Teresa Fischer/Kris Henderson Gauge ID#: 44286-7-700

Weather: Cool & cloudy with wind & rain

Location ID: LOCATION # 1 Scenario Type: Fan Off; Doors Closed

Sample Start Time: 0734 Sample Initial Vacuum: 29.1" (certified)

Time	Differential Pressure (pa)		Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
	sub-slab/ambient	ambient/outside			
0734	-0.2	3.7	52	-24	NA
0933	-0.6	0.0	54	-24	NA
1142	0.7	-0.9	52	-21	NA
1341	1.2	-0.6	55	-15	NA
1539	-1.1	-0.4	51	-10	NA
1746	-1.3	-1.0	51	-2	Summa Closed
—	—	—	—	—	Sample ID C400 VI1 SUBOFCL-R

Teresa Fischer 5/15/2018

[signature] 5/15/2018

D3-32

Indoor Air Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study** Date: 01/27/2018 Page 1 of 1

Project Number: KX6467/01/04 Project Location: **Paducah Gaseous Diffusion Plant**

Recorded By: Teresa Fischer/Kris Henderson SUMMA ID# and Regulator ID#: 09626 / 10051

Weather: Clear & cold; Windy w/ intermittent rain

Location ID: 1 Scenario Type: Fan Off; Doors Closed

Sample Start Time: 0734 Sample Initial Vacuum: -29.4" Hg (certified)

Time	Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
0734	52	> -30	Summa opened
0934	54	-29	NA
1142	52	-23	NA
1341	55	-18	NA
1539	51	-13	NA
1747	51	-8	Summa closed
—	—	—	Sample ID C400VI1INOFCL-R

Teresa Fischer 5/15/2018

[signature] 5/15/2018

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C-400 Vapor Intrusion Study
Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah
Deactivation Project

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study – Fan Off; Doors Closed LOCATION 2

LOCATION: PGDP PROJECT NO.: KX6467 TASK NO: 01/04

DESCRIPTION: VI Sampling DATE: 01/26/2018

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Clear & Cold

0940 Helium Seal Check

- Indoor Air Summa - 10132; Flow Reg - 11512
- Subslab Summa - 10530; Flow Reg - 11497
- Helium Seal Check & Shut In Test passed

1010 Complete activities @ Location 2

Teresa Fischer 01/26/2018

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DFR_ One Page Teresa Fischer 5/15/2018 SHEET NO 1 OF 1

SOIL GAS PROBE MEASUREMENTS

Geosyntec consultants

① Project Name: C-400 Vapor Intrusion Study
Date: 01/26/2018 Project Number: KX6467/01
Site Location: Paducah Gaseous Diffusion Plant
Weather: Clear & cold
Field Personnel: Teresa Fischer, Kris Henderson
Recorded By: T. Fischer

Probe No.: LOCATION 2 [X] Sub-slab probe [ ] Soil gas probe
Mini Rae 2000 Serial No.: DAO-248-100-19 Lamp: 10.6 / 11.7 eV
Landtech GEM 2000 Landfill Gas Meter Serial No. M: KAO-399-3
MDG 2002 Helium detector Serial No.: 1072
Tracer Gas: [X] Helium [ ] Other

② Surface Type: [ ] Asphalt [X] Concrete [ ] Grass [ ] Other
Surface Thickness (i.e., asphalt or concrete) 20 inches centimeters [ ] Unknown

③ 1 Casing Volume
[X] Sub-slab <0.1 L
Soil gas probe ______ (L)

⑤ Field tubing blank reading (ppm$_v$) completed? [✓] Yes [ ] No PID Reading 0 ppm$_v$

⑥ Shut in test prior to purging completed? Yes [✓] No [ ]

⑦ Purging

Date	Start Time	End Time	Elapsed Time (min.)	Bag Volume (L)	Purge Rate (LPM)	TAF 4/26/2018 —	CH_4 (%)	CO_2 (%)	O_2 (%)	Tracer Gas Shroud (%) Min	Tracer Gas Shroud (%) Max	Tracer Gas Sample (ppm$_v$, %) (circle one)	VOCs by PID (ppm$_v$)
1/26/2018	0950	0953	3	1.0	0.75	—	0	0.1	20.9	23.6	23.5	0	0
1/26/2018	0957	0959	2	1.0	0.8	—	0.1	0.1	20.9	22.0	21.8	0	0
1/26/2018	1000	1003	3	0.75	0.75	—	0.1	0.1	20.9	21.7	20.0	0	6
—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—

⑧ Helium concentration in field screened samples is less than 5% of minimum concentration in the shroud? [✓] Yes [ ] No **Note:** 1% helium = 10,000 ppm$_v$

⑨ Shut in test prior to sample collection completed? Yes [✓] No [ ]

⑩ Sample Collection

Date	Time	Sample ID	Summa Canister ID	Flow Controller #	Vacuum Gauge #	Initial Vacuum (in. Hg)	Final Vacuum (in. Hg)
1/27/2018	1750	C400VI2SUBOFCL-R	10530	11497	—	-30	-3
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—

Comments: NA
NA

Teresa Fischer 5/15/2018 [signature] 5/15/2018

D3-35

Differential Pressure and Ambient Temperature Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study** Date: 01/27/2018 Page 1 of 1

Project Number: KX6467/01/04 Project Location: **Paducah Gaseous Diffusion Plant**

Recorded By: Teresa Fischer/Kris Henderson Gauge ID#: 44286-7-700

Weather: Cloudy & cool; intermittent rain; windy in morning

Location ID: LOCATION # 2 Scenario Type: Fan Off; Doors Closed

Sample Start Time: 0737 Sample Initial Vacuum: 29.4" (certified)

Time	Differential Pressure (pa)		Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
	sub-slab/ambient	ambient/outside			
0737	1.1	0.9	51	-30	NA
0936	6.1	-1.2	53	-27	NA
1146	3.8	-0.3	51	-21	NA
1345	2.5	-0.4	55	-15	NA
1542	0.3	-1.6	50	-11	NA
1750	-0.6	-1.0	50	-3	Summa Closed
—	—	—	—	—	Sample ID C400VI2SUBOFCL-R

Teresa Fischer 5/15/2018

[signature] 5/15/2018

Indoor Air Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study** Date: 01/21/2018 Page 1 of 1

Project Number: KX6467/01/04 Project Location: **Paducah Gaseous Diffusion Plant**

Recorded By: Teresa Fischer/Kris Henderson SUMMA ID# and Regulator ID#: 10132 (Summa) / 11512 (FR)

Weather: Cloudy & cool; windy & rain

Location ID: 2 Scenario Type: Fan Off; Doors Closed

Sample Start Time: 0737 Sample Initial Vacuum: 29.1" (certified)

Time	Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
0737	51	-28	NA
0939	53	-24	NA
1146	51	-20	NA
1345	55	-15	NA
1542	50	-10	NA
1751	50	-5	Summa Closed
—	—	—	Sample ID C400VI21NOFCL-2

Teresa Fisch 5/15/2018

Kris Henderson 5/15/2018

D3-36

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C-400 Vapor Intrusion Study
Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah
Deactivation Project

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study – Fan Off; Doors Closed LOCATION 3

LOCATION: PGDP PROJECT NO.: KX6467 TASK NO: 01/04

DESCRIPTION: VI Sampling DATE: 01/26/2018

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Clear & cool

1500 Set up for shut in & helium seal check
- Indoor Air Summa 11843; Flow Reg 1176 → -29.2"
- Substab Summa 10329; Flow Reg 10863 → -29.5"

1525 Failed Helium Seal Check
- Probe installed in very tight formation & takes 15 to 20 minutes to equilibrate while running test.
- Re-grout probe

1608 Re-start Helium Seal Check; Shut-in test

1634 Complete Helium Seal Check → pass

Teresa [signature] 1/26/2018

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DFR_ One Page Teresa Frisch 5/15/2018 SHEET NO 1 OF 1

SOIL GAS PROBE MEASUREMENTS

Geosyntec consultants

① Project Name: C-400 Vapor Intrusion Study
Date: 01/26/2018 Project Number: KX6467/01
Site Location: Paducah Gaseous Diffusion Plant
Weather: Clear & cold
Field Personnel: Teresa Fischer, Kris Henderson
Recorded By: T. Fischer

Probe No.: LOCATION 3 [X] Sub-slab probe [ ] Soil gas probe
Mini Rae 2000 Serial No.: DAQ-248-100-19 Lamp: 10.6 / 11.7 eV
Landtech GEM 2000 Landfill Gas Meter Serial No. M: KAO-399-3
MDG 2002 Helium detector Serial No.: 1072
Tracer Gas: [X] Helium [ ] Other

② Surface Type: [ ] Asphalt [X] Concrete [ ] Grass [ ] Other
Surface Thickness (i.e., asphalt or concrete) 19 1/4 inches centimeters [ ] Unknown

③ 1 Casing Volume
[X] Sub-slab <0.1 L
Soil gas probe ______ (L)

⑤ Field tubing blank reading (ppm$_v$) completed? [X] Yes [ ] No PID Reading 0.3 ppm$_v$

⑥ Shut in test prior to purging completed? Yes [X] No [ ]

⑦ Purging

Date	Start Time	End Time	Elapsed Time (min.)	Bag Volume (L)	Purge Rate (LPM)	TAG 4/26/2018 —	CH_4 (%)	CO_2 (%)	O_2 (%)	Tracer Gas Shroud (%) Min	Tracer Gas Shroud (%) Max	Tracer Gas Sample (ppm$_v$, %) (circle one)	VOCs by PID (ppm$_v$)
1/26/18	1516	1520	4	0.75	0.1	—	*	*	*	19.8	24.4	2.1	2.6
1/26/18	1525	1527	2	0.75	0.1	—	*	*	*	30.6	33.5	5.0	1.0
1/26/18	1608	1610	2	0.50	0.1	—	*	*	*	26.3	32.4	2.1	*
1/26/18	1631	1634	2	0.50	0.1	—	*	*	*	26.9	33.9	1.7	0.7
—	—	—	—	—	—	—	—	—	—	—	—	—	—

⑧ Helium concentration in field screened samples is less than 5% of minimum concentration in the shroud? [X] Yes [ ] No **Note:** 1% helium = 10,000 ppm$_v$

⑨ Shut in test prior to sample collection completed? Yes [X] No [ ]

⑩ Sample Collection

Date	Time	Sample ID	Summa Canister ID	Flow Controller #	Vacuum Gauge #	Initial Vacuum (in. Hg)	Final Vacuum (in. Hg)
1/27/18	1810	C400VI3SUB0FCL-R	10329	10863	—	-29.5	-10
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—

Comments: * - Not enough air in Tedlar to screen for these parameters
Teresa Fischer 5/15/2018 [signature] 5/15/2018

D3-38

D3-39

Differential Pressure and Ambient Temperature Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 01/22/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
Gauge ID#: 44286-7-700
Weather: Cloudy & cool; intermittent rain; windy in morning

Location ID: LOCATION # 3
Scenario Type: Fan Off; Doors Closed
Sample Start Time: 0644
Sample Initial Vacuum: -29.5" (certified)

Time	Differential Pressure (pa)		Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
	sub-slab/ambient	ambient/outside			
0642	-9.2	1.4	50	-30.0	Summa Opened
1002	-4.5	~~0.0~~ 0.2	51	-24.0	closed 1002; opened 1022
1201	-1.9	0.4	52	-20.0	closed 1201; opened 1215
1358	-4.7	-0.5	52	-17.0	closed 1358; opened 1412
1556	-6.8	-0.4	54	-11	closed 1556; opened 1609
1810	-5.2	-0.8	51	-8	SUMMA closed
—	—	—	—	—	Sample ID C400V13 SUB0FCL-R

Teresa Fischer 5/15/2018

Kris Henderson 5/15/2018

Indoor Air Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**	Date: 01/27/2018 Page 1 of 1
Project Number: KX6467/01/04	Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson	SUMMA ID# and Regulator ID#: 11143 / 11761
Weather: Cool & cloudy; windy w/ intermittent rain	

Location ID: 3	Scenario Type: Fan Off; Doors Closed
Sample Start Time: 0642	Sample Initial Vacuum: -29.2" Hg (certified)

Time	Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
0642	50	> -30	Summa Opened
1002	55	-29	NA
1201	52	-25	NA
1358	52	-18	NA
1557	54	-12	NA
1648	55	-10	Summa Closed
—	—	—	Sample ID ~~C400-V13OF~~ C400V13INOFCL-R

TAF 1/27/18

Teresa Fischer 5/15/2018

Kris Henderson 5/15/2018

D3-40

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C-400 Vapor Intrusion Study
Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah Deactivation Project

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study – Fan Off; Doors Closed LOCATION 4

LOCATION: PGDP PROJECT NO.: KX6467 TASK NO: 01/04

DESCRIPTION: VI Sampling DATE: 01/26/2018

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Clear & cool

1340 Setup shut-in & helium seal check at Location 4

- Sub-slab summa ~~10013~~ 11701 TAP 1/26/18; Flow Reg 09704 → -29.4"
- Indoor air summa 10319; Flow Reg 10162 → -29.4"
- Shut-in & helium seal check passed

1407 Field activities completed at Location 4

Teresa [signature] 1/26/2018

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DFR_ One Page Teresa Frisch 5/15/2018 SHEET NO 1 OF 1

SOIL GAS PROBE MEASUREMENTS

Geosyntec consultants

① Project Name: C-400 Vapor Intrusion Study
Date: 01/26/2018 Project Number: KX6467/01
Site Location: Paducah Gaseous Diffusion Plant
Weather: Clear & cool
Field Personnel: Teresa Fischer, Kris Henderson
Recorded By: T. Fischer

Probe No.: LOCATION 4 [X] Sub-slab probe [ ] Soil gas probe
Mini Rae 2000 Serial No.: DAQ-248-100-19 Lamp: 10.6 / 11.7 eV
Landtech GEM 2000 Landfill Gas Meter Serial No. M: KA0-399-3
MDG 2002 Helium detector Serial No.: 1072
Tracer Gas: [X] Helium [ ] Other

② Surface Type: [ ] Asphalt [X] Concrete [ ] Grass [ ] Other
Surface Thickness 15 1/2 inches centimeters [ ] Unknown
(i.e.. asphalt or concrete)

③ 1 Casing Volume
[X] Sub-slab <0.1 L
Soil gas probe ______ (L)

⑤ Field tubing blank reading (ppm_v) completed? [✓] Yes [ ] No PID Reading 0.7 ppm_v

⑥ Shut in test prior to purging completed? Yes [✓] No [ ]

⑦ Purging

Date	Start Time	End Time	Elapsed Time (min.)	Bag Volume (L)	Purge Rate (LPM)	TAP 4/26/2018 —	CH_4 (%)	CO_2 (%)	O_2 (%)	Tracer Gas Shroud (%) Min	Tracer Gas Shroud (%) Max	Tracer Gas Sample (ppm_v, %) (circle one)	VOCs by PID (ppm_v)
1/26/2018	1348	1349	1	1	0.75	—	0.1	0.1	20.9	33.6	33.7	0	2.9
1/26/2018	1352	1353	1	1	0.75	—	0.1	0.1	21.0	30.0	30.6	0	2.4
1/26/2018	1355	1356	1	1	0.75	—	0.2	0.1	21.0	26.4	27.3	0	0.8
NA													
NA													

⑧ Helium concentration in field screened samples is less than 5% of minimum concentration in the shroud? [✓] Yes [ ] No **Note:** 1% helium = 10,000 ppm_v

⑨ Shut in test prior to sample collection completed? Yes [✓] No [ ]

⑩ Sample Collection TAP 1/29/2018

Date	Time	Sample ID	Summa Canister ID	Flow Controller #	Vacuum Gauge #	Initial Vacuum (in. Hg)	Final Vacuum (in. Hg)
1/27/2018	1756	C400VI4SUBOFCL-R	09704	~~10613~~ 11701	—	-29.4	-5
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—

Comments: NA

Teresa Fischer 5/15/2018 [signature] 5/15/2018

D3-42

SGP measurements

Differential Pressure and Ambient Temperature Monitoring Record

Geosyntec consultants

120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study** Date: 01/ 27/2018 Page 1 of 1

Project Number: KX6467/01/04 Project Location: **Paducah Gaseous Diffusion Plant**

Recorded By: Teresa Fischer/Kris Henderson Gauge ID#: 44286 - 7-700

Weather: Cloudy & cool ; intermittent rain ; windy in morning

Location ID: LOCATION # 4 Scenario Type: Fan Off; Doors Closed

Sample Start Time: 0747 Sample Initial Vacuum: -29.4" (Certified)

Time	Differential Pressure (pa)		Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
	sub-slab/ambient	ambient/outside			
0747	- 0.1	0.1	51	> -30	NA
0945	- 2.1	-0.3	52	-27	NA
1149	1.7	- 0.4	52	-21	NA
1347	2.8	-0.3	53	-18	NA
1547	-0.5	-[illegible]6	52	-10	NA
175[illegible]	-2.7	-1.1	51	-5	Summa Closed
—	—	—	—	—	Sample ID C400 VI4SUBOFCL-R

Teresa Fischer 5/15/2018

Kris Henderson 5/15/2018

D3-44

Indoor Air Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 01/27/2018 TAF 1/27/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
SUMMA ID# and Regulator ID#: 1031A (S) / ~~10162~~ 10102 (FR)
Weather: Cloudy & Cool ; Wind & Rain

Location ID: 4
Scenario Type: Fan Off; Doors Closed
Sample Start Time: 0747
Sample Initial Vacuum: -29.4" Hg (certified)

Time	Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
0747	51	-28	NA
0945	52	-24	NA
1149	52	-18	NA
1347	53	-13	NA
1547	52	-9	NA
1751	52	-6	Summa Closed
—	—	—	Sample ID ~~C400VI4INCLOF-R~~

C400VI4INOFCL-R TAF 1/27/18

Teresa Fischer 5/15/2018

Kris Henderson 5/15/2018

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C-400 Vapor Intrusion Study
Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah
Deactivation Project

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study – Fan Off; Doors Closed LOCATION 5

LOCATION: PGDP PROJECT NO.: KX6467 TASK NO: 01/04

DESCRIPTION: VI Sampling DATE: 01/26/2018

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Clear & Cool

1035 Set up for shut in & helium seal check
- Indoor Air Summa 10734 ; Flow Reg 11536 → -29.1"
  Duplicate 10682 ; Flow Reg 15011 → -29.3"
- Sub-slab Summa 11196 ; Flow Reg 10662 → -29.4"
- Shut-in & helium seal check passed

1120 Complete field activities at Location 5

Teresa [signature] 1/26/18

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DFR_ One Page Teresa Frisch 5/15/2018 SHEET NO 1 OF 1

SOIL GAS PROBE MEASUREMENTS

Geosyntec consultants

① Project Name: C-400 Vapor Intrusion Study
Date: 01/26/2018 Project Number: KX6467/01
Site Location: Paducah Gaseous Diffusion Plant
Weather: Clear & Cool
Field Personnel: Teresa Fischer, Kris Henderson
Recorded By: T. Fischer

Probe No.: LOCATION 5 ☒ Sub-slab probe ☐ Soil gas probe
Mini Rae 2000 Serial No.: DAQ-248-100-19 Lamp: 10.6 / 11.7 eV
Landtech GEM 2000 Landfill Gas Meter Serial No. M: KAO-399-3
MDG 2002 Helium detector Serial No.: 1072
Tracer Gas: ☒ Helium ☐ Other

② Surface Type: ☐ Asphalt ☒ Concrete ☐ Grass ☐ Other
Surface Thickness 20 1/2 inches centimeters ☐ Unknown
(i.e., asphalt or concrete)

③ 1 Casing Volume
☒ Sub-slab <0.1 L
Soil gas probe ______ (L)

D3-46

⑤ Field tubing blank reading (ppm$_v$) completed? ☑ Yes ☐ No PID Reading 0 ppm$_v$

⑥ Shut in test prior to purging completed? Yes ☑ No ☐

⑦ Purging

Date	Start Time	End Time	Elapsed Time (min.)	Bag Volume (L)	Purge Rate (LPM)	TAP 4/26/2018 —	CH_4 (%)	CO_2 (%)	O_2 (%)	Tracer Gas Shroud (%) Min	Tracer Gas Shroud (%) Max	Tracer Gas Sample (ppm, %) (circle one)	VOCs by PID (ppm$_v$)
1/26/18	1048	1049	1	0.25	0.7	—	0.1	0	20.8	21.0	21.6	0	>15,000
1/26/18	1052	1057	5	<0.25	0.7	—	*	*	*	20.0	21.7	*	*
1/26/18	1059	1101	2	0.25	0.7	—	0	0.1	20.9	20.8	21.9	0	>15,000
1/26/18	1110	1112	2	0.25	0.6	—	0.1	0.1	20.9	20.0	20.6	0	>15,000
—	—	—	—	—	—	—	—	—	—	—	—	—	—

⑧ Helium concentration in field screened samples is less than 5% of minimum concentration in the shroud? ☑ Yes ☐ No **Note:** 1% helium = 10,000 ppm$_v$

⑨ Shut in test prior to sample collection completed? Yes ☑ No ☐

⑩ Sample Collection

Date	Time	Sample ID	Summa Canister ID	Flow Controller #	Vacuum Gauge #	Initial Vacuum (in. Hg)	Final Vacuum (in. Hg)
1/27/2018	1735	C400VISSUB0FCL-R	11196	10662	—	-29.4	-6
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—

Comments: * Not enough air in tedlar bags for these parameters to be field screened
Teresa Fischer 5/15/2018 [signature] 5/15/2018

Differential Pressure and Ambient Temperature Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study** Date: 01/27/2018 Page 1 of 1

Project Number: KX6467/01/04 Project Location: **Paducah Gaseous Diffusion Plant**

Recorded By: Teresa Fischer/Kris Henderson Gauge ID#: 44286-7-700

Weather: Cloudy & cool; intermittent rain; windy in morning

Location ID: LOCATION # 5 Scenario Type: Fan Off; Doors Closed

Sample Start Time: 0728 Sample Initial Vacuum: 29.4" (certified)

Time	Differential Pressure (pa)		Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
	sub-slab/ambient	ambient/outside			
0728	0.2	0.3	53	> -30	NA
0931	-1.4	0.0	53	-28	NA
1135	0.2	-0.1	54	-22	NA
1337	-1.0	0.1	56	-18	NA
1533	-0.5	-0.1	53	-11	NA
1735	-0.8	-0.5	53	-6	SUMMA closed
—	—	—	—	—	Sample ID C400VIS SUBOFCL-R

Teresa Fischer 5/15/2018

Kristin Henderson 5/15/2018

D3-48

Indoor Air Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 01/27/2018 Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
SUMMA ID# and Regulator ID#: 10734 / 11536
Weather: Cloudy & cool; intermittent rain
Duplicate 10602 / 15011

Location ID: 5
Scenario Type: Fan Off; Doors Closed
Sample Start Time: 0728
Sample Initial Vacuum: 29.1" & 29.3" (D) (certified)

Time	Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg) / D	Comments
0728	53	-28 / -29	NA
0928	54	-26 / -24	NA
1135	53	-21 / -19	NA
1335	57	-18 / -12	NA
1536	53	-11 / -8	NA
1737	53	-7 / -2	Summas Closed
—	—	—	Sample ID C400VISINOFCL-R

C400VISINOFCLD-R

Teresa Fischer 5/15/2018

Kristopher Henderson 5/15/2018

Geosyntec consultants

engineers | scientists | innovators

C-400 Vapor Intrusion Study
Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah Deactivation Project

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study – Fan Off; Doors Closed LOCATION 6

LOCATION: PG DP PROJECT NO.: KX6467 TASK NO: 01/04

DESCRIPTION: VI Sampling DATE: 01/26/2018

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Clear & cold 33°F @ 0650

0650 Set up for Helium Seal Check
- Indoor Air Summas ID# 10555; Flow Reg ID# 10153 → -29.3"
  09617; Flow Reg ID# 10054 → -28.8"
- Subslab Summas ID# 10807; Flow Reg ID# 11527 → -29.4"
- Troubleshoot & repair Lungbox.

0905 Complete seal check & shut in tests
- Summa is sealed → pass

Teresa F 1/26/2018

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DFR_ One Page Teresa Fischer 5/15/2018 SHEET NO 1 OF 1

SOIL GAS PROBE MEASUREMENTS

Geosyntec consultants

D3-50

(1) Project Name: C-400 Vapor Intrusion Study
Date: 01/26/2018 Project Number: KX6467/01
Site Location: Paducah Gaseous Diffusion Plant
Weather: Clear & Cold
Field Personnel: Teresa Fischer, Kris Henderson
Recorded By: T. Fischer

Probe No.: LOCATION 6 [X] Sub-slab probe [ ] Soil gas probe
Mini Rae 2000 Serial No.: 592-909072 Lamp: 10.6 / 11.7 eV
Landtech GEM 2000 Landfill Gas Meter Serial No. M: GM07658/04
MDG 2002 Helium detector Serial No.: 10702
Tracer Gas: [X] Helium [ ] Other

(2) Surface Type: [ ] Asphalt [X] Concrete [ ] Grass [ ] Other____
Surface Thickness 8 inches / centimeters [ ] Unknown
(i.e., asphalt or concrete)

(3) 1 Casing Volume
[X] Sub-slab <0.1 L
Soil gas probe ____ (L)

(5) Field tubing blank reading (ppm$_v$) completed? [✓] Yes [ ] No PID Reading 0 ppm$_v$

(6) Shut in test prior to purging completed? Yes [✓] No [ ]

(7) Purging

Date	Start Time	End Time	Elapsed Time (min.)	Bag Volume (L)	Purge Rate (LPM)	~~TAF~~ 4/26/2018 —	CH_4 (%)	CO_2 (%)	O_2 (%)	Tracer Gas: Shroud (%) ~~TAF~~ 4/26/18 Min	Tracer Gas: Shroud (%) Max	Tracer Gas: Sample (ppm$_v$, %) (circle one)	VOCs by PID (ppm$_v$)
1/26/2018	0848	0853	5	0.25	0.6	—	NA	NA	NA	24.8	27.1	0	0.5
1/26/2018	0856	0859	3	0.75	0.7	—	0	0.1	20.7	25.4	25.5	0	0
1/26/2018	0902	0905	3	1.0	0.8	—	0	0.1	20.7	22.4	21.4	0	0
—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—

(8) Helium concentration in field screened samples is less than 5% of minimum concentration in the shroud? [✓] Yes [ ] No **Note:** 1% helium = 10,000 ppm$_v$

(9) Shut in test prior to sample collection completed? Yes [✓] No [ ]

(10) Sample Collection

Date	Time	Sample ID	Summa Canister ID	Flow Controller #	Vacuum Gauge #	Initial Vacuum (in. Hg)	Final Vacuum (in. Hg)
1/27/18	1658	C400V16SUBOFCL-R	10807	11527	—	-29	-2
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—

Comments: NA

Teresa Fischer 5/15/2018 Kris Henderson 5/15/2018

Differential Pressure and Ambient Temperature Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study** Date: 01/27/2018 Page 1 of 1
Project Number: KX6467/01/04 Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson Gauge ID#: 44286-7-700
Weather: Cloudy & cool; Windy & Rain

Location ID: LOCATION # 6 Scenario Type: Fan Off; Doors Closed
Sample Start Time: 0656 Sample Initial Vacuum: -29.4" (confirmed)

KH 1/27/18 0656

D3-51

Time	Differential Pressure (pa)		Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
	sub-slab/ambient	ambient/outside			
~~1-27-18~~	0.2	-1.6 - -24.5	52	-29.4	Summa opened
0856	0.0	0.8	58	-24	NA
1056	-0.1	0.4	56	-19	NA
1255	0.0	0.0	55	-12	NA
1455	0.0	0.0	54	-8	NA
1658	0.0	-0.2	53	-2	Summa Closed
—	—	—	—	—	Sample ID C400 V16SUBOFCL-R

Teresa Fischer 5/15/2018

Kris Henderson 5/15/2018

Indoor Air Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study** Date: 01/27/2018 Page 1 of 1

Project Number: KX6467/01/04 Project Location: **Paducah Gaseous Diffusion Plant**

Recorded By: Teresa Fischer/Kris Henderson SUMMA ID# and Regulator ID#: 16555 / 10163

Weather: Clear & cold (33° @ 0600) Duplicate 09617 / 10054

Location ID: 6 Scenario Type: Fan Off; Doors Closed

Sample Start Time: 0657 Sample Initial Vacuum: -29.3" Hg / -28.8" Hg Dup (certified)

Time	Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg) D	Comments
0657	52	-29 / -28	Summas opened
0857	58	-24 / -23	NA
1056	56	-20 / -18	NA
1255	55	-15 / -12	NA
1455	54	-9 / -7	NA
1657	53	-5 / -1	Summas closed
—	—	—	Sample ID C400VI6INOFCL-R

C400VI6INOFCLD-R (Duplicate)

Teresa Fischer 5/15/2018

Kris Henderson 5/15/2018

D3-52

Geosyntec consultants engineers | scientists | innovators	**C-400 Vapor Intrusion Study** **Paducah Gaseous Diffusion Plant** **Fluor Federal Services, Inc. Paducah** **Deactivation Project**

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study – Fan Off; Doors Closed LOCATION 7

LOCATION: PGDP PROJECT NO.: KX6467 TASK NO: 01/04

DESCRIPTION: VI Sampling DATE: 01/26/2018

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Clear & cool

1300 Don PPE to enter C-400

- Setup shut-in test & helium seal check
- Indoor Air Summa 10562; Flow Reg 11272 → -29.5
- Subslab Summa 10117; Flow Reg 10448 → -29.4

1335 Helium Seal Check failed. Re-grout port

1445 Conduct shut-in & seal check again - passed

1448 Field activities completed at Location 7

Teresa F
1/26/18

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DFR_ One Page

Teresa Fischer 5/15/2018

SHEET NO 1 OF 1

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SOIL GAS PROBE MEASUREMENTS

Geosyntec consultants

① Project Name: C-400 Vapor Intrusion Study
Date: 01/26/2018 Project Number: KX6467/01
Site Location: Paducah Gaseous Diffusion Plant
Weather: Clear
Field Personnel: Teresa Fischer, Kris Henderson
Recorded By: ______

Probe No.: LOCATION 7 [X] Sub-slab probe ☐ Soil gas probe
Mini Rae 2000 Serial No.: DAQ-248-100-19 Lamp: 10.6 / 11.7 eV
Landtech GEM 2000 Landfill Gas Meter Serial No. M: KAO-399-3
MDG 2002 Helium detector Serial No.: 1022
Tracer Gas: [X] Helium ☐ Other ______

② Surface Type: ☐ Asphalt [X] Concrete ☐ Grass ☐ Other ______
Surface Thickness 20 1/4 inches/centimeters ☐ Unknown
(i.e., asphalt or concrete)

③ 1 Casing Volume
[X] Sub-slab <0.1 L
Soil gas probe ______ (L)

⑤ Field tubing blank reading (ppm$_v$) completed? [✓] Yes ☐ No PID Reading 2.7 ppm$_v$ 1.2 @ 1415

⑥ Shut in test prior to purging completed? Yes [✓] No ☐

⑦ Purging

Date	Start Time	End Time	Elapsed Time (min.)	Bag Volume (L)	Purge Rate (LPM)	TMP 4/26/2018 —	CH$_4$ (%)	CO$_2$ (%)	O$_2$ (%)	Tracer Gas: Shroud (%) Min	Tracer Gas: Shroud (%) Max	Tracer Gas: Sample (ppm$_v$, %) (circle one)	VOCs by PID (ppm$_v$)
1/26/18	1329	1330	1	1	0.65	TMP 4/26/18	0.1	0.1	20.8	32.1	32.2	8,100	7.0
~~1/26/18~~	~~1333~~				~~0.6~~					~~27~~	~~28.6~~		
* 1/26/18	1334	1335	1	0.25	0.6	— TMP	NA	NA	NA	21.0	21.9	12,000	26.7
1/26/18	1443	1445	2	0.75	0.7	— TMP 4/26/2018	0	0.1	21.0	28.6	29.9	0	28.9
1/26/18	1446	1448	2	0.75	0.65	—	0.1	0.1	21.1	23.2	23.7	0	28.4

⑧ Helium concentration in field screened samples is less than 5% of minimum concentration in the shroud? [✓] Yes ☐ No
Note: 1% helium = 10,000 ppm$_v$

⑨ Shut in test prior to sample collection completed? Yes [✓] No ☐

⑩ Sample Collection

Date	Time	Sample ID	Summa Canister ID	Flow Controller #	Vacuum Gauge #	Initial Vacuum (in. Hg)	Final Vacuum (in. Hg)
1/27/2018	1732	C400VI7SUBOFCL-R	10117	10448	—	-29.4	-5
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—

Comments: * Need to re-seal. Probe re-grouted
Kris Henderson 5/15/2018 Teresa Fischer 5/15/2018

SGP measurements - pneumatic testing.xl

Differential Pressure and Ambient Temperature Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**

Date: 01/27/2018

Page 1 of 1

Project Number: KX6467/01/04

Project Location: **Paducah Gaseous Diffusion Plant**

Recorded By: Teresa Fischer/Kris Henderson

Gauge ID#: 44286-7-700

Weather: Cloudy & cool; intermittent rain; windy in morning

Location ID: LOCATION # 7

Scenario Type: Fan Off; Doors Closed

Sample Start Time: 0723

Sample Initial Vacuum: -29.4" (certified)

Time	Differential Pressure (pa)		Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg) TAF 1/27/18	Comments
	sub-slab/ambient	ambient/outside			
0723	1.4	-19.1	54	-28 ~~-29.4~~	NA
0927	-4.1	0.0	54	-22	NA
1127	-6.0	-0.3	51	-16	NA
1329	-1.8	-0.2	53	-11	NA
1528	-1.3	-0.3	55	-10	NA
1732	-2.2	-0.4	54	-5	Summa closed
—	—	—	—	—	Sample ID C400VI7SUBOFCL-R

Teresa Fischer 5/15/2018

Kristoffer Henderson 5/15/2018

D3-56

Indoor Air Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 01/27/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
SUMMA ID# and Regulator ID#: 1052 / 11127 TAF 1/27/18
Weather: Cloudy & cool; intermittent rain; windy in morning

Location ID: 7
Scenario Type: Fan Off; Doors Closed
Sample Start Time: 0723
Sample Initial Vacuum: -29" (certified)

Time	Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
0723	54	-29	NA
0923	54	-24	NA
1127	52	-16	NA
1329	57	-11	NA
1528	54	-5	NA
1733	54	-2	Summa Closed
—	—	—	Sample ID # C400VI7IN0FCL-R

TAF 1/27/18

Teresa Fischer 5/15/2018
Kristen Henderson 5/15/2018

Geosyntec consultants

engineers | scientists | innovators

C-400 Vapor Intrusion Study
Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah Deactivation Project

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study – Fan Off; Doors Closed LOCATION 8

LOCATION: PGDP PROJECT NO.: KX6467 TASK NO: 01/04

DESCRIPTION: VI Sampling DATE: 01/26/2018

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Clear & Cool

1530 Set Summa at Location 8
– Summa 11227 –29.3"
– Regulator 11625
TAP 4/26/2018

1-27-18
- 0626 Purged sample line 3 liters
- See field form for details.

Teresa [signature]
1/26 & 27/18

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DFR_ One Page

Teresa Fisher 5/15/2018

SHEET NO 1 OF 1

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Differential Pressure and Ambient Temperature Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study** Date: 1/27/18 Page 1 of 1

Project Number: KX6467/01/04 Project Location: **Paducah Gaseous Diffusion Plant**

Recorded By: Teresa Fischer/Kris Henderson Gauge ID#: 44286-7-700

Weather: Cool & cloudy; Windy w/ intermittent rain

Location ID: LOCATION 8 Scenario Type: Fan Off; Doors Closed

Sample Start Time: 0650 Sample Initial Vacuum: -29.3 (certified)

Time	Differential Pressure (pa) Exhaust Fan to Ambient	Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
0649	-1.0	48	-29	Summa opened
0849	-2.0	55	-26	NA
1048	-0.3	56	-20	NA
1247	-0.3	53	-15	NA
1448	-0.2	56	-11	NA
1654	-0.1	51	-4	Summa closed
—	—	—	—	Sample ID C400V18EXH OFCL-R

Teresa Fischer 5/15/2018

[illegible signature] 5/15/2018

INSTRUMENT CALIBRATION REPORT

Pine Environmental Services LLC

10521 Research Drive
Suite 102
Knoxville, TN 37932
Toll-free: (877) 355-7907

Pine Environmental Services, Inc.

Instrument ID 20904
Description MIniRae 3000
Calibrated 1/24/2018 9:40:26AM

Manufacturer	Rae Systems	**State Certified**	
Model Number	MiniRAE 3000	**Status**	Pass
Serial Number/ Lot Number	592-909072	**Temp °C**	21
Location	Tennessee	**Humidity %**	22
Department			

Calibration Specifications

Group #	1	**Range Acc %**	0.0000
Group Name	ISOBUTYLENE	**Reading Acc %**	3.0000
Stated Accy	Pct of Reading	**Plus/Minus**	0.00

Nom In Val / In Val	In Type	Out Val	Out Type	Fnd As	Lft As	Dev%	Pass/Fail
100.00 / 100.00	PPM	100.00	PPM	100.00	100.00	0.00%	Pass

Test Instruments Used During the Calibration **(As Of Cal Entry Date)**

Test Standard ID	Description	Manufacturer	Model Number	Serial Number / Lot Number	Last Cal Date/ Opened Date	Next Cal Date / Expiration Date
TN 100PPM ISO DAQ-248-100-19	TN 100PPM ISO	Calgaz	34LS-248-100	DAQ-248-100-19		3/28/2020

Notes about this calibration

Calibration Result Calibration Successful
Who Calibrated Derek Farmer

All instruments are calibrated by Pine Environmental Services LLC according to the manufacturer's specifications, but it is the customer's responsibility to calibrate and maintain this unit in accordance with the manufacturer's specifications and/or the customer's own specific needs.

Notify Pine Environmental Services LLC of any defect within 24 hours of receipt of equipment
Please call 800-301-9663 for Technical Assistance

5/15/2018

INSTRUMENT QC/ PACKING LIST

Description	RAE Systems MiniRAE 3000
Instrument ID	20904
Date Calibrated	1-24-18

www.pine-environmental.com

Standard Items	**Prepared**	**QC check**	**Received by customer**	**Returned to Pine**
MiniRAE 3000 w/ ______eV lamp and carry case	✓	✓	✓	
Protective rubber boot	✓	✓	✓	
Manual	✓	✓	✓	
Quick reference card	✓	✓	✓	
Probe tip	✓	✓	✓	
Charger/ adapter, or charger and cradle	✓	✓	✓	
(2) Hydrophobic filters	✓	✓	✓	
Alkaline battery adapter	✓	✓	✓	
(4) AA Alkaline batteries	✓	✓	✓	
ProCal calibration sheet	✓	✓	✓	

4/26/2018

TAP

Supporting Items

100 ppm isobutylene calibration gas				
100 ppm Isobutylene SDS				
✓ *Must match cylinder with setup*				
Gas regulator				
Tedlar bag				
Datalogging software				
Communications cable				

Prepared by: JM
QC checked by: DA
Date: 1/24

This packing list is to ensure that every item needed to operate the unit was sent and received. Upon receiving a shipment, please fill out the "Received by customer" column. Call Pine within 24 hours of receiving the equipment if any pieces are missing, damaged, or malfunctioning. Thank you for choosing Pine Environmental Services LLC

[illegible] 5/15/2018

INSTRUMENT CALIBRATION REPORT

Pine Environmental Services LLC

10521 Research Drive
Suite 102
Knoxville, TN 37932
Toll-free: (877) 355-7907

Pine Environmental Services, Inc.

Instrument ID 12483
Description Landtec GEM-2000
Calibrated 1/24/2018 1:20:52PM

Manufacturer	CES Landtec	**State Certified**	
Model Number	GEM2000	**Status**	Pass
Serial Number/ Lot Number	GM07658	**Temp °C**	21
Location	Tennessee	**Humidity %**	22
Department			

Calibration Specifications

Group # 1
Group Name Methane
Stated Accy Pct of Reading
Range Acc % 0.0000
Reading Acc % 3.0000
Plus/Minus 0.0

Nom In Val / In Val	In Type	Out Val	Out Type	Fnd As	Lft As	Dev%	Pass/Fail
50.0 / 50.0	%Volume	50.0	%Volume	50.0	50.0	0.00%	Pass

Group # 2
Group Name Carbon Dioxide
Stated Accy Pct of Reading
Range Acc % 0.0000
Reading Acc % 3.0000
Plus/Minus 0.0

Nom In Val / In Val	In Type	Out Val	Out Type	Fnd As	Lft As	Dev%	Pass/Fail
35.0 / 35.0	%Volume	35.0	%Volume	35.0	35.0	0.00%	Pass

Group # 3
Group Name Oxygen
Stated Accy Pct of Reading
Range Acc % 0.0000
Reading Acc % 3.0000
Plus/Minus 0.0

Nom In Val / In Val	In Type	Out Val	Out Type	Fnd As	Lft As	Dev%	Pass/Fail
20.9 / 20.9	%Volume	20.9	%Volume	20.9	20.9	0.00%	Pass

Test Instruments Used During the Calibration **(As Of Cal Entry Date)**

Test Standard ID	Description	Manufacturer	Model Number	Serial Number / Lot Number	Last Cal Date/ Opened Date	Next Cal Date / Expiration Date
TN 50 CH4/35 CO2 17LX	TX 50 CH4/35 CO2 17L HAM-399-2	Liquid Technology	GP12116	KAO-399-3		10/31/2018

Notes about this calibration

Calibration Result Calibration Successful
Who Calibrated Derek Farmer

Teresa Fischer 5/15/2018

INSTRUMENT QC/ PACKING LIST

Description	Landtec GEM-2000
Instrument ID	12483
Date Calibrated	1-24-18

PINE
www.pine-environmental.com

Standard Items	Prepared	QC check	Received by customer	Returned to Pine
GEM-2000 w/ hard case	✓	✓	✓ 4/26/2018	
Fabric carry case	✓	✓	✓	
Manual	✓	✓	✓	
Quick reference card	✓	✓	✓ TAF	
Charger, AC cord (if applicable)	✓	✓	✓	
(2) 4' lengths of sample tubing w/ filter, housing, and 4 male quick connects			TAF 4/26/2018	
(2) Extra hydrophobic filters	✓	✓	✓	
(2) extra male quick connects			4/26/2018	
Comm. Cable and data logging software	✓	✓	✓	
Case insert warning			✓	
ProCal calibration sheet	✓	✓	✓ TAF	

Supporting Items

Supporting Items	Prepared	QC check	Received by customer	Returned to Pine
CH_4 and CO_2 calibration gas mix				
CH_4 and CO_2 calibration gas SDS ✓ *Must match cylinder with setup*				
4% Oxygen, balance N_2 gas mix				
4% Oxygen, balance N_2 gas SDS ✓ *Must match cylinder with setup*				
Gas regulator, female (.25 or .5 lpm)				
Gas regulator, male (.25 or .5 lpm)				
Calibration tubing (6" tubing w/ male quick connect)				
Temperature probe				

Prepared by: JM
QC checked by: DF
Date: 1/24

This packing list is to ensure that every item needed to operate the unit was sent and received. Upon receiving a shipment, please fill out the "Received by customer" column. Call Pine within 24 hours of receiving the equipment if any pieces are missing, damaged, or malfunctioning. Thank you for choosing Pine Environmental Services LLC

Teresa Fischer 5/15/2018

INSTRUMENT CALIBRATION REPORT

Pine Environmental Services LLC

4037 Darling Court
Lilburn, GA 30047
Toll-free: (800) 842-1088

Pine Environmental Services, Inc.

Instrument ID 10702
Description Radiodetection MGD-2002 Multi-Gas Leak Locator
Calibrated 1/23/2018 5:35:20PM

Manufacturer	Radiodetection	**State Certified**	
Model Number	MGD-2002	**Status**	Pass
Serial Number/ Lot Number	040951	**Temp °C**	21
Location	Georgia	**Humidity %**	34
Department			

Calibration Specifications

Group # 1
Group Name Zero to 99.999%
Test Performed: Yes **As Found Result: Pass** **As Left Result: Pass**

Test Instruments Used During the Calibration **(As Of Cal Entry Date)**

Test Standard ID	Description	Manufacturer	Model Number	Serial Number / Lot Number	Last Cal Date/ Opened Date	Next Cal Date / Expiration Date

Notes about this calibration

Calibration Result Calibration Successful
Who Calibrated Jeff Rasmussen

All instruments are calibrated by Pine Environmental Services LLC according to the manufacturer's specifications, but it is the customer's responsibility to calibrate and maintain this unit in accordance with the manufacturer's specifications and/or the customer's own specific needs.

Notify Pine Environmental Services LLC of any defect within 24 hours of receipt of equipment
Please call 800-301-9663 for Technical Assistance

Teresa Fischer 5/15/2018

INSTRUMENT QC/ PACKING LIST

Description	Dielectric MGD-2002
Instrument ID	10702
Date Prepared	1-23-18

PINE
www.pine-environmental.com

Standard Items	Prepared	QC check	Received by customer	Returned to Pine
MGD-2002 and carry case	✓	✓	✓	
Manual	✓	✓	✓	
Quick reference card	✓	✓	✓	
Charger	✓	✓	✓	
12VDC auto plug adapter	✓	✓	✓	
Needle probe	✓	✓	✓	
Ground probe	✓	✓	✓	
Handle assembly with moisture filter cartridge	✓	✓	✓	
Extra moisture filter cartridge	✓	✓	✓	
Drying adapter for cartridges	✓	✓	✓	
Carry strap	✓	✓	✓	
ProCal inspection report	✓	✓	✓	

4/26/2018

TAF

Prepared by: AR
QC checked by: SB
Date: 1/23/18

This packing list is to ensure that every item needed to operate the unit was sent and received. Upon receiving a shipment, please fill out the "Received by customer" column. Call Pine within 24 hours of receiving the equipment if any pieces are missing, damaged, or malfunctioning. Thank you for choosing Pine Environmental Services LLC.

Teresa Fischer 5/15/2018

INSTRUMENT CALIBRATION REPORT

Advanced Labs, Inc.

Pine Environmental Services, Inc

Instrument ID 39207
Description TSI 8330 VelociCheck
Calibrated 9/27/2017

Manufacturer	TSI	**Classification**	
Model Number	8330	**Status**	pass
Serial Number	96060227	**Frequency**	Yearly
Location	New Jersey	**Department**	Lab
Temp	76	**Humidity**	33

Calibration Specifications

Group # 1 **Range Acc %** 0.0000
Group Name Temperature **Reading Acc %** 0.0000
Stated Accy Plus / Minus **Plus/Minus** 5.00

Nom In Val / In Val	In Type	Out Val	Out Type	Fnd As	Lft As	Dev%	Pass/Fail
70.00 / 75.60	°F	75.60	°F	76.00	76.00	0.53%	Pass

Group # 2 **Range Acc %** 0.0000
Group Name Velocity **Reading Acc %** 5.0000
Stated Accy Pct of Reading **Plus/Minus** 0.00

Nom In Val / In Val	In Type	Out Val	Out Type	Fnd As	Lft As	Dev%	Pass/Fail
0.00 / 0.00	ft/min	0.00	ft/min	0.00	0.00	0.00%	Pass
40.00 / 40.00	ft/min	40.00	ft/min	40.00	40.00	0.00%	Pass
70.00 / 70.00	ft/min	70.00	ft/min	70.00	70.00	0.00%	Pass
100.00 / 100.00	ft/min	100.00	ft/min	103.00	103.00	3.00%	Pass
150.00 / 150.00	ft/min	150.00	ft/min	153.00	153.00	2.00%	Pass
325.00 / 325.00	ft/min	325.00	ft/min	330.00	330.00	1.54%	Pass
700.00 / 700.00	ft/min	700.00	ft/min	700.00	700.00	0.00%	Pass
1000.00 / 1000.00	ft/min	1000.00	ft/min	990.00	990.00	-1.00%	Pass
1500.00 / 1500.00	ft/min	1500.00	ft/min	1,490.00	1,490.00	-0.67%	Pass
2000.00 / 2000.00	ft/min	2000.00	ft/min	2,000.00	2,000.00	0.00%	Pass

Test Instruments Used During the Calibration

Test Instrument ID	Description	Manufacturer	Serial Number	Last Cal Date (As Of Cal Entry Date)	Next Cal Date (As Of Cal Entry Date)
MICHELL DM-509-TX-01	Relative Humidity Meter	Michell	273296	8/25/2017	8/25/2018
OMEGA HX93AC/DP25-E	Omega HX93AC/DP25-E	Omega Engineering	1010368 035025 035026	9/15/2016	9/15/2018
OMEGA PX02K1-16A5T /DP25-E-A	Omega PX02K1-16A5T/DP25-E-A	Omega Engineering	168377/8375030	9/15/2016	9/15/2018
OMEGA WT4401-D	Omega WT4401-D	Omega Engineering	101105	9/15/2016	9/15/2018

Teresa Fischer 5/15/2018

INSTRUMENT CALIBRATION REPORT

Advanced Labs, Inc.

Pine Environmental Services, Inc

Instrument ID 39207
Description TSI 8330 VelociCheck
Calibrated 9/27/2017

Notes about this calibration

Calibration Result Calibration Successful
Who Calibrated David Galego

Advanced Labs, Inc. hereby certifies that this instrument is calibrated and functions to meet the manufacture's specifications using NIST traceable standards, or is derived from accepted values of physical constants.

Teresa Fischer 5/15/2018

Advanced Labs, Inc., Windsor Industrial Park, 92 North Main Street, Bldg 20, Windsor, NJ 08561, 800-301-9663

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C-400 Vapor Intrusion Study
Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah
Deactivation Project

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study – Fan On; Doors Open

LOCATION: PGDP PROJECT NO.: KX6467 TASK NO: 01/04

DESCRIPTION: VI Sampling DATE: 02/ 9 /2018

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Clear & cold

TAP 2/9/2018

0545 Assemble at ~~C-730~~ C-730

- Jason Brulton . Brandon Taylor ; Kris Henderson ; David Jensen, Teresa Fischer
- Mobilize to Limited Area to complete Scenario set up

0555 Arrive at C-400

- All Bay Doors on north side open all the way
- Three of four bay doors open all way on south side; Door 6 is broken & open ~1 ~~foot~~
- Large exterior heaters off
- Exhaust fan on
- Scenario set up is complete; proceed with Shut in & Helium Seal Checks

0600 Check PID & Landtec meter calibration

- PID is not operating properly and will not be used.
- Stage equipment & materials in clean area within C-400

0630 Briefing with Jeff Seaton & Paul Colthrop

0705 Don PPE & enter C-400 CA

- Set up sub-slab & indoor air summa canisters at Locations 1, 2, 4, 5, 7
- Conduct shut in & Helium Seal Check at sub-slab locations → see individual Location forms for details

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SHEET NO 1 OF 2

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**C-400 Vapor Intrusion Study
Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah
Deactivation Project**

1030 Exit CA of C400; Doff PPE
1115 Set up summa canister at Location 8; lines to be
~~1115~~ purged prior to opening canister
TAP 2/9/18
1125 Set up summa canisters at Location 6
1210 Set up summa canisters at Location 3.
- See individual Locations forms for details
1330 Place tripods at Ambient Locations
1345 Leave Limited Area
- Unpack meters, equipment & materials that will not be used during sampling
- Calibration check
1500 End of field activities

[signature] 2/9/2018

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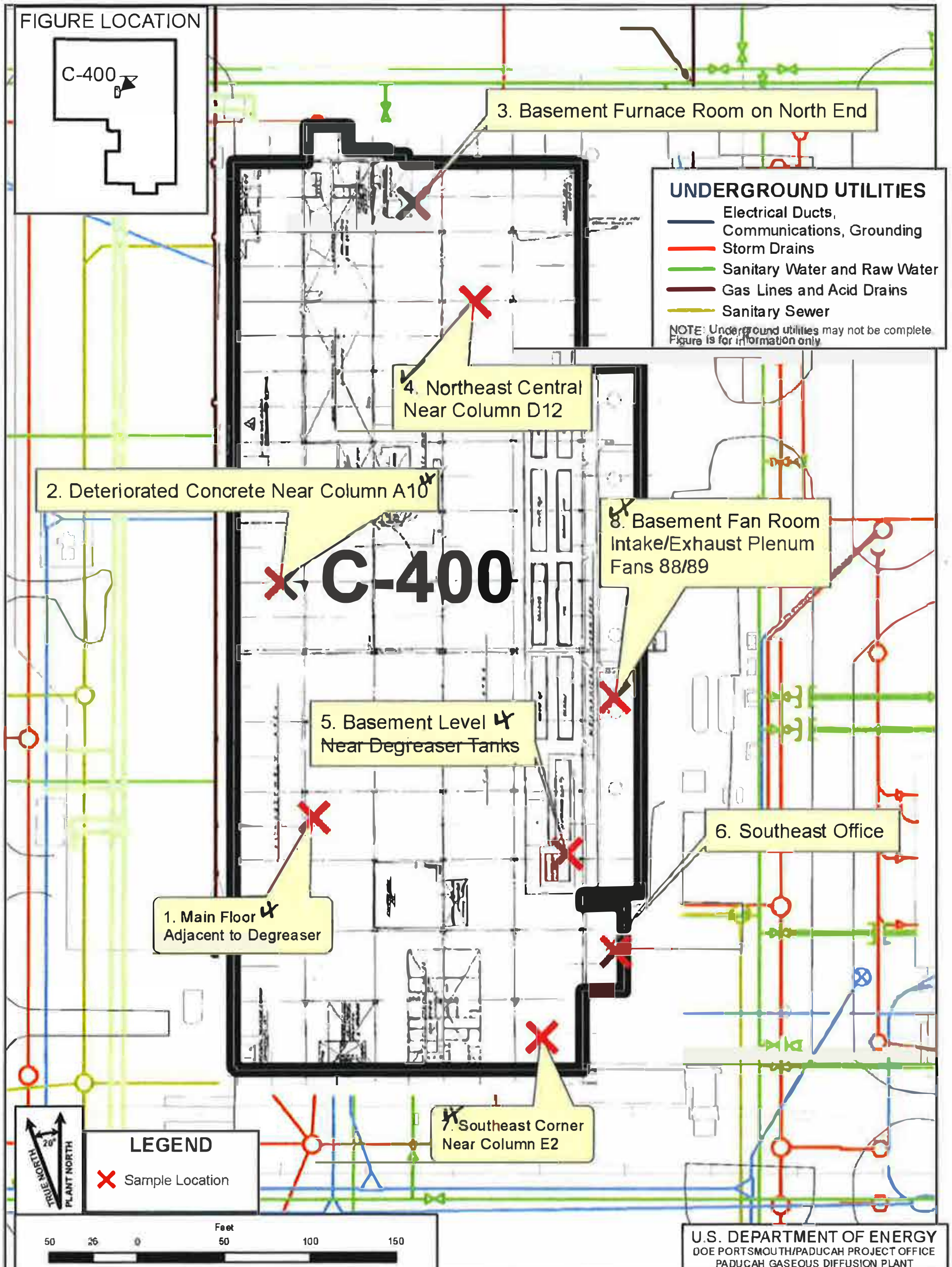


Figure 12. Indoor Sampling Locations for C-400 Building Vapor Intrusion Study

FLUOR

G:\GIS\ARCVIEWS\PROJECTS\Vapor Intrusion\MOA 400\Figure 12 C-400 Map (with Approximate Sampling Locations for VI).mxd
7/25/2017

Teresa Fischer 5/15/2018

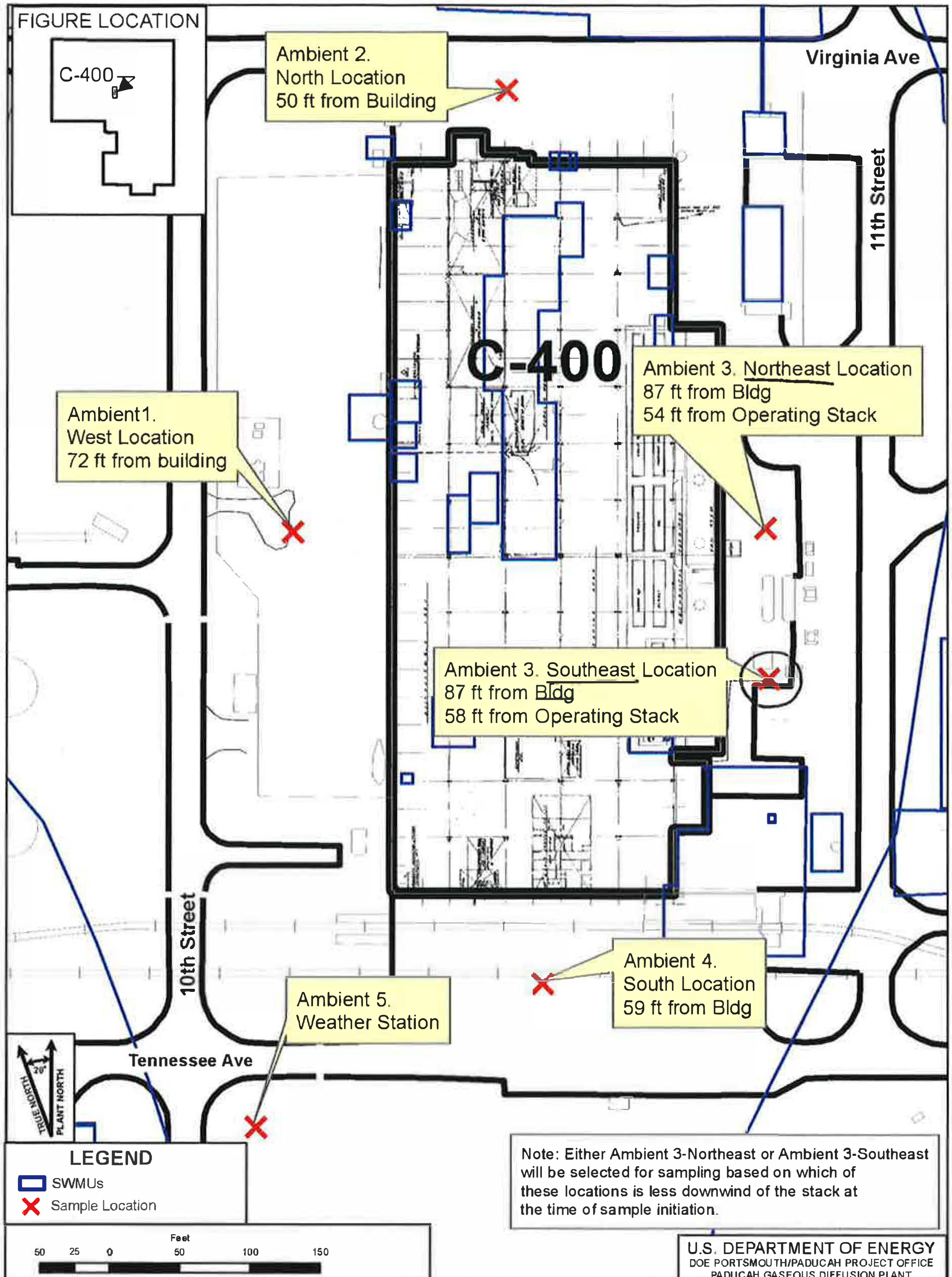


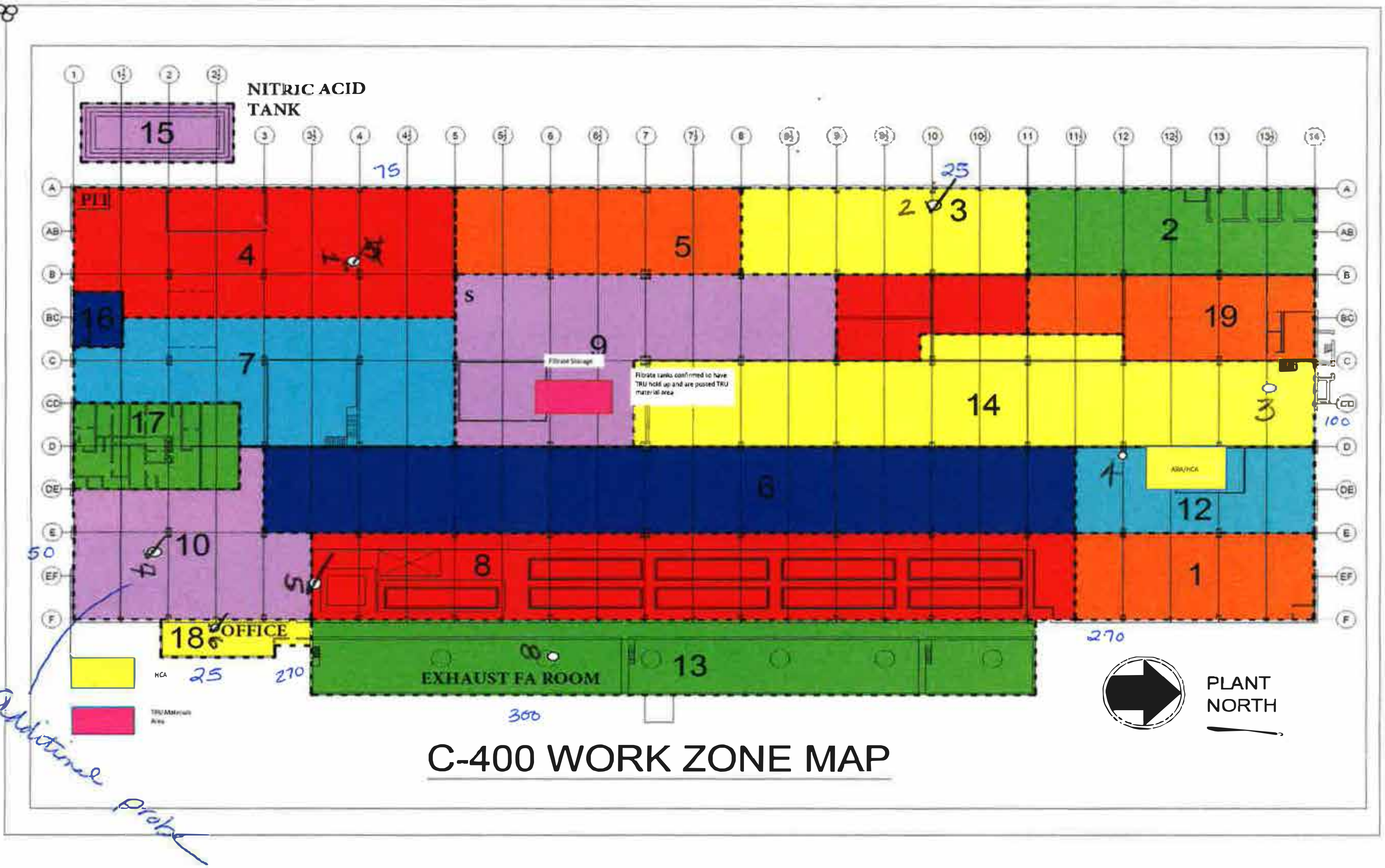
Figure 13. C-400 Map (with Approximate Ambient Sampling Locations)

G:\GIS\ARCVIEWS\PROJECTS\Vapor Intrusion\MOA 400\Figure 13 C-400 Ambient Sampling Locations.mxd
7/25/2017

5/15/2018

D3-71

5/15/2018



C-400 WORK ZONE MAP

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C-400 Vapor Intrusion Study
Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah
Deactivation Project

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study – Fan On; Doors Open

LOCATION: PGDP PROJECT NO.: KX6467 TASK NO: 01/04

DESCRIPTION: VI Sampling DATE: 02/10/2018

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Cold; light rain; slight wind from NW

0545 Mobilize to limited area from C-730 TOS.
- Brandon Taylor, Sam Martin, Kris Henderson,
David Jensen, Teresa Fischer

0555 Arrive at C400
- Set up Ambient Air summa canisters; Weather Station

0615 Mobilize to start Ambient Air summas & other summas outside CA; see individual location forms

0645 Don PPE to enter CA

0705 Enter CA
- Start summa canisters within CA; see individual forms

0730 Leave CA
- Doff PPE
- See individual location forms for details.

0915 RADCON Requested double booties & gloves @ Location 5.
- 10 minute delay while waiting for double booties & gloves before being able to enter Location 5 for indoor air readings.
- Subsequent Location readings also delayed; see individual location forms for details

1757 All ambient & sub-slab/indoor air canisters collected.

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C-400 Vapor Intrusion Study
Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah
Deactivation Project

Samples:

C400VI1SUBONOP-R

C400VI1INONOP-R

C400VI1AMBONOP-R

TAP 4/26/2018

C400VI2SUBONOP-R

C400VI2IN~~OP~~ONOP-R TAP 2/10/18

C400VI2AMBONOP-R

TAP 4/26/2018

C400VI3SUBONOP-R

C400VI3INONOP-R

~~C400VI3AMBONOP-R~~ TAP 2/10/18

C400VI3SEAMBONOP-R

C400VI4SUBONOP-R

C400VI4INONOP-R

C400VI4AMBONOP-R

TAP 4/26/2018

C400VI5SUBONOP-R

C400VI5INONOP-R | C400VI5INONOP-RD

C400VI6SUBONOP-R

C400VI6INONOP-R | C400VI6INONOP-RD

TAP 4/26/2018

C400VI7SUBONOP-R

C400VI7INONOP-R

TAP 4/26/2018

C400VI8EXHONOP-R

1830 Field activities complete; leave limited area

TAP 2/10/18

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C-400 Vapor Intrusion Study
Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah Deactivation Project

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study – Fan On; Doors Open Ambient Locations

LOCATION: PGDP PROJECT NO.: KX6467 TASK NO: 01/04

DESCRIPTION: VI Sampling DATE: 02/10/2018

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Cold; light rain with wind from NW

0605 Set up Ambient Location summa canisters.
- Ambient Location 3 set up at SE location → wind direction is from northwest
- Start sampling at 0616 → see individual location forms for details.

1638 All Ambient Location summa canisters closed and collected

1830 Field activities complete. leave limited area

[signature] 2/10/18

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Ambient Air
Monitoring Record 1

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/10/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: T. Fischer
SUMMA ID# and Regulator ID#: 11194 / 10446
Weather: Cold & drizzle

Location ID: Location 1 - Ambient
Scenario Type: Fan On; Doors Open
Sample Start Time: 0629
Sample Initial Vacuum: -29.6" certified

Time	Summa Canister Vacuum (in Hg)	Comments
0629	-27 (can)	Summa opened
0827	-24	Rain stopped
1027	-18.5	Windy
1229	-13.5	Windy
1425	-8.5	Windy
1630	-3.5	Windy; summa closed
		2/10/18
		Sample ID - C400VI1AMB0NOP-R

5/15/2018

5/15/2018

Ambient Air
Monitoring Record 2

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/10/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer
SUMMA ID# and Regulator ID#: 11690 / 10145
Weather: Cold + drizzle

Location ID: Location 2 - Ambient
Scenario Type: Fan On; Doors Open
Sample Start Time: 0616
Sample Initial Vacuum: -29.4" Hg (cert)

Time	Summa Canister Vacuum (in Hg)	Comments
0616	-28 (can)	Summa opened
0811	-24	Rain stopped
1017	-19.5	NA
1221	-14	NA
1418	-9	NA
1619	-3.5	NA; Summa closed
		Teresa Fischer
		2/10/18
		Sample ID - C400VI2AMBONOAR

Teresa Fischer 5/15/2018

[signature] 5/15/2018

D3-76

D3-77

Ambient Air
Monitoring Record 3 SE

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study** | Date: 02/10 2018 | Page 1 of 1
Project Number: KX6467/01/04 | Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: T. Fischer | SUMMA ID# and Regulator ID#: 10187 / 10139
Weather: Cold & drizzle

Location ID: Location 3 - Ambient | Scenario Type: Fan On; Doors Open
Sample Start Time: 0622 | Sample Initial Vacuum: -29.7" Hg (Certified)

Time	Summa Canister Vacuum (in Hg)	Comments
0622	-29.7	Summa opened
0820	-26	NA ; Rain stopped
~~0819~~ 1019 TAF 2/10/2018	-21	NA ; Windy
1225	-16.5	Windy
1420	-11.5	Windy
1622	-6.5	Windy ; Summa closed
		[signature] 2/18/2018
		Sample ID - ~~C400VI3SEAMBONOP-R~~

C400VI3SEAMBONOP-R TAF 2/10/18

[signature] 5/15/2018

[signature] 5/15/2018

D3-78

Ambient Air
Monitoring Record 4

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/10/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: T. Fischer
SUMMA ID# and Regulator ID#: 10272 / 10049
Weather: Cold & drizzle

Location ID: Location 4 - Ambient
Scenario Type: Fan On; Doors Open
Sample Start Time: 0637
Sample Initial Vacuum: -29.4" Hg (certified)

Time	Summa Canister Vacuum (in Hg)	Comments
0637	-29 (can)	Summa opened
0835	-25.5	Rain stopped
1035	-21	Windy
1234	-15	Windy
1435	-11	Windy
1637	-5	Windy; Summa closed
		Teresa F
		2/10/18
		Sample ID - C400VI4AMBONDP-R

Teresa Fischer 5/15/2018

[signature] 5/15/2018

Weather Station Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**

Date: 02/10/2018

Page 1 of 1

Project Number: KX6467/01/04

Project Location: **Paducah Gaseous Diffusion Plant**

Recorded By: Teresa Fischer/Kris Henderson

Location ID: Weather Station

Scenario Type: Fan On; Doors Open

Time	Ambient Temp. (deg. F)	Relative Humidity (%)	Barometric Pressure (inches Hg)	Wind Direction	Wind Speed (mph)
0632	40	41	30.04	NW	4
0830	39	48	30.04	N-NW	5
1030	38	51	30.05	N	5
1231	39	49	30.00	N	6
1430	40	48	29.98	N	5
1634	40	51	29.97	N	6

Teresa F 2/10/18

Teresa Fischer 5/15/2018

5/15/2018

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C-400 Vapor Intrusion Study
Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah Deactivation Project

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study – Fan On; Doors Open LOCATION 1

LOCATION: PGDP PROJECT NO.: KX6467 TASK NO: 01/04

DESCRIPTION: VI Sampling DATE: 02/ 9 /2018

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Clear & cold

0800 Set up Helium Seal Check
- Sub-slab summa → 10560; Flow Controller 11053; -29.6" Hg (certified).
- Indoor Air summa 11274; Flow controller 11511; -29.4" Hg (certified).

0926 Run Helium Seal Check & Shut in
- Seal check & shut in passed.

~~10~~ TAP 2/9/18

0940 Finish activities at Location 1

Teresa Fischer 2/9/18

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DFR_ One Page Teresa Fischer 5/15/2018 SHEET NO 1 OF 1

SOIL GAS PROBE MEASUREMENTS

Geosyntec consultants

① Project Name: C-400 Vapor Intrusion Study
Date: 02/ 9 /2018 Project Number: KX6467/01
Site Location: Paducah Gaseous Diffusion Plant ; 1
Weather: Clear & cold
Field Personnel: Teresa Fischer, Kris Henderson
Recorded By: Teresa Fischer

Probe No.: LOCATION 1 [X] Sub-slab probe [ ] Soil gas probe
Mini Rae 2000 Serial No.: NA Lamp: 10.6 / 11.7 eV
Landtech GEM 2000 Landfill Gas Meter Serial No. M: KAO - 399 - 3
MDG 2002 Helium detector Serial No.: 10702
Tracer Gas: [X] Helium [ ] Other

② Surface Type: [ ] Asphalt [X] Concrete [ ] Grass [ ] Other
Surface Thickness 18 3/4 inches/centimeters [ ] Unknown
(i.e., asphalt or concrete)

③ 1 Casing Volume
[X] Sub-slab <0.1 L
Soil gas probe ______ (L)

⑤ Field tubing blank reading (ppm$_v$) completed? [ ] Yes [X] No PID Reading NA ppm$_v$ *

⑥ Shut in test prior to purging completed? Yes [✓] No [ ]

⑦ Purging

Date	Start Time	End Time	Elapsed Time (min.)	Bag Volume (L)	Purge Rate (LPM)	TAP 4/26/2018 —	CH_4 (%)	CO_2 (%)	O_2 (%)	Tracer Gas Shroud (%) Min	Tracer Gas Shroud (%) Max	Tracer Gas Sample (ppm, %) (circle one)	VOCs by PID (ppm$_v$)
2/9/18	0931	0932	1	0.75	0.5	—	0.1	0.1	20.8	23.2	23.9	0	NA
2/9/18	0934	0935	1	0.75	0.6	—	0.1	0.1	20.8	24.7	~~23.~~ 25.9	0	NA
—	—	—	—	—	—	—	—	—	—	—	TAP	2/9/18	—
2/9/18	0937	0939	2	0.75	0.5	—	0.1	0.1	20.8	21.1	23.1	0	NA
—	—	—	—	—	—	—	—	—	—	—	—	—	—

⑧ Helium concentration in field screened samples is less than 5% of minimum concentration in the shroud? [✓] Yes [ ] No **Note:** 1% helium = 10,000 ppm$_v$

⑨ Shut in test prior to sample collection completed? Yes [✓] No [ ]

⑩ Sample Collection

Date	Time	Sample ID	Summa Canister ID	Flow Controller #	Vacuum Gauge #	Initial Vacuum (in. Hg)	Final Vacuum (in. Hg)
2/10/2018	1730	C400VI1SUB0N0P-R	10560	11053	—	-29.6 (cert)	-6 (can)
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—

Comments: * PID not working properly

Teresa Fischer 5/15/2018 [signature] 5/15/2018

Differential Pressure and Ambient Temperature Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/10/2018 Page 1 of 1

Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**

Recorded By: Teresa Fischer/Kris Henderson
Gauge ID#: 42900-7-700

Weather: Cold & drizzle

Location ID: LOCATION # 1
Scenario Type: Fan On; Doors Open

Sample Start Time: 0722
Sample Initial Vacuum: -29.6" (certified)

Time	Differential Pressure (pa)		Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
	sub-slab/ambient	ambient/outside			
0722	0.1	-0.4	44	-30 (can)	Summa opened
0930	-1.4	6.4	40	-25	NA
1120	-0.9	-1.5	40	-21	NA
* 1321	2.4	-0.4	39	-16	NA
1423	1.7	-0.8	39	-10.5	NA
1736	1.7	-1.0	38	-6	NA
—	—	—	—	—	Sample ID C400VI1SUBONDP-A

* Cross check differential pressure readings

Teresa Fischer 5/15/2018

[signature] 5/15/2018

D3-83

Indoor Air Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/ 10 /2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
SUMMA ID# and Regulator ID#: 11274 / 11511
Weather: Cold & drizzle

Location ID: 1
Scenario Type: Fan On; Doors Open
Sample Start Time: 0722
Sample Initial Vacuum: - 29.4" (certified)

Time	Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
0722	44	-30 (can)	Summa opened
0930	40	-26.5	NA
1121	40	-22.5	NA
1321	39	-16.5	NA
1423	39	-11	NA
1730	38	-6 (can)	Summa Closed
—	—	—	Sample ID C400V11 INONOP-R

Teresa Fischer 5/15/2018

[signature] 5/15/2018

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C-400 Vapor Intrusion Study
Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah
Deactivation Project

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study – Fan On; Doors Open LOCATION ~~B~~2 TAF 2/9/18

LOCATION: PGDP PROJECT NO.: KX6467 TASK NO: 01/04

DESCRIPTION: VI Sampling DATE: 02/ 9 /2018

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Clear & cold

0805 Set up Helium Seal Check
- Sub-slab summa 09775; Flow controller 09842; -29.6" Hg certified.
- Indoor air summa 09546; Flow controller 10454; -29.6" Hg certified

0953 Start Helium Seal Check
- Passed check

1004 Complete set up at Location 2.

Teresa [signature] 2/9/18

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DFR_ One Page Teresa [signature] 5/15/2018 SHEET NO 1 OF 1

SOIL GAS PROBE MEASUREMENTS

Geosyntec consultants

① Project Name: C-400 Vapor Intrusion Study
Date: 02/ 9 /2018 Project Number: KX6467/01
Site Location: Paducah Gaseous Diffusion Plant ; 2
Weather: Clear & cold
Field Personnel: Teresa Fischer, Kris Henderson
Recorded By: T. Fischer

Probe No.: LOCATION 2 [X] Sub-slab probe [ ] Soil gas probe
Mini Rae 2000 Serial No.: NA Lamp: 10.6 / 11.7 eV
Landtech GEM 2000 Landfill Gas Meter Serial No. M: KAO - 399-3
MDG 2002 Helium detector Serial No.: 10702
Tracer Gas: [X] Helium [ ] Other

② Surface Type: [ ] Asphalt [X] Concrete [ ] Grass [ ] Other____
Surface Thickness 20 inches/centimeters [ ] Unknown
(i.e., asphalt or concrete)

③ 1 Casing Volume
[X] Sub-slab <0.1 L
Soil gas probe ______ (L)

⑤ Field tubing blank reading (ppm$_v$) completed? [ ] Yes [✓] No PID Reading NA ppm$_v$ *

⑥ Shut in test prior to purging completed? Yes [✓] No [ ]

⑦ Purging

Date	Start Time	End Time	Elapsed Time (min.)	Bag Volume (L)	Purge Rate (LPM)	TAP 4/26/2018	CH_4 (%)	CO_2 (%)	O_2 (%)	Tracer Gas Shroud (%) Min	Tracer Gas Shroud (%) Max	Tracer Gas Sample (ppm$_v$, %) (circle one)	VOCs by PID (ppm$_v$)
2/9/18	0953	0954	1	0.75	0.5	—	0.1	0.1	20.9	21.2	25.8	0	NA
2/9/18	0956	0958	2	0.75	0.5	—	0.0	0.1	20.9	24.1	24.9	0	NA
2/9/18	1000	1002	2	0.75	0.5	—	0.1	0.1	21.0	21.7	22.8	0	NA
—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—

⑧ Helium concentration in field screened samples is less than 5% of minimum concentration in the shroud? [✓] Yes [ ] No **Note:** 1% helium = 10,000 ppm$_v$

⑨ Shut in test prior to sample collection completed? Yes [✓] No [ ]

⑩ Sample Collection

Date	Time	Sample ID	Summa Canister ID	Flow Controller #	Vacuum Gauge #	Initial Vacuum (in. Hg)	Final Vacuum (in. Hg)
2/10/2018	1734	C400VI2SUB0NOP-R	09775	09842	—	-29.6 (cert)	-6
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—

Comments: * PID not working properly

Teresa Fischer 5/15/2018 [signature] 5/15/2018

D3-85

D3-86

Differential Pressure and Ambient Temperature Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/10 /2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
Gauge ID#: 42990-7-700
Weather: Cold & drizzle

Location ID: LOCATION # 2
Scenario Type: Fan On; Doors Open
Sample Start Time: 0726
Sample Initial Vacuum: -29.6 " Hg (cert)

Time	Differential Pressure (pa)		Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
	sub-slab/ambient	ambient/outside			
0726	-0.2	0.3	40	-30 (can)	Summa opened
0935	0.9	-13.8	-38	-26.5	NA
1124	-1.0	-0.8	36	-21	N/A
1325	-0.6	-0.4	37	-16	Windy
1427	0	1.2	38	-9	Windy
1734	0.21	3.0	36	-6	Windy
—	—	—	—	—	Sample ID C400 V12 SUBONOP-R

Teresa Fischer 5/15/2018

Kris Henderson 5/15/2018

D3-87

Indoor Air Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/ 10 /2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
SUMMA ID# and Regulator ID#: 09546 / 10454
Weather: Cold & drizzle

Location ID: 2
Scenario Type: Fan On; Doors Open
Sample Start Time: 0726
Sample Initial Vacuum: -29.6" Hg (cert)

Time	Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
0726	40	-28 (can)	Summa opened
0935	38	-26	NA
1124	36	-22	NA
1325	37	-16.5	Windy
1427	38	-11	Windy
~~1634~~ 1734	36	-6	Summa Closed; Windy
TAF	2/10/18	—	Sample ID C400VI2INONOP-R

Teresa Fischer 5/15/2018

Kris Henderson 5/15/2018

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C-400 Vapor Intrusion Study
Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah
Deactivation Project

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study – Fan On; Doors Open LOCATION 3

LOCATION: PGDP PROJECT NO.: KX6467 TASK NO: 01/04

DESCRIPTION: VI Sampling DATE: 02/9 /2018

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Clear & cool

1156 Setup Helium Seal Check at Location 3
- Summa canister Indoor Air 09871; Flow Controller 11602;
  - 29.3" Hg certified)

1254 Helium Seal Check complete.
- Location 3 does not pass test due to tight subsurface sediments (clay).
- Summa canister set up passed shut-in test
- Probe & seal intact; no leaks suspected.

1257 Complete activities at Location 3

Teresa [signature] 2/9/2018

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DFR_ One Page Teresa Proche 5/15/2018 SHEET NO 1 OF 1

SOIL GAS PROBE MEASUREMENTS

Geosyntec consultants

① Project Name: C-400 Vapor Intrusion Study
Date: 02/9/2018
Project Number: KX6467/01
Site Location: Paducah Gaseous Diffusion Plant ; 3
Weather: Clear & Cool
Field Personnel: Teresa Fischer, Kris Henderson
Recorded By: T. Fischer

Probe No.: LOCATION 3
[X] Sub-slab probe
[ ] Soil gas probe
Mini Rae 2000 Serial No.: NA
Lamp: 10.6 / 11.7 eV
Landtech GEM 2000 Landfill Gas Meter Serial No. M: KAO-399-3
MDG 2002 Helium detector Serial No.: 1070
Tracer Gas: [X] Helium [ ] Other

② Surface Type: [ ] Asphalt [X] Concrete [ ] Grass [ ] Other
Surface Thickness 19 1/4 inches/centimeters [ ] Unknown
(i.e., asphalt or concrete)

③ 1 Casing Volume
[X] Sub-slab <0.1 L
Soil gas probe ______ (L)

⑤ Field tubing blank reading (ppm$_v$) completed? [ ] Yes [X] No PID Reading NA ppm$_v$*

⑥ Shut in test prior to purging completed? Yes [X] No [ ]

⑦ Purging

Date	Start Time	End Time	Elapsed Time (min.)	Bag Volume (L)	Purge Rate (LPM)	TAF 4/26/2018	CH_4 (%)	CO_2 (%)	O_2 (%)	Tracer Gas Shroud (%) Min	Tracer Gas Shroud (%) Max	Tracer Gas Sample (ppm$_v$, %) (circle one)	VOCs by PID (ppm$_v$)
2/9/2018	1205	1212	7	0.5	0.2	—	0.1	0.0	20.9	14.5	22.8	15,775ppm	NA
2/9/2018	1217	1224	7	0.5	0.2	—	0.1	0.0	20.1	14.3	23.0	2.1 %	NA
2/9/2018	1228	1235	7	0.5	0.2	—	0.1	0.0	20.6	14.7	24.9	19,575ppm	NA
2/9/2018	1240	1247	7	0.5	0.2	—	0.1	0.0	20.3	14.5	24.9	2.4 %	NA
—	—	—	—	—	—	—	—	—	—	—	—	—	—

⑧ Helium concentration in field screened samples is less than 5% of minimum concentration in the shroud? [X] Yes [ ] No
Note: 1% helium = 10,000 ppm$_v$

⑨ Shut in test prior to sample collection completed? Yes [X] No [ ]

⑩ Sample Collection

Date	Time	Sample ID	Summa Canister ID	Flow Controller #	Vacuum Gauge #	Initial Vacuum (in. Hg)	Final Vacuum (in. Hg)
2/10/2018	1757	C400VI3SDBONOP-R	11167	10621	—	-29.6 (cert)	-7
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—

Comments: * PID not working properly.

Teresa Fischer 5/15/2018 [signature] 5/15/2018

D3-90

Differential Pressure and Ambient Temperature Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/10/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
Gauge ID#: 42990-7-700
Weather: Cold & drizzle

Location ID: LOCATION # 3
Scenario Type: Fan On; Doors Open
Sample Start Time: 0618
Sample Initial Vacuum: -29.6" Hg (cert)

Time	Differential Pressure (pa)		Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
	sub-slab/ambient	ambient/outside			
0618	0.0	-2.5	41	< -30	NA
0942	-1.0	2/10/18 ~~0.0~~ 2.0	43	-24	closed 0942; opened 0952
1138	-4.9	-3.1	45	-20	closed 1138; opened 1149
1339	-2.7	-3.4	46	-17	closed 1339; opened 1346
1535	1.0	-2.7	45	-13	closed 1535; 1543
1757	-1.0	-5.9	46	-7	Summa closed
—	—	—	—	—	Sample ID C400V13SUB0NOP-R

Teresa Fischer 5/15/2018

Kris Henderson 5/15/2018

Indoor Air Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/10/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
SUMMA ID# and Regulator ID#: 09871/11602
Weather: cold, cloudy

Location ID: 3
Scenario Type: Fan On; Doors Open
Sample Start Time: 0615
Sample Initial Vacuum: -29.3" Hg (Certified)

Time	Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
0615	41	-26	NA
0942	43	-19	NA
1138	45	-15	NA
1339	46	-10	NA
1537	45	-5	NA
1618	45	-3.5	~~NA~~ SUMMA closed
—	—	—	Sample ID ~~C400V13NOFOP-R~~

C400V13NONOP-R TAF 2/10/18

Teresa Fischer 5/15/2018

Kris Henderson 5/15/2018

D3-91

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C-400 Vapor Intrusion Study
Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah
Deactivation Project

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study – Fan On; Doors Open LOCATION 4

LOCATION: PG_ID PROJECT NO.: KX6467 TASK NO: 01/04

DESCRIPTION: VI Sampli ng DATE: 02/ 9 /2018

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Clear & Cold

0711 Set up Helium Seal Check
- Summa Canister for sub-slab → 10190; Flow Con 11600; -29.7" Hg
- Summa Canister for indoor air → 10979; Flow Controller 11477; Certified vacuum -29.6" Hg
- Concrete seal cracked; reseal.

0720 To be seal checked Later
1008 Run Helium Seal Check
- Pass check

1025 Complete set up at Location 4

Teresa A F
2/9/2018

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DFR_ One Page Teresa Frasher 5/15/2018 SHEET NO 1 OF 1

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SOIL GAS PROBE MEASUREMENTS

Geosyntec consultants

① Project Name: C-400 Vapor Intrusion Study
Date: 02/9 /2018 Project Number: KX6467/01
Site Location: Paducah Gaseous Diffusion Plant ; 4
Weather: Clear & cold
Field Personnel: Teresa Fischer, Kris Henderson
Recorded By: T. Fischer

Probe No.: LOCATION 4 [X] Sub-slab probe [ ] Soil gas probe
Mini Rae 2000 Serial No.: NA Lamp: 10.6 / 11.7 eV
Landtech GEM 2000 Landfill Gas Meter Serial No. M: KAO - 399-3
MDG 2002 Helium detector Serial No.: 1020
Tracer Gas: [X] Helium [ ] Other

② Surface Type: [ ] Asphalt [X] Concrete [ ] Grass [ ] Other______
Surface Thickness 15 1/2 inches/centimeters [ ] Unknown
(i.e., asphalt or concrete)

③ 1 Casing Volume
[X] Sub-slab <0.1 L
Soil gas probe ______ (L)

⑤ Field tubing blank reading (ppm_v) completed? [ ] Yes [✓] No PID Reading NA ppm_v *

⑥ Shut in test prior to purging completed? Yes [✓] No [ ]

⑦ Purging

Date	Start Time	End Time	Elapsed Time (min.)	Bag Volume (L)	Purge Rate (LPM)	TAP 4/26/2018	CH_4 (%)	CO_2 (%)	O_2 (%)	Tracer Gas Shroud (%) Min	Tracer Gas Shroud (%) Max	Tracer Gas Sample (ppm, %) (circle one)	VOCs by PID (ppm_v)
2/9/18	1013	1016	3	0.75	0.5	—	0.1	0.1	21.1	21.2	22.7	0	NA
2/9/18	1018	1020	2	0.50	0.5	—	0.1	0.1	21.0	24.3	25.9	0	NA
2/9/18	1021	1023	2	0.50	0.5	—	0.1	0.1	21.0	22.3	23.1	0	NA
—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—

⑧ Helium concentration in field screened samples is less than 5% of minimum concentration in the shroud? [✓] Yes [ ] No **Note:** 1% helium = 10,000 ppm_v

⑨ Shut in test prior to sample collection completed? Yes [✓] No [ ]

⑩ Sample Collection

Date	Time	Sample ID	Summa Canister ID	Flow Controller #	Vacuum Gauge #	Initial Vacuum (in. Hg)	Final Vacuum (in. Hg)
2/10/2018	1714	C400VI4SUBONOP-R	10190	11600	—	-29.7 (cert)	-5
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—

Comments: * PID not working properly

Teresa Fischer 5/15/2018 [signature] 5/15/2018

Differential Pressure and Ambient Temperature Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study** Date: 02/10/2018 Page 1 of 1

Project Number: KX6467/01/04 Project Location: **Paducah Gaseous Diffusion Plant**

Recorded By: Teresa Fischer/Kris Henderson Gauge ID#: 42990-7-706

Weather: Cold ; drizzle

Location ID: LOCATION # 4 Scenario Type: Fan On; Doors Open

Sample Start Time: 0709 Sample Initial Vacuum: -29.7" Hg (cert)

Time	Differential Pressure (pa)		Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
	sub-slab/ambient	ambient/outside			
0709	2.8	2.0	51	-29	Summa opened
0911	0.1	-3.4	49	-24	NA
1108	1.2	-2.5	50	-19	NA
1310	2.3	-6.9	49	-13	NA
1413	1.6	-4.0	40	-10	NA
~~1614~~	2.0	-11.0	37	-5	Summa Closed; Windy
1714	—	—	—	—	Sample ID: C400V1430BONOP-12;

TMF
2/10/18

Teresa Fischer 5/15/2018

Kris Henderson 5/15/2018

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D3-95

Indoor Air Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/10/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
SUMMA ID# and Regulator ID#: 10979/11477
Weather: Cold; drizzle

Location ID: 4
Scenario Type: Fan On; Doors Open
Sample Start Time: 0708
Sample Initial Vacuum: -29.6" Hg (certified)

Time	Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
0708	51	-30	Summa opened
0911	49	-26.5	NA
1108	50	-22	NA
1310	50	-17	NA
1513	44	-12	NA
1714	37	-8	NA; summa closed
—	—	—	Sample ID C400VI4INONOP-R

Teresa Fischer 5/15/2018

Kris Henderson 5/15/2018

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C-400 Vapor Intrusion Study
Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah
Deactivation Project

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study – Fan On; Doors Open LOCATION 5

LOCATION: PGDP PROJECT NO.: KX6467 TASK NO: 01/04

DESCRIPTION: VI Sampling DATE: 02/9 /2018

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Clear & Cold

0726 Set up Helium Seal Check
- Subslab summa canister 09998; Flow controller 11238; -29.1" Hg certified
- Indoor air summa → 11214; Flow con. 10457; -29.6" Hg certified
- Indoor air summa duplicate → 11081; Flow con. 11420; -29.6" Hg certified

0818 Run Helium Seal Check
- Helium seal check passed

0855 Location 5 set up complete

Teresa A. Frisch 2/9/2018

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Teresa Frisch 5/15/2018

SHEET NO 1 OF 1

SOIL GAS PROBE MEASUREMENTS

Geosyntec consultants

① Project Name: C-400 Vapor Intrusion Study
Date: 02/9/2018 Project Number: KX6467/01
Site Location: Paducah Gaseous Diffusion Plant ; 5
Weather: Clear & Cold
Field Personnel: Teresa Fischer, Kris Henderson
Recorded By: T. Fischer

Probe No.: LOCATION 5 ☒ Sub-slab probe ☐ Soil gas probe
Mini Rae 2000 Serial No.: NA Lamp: 10.6 / 11.7 eV
Landtech GEM 2000 Landfill Gas Meter Serial No. M: KAO - 399 - 3
MDG 2002 Helium detector Serial No.: 10702
Tracer Gas: ☒ Helium ☐ Other

② Surface Type: ☐ Asphalt ☒ Concrete ☐ Grass ☐ Other
Surface Thickness 20 1/2 inches centimeters ☐ Unknown
(i.e., asphalt or concrete)

③ 1 Casing Volume
☒ Sub-slab <0.1 L
Soil gas probe ______ (L)

⑤ Field tubing blank reading (ppm_v) completed? ☐ Yes ☑ No PID Reading NA ppm_v *

⑥ Shut in test prior to purging completed? Yes ☑ No ☐

⑦ Purging

Date	Start Time	End Time	Elapsed Time (min.)	Bag Volume (L)	Purge Rate (LPM)	TAP 4/24/2018	CH_4 (%)	CO_2 (%)	O_2 (%)	Tracer Gas Shroud (%) Min	Tracer Gas Shroud (%) Max	Tracer Gas Sample (ppm_v, %) (circle one)	VOCs by PID (ppm_v)
2/9/18	0820	0824	4	0.75	0.5	—	0	0.1	20.9	17.3	23	2.9	NA
2/9/18	0833	0836	3	0.75	0.4	—	0.1	0.1	20.8	23.5	25.9	17,250	NA
2/9/18	0839	0842	3	0.75	0.35	—	0.1	0.1	20.9	23.1	26.9	16,925	NA
2/9/18	0948	0851	3	0.75	0.35	—	0.1	0.1	20.8	17.0	21.1	17,000	NA
—	—	—	—	—	—	—	—	—	—	—	—	—	—

⑧ Helium concentration in field screened samples is less than 5% of minimum concentration in the shroud? ☑ Yes ☐ No **Note:** 1% helium = 10,000 ppm_v

⑨ Shut in test prior to sample collection completed? Yes ☑ No ☐

⑩ Sample Collection TAP 2/10/18

Date	Time	Sample ID	Summa Canister ID	Flow Controller #	Vacuum Gauge #	Initial Vacuum (in. Hg)	Final Vacuum (in. Hg)
1722	2/10/18	C400VISSOBONOP-R	09998	11238	NA	-29.1 Cert	-5
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—

Comments: * PID not working properly.

Teresa Fischer 5/15/2018 [signature] 5/15/2018

D3-97

D3-98

Differential Pressure and Ambient Temperature Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/10/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
Gauge ID#: 42990-7-700
Weather: Cold & drizzle

Location ID: LOCATION # 5
Scenario Type: Fan On; Doors Open
Sample Start Time: 0716
Sample Initial Vacuum: -29.1" Hg (certified)

Time	Differential Pressure (pa)		Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
	sub-slab/ambient	ambient/outside			
0716	-0.5	0.1	44	-28	Summa opened
0918	-2.4	0.2	41	-24	NA
1114	-0.4	0.0	41	-19	NA
1317	-1.7	2.2	40	-14	NA
1419	-1.6	1.0	41	-10	NA
1722	0.9	1.2	38	-5	Summa closed
—	—	—	—	—	Sample ID C400V15SUB0NOP-R

Teresa Fischer 5/15/2018

Kris Henderson 5/15/2018

D3-99

Indoor Air Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/ 10/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
SUMMA ID# and Regulator ID#: 11214 | 10457
Weather: Cold & drizzle
Duplicate 11081 | 11420

Location ID: S
Scenario Type: Fan On; Doors Open
Sample Start Time: 0716
Sample Initial Vacuum: -29.6" Hg & -29.6" Hg (Dup) (Certified)

Time	Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg) Dup	R	Comments
0716	44	-28	-30	Summas opened
0915	43	-24	-26	NA
1114	41	-22	-19	NA
1314	40	-15.5	-17	NA
1519	41	-9	-13	NA
1722	38	-8	-4	Summas closed
—	—	-	-	Sample ID C400VI5INONOP-RD

C400VI5INONOP-R

Teresa Fischer 5/15/2018

Kris Henderson 5/15/2018

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C-400 Vapor Intrusion Study
Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah
Deactivation Project

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study – Fan On; Doors Open LOCATION 6

LOCATION: PGDP PROJECT NO.: KX6467 TASK NO: 01/04

DESCRIPTION: VI Sampling DATE: 02/9 /2018

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Clear & cool

1122 Set up Helium Seal Check

- Summa Canister Indoor Air 10575; Flow Controller 10153; -29.3" Hg (certified)
- Summa Canister Indoor Air Dup. 10114; Flow Controller 10437; -29.2" Hg (certified)
- Summa Canister sub-slab 11042; Flow Controller 11595; -29.6" Hg (certified)

1145 Set up complete. Seal check passed.

Teresa A. Fischer
2/9/2018

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Teresa Fischer 5/15/2018

SHEET NO 1 OF 1

SOIL GAS PROBE MEASUREMENTS

Geosyntec consultants

D3-101

(1) Project Name: C-400 Vapor Intrusion Study
Date: 02/9/2018 Project Number: KX6467/01
Site Location: Paducah Gaseous Diffusion Plant ; 6
Weather: Clear & cool
Field Personnel: Teresa Fischer, Kris Henderson
Recorded By: T. Fischer

Probe No.: LOCATION 6 [X] Sub-slab probe [ ] Soil gas probe
Mini Rae 2000 Serial No.: NA Lamp: 10.6 / 11.7 eV
Landtech GEM 2000 Landfill Gas Meter Serial No. M: KAO-399-3
MDG 2002 Helium detector Serial No.: 10702
Tracer Gas: [X] Helium [ ] Other

(2) Surface Type: [ ] Asphalt [X] Concrete [ ] Grass [ ] Other
Surface Thickness (i.e., asphalt or concrete) 6 inches/centimeters [ ] Unknown

(3) 1 Casing Volume
[X] Sub-slab <0.1 L
Soil gas probe ______ (L)

(5) Field tubing blank reading (ppm$_v$) completed? [ ] Yes [✓] No PID Reading 0 ppm$_v$ *

(6) Shut in test prior to purging completed? Yes [✓] No [ ]

(7) Purging

Date	Start Time	End Time	Elapsed Time (min.)	Bag Volume (L)	Purge Rate (LPM)	~~—~~ TF 4/20/2018 —	CH_4 (%)	CO_2 (%)	O_2 (%)	Tracer Gas Shroud (%) Min	Tracer Gas Shroud (%) Max	Tracer Gas Sample (ppm, %) (circle one)	VOCs by PID (ppm$_v$)
2/9/2018	1129	1130	1	0.75	0.55	—	0.1	0.1	20.5	22.4	31.4	0	NA
2/9/2018	1132	1134	2	0.75	0.5	—	0.1	0.1	20.6	23.6	26.1	0	NA
2/9/2018	1136	1139	3	0.75	0.4	—	0.1	0.1	20.6	18.2	23.5	0	NA
—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—

(8) Helium concentration in field screened samples is less than 5% of minimum concentration in the shroud? [✓] Yes [ ] No **Note:** 1% helium = 10,000 ppm$_v$

(9) Shut in test prior to sample collection completed? Yes [✓] No [ ]

(10) Sample Collection

Date	Time	Sample ID	Summa Canister ID	Flow Controller #	Vacuum Gauge #	Initial Vacuum (in. Hg)	Final Vacuum (in. Hg)
2/10/18	1636	C400VI6SUBANOP-R	11042	11595	—	-29.6	-6
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—

Comments: * PID not working properly

Teresa Fischer 5/15/2018 [signature] 5/15/2018

D3-102

Differential Pressure and Ambient Temperature Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/10/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
Gauge ID#: 42990-7-700
Weather: cold; cloudy

Location ID: LOCATION # 6
Scenario Type: Fan On; Doors Open
Sample Start Time: 0636
Sample Initial Vacuum: -29.6" Hg (certified)

Time	Differential Pressure (pa)		Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
	sub-slab/ambient	ambient/outside			
0636	0.0	-0.5	62	-28	Summa opened
0834	0.0	-0.1	63	-24	NA
1034	-0.1	-0.2	59	-21	NA
1235	0.0	0.3	70	-16	NA
1434	0.1	0.2	69	-11	NA
1636	0.1	-0.1	63	-6	Summa closed
—	—	—	—	—	Sample ID C400VI6SUBONOP-R

Teresa Fischer 5/15/2018

Kris Henderson 5/15/2018

D3-103

Indoor Air Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/ 10/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
SUMMA ID# and Regulator ID#: 10575/ 10153
Weather: Cold; drizzle
Duplicate 10114 / 10437

Location ID: 6
Scenario Type: Fan On; Doors Open
Sample Start Time: 0636
Sample Initial Vacuum: -29.3" Hg & -29.2" Hg (Dup) (Certified)

Time	Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg) R	Summa Can Vacuum (in Hg) D	Comments
0636	62	-28	-30	Summas opened
0834	63	-24	-26	NA
1034	60	-20	-21	NA
1235	70	-15	-17	NA
1434	69	-11	-13	NA
1636	63	-7	-7	Summas closed
—	—	—		Sample ID C400V16INONOP-R

C400V16INONOP-RD

Teresa Fischer 5/15/2018

Kris Henderson 5/15/2018

Geosyntec consultants engineers | scientists | innovators	**C-400 Vapor Intrusion Study** **Paducah Gaseous Diffusion Plant** **Fluor Federal Services, Inc. Paducah** **Deactivation Project**

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study – Fan On; Doors Open LOCATION 7

LOCATION: PGDP PROJECT NO.: KX6467 TASK NO: 01/04

DESCRIPTION: VI Sampling DATE: 02/9/2018

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Clear & cold

0746 Set up Helium Seal check
- Regrout due to cracked seal.
- Indoor air summa 09819; Flow controller K294; -29.6" Hg certified.
- Sub-slab summa 10566; Flow controller 10633; -29.6" Hg certified
- Return for check later

0908 Set helium seal check.
0921 Helium seal check passed.

Theresa Fischer 2/9/2018

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DFR_ One Page Theresa Fischer 5/15/2018 SHEET NO 1 OF 1

SOIL GAS PROBE MEASUREMENTS

Geosyntec consultants

D3-105

① Project Name: C-400 Vapor Intrusion Study
Date: 02/9/2018 Project Number: KX6467/01
Site Location: Paducah Gaseous Diffusion Plant 7
Weather: Clear cold
Field Personnel: Teresa Fischer, Kris Henderson
Recorded By: T. Fischer

Probe No.: LOCATION 7 [X] Sub-slab probe [ ] Soil gas probe
Mini Rae 2000 Serial No.: NA Lamp: 10.6 / 11.7 eV
Landtech GEM 2000 Landfill Gas Meter Serial No. M: KAO-399-3
MDG 2002 Helium detector Serial No.: 10702
Tracer Gas: [X] Helium [ ] Other

② Surface Type: [ ] Asphalt [X] Concrete [ ] Grass [ ] Other____
Surface Thickness 20 1/4 inches/centimeters [ ] Unknown
(i.e., asphalt or concrete)

③ 1 Casing Volume
[X] Sub-slab <0.1 L
Soil gas probe ______ (L)

⑤ Field tubing blank reading (ppm$_v$) completed? [ ] Yes [✓] No PID Reading NA ppm$_v$ *

⑥ Shut in test prior to purging completed? Yes [✓] No [ ]

⑦ Purging

Date	Start Time	End Time	Elapsed Time (min.)	Bag Volume (L)	Purge Rate (LPM)	TAP 4/26/2018 —	CH_4 (%)	CO_2 (%)	O_2 (%)	Tracer Gas Shroud (%) Min	Tracer Gas Shroud (%) Max	Tracer Gas Sample (ppm$_v$, %) (circle one)	VOCs by PID (ppm$_v$)
2/9/18 ~~0909~~ TAP 2/9/18	0909	0911	3	0.75	0.5	—	0	0.1	20.8	11.0	23.9	25	NA
2/9/18	0914	0917	3	0.75	0.5	—	0	0.1	20.7	24.4	420	0	NA
2/9/18	0918	0919	1	0.75	0.5	—	0	0.1	20.8	19.2	34.1	0	NA
—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—

⑧ Helium concentration in field screened samples is less than 5% of minimum concentration in the shroud? [✓] Yes [ ] No **Note:** 1% helium = 10,000 ppm$_v$

⑨ Shut in test prior to sample collection completed? Yes [✓] No [ ]

⑩ Sample Collection

Date	Time	Sample ID	Summa Canister ID	Flow Controller #	Vacuum Gauge #	Initial Vacuum (in. Hg)	Final Vacuum (in. Hg)
2/10/18	1718	C400VI7SUB0NOP-R	10566	10633	—	-29.6 (cert)	-5
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—

Comments: * PID Meter not working

Teresa Fischer 5/15/2018 [signature] 5/15/18

D3-106

Differential Pressure and Ambient Temperature Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/10/2018 Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
Gauge ID#: 42990-7-700
Weather: Cold & drizzle

Location ID: LOCATION # 7
Scenario Type: Fan On; Doors Open
Sample Start Time: 0714
Sample Initial Vacuum: -29.6" Hg cert

Time	Differential Pressure (pa)		Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
	sub-slab/ambient	ambient/outside			
0714	1.0	0.2	44	-30	Summa opened
0915	-1.1	1.7	44	-26	NA
1112	0.3	0.3	41	-22	NA
1314	1.9	0.7	40	~~-15.5~~ -15.5 TAF 2/10/18	
~~1416~~ 1516 TAF 2/10/18	0.7	1.1	41	-10	NA
1718	0.3	1.8	38	-5	Summa Closed
—	—	—	—	—	Sample ID C400VI7FNONOP-R

Teresa Fischer 5/15/2018

Kris Henderson 5/15/2018

Indoor Air Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/ 10 /2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
SUMMA ID# and Regulator ID#: 09819 / K294
Weather: Cold & drizzle

Location ID: 7
Scenario Type: Fan On; Doors Open
Sample Start Time: 0712
Sample Initial Vacuum: -29.6" Hg (cert)

Time	Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
0712	44	-29	Summa opened
0915	44	-24	NA
1111	41	-18	NA
1314	40	-13.5	NA
1416	41	-8	NA
1718	38	-3	Summa closed
—	—	—	Sample ID C400VI7INONOP-R

Teresa Fischer 5/15/2018

[signature] 5/15/2018

D3-107

Geosyntec consultants

engineers | scientists | innovators

C-400 Vapor Intrusion Study
Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah
Deactivation Project

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study – Fan On; Doors Open LOCATION 8

LOCATION: PGDP PROJECT NO.: KX6467 TASK NO: 01/04

DESCRIPTION: VI Sampling DATE: 02/9 /2018 & 2/10/18

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Clear & cool

2/9/18 1118 Set up summa canister at Location 8
- Summa canister 11302; Flow controller 09905; -29.6" Hg (certified).

2/10/18 0631 Started SUMMA sampling at location 8
canister reading -30.0 "Hg
- Purge lines 3 times prior to opening summa

Teresa F 2/10/18

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DFR_ One Page Teresa Fischer 5/15/2018 SHEET NO 1 OF 1

Differential Pressure and Ambient Temperature Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/10/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
Gauge ID#: 42990-7-700
Weather: cold; cloudy

Location ID: LOCATION 8
Scenario Type: Fan On; Doors Open
Sample Start Time: 0631
Sample Initial Vacuum: -29.6" Hg (certified)

Time	Differential Pressure (pa) Exhaust Fan to Ambient	Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
0631	0.6	52	-30.0	Summa opened
0828	-0.2	55	-26.0	NA
1029	2.0	50	-22.0	NA
1231	KFH 2-10-18 ~~+0.6~~ 0.6	68	-16	NA
1431	0.4	63	-12	NA
1631	0.2	63	-6	Summa closed
—	—	—	—	Sample ID C400VI8EXHONOP-12

Teresa Fischer 5/15/2018

5/15/2018

INSTRUMENT CALIBRATION REPORT

Pine Environmental Services LLC

10521 Research Drive
Suite 102
Knoxville, TN 37932
Toll-free: (877) 355-7907

Pine Environmental Services, Inc.

Instrument ID 20904
Description MIniRae 3000
Calibrated 1/24/2018 9:40:26AM

Manufacturer	Rae Systems	**State Certified**	
Model Number	MiniRAE 3000	**Status**	Pass
Serial Number/ Lot Number	592-909072	**Temp °C**	21
Location	Tennessee	**Humidity %**	22
Department			

Calibration Specifications

Group # 1
Group Name ISOBUTYLENE
Stated Accy Pct of Reading
Range Acc % 0.0000
Reading Acc % 3.0000
Plus/Minus 0.00

Nom In Val / In Val	In Type	Out Val	Out Type	Fnd As	Lft As	Dev%	Pass/Fail
100.00 / 100.00	PPM	100.00	PPM	100.00	100.00	0.00%	Pass

Test Instruments Used During the Calibration **(As Of Cal Entry Date)**

Test Standard ID	Description	Manufacturer	Model Number	Serial Number / Lot Number	Last Cal Date/ Opened Date	Next Cal Date / Expiration Date
TN 100PPM ISO DAQ-248-100-19	TN 100PPM ISO	Calgaz	34LS-248-100	DAQ-248-100-19		3/28/2020

Notes about this calibration

Calibration Result Calibration Successful
Who Calibrated Derek Farmer

All instruments are calibrated by Pine Environmental Services LLC according to the manufacturer's specifications, but it is the customer's responsibility to calibrate and maintain this unit in accordance with the manufacturer's specifications and/or the customer's own specific needs.

Notify Pine Environmental Services LLC of any defect within 24 hours of receipt of equipment
Please call 800-301-9663 for Technical Assistance

5/15/2018

INSTRUMENT QC/ PACKING LIST

Description	RAE Systems MiniRAE 3000
Instrument ID	20904
Date Calibrated	1-24-18

PINE
www.pine-environmental.com

Standard Items	**Prepared**	**QC check**	**Received by customer**	**Returned to Pine**
MiniRAE 3000 w/ ______eV lamp and carry case	✓	✓	✓	____
Protective rubber boot	✓	✓	✓	____
Manual	✓	✓	✓	____
Quick reference card	✓	✓	✓	____
Probe tip	✓	✓	✓	____
Charger/ adapter, or charger and cradle	✓	✓	✓	____
(2) Hydrophobic filters	✓	✓	✓	____
Alkaline battery adapter	✓	✓	✓	____
(4) AA Alkaline batteries	✓	✓	✓	____
ProCal calibration sheet	✓	✓	✓	____

4/26/2018

TAP

Supporting Items

100 ppm isobutylene calibration gas	____	____	____	____
100 ppm Isobutylene SDS	____	____	____	____
✓ *Must match cylinder with setup*				
Gas regulator	____	____	____	____
Tedlar bag	____	____	____	____
Datalogging software	____	____	____	____
Communications cable	____	____	____	____

Prepared by: JM
QC checked by: [signature]
Date: 1/24

This packing list is to ensure that every item needed to operate the unit was sent and received. Upon receiving a shipment, please fill out the "Received by customer" column. Call Pine within 24 hours of receiving the equipment if any pieces are missing, damaged, or malfunctioning. Thank you for choosing Pine Environmental Services LLC

[signature] 5/15/2018

INSTRUMENT CALIBRATION REPORT

Pine Environmental Services LLC

10521 Research Drive
Suite 102
Knoxville, TN 37932
Toll-free: (877) 355-7907

Pine Environmental Services, Inc.

Instrument ID 12483
Description Landtec GEM-2000
Calibrated 1/24/2018 1:20:52PM

Manufacturer	CES Landtec	**State Certified**	
Model Number	GEM2000	**Status**	Pass
Serial Number/ Lot Number	GM07658	**Temp °C**	21
Location	Tennessee	**Humidity %**	22
Department			

Calibration Specifications

Group # 1 | **Range Acc %** 0.0000
Group Name Methane | **Reading Acc %** 3.0000
Stated Accy Pct of Reading | **Plus/Minus** 0.0

Nom In Val / In Val	In Type	Out Val	Out Type	Fnd As	Lft As	Dev%	Pass/Fail
50.0 / 50.0	%Volume	50.0	%Volume	50.0	50.0	0.00%	Pass

Group # 2 | **Range Acc %** 0.0000
Group Name Carbon Dioxide | **Reading Acc %** 3.0000
Stated Accy Pct of Reading | **Plus/Minus** 0.0

Nom In Val / In Val	In Type	Out Val	Out Type	Fnd As	Lft As	Dev%	Pass/Fail
35.0 / 35.0	%Volume	35.0	%Volume	35.0	35.0	0.00%	Pass

Group # 3 | **Range Acc %** 0.0000
Group Name Oxygen | **Reading Acc %** 3.0000
Stated Accy Pct of Reading | **Plus/Minus** 0.0

Nom In Val / In Val	In Type	Out Val	Out Type	Fnd As	Lft As	Dev%	Pass/Fail
20.9 / 20.9	%Volume	20.9	%Volume	20.9	20.9	0.00%	Pass

Test Instruments Used During the Calibration (As Of Cal Entry Date)

Test Standard ID	Description	Manufacturer	Model Number	Serial Number / Lot Number	Last Cal Date/ Opened Date	Next Cal Date / Expiration Date
TN 50 CH4/35 CO2 17LX	TX 50 CH4/35 CO2 17L HAM-399-2	Liquid Technology	GP12116	KAO-399-3		10/31/2018

Notes about this calibration

Calibration Result Calibration Successful
Who Calibrated Derek Farmer

Teresa Fischer 5/15/2018

INSTRUMENT QC/ PACKING LIST

Description	Landtec GEM-2000
Instrument ID	12483
Date Calibrated	1-24-18

PINE

www.pine-environmental.com

Standard Items	**Prepared**	**QC check**	**Received by customer**	**Returned to Pine**
GEM-2000 w/ hard case	✓	✓	✓ 4/26/2018	
Fabric carry case	✓	✓	✓	
Manual	✓	✓	✓	
Quick reference card	✓	✓	✓ TAF	
Charger, AC cord (if applicable)	✓	✓	✓	
(2) 4' lengths of sample tubing w/ filter, housing, and 4 male quick connects			TAF 4/26/2018	
(2) Extra hydrophobic filters	✓	✓	✓	
(2) extra male quick connects				
Comm. Cable and data logging software	✓	✓	✓ 4/26/2018	
Case insert warning			✓	
ProCal calibration sheet	✓	✓	✓ TAF	

Supporting Items				
CH_4 and CO_2 calibration gas mix				
CH_4 and CO_2 calibration gas SDS ✓ *Must match cylinder with setup*				
4% Oxygen, balance N_2 gas mix				
4% Oxygen, balance N_2 gas SDS ✓ *Must match cylinder with setup*				
Gas regulator, female (.25 or .5 lpm)				
Gas regulator, male (.25 or .5 lpm)				
Calibration tubing (6" tubing w/ male quick connect)				
Temperature probe				

Prepared by: JM

QC checked by: [illegible]

Date: 1/24

This packing list is to ensure that every item needed to operate the unit was sent and received. Upon receiving a shipment, please fill out the "Received by customer" column. Call Pine within 24 hours of receiving the equipment if any pieces are missing, damaged, or malfunctioning. Thank you for choosing Pine Environmental Services LLC

Teresa Fischer 5/15/2018

INSTRUMENT CALIBRATION REPORT

Pine Environmental Services LLC

4037 Darling Court
Lilburn, GA 30047
Toll-free: (800) 842-1088

Pine Environmental Services, Inc.

Instrument ID 10702
Description Radiodetection MGD-2002 Multi-Gas Leak Locator
Calibrated 1/23/2018 5:35:20PM

Manufacturer	Radiodetection	**State Certified**	
Model Number	MGD-2002	**Status**	Pass
Serial Number/ Lot Number	040951	**Temp °C**	21
Location	Georgia	**Humidity %**	34
Department			

Calibration Specifications

Group # 1
Group Name Zero to 99.999%
Test Performed: Yes **As Found Result: Pass** **As Left Result: Pass**

Test Instruments Used During the Calibration **(As Of Cal Entry Date)**

Test Standard ID	Description	Manufacturer	Model Number	Serial Number / Lot Number	Last Cal Date/ Opened Date	Next Cal Date / Expiration Date

Notes about this calibration

Calibration Result Calibration Successful
Who Calibrated Jeff Rasmussen

All instruments are calibrated by Pine Environmental Services LLC according to the manufacturer's specifications, but it is the customer's responsibility to calibrate and maintain this unit in accordance with the manufacturer's specifications and/or the customer's own specific needs.

Notify Pine Environmental Services LLC of any defect within 24 hours of receipt of equipment
Please call 800-301-9663 for Technical Assistance

Teresa Fischer 5/15/2018

INSTRUMENT QC/ PACKING LIST

Description	Dielectric MGD-2002
Instrument ID	10702
Date Prepared	1-23-18

PINE
www.pine-environmental.com

Standard Items	Prepared	QC check	Received by customer	Returned to Pine
MGD-2002 and carry case	✓	✓	✓	
Manual	✓	✓	✓	
Quick reference card	✓	✓	✓	
Charger	✓	✓	✓	
12VDC auto plug adapter	✓	✓	✓	
Needle probe	✓	✓	✓	
Ground probe	✓	✓	✓	
Handle assembly with moisture filter cartridge	✓	✓	✓	
Extra moisture filter cartridge	✓	✓	✓	
Drying adapter for cartridges	✓	✓	✓	
Carry strap	✓	✓	✓	
ProCal inspection report	✓	✓	✓	

4/26/2018

TAF

Prepared by: JR
QC checked by: SB
Date: 1/23/18

This packing list is to ensure that every item needed to operate the unit was sent and received. Upon receiving a shipment, please fill out the "Received by customer" column. Call Pine within 24 hours of receiving the equipment if any pieces are missing, damaged, or malfunctioning. Thank you for choosing Pine Environmental Services LLC.

Teresa Fischer 5/15/2018

INSTRUMENT CALIBRATION REPORT

Advanced Labs, Inc.

Pine Environmental Services, Inc

Instrument ID 39207
Description TSI 8330 VelociCheck
Calibrated 9/27/2017

Manufacturer TSI
Model Number 8330
Serial Number 96060227
Location New Jersey
Temp 76

Classification
Status pass
Frequency Yearly
Department Lab
Humidity 33

Calibration Specifications

Group # 1
Group Name Temperature
Stated Accy Plus / Minus
Range Acc % 0.0000
Reading Acc % 0.0000
Plus/Minus 5.00

Nom In Val / In Val	In Type	Out Val	Out Type	Fnd As	Lft As	Dev%	Pass/Fail
70.00 / 75.60	°F	75.60	°F	76.00	76.00	0.53%	Pass

Group # 2
Group Name Velocity
Stated Accy Pct of Reading
Range Acc % 0.0000
Reading Acc % 5.0000
Plus/Minus 0.00

Nom In Val / In Val	In Type	Out Val	Out Type	Fnd As	Lft As	Dev%	Pass/Fail
0.00 / 0.00	ft/min	0.00	ft/min	0.00	0.00	0.00%	Pass
40.00 / 40.00	ft/min	40.00	ft/min	40.00	40.00	0.00%	Pass
70.00 / 70.00	ft/min	70.00	ft/min	70.00	70.00	0.00%	Pass
100.00 / 100.00	ft/min	100.00	ft/min	103.00	103.00	3.00%	Pass
150.00 / 150.00	ft/min	150.00	ft/min	153.00	153.00	2.00%	Pass
325.00 / 325.00	ft/min	325.00	ft/min	330.00	330.00	1.54%	Pass
700.00 / 700.00	ft/min	700.00	ft/min	700.00	700.00	0.00%	Pass
1000.00 / 1000.00	ft/min	1000.00	ft/min	990.00	990.00	-1.00%	Pass
1500.00 / 1500.00	ft/min	1500.00	ft/min	1,490.00	1,490.00	-0.67%	Pass
2000.00 / 2000.00	ft/min	2000.00	ft/min	2,000.00	2,000.00	0.00%	Pass

Test Instruments Used During the Calibration

Test Instrument ID	Description	Manufacturer	Serial Number	(As Of Cal Entry Date) Last Cal Date	Next Cal Date
MICHELL DM-509-TX-01	Relative Humidity Meter	Michell	273296	8/25/2017	8/25/2018
OMEGA HX93AC/DP25-E	Omega HX93AC/DP25-E	Omega Engineering	1010368 035025 035026	9/15/2016	9/15/2018
OMEGA PX02K1-16A5T /DP25-E-A	Omega PX02K1-16A5T/DP25-E-A	Omega Engineering	168377/8375030	9/15/2016	9/15/2018
OMEGA WT4401-D	Omega WT4401-D	Omega Engineering	101105	9/15/2016	9/15/2018

Theresa Fischer 5/15/2018

INSTRUMENT CALIBRATION REPORT

Advanced Labs, Inc.

Pine Environmental Services, Inc

Instrument ID 39207
Description TSI 8330 VelociCheck
Calibrated 9/27/2017

Notes about this calibration

Calibration Result Calibration Successful
Who Calibrated David Galego

Advanced Labs, Inc. hereby certifies that this instrument is calibrated and functions to meet the manufacture's specifications using NIST traceable standards, or is derived from accepted values of physical constants.

Teresa Fischer 5/15/2018

Geosyntec consultants

engineers | scientists | innovators

C-400 Vapor Intrusion Study
Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah
Deactivation Project

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study – Fan On; Doors Closed

LOCATION: PGDP PROJECT NO.: KX6467 TASK NO: 01/04

DESCRIPTION: VI Sampling DATE: 02/11/2018

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Cold; Rain

0645 Assemble at C-730-TOS
- Jason Boulton, Brandon Taylor, Teresa Fischer, Kris Henderson
- Mobilize to Limited Area; C400

0700 Arrive at C400
- Set equipment within clean area of C-400.
- Assemble summa canisters

0745 Don PPE to set summas at Locations 1, 2, 4, 5, & 7
- Set up summas at each location within CA; Helium Seal Check conducted on 2/9/2018. Only a shut in test to verify each sub-slab summa canister is holding vacuum to be conducted.

0845 Doff PPE after completing activities within CA.

0905 Set summas up at Locations 3, 6, & 8. Conduct shut in test at Locations 6 & 3

0930 All sub-slab summas pass shut-in test.
- See individual Location forms for details

1000 Field activities complete. Leave CA.

Teresa F
2/11/18

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DFR_One Page Teresa Fischer 5/15/2018 SHEET NO 1 OF 1

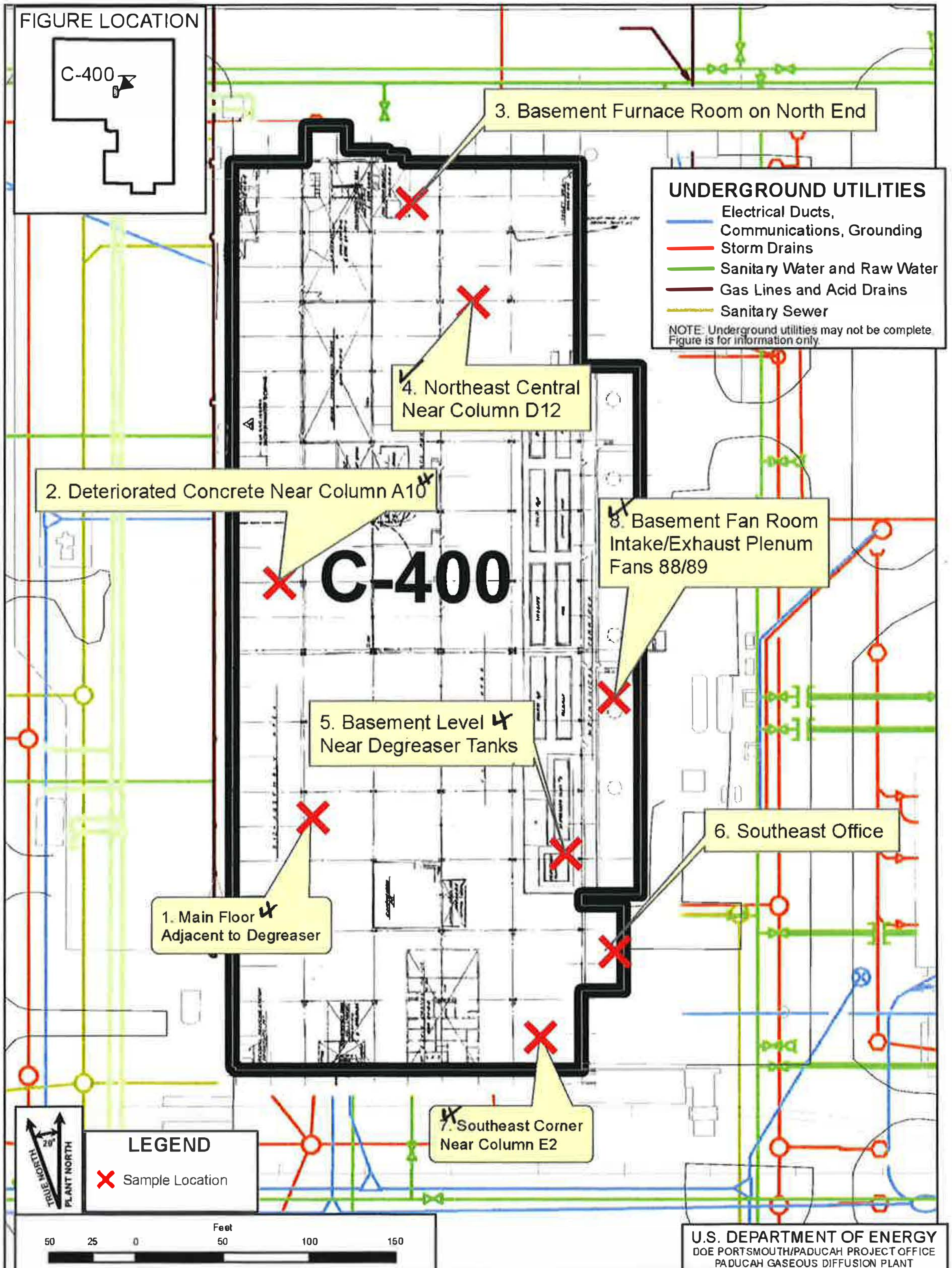


Figure 12. Indoor Sampling Locations for C-400 Building Vapor Intrusion Study

FLUOR

G:\GIS\ARCVIEWS\PROJECTS\Vapor Intrusion\MOA 400\Figure 12 C-400 Map (with Approximate Sampling Locations for VI).mxd
7/25/2017

Teresa Fischer 5/15/2018

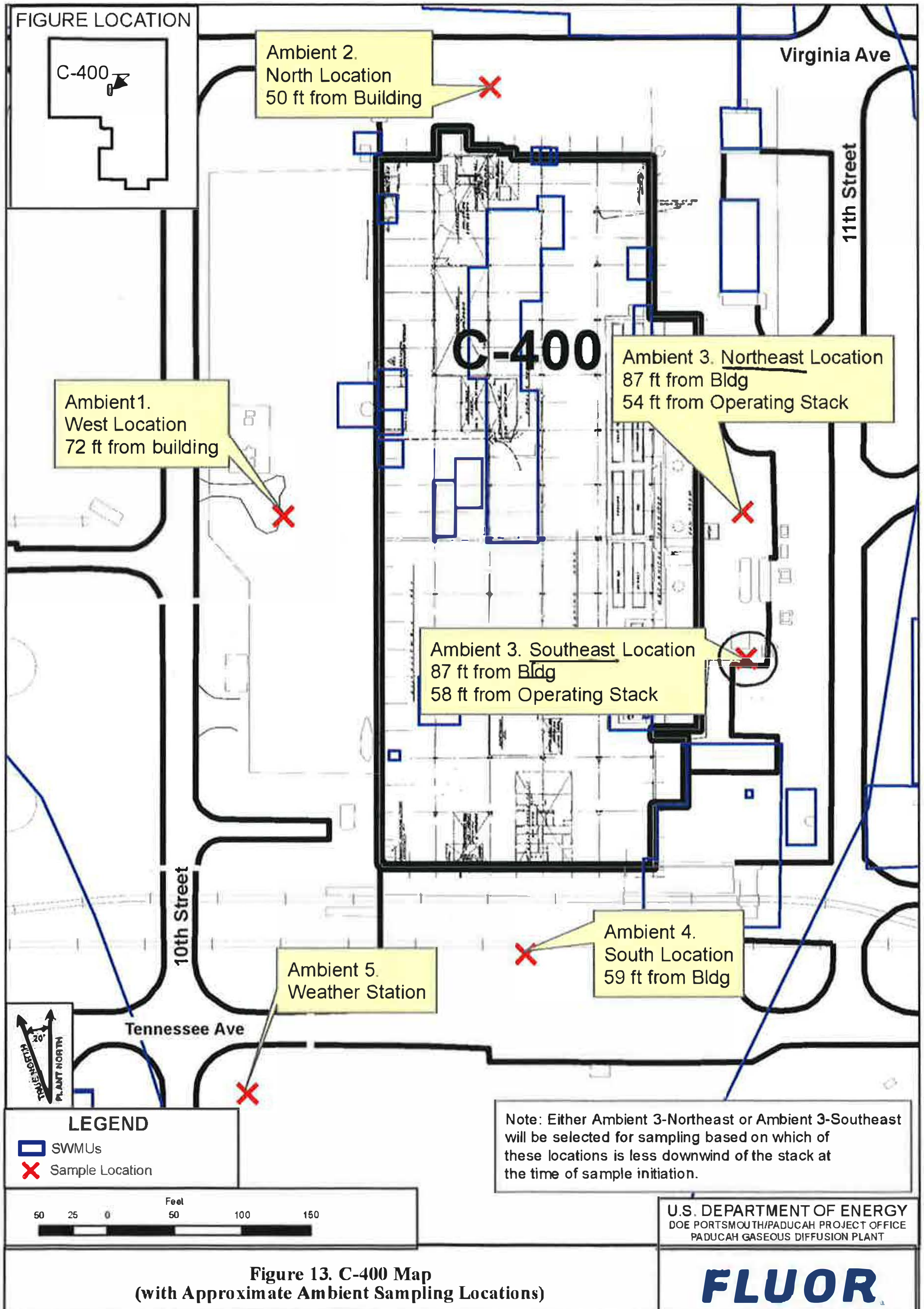
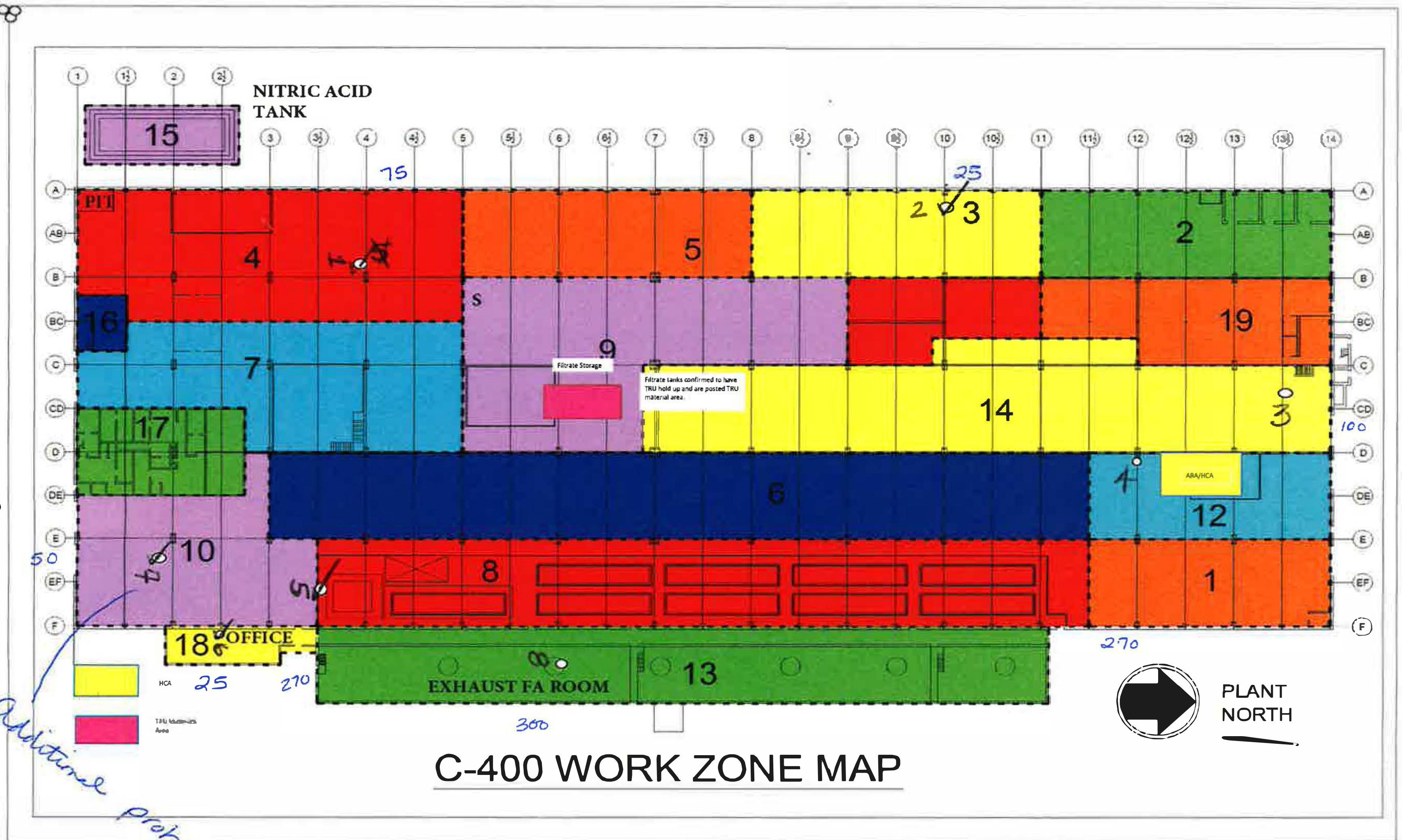


Figure 13. C-400 Map
(with Approximate Ambient Sampling Locations)

G:\GIS\ARCVIEWS\PROJECTS\Vapor Intrusion\MOA 400\Figure 13 C-400 Ambient Sampling Locations.mxd
7/25/2017

Tureen Price 5/15/2018

D3-121



C-400 WORK ZONE MAP

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C-400 Vapor Intrusion Study
Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah
Deactivation Project

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study – Fan On; Doors Closed

LOCATION: PGDP PROJECT NO.: KX6467 TASK NO: 01/04

DESCRIPTION: VI Sampling DATE: 02/12/2018

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Clear & cold (24°@0600)

0545 Assemble at C-780
- Jason Brutton; Brandon Taylor; Kris Henderson; Teresa Fischer
- Leave for Limited Area (LA)

0600 Arrive at C400
- Briefing at BCS with Jeff Seaton

0605 Set up Ambient Air summas & weather station
- Conduct line evacuation at Location 8

0620 RADCON arrives
- Mobilize to open summa canisters outside of CA.

0640 Don PPE to enter CA
- Start sub-slab & indoor air summas; collect first set of readings

0720 Doff PPE.
- See individual location forms for details

1625 Start last round of Ambient Air readings; close summa canisters.
- Collect Location 3 Ambient Air summa; close canisters
- Collect other summa canisters outside CA; close canisters.

1705 Don PPE to enter CA; shut down summa canisters

1740 Summas collected from CA; Doff PPE

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Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah
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Samples:

C400V11SUBONCL-R
INONCL-R
AMBONCL-R
C400V12SUBONCL-R
INONCL-R
AMBONCL-R
C400V13SUBONCL-R
INONCL-R
SEAMBONCL-R
C400V14SUBONCL-R
INONCL-R
AMBONCL-R
C400V15SUBONCL-R
INONCL-R
INONCL-RD
C400V16SUBONCL-R
INONCL-R
INONCL-RD
C400V17SUBONCL-R
INONCL-R
C400V18EXHONCL-R

1815 Field activities complete. Leave Limited area.

2/12/18

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Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah
Deactivation Project

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study – Fan On; Doors Closed Ambient Locations

LOCATION: PG DP PROJECT NO.: KX6467 TASK NO: 01/04

DESCRIPTION: VI Sampling DATE: 02/12/2018

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Clear, cold, windy

0600 Arrive at C400. Set up Ambient Locations 1 - 4.
- Ambient 3 set up at SE location → wind blowing from N-NW at ~5 mph.
- Summas opened starting at 0628 → see individual forms for details

1630 All Ambient locations summas closed.
Field activities completed. Leave limited area

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Ambient Air
Monitoring Record 1

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120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/12/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: T. Fischer
SUMMA ID# and Regulator ID#: 11298 / 11755
Weather: Clear & cold (24° @ 0600)

Location ID: Location 1 - Ambient
Scenario Type: Fan On; Doors Closed
Sample Start Time: 0634
Sample Initial Vacuum: -29.8" Hg (certified)

Time	Summa Canister Vacuum (in Hg)	Comments
0634	-28 (can)	Summa opened
0835	-25	NA
1032	-20	Windy
1230	-15	Windy
1430	-11	Windy
1634	-5	Windy; Summa closed
		[signature] 2/12/18
		Sample ID - C400VI1AMBONCL-R

[signature] 5/15/2018

[signature] 5/15/2018

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Ambient Air Monitoring Record 2

Geosyntec consultants

120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/12/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: T. Fischer
SUMMA ID# and Regulator ID#: 10103/10448
Weather: Clear & cold (24°@ 0600)

Location ID: Location 2 - Ambient
Scenario Type: Fan On; Doors Open
Sample Start Time: 0635
Sample Initial Vacuum: -29.6" Hg (certified)

Time	Summa Canister Vacuum (in Hg)	Comments
0635	-27(can)	Summa opened
0836	-24	NA
1033	-17	Windy
1233	-12	Windy
1431	-7	Windy
1635	-1.5	Windy; Summa Closed
	T. Fischer 2/12/18	
—	—	Sample ID - C400V12 AMBONCL-R

TAP 4/26/2018

Turean Fischer 5/15/2018

[signature] 5/15/2018

Ambient Air
Monitoring Record 3SE

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/12/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: T. Fischer
SUMMA ID# and Regulator ID#: 09821 / 11468
Weather: Clear & cold (24° @ 0600)

Location ID: Location 3 - Ambient
Scenario Type: Fan On; Doors Closed
Sample Start Time: 0628
Sample Initial Vacuum: -29.8" Hg (certified)

Time	Summa Canister Vacuum (in Hg)	Comments
0625	≥30" (can)	Summa opened
0830	-27	NA
1027	-22	Windy
1226	-16	Windy
1426	-12	Windy
1627	-7	Windy; Summa closed.
	TAF 2/12/18	
—	—	Sample ID - C400VI3SEAMBONCL-R

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Turner Fischer 5/15/2018

[signature] 5/15/2018

D3-127

D3-128

Ambient Air
Monitoring Record 4

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/12/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: T. Fischer
SUMMA ID# and Regulator ID#: 10987 / 10048
Weather: Clear & cold (24° @ 0600)

Location ID: Location 4 - Ambient
Scenario Type: Fan On; Doors Closed
Sample Start Time: 0630
Sample Initial Vacuum: -29. Hg (certified)

Time	Summa Canister Vacuum (in Hg)	Comments
0630	>30 (can)	Summa opened
0833	-27.5	NA
1029	-23	Windy
1228	-18	Windy
1428	-13	Windy
1630	-8	Windy; Summa closed
	Teresa F.	2/12/18
—	—	Sample ID - C400VI4AMBONCL-R

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[signature] 5/15/2018

Weather Station
Monitoring Record

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Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Project Number: KX6467/01/04
Recorded By: T. Fischer

Date: 02/12/2018
Page 1 of 1
Project Location: **Paducah Gaseous Diffusion Plant**

Location ID: Weather Station

Scenario Type: Fan Off; Doors Closed

Time	Ambient Temp. (deg. F)	Relative Humidity (%)	Barometric Pressure (inches Hg)	Wind Direction	Wind Speed (mph)
0632	22	75	30.51	N	6
0833	24	75	30.57	N	5
1031	32	71	30.59	N	5
1228	37	59	30.57	N	1
1429	40	57	30.55	N	7
1732	38	63	30.56	N	6

Teresa F 2/12/18

Teresa Fischer 5/15/2018

[signature] 5/15/2018

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C-400 Vapor Intrusion Study
Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah Deactivation Project

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study – Fan On; Doors Closed LOCATION 1

LOCATION: PGDP PROJECT NO.: KX6467 TASK NO: 01/04

DESCRIPTION: VI Sampling DATE: 02/11 /2018

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Cold; Rain

0826 Set up summa canisters at Location 1
- Sub slab → 10985; Flow Con. 11652; -29.7" Hg (certified)
- Indoor Air → 10851; Flow Con 10163; -29.7" Hg (certified)

0828 Shut in test complete. Summa system passed.

Teresa [signature]
2/11/18

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Differential Pressure and Ambient Temperature Monitoring Record

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Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study** Date: 02/ 12/2018 Page 1 of 1
Project Number: KX6467/01/04 Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson Gauge ID#: 42900-7-700
Weather: Clear & cold

Location ID: LOCATION # 1 Scenario Type: Fan On; Doors Closed
Sample Start Time: 0717 Sample Initial Vacuum: 29.7" Hg (certified)

D3-131

Time	Differential Pressure (pa)		Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
	sub-slab/ambient	ambient/outside			
0717	-5.5	-5.6	33	-29.7	Summa Opened
0925	-2.2	-6.4	35	-26.5	NA
1119	-1.5	-4.6	36	-21.5	NA
1318	-0.8	-4.2	38	-16	NA
1515	-1.0	-1.7	39	-12	NA
1725 ~~1725~~	-0.8	-3.3	39	-8	NA; Summa Closed
—	—	—	—	—	Sample ID C400VI1SUBONCL-R

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Kris Henderson 5/15/2018

Indoor Air Monitoring Record

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Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/ 12/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
SUMMA ID# and Regulator ID#: 10851/ 10163
Weather: Clear & cold

Location ID: 7
Scenario Type: Fan On; Doors Closed
Sample Start Time: 0716
Sample Initial Vacuum: - 29.7" Hg (certified)

Time	Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
0716	33	-30(can)	Summa opened
0925	35	-26	NA
1119	36	-20.5	NA
1318	38	-17	NA
1515	39	-12	NA
1725	39	-7	Summa closed
—	—	—	Sample ID C400VI1INONCL-R

Teresa Fischer 5/15/2018

Kris Henderson 5/15/2018

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C-400 Vapor Intrusion Study
Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah
Deactivation Project

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study – Fan On; Doors Closed LOCATION 2

LOCATION: PGDP PROJECT NO.: KX6467 TASK NO: 01/04

DESCRIPTION: VI Sampling DATE: 02/ 11/2018

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Cold; Rain

0830 Set up summas at Location 2
- Sub-slab → 11172; Flow Con. 11272; -29.7" Hg (certified).
- Indoor air → 10770; Flow Con. 11512; No vacuum certificate

Shut in Test complete. Summa system passed.

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Project Name: **C-400 Vapor Intrusion Study**
Date: 02/17/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
Gauge ID#: 42990-7-700
Weather: Clear & Cold

Location ID: LOCATION # 2
Scenario Type: Fan On; Doors Closed
Sample Start Time: 0719
Sample Initial Vacuum: -29.7" Hg (certified)

Time	Differential Pressure (pa)		Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
	sub-slab/ambient	ambient/outside			
0719	-0.0	-5.3	31	-30	Summa Opened
0928	-0.5	-3.5	32	-25	NA
1121	0.1	-2.7	34	-19.5	NA
1321	0.4	2.9	35	-14	NA
1517	-1.4	-1.4	38	-10.5	NA
1729	-0.9	-2.5	37	-5	Summa Closed
—	—	—	—	—	Sample ID C400V12-SUBONCL-R

Teresa Fischer 5/15/2018

Kristoffer Henderson 5/15/2018

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Indoor Air Monitoring Record

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Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/ 12/2018 Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
SUMMA ID# and Regulator ID#: 10470 / 11512
Weather: Clear & cold

Location ID: 2
Scenario Type: Fan On; Doors Closed
Sample Start Time: 0719
Sample Initial Vacuum: -28" (certified)

Time	Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
0719	30	-28	Summa Opened
0928	32	-25	NA
1121	34	-20	NA
1321	35	-15	NA
1617	37	-10	NA
1729	37	-5	Summa Closed
—	—	—	Sample ID C400VI2INONCL-R

Teresa Fischer 5/15/2018

Kris Henderson 5/15/2018

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C-400 Vapor Intrusion Study
Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah
Deactivation Project

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study – Fan On; Doors Closed LOCATION 3

LOCATION: PG DP PROJECT NO.: KX6467 TASK NO: 01/04

DESCRIPTION: VI Sampling DATE: 02/11 /2018

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Cold; Rain

0924 Set up summas at Location 3
- Indoor Air → 09629; Flow Con. 10162; -29.8" Hg
- Sub-Slab → 11014; Flow Con. 10652; -29.6" Hg

0928 Shut in test complete. Summa system holds vacuum.

Teresa A. F— 2/11/18

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Differential Pressure and Ambient Temperature Monitoring Record

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Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/ 12/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
Gauge ID#: 42990-7-700
Weather: Clear & cold

Location ID: LOCATION # 3
Scenario Type: Fan On; Doors Closed
Sample Start Time: 0632 (TF) 2/12/18
Sample Initial Vacuum: certified -29.6" Hg

Time	Differential Pressure (pa)		Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
	sub-slab/ambient	ambient/outside			
0632	-3.1	-11.8	35	-29	Summa opened
0941	-1.1	-24.1	44	-23.5	NA
1132	-6.3	-3.7	44	-19	NA
1333	-1.3	-1.0	46	-14	NA
1528	-3.9	-10 to -20	45	-11	NA
1751	-3.2	-11.4	48	-6	Summa Close
—	—	—	—	—	Sample ID C400 VI 3SUBONCL-R

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Kristoffer Henderson 5/15/2018

Indoor Air Monitoring Record

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Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/ 12 /2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
SUMMA ID# and Regulator ID#: 09629 / 10162
Weather: Clear & Cold

Location ID: 3
Scenario Type: Fan On; Doors Closed
Sample Start Time: 0629
Sample Initial Vacuum: certified -29.8" Hg

Time	Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
0629	35	-27.5	SUMMA opened
0941	45	-25	NA
1132	43	-16	NA
1333	46	-11.5	NA
1528	45	-7	NA
1629 ~~1429~~	45	-3	NA; Summa Closed
—	—	—	Sample ID C400VI3INONCL-R

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2/12/2018

D3-138

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Kris Henderson 5/15/2018

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C-400 Vapor Intrusion Study
Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah
Deactivation Project

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study – Fan On; Doors Closed LOCATION 4

LOCATION: PGDP PROJECT NO.: KX6467 TASK NO: 01/04

DESCRIPTION: VI Sampling DATE: 02/11/2018

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Cold; Rain

0800 Set up summas at Location 4
Summa Sub-Slab 10273; Flow Cont 09704;
- 29.8" (certified)
Summa Indoor Air 10121; Flow Cont. 11761;
- 29.7" Hg (certified)
- Shut in test complete. Set up holds vacuum.

Teresa F 2/11/18

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Differential Pressure and Ambient Temperature Monitoring Record

Geosyntec consultants
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Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/12/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
Gauge ID#: 42990-7-700
Weather: Clear & Cold

Location ID: LOCATION # 4
Scenario Type: Fan On; Doors Closed
Sample Start Time: 0707
Sample Initial Vacuum: -29.8" Hg (certified)

Time	Differential Pressure (pa)		Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
	sub-slab/ambient	ambient/outside			
0707	-6.9	2.0	38	> -30	Summa opened
0913	-4.0	5.0	42	-28	NA
1109	-2.8	-8.1	45	-25	NA
1308	-1.1	-7.7	47	-20	NA
1505	-0.9	-8.8	45	-16	NA
1712	-2.0	-8.0	39	-12	Summa Closed
—	—	—	—	—	Sample ID C400V14SUBONCL-R

Teresa Fischer 5/15/2018

[signature] 5/15/2018

Indoor Air Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

D3-141

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/ 12 /2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
SUMMA ID# and Regulator ID#: 10121 / 11761
Weather: Clear & cold

Location ID: 4
Scenario Type: Fan On; Doors Closed
Sample Start Time: 0705
Sample Initial Vacuum: -29.7" (certified)

Time	Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
0705	39	-30 (can)	Summa opened
0913	42	-28	NA
1109	45	-20	NA
1308	47	-15	NA
1505	45	-10	NA
1712 ~~1612~~	39	-5	Summa closed
TAP	2/12/18	—	Sample ID C400VI4 INONCL-R

Teresa Fischer 5/15/2018

Kris Henderson 5/15/2018

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C-400 Vapor Intrusion Study
Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah Deactivation Project

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study – Fan On; Doors Closed LOCATION 5

LOCATION: PG DP PROJECT NO.: KX6467 TASK NO: 01/04

DESCRIPTION: VI Sampling DATE: 02/12 /2018

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Cold; Rain

0810 Set up summas at Location 5
- Indoor Air Summas → 10852 ; Flow controller 10157; 29.6" Hg
  Dup → 10801 ; Flow controller ~~10+~~ 11051 ; No vac. cert.
- Sub slab summa → 11149 ; Flow Con. 11291 ; TAF 2/11/18
  - 29.7" Hg certified

0815 Shut in test complete. Summa system holds vacuum

Teresa F 2/11/18

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Differential Pressure and Ambient Temperature Monitoring Record

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120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/12/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
Gauge ID#: 42990-7-700
Weather: Clear & cold

Location ID: LOCATION # 5
Scenario Type: Fan On; Doors Closed
Sample Start Time: 0711
Sample Initial Vacuum: -29.7" Hg (certified)

Time	Differential Pressure (pa)		Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
	sub-slab/ambient	ambient/outside			
0711	0.6	-4.3	36	> -30	Summa opened
0915	0.9	-4.3	39	-28	NA
1112	-0.1	-2.7	41	-23	NA
1312	-0.4	-4.9	41	-18	NA
1408	-0.7	-1.8	42	-14	NA
1711	-0.6	-2.5	40	-8	Summa Closed
—	—	—	—	—	Sample ID C400VI5SUBONCL-R

Teresa Fischer 5/15/2018

Kristoffer Henderson 5/15/2018

Indoor Air Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

D3-144

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/12/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
SUMMA ID# and Regulator ID#: 10801 (Dup)/11051
10852/10157
Weather: Clear & cold

Location ID: 5
Scenario Type: Fan On; Doors Closed
Sample Start Time: 0709
Sample Initial Vacuum: No vacuum/29.6"Hg (D) certified

Time	Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)		Comments
0709	36	D 29	<30	Summas opened
0915	39	-27.5	-30	NA
1112	41	-26	-29	NA
1312	41	-21	-27	NA
1409	42	-17	-20	NA
~~1611~~ 1711	40	-11	-15	NA
TF 2/12/18	—			Sample ID C400VI5INONCL-RD (Duplicate)

C400VI5INONCL-R

Teresa Fischer 5/15/2018

Kristoffer Henderson 5/15/2018

Geosyntec consultants engineers | scientists | innovators	**C-400 Vapor Intrusion Study** **Paducah Gaseous Diffusion Plant** **Fluor Federal Services, Inc. Paducah** **Deactivation Project**

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study – Fan On; Doors Closed LOCATION 6

LOCATION: PGDP PROJECT NO.: KX6467 TASK NO: 01/04

DESCRIPTION: VI Sampling DATE: 02/11/2018

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Cold ; Rain

0913 Set up summas at Location 6.

- Indoor air → 10580 ; Flow Con. 10205 ; -29.7" Hg

~~Subslab~~ Dup → 09514 ; Flow Con. 10051 ; -29.8" Hg

TAP 2/11/2018

- Subslab → 09524 ; Flow Con. 09843 ; -29.6" Hg

0918 Shut in test complete. Summa system holds vacuum.

Teresa Fr 2/11/2018

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DFR_ One Page Teresa Frazier 5/15/2018 SHEET NO 1 OF 1

D3-146

Differential Pressure and Ambient Temperature Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/12/2018 Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
Gauge ID#: 42990-7-700
Weather: Clear Cold

Location ID: LOCATION # 6
Scenario Type: Fan On; Doors Closed
Sample Start Time: 06.39
Sample Initial Vacuum: -29.6" Hg (certified)

Time	Differential Pressure (pa)		Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
	sub-slab/ambient	ambient/outside			
0639	0.1	-4.0	58	-29	Summa open
0839	0.1	-4.0	62	-26	NA
1038	0.0	-2.1	65	-22	NA
1238	0.0	-3.3	65	-16	NA
1439	0.0	-08	65	-11	NA
1639	0.1	-1.6	62	-6	NA; Summa closed
—	—	—	—	—	Sample ID C400VI6SUBONCL-R

Teresa Fischer 5/15/2018

Kristoffer Henderson 5/15/2018

Indoor Air Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/12/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
SUMMA ID# and Regulator ID#: 10580 / 10205
09514 / 10051
Weather: Clear & cold

Location ID: 6
Scenario Type: Fan On; Doors Closed
Sample Start Time: 0639.
Sample Initial Vacuum: -29.7" Hg / -29.8" Hg (Dup) (Certified)

Time	Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	D	Comments
0639	57	-30	-25	Summas opened
0839	62	-29	-21	NA
1039	65	-27	-17	NA
1238	66	-20	-13	NA
1539	65	-15	-8	NA
1639	62	-11	-3	Summas closed
—	—	—	—	Sample ID C400VI6INONCL-RD (Dup)

C400VI6INONCL-R

Teresa Fischer 5/15/2018

[signature] 5/15/2018

Geosyntec consultants

engineers | scientists | innovators

C-400 Vapor Intrusion Study
Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah
Deactivation Project

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study – Fan On; Doors Closed LOCATION 7

LOCATION: PGDP PROJECT NO.: KX6467 TASK NO: 01/04

DESCRIPTION: VI Sampling DATE: 02/11/2018

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Cold; Rain

0816 Set summa canisters up at Location 7
- Sub-slab → 09627; Flow Con. 11536; 29.7" Hg (certified)
- Indoor Air → 09965; Flow Con. 10054; 29.7" Hg (certified)

0820 Shut in test complete; system holds vacuum.

Teresa 2/11/2018

TAP 2/11/18

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DFR_ One Page Teresa Fischer 5/15/2018 SHEET NO 1 OF 1

Differential Pressure and Ambient Temperature Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/ 12/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
Gauge ID#: 42900-7-700
Weather: Clear & cold

Location ID: LOCATION # 7
Scenario Type: Fan On; Doors Closed
Sample Start Time: 0714
Sample Initial Vacuum: -29.7" Hg (certified)

Time	Differential Pressure (pa) sub-slab/ambient	Differential Pressure (pa) ambient/outside	Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
0714	-1.8	-3.2	37	-29.5	Summa opened
0920	1.9	1.5	39	-26	NA
1116	-0.9	-0.5	40	-20.5	NA
1315	-0.8	-0.6	41	-16	NA
1511	-0.6	1.6	42	-11	NA
1722	-0.5	-1.6	41	-6	Summa closed
—	—	—	—	—	Sample ID C400VI7SUBONCL-R

Teresa Fischer 5/15/2018

Kristoffer Henderson 5/15/2018

Indoor Air Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/ 12/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
SUMMA ID# and Regulator ID#: 09965/10054
Weather: Clear & cold

Location ID: 7
Scenario Type: Fan On; Doors Closed
Sample Start Time: 0712
Sample Initial Vacuum: -29.7" Hg (certified)

Time	Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
0712	36	-28.5	Summa opened
0920	39	-23.5	NA
1116	40	-19	NA
1315	41	-13	NA
1511	42	-8	NA
1722	41	-2	Summa closed
—	—	—	Sample ID C400VI7INONCL-R

Teresa Fischer 5/15/2018

Kristoffer Henderson 5/15/2018

D3-150

Geosyntec consultants

engineers | scientists | innovators

**C-400 Vapor Intrusion Study
Paducah Gaseous Diffusion Plant
Fluor Federal Services, Inc. Paducah
Deactivation Project**

DAILY FIELD REPORT

PROJECT: C-400 Vapor Intrusion Study – Fan On; Doors Closed LOCATION 8

LOCATION: PGDP PROJECT NO.: KX6467 TASK NO: 01/04

DESCRIPTION: VI Sampling DATE: 02/11 /2018

CONTRACTOR: Geosyntec Consultants and GEO Consulting

WEATHER: Cold ; Rain

2/11/18 0909 Set up summa canister.

- Summa 10231 ; Flow Cont 99901 ; 29.8" Hg (certified)

0910 Set up complete

TAP 4/26/18

2/12/18 0620 Purge lines three times

0636 SUMMA opened

~~1636~~ 1636 Summa closed

TAP 2/12/18

Teresa F. 2/12/18

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DFR_ One Page Teresa Fischer 5/15/2018 SHEET NO 1 OF 1

Differential Pressure and Ambient Temperature Monitoring Record

Geosyntec consultants
120 Market Place Blvd, Suite 180, Bldg. A
Knoxville, TN 37922
Phone: (865) 330-0037

Project Name: **C-400 Vapor Intrusion Study**
Date: 02/12/2018
Page 1 of 1
Project Number: KX6467/01/04
Project Location: **Paducah Gaseous Diffusion Plant**
Recorded By: Teresa Fischer/Kris Henderson
Gauge ID#: 42990-7-700
Weather: Clear & cold (24° @ 0600)

Location ID: LOCATION 8
Scenario Type: Fan On; Doors Closed
Sample Start Time: 0636
Sample Initial Vacuum: 29.8" Hg (certified)

Time	Differential Pressure (pa) Exhaust Fan to Ambient	Ambient Temp. (deg. F)	Summa Can Vacuum (in Hg)	Comments
0636	-0.1	50	-26	NA
0837	-2.2	62	-21	NA
1036	-2.4	61	-17	NA
1235	-2.3	59	-11	NA
1436	5.1	61	-7.5	NA; Windy
1636	-1.0	55	-2	Windy
—	—	—	—	Sample ID C400VI8EXHONG-R

Teresa Fischer 5/15/2018

Kristoffer Henderson 5/15/2018

D3-152

INSTRUMENT CALIBRATION REPORT

Advanced Labs, Inc.

Pine Environmental Services, Inc

Instrument ID 39207
Description TSI 8330 VelociCheck
Calibrated 9/27/2017

Manufacturer	TSI	**Classification**	
Model Number	8330	**Status**	pass
Serial Number	96060227	**Frequency**	Yearly
Location	New Jersey	**Department**	Lab
Temp	76	**Humidity**	33

Calibration Specifications

Group # 1
Group Name Temperature
Stated Accy Plus / Minus
Range Acc % 0.0000
Reading Acc % 0.0000
Plus/Minus 5.00

Nom In Val / In Val	In Type	Out Val	Out Type	Fnd As	Lft As	Dev%	Pass/Fail
70.00 / 75.60	°F	75.60	°F	76.00	76.00	0.53%	Pass

Group # 2
Group Name Velocity
Stated Accy Pct of Reading
Range Acc % 0.0000
Reading Acc % 5.0000
Plus/Minus 0.00

Nom In Val / In Val	In Type	Out Val	Out Type	Fnd As	Lft As	Dev%	Pass/Fail
0.00 / 0.00	ft/min	0.00	ft/min	0.00	0.00	0.00%	Pass
40.00 / 40.00	ft/min	40.00	ft/min	40.00	40.00	0.00%	Pass
70.00 / 70.00	ft/min	70.00	ft/min	70.00	70.00	0.00%	Pass
100.00 / 100.00	ft/min	100.00	ft/min	103.00	103.00	3.00%	Pass
150.00 / 150.00	ft/min	150.00	ft/min	153.00	153.00	2.00%	Pass
325.00 / 325.00	ft/min	325.00	ft/min	330.00	330.00	1.54%	Pass
700.00 / 700.00	ft/min	700.00	ft/min	700.00	700.00	0.00%	Pass
1000.00 / 1000.00	ft/min	1000.00	ft/min	990.00	990.00	-1.00%	Pass
1500.00 / 1500.00	ft/min	1500.00	ft/min	1,490.00	1,490.00	-0.67%	Pass
2000.00 / 2000.00	ft/min	2000.00	ft/min	2,000.00	2,000.00	0.00%	Pass

Test Instruments Used During the Calibration

				(As Of Cal Entry Date)	
Test Instrument ID	**Description**	**Manufacturer**	**Serial Number**	**Last Cal Date**	**Next Cal Date**
MICHELL DM-509-TX-01	Relative Humidity Meter	Michell	273296	8/25/2017	8/25/2018
OMEGA HX93AC/DP25-E	Omega HX93AC/DP25-E	Omega Engineering	1010368 035025 035026	9/15/2016	9/15/2018
OMEGA PX02K1-16A5T /DP25-E-A	Omega PX02K1-16A5T/DP25-E-A	Omega Engineering	168377/8375030	9/15/2016	9/15/2018
OMEGA WT4401-D	Omega WT4401-D	Omega Engineering	101105	9/15/2016	9/15/2018

Teresa Fischer 5/15/2018

INSTRUMENT CALIBRATION REPORT

Advanced Labs, Inc.

Pine Environmental Services, Inc

Instrument ID	39207
Description	TSI 8330 VelociCheck
Calibrated	9/27/2017

Notes about this calibration

Calibration Result	Calibration Successful
Who Calibrated	David Galego

Advanced Labs, Inc. hereby certifies that this instrument is calibrated and functions to meet the manufacture's specifications using NIST traceable standards, or is derived from accepted values of physical constants.

Teresa Fischer 5/15/2018

Advanced Labs, Inc., Windsor Industrial Park, 92 North Main Street, Bldg 20, Windsor, NJ 08561, 800-301-9663

ATTACHMENT D4

NATIONAL WEATHER SERVICE DATA

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Paducah, KY

Barkley Regional

Weather History for KPAH - January, 2018

January

27

2018

View
Saturday, January 27, 2018

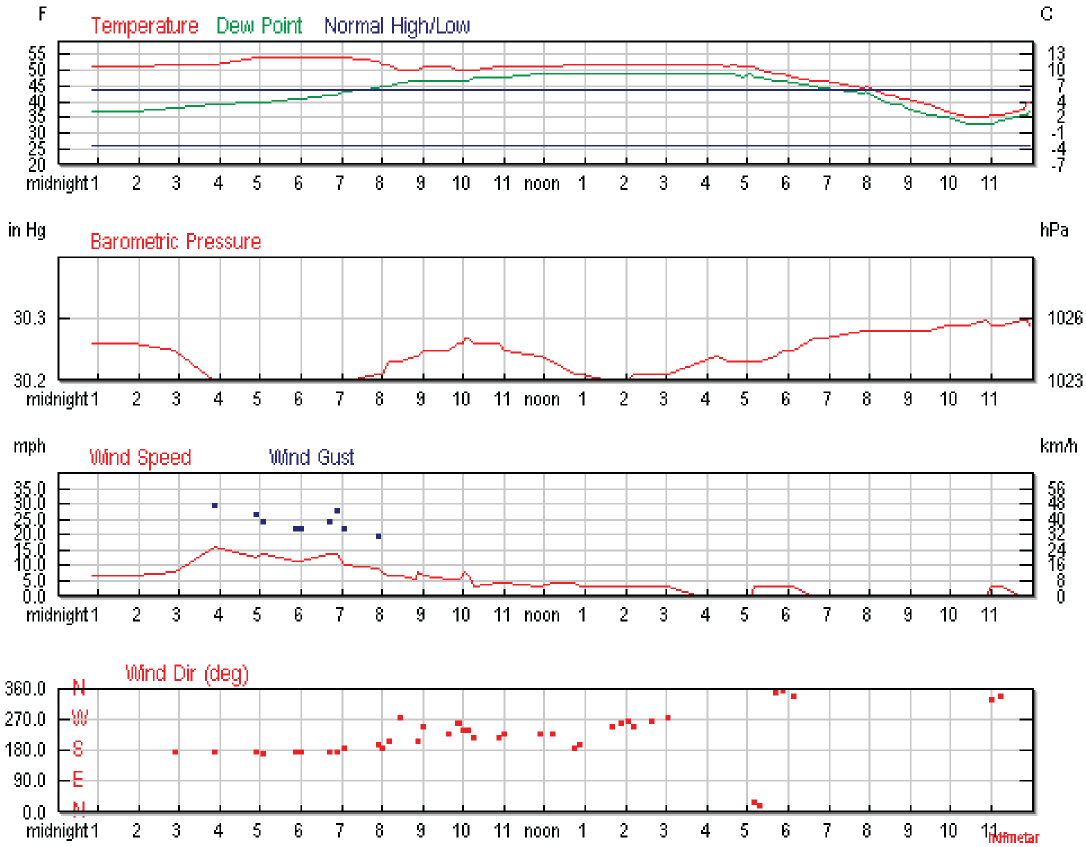
Daily	Weekly	Monthly	Custom

	Actual	Average	Record
Temperature			
Mean Temperature	**45** °F	**35** °F	
Max Temperature	**55** °F	**44** °F	**70** °F (1947)
Min Temperature	**35** °F	**26** °F	**-5** °F (1940)
Degree Days			
Heating Degree Days	20	30	
Month to date heating degree days	931	827	
Since 1 July heating degree days	2465	2458	
Cooling Degree Days	0	0	
Month to date cooling degree days	0	0	
Year to date cooling degree days	0	0	
Moisture			
Dew Point	**44** °F		
Average Humidity	76		

	Actual	Average	Record
Maximum Humidity	93		
Minimum Humidity	59		
Precipitation			
Precipitation	**0.51** in	**0.12** in	**2.49** in (2009)
Month to date precipitation	4.00	3.18	
Year to date precipitation	4.00	3.18	
Snow			
Snow	**0.00** in	**0.10** in	**3.80** in (1985)
Month to date snowfall	12.4	2.5	
Since 1 July snowfall	12.4	4.8	
Snow Depth	**0.00** in		
Sea Level Pressure			
Sea Level Pressure	**30.24** in		
Wind			
Wind Speed	**5** mph (SW)		
Max Wind Speed	**18** mph		
Max Gust Speed	**29** mph		
Visibility	**3** miles		
Events	Fog , Rain		

T = Trace of Precipitation, MM = Missing Value   Source: NWS Daily Summary

Daily Weather History Graph



Search for Another Location

Airport or City:

KPAH

Submit

Trip Planner

Search our weather history database for the weather conditions in past years. The results will help you decide how hot, cold, wet, or windy it might be!

Date:

January

27

Submit

Astronomy

Jan. 27, 2018	Rise	Set
Actual Time	7:01 AM CST	5:14 PM CST

Jan. 27, 2018	Rise	Set
Civil Twilight	6:33 AM CST	5:42 PM CST
Nautical Twilight	6:02 AM CST	6:13 PM CST
Astronomical Twilight	5:31 AM CST	6:44 PM CST
Moon	1:30 PM CST (1/27)	2:55 AM CST (1/27)
Length of Visible Light	11h 08m	
Length of Day	10h 13m	

Waxing Gibbous, 80% of the Moon is Illuminated

Jan 27	Jan 31	Feb 7	Feb 15	Feb 23
Waxing Gibbous	Full	Last Quarter	New	First Quarter

Hourly Weather History & Observations

Time (CST)	Temp.	Windchill	Dew Point	Humidity	Pressure	Visibility	Wind Dir	Wind Speed	Gust Speed	Precip	Events
12:53 AM	**51.1** °F	-	**37.0** °F	59%	**30.26** in	**10.0** mi	South	**6.9** mph	-	**0.00** in	Rain
1:53 AM	**51.1** °F	-	**37.0** °F	59%	**30.26** in	**10.0** mi	Variable	**6.9** mph	-	**0.00** in	Rain
2:53 AM	**52.0** °F	-	**37.9** °F	59%	**30.25** in	**10.0** mi	South	**8.1** mph	**20.7** mph	**0.01** in	
3:53 AM	**52.0** °F	-	**39.0** °F	61%	**30.20** in	**10.0** mi	South	**16.1** mph	**29.9** mph	**0.00** in	
4:53 AM	**54.0** °F	-	**39.9** °F	59%	**30.20** in	**10.0** mi	South	**12.7** mph	**26.5** mph	N/A	
5:03 AM	**54.0** °F	-	**39.9** °F	59%	**30.20** in	**10.0** mi	South	**13.8** mph	**24.2** mph	N/A	
5:53 AM	**54.0** °F	-	**41.0** °F	62%	**30.20** in	**10.0** mi	South	**11.5** mph	**21.9** mph	N/A	
6:01 AM	**54.0** °F	-	**41.0** °F	62%	**30.20** in	**10.0** mi	South	**11.5** mph	**21.9** mph	N/A	
6:42 AM	**54.0** °F	-	**42.1** °F	64%	**30.20** in	**10.0** mi	South	**13.8** mph	**24.2** mph	**0.00** in	Rain
6:53 AM	**54.0** °F	-	**42.1** °F	64%	**30.20** in	**10.0** mi	South	**13.8** mph	**27.6** mph	**0.00** in	Rain
7:04 AM	**54.0** °F	-	**43.0** °F	66%	**30.20** in	**8.0** mi	South	**10.4** mph	**21.9** mph	**0.00** in	Rain

Time (CST)	Temp.	Windchill	Dew Point	Humidity	Pressure	Visibility	Wind Dir	Wind Speed	Gust Speed	Precip	Events
7:53 AM	**53.1** °F	-	**44.1** °F	71%	**30.21** in	**9.0** mi	SSW	**9.2** mph	**19.6** mph	**0.01** in	
8:00 AM	**52.0** °F	-	**45.0** °F	77%	**30.21** in	**1.5** mi	South	**8.1** mph	-	**0.02** in	Rain
8:11 AM	**52.0** °F	-	**45.0** °F	77%	**30.23** in	**3.0** mi	SSW	**6.9** mph	**19.6** mph	**0.10** in	Rain
8:27 AM	**50.0** °F	-	**46.0** °F	86%	**30.23** in	**1.8** mi	West	**6.9** mph	-	**0.12** in	Rain
8:51 AM	**50.0** °F	-	**46.4** °F	87%	**30.24** in	**2.5** mi	Variable	**5.8** mph	-	**0.26** in	Rain
8:53 AM	**50.0** °F	-	**46.9** °F	89%	**30.24** in	**2.5** mi	SSW	**8.1** mph	-	**0.26** in	Rain
9:01 AM	**51.1** °F	-	**46.9** °F	86%	**30.25** in	**3.0** mi	WSW	**6.9** mph	-	**0.02** in	Rain
9:37 AM	**51.1** °F	-	**46.9** °F	86%	**30.25** in	**3.0** mi	SW	**5.8** mph	-	**0.08** in	Rain
9:51 AM	**50.0** °F	-	**46.4** °F	87%	**30.26** in	**3.0** mi	West	**5.8** mph	-	**0.10** in	Rain
9:53 AM	**50.0** °F	-	**46.9** °F	89%	**30.26** in	**3.0** mi	West	**5.8** mph	-	**0.10** in	Rain
9:59 AM	**50.0** °F	-	**46.9** °F	89%	**30.26** in	**1.8** mi	WSW	**6.9** mph	-	**0.03** in	Rain
10:03 AM	**50.0** °F	-	**46.9** °F	89%	**30.27** in	**1.8** mi	WSW	**8.1** mph	-	**0.05** in	Rain
10:06 AM	**50.0** °F	-	**46.9** °F	89%	**30.27** in	**2.0** mi	WSW	**6.9** mph	-	**0.05** in	Rain
10:16 AM	**50.0** °F	-	**48.0** °F	93%	**30.26** in	**3.0** mi	SW	**3.5** mph	-	**0.06** in	Rain
10:53 AM	**51.1** °F	-	**48.0** °F	89%	**30.26** in	**6.0** mi	SW	**4.6** mph	-	**0.10** in	Rain
11:01 AM	**51.1** °F	-	**48.0** °F	89%	**30.25** in	**6.0** mi	SW	**4.6** mph	-	**0.00** in	Rain
11:53 AM	**51.1** °F	-	**48.9** °F	92%	**30.24** in	**4.0** mi	SW	**3.5** mph	-	**0.02** in	
12:11 PM	**51.1** °F	-	**48.9** °F	92%	**30.23** in	**2.0** mi	SW	**4.6** mph	-	N/A	
12:44 PM	**52.0** °F	-	**48.9** °F	89%	**30.21** in	**3.0** mi	South	**4.6** mph	-	N/A	
12:53 PM	**52.0** °F	-	**48.9** °F	89%	**30.21** in	**4.0** mi	SSW	**3.5** mph	-	N/A	
1:40 PM	**52.0** °F	-	**48.9** °F	89%	**30.20** in	**1.8** mi	WSW	**3.5** mph	-	**0.00** in	

Time (CST)	Temp.	Windchill	Dew Point	Humidity	Pressure	Visibility	Wind Dir	Wind Speed	Gust Speed	Precip	Events
1:53 PM	**52.0** °F	-	**48.9** °F	89%	**30.20** in	**1.8** mi	West	**3.5** mph	-	**0.01** in	
2:04 PM	**52.0** °F	-	**48.9** °F	89%	**30.20** in	**1.8** mi	West	**3.5** mph	-	N/A	
2:12 PM	**52.0** °F	-	**48.9** °F	89%	**30.21** in	**2.5** mi	WSW	**3.5** mph	-	N/A	
2:37 PM	**52.0** °F	-	**48.9** °F	89%	**30.21** in	**3.0** mi	West	**3.5** mph	-	N/A	
2:53 PM	**52.0** °F	-	**48.9** °F	89%	**30.21** in	**4.0** mi	Variable	**3.5** mph	-	N/A	
3:03 PM	**52.0** °F	-	**48.9** °F	89%	**30.21** in	**3.0** mi	West	**3.5** mph	-	N/A	
3:53 PM	**52.0** °F	-	**48.9** °F	89%	**30.23** in	**6.0** mi	Calm	Calm	-	N/A	
4:15 PM	**52.0** °F	-	**48.9** °F	89%	**30.24** in	**2.5** mi	Calm	Calm	-	N/A	
4:32 PM	**51.1** °F	-	**48.9** °F	92%	**30.23** in	**4.0** mi	Calm	Calm	-	N/A	
4:37 PM	**52.0** °F	-	**48.9** °F	89%	**30.23** in	**4.0** mi	Calm	Calm	-	N/A	
4:53 PM	**51.1** °F	-	**48.0** °F	89%	**30.23** in	**3.0** mi	Calm	Calm	-	N/A	
5:05 PM	**51.1** °F	-	**48.9** °F	92%	**30.23** in	**1.8** mi	Calm	Calm	-	N/A	
5:10 PM	**51.1** °F	-	**48.0** °F	89%	**30.23** in	**0.2** mi	NNE	**3.5** mph	-	N/A	Fog
5:17 PM	**50.0** °F	-	**48.0** °F	93%	**30.23** in	**0.2** mi	NNE	**3.5** mph	-	N/A	Fog
5:41 PM	**48.9** °F	-	**46.9** °F	93%	**30.24** in	**0.2** mi	North	**3.5** mph	-	N/A	Fog
5:53 PM	**48.9** °F	-	**46.9** °F	93%	**30.25** in	**0.2** mi	North	**3.5** mph	-	N/A	Fog
6:08 PM	**48.0** °F	-	**46.0** °F	93%	**30.25** in	**0.2** mi	NNW	**3.5** mph	-	N/A	Fog
6:36 PM	**46.9** °F	-	**45.0** °F	93%	**30.27** in	**0.2** mi	Calm	Calm	-	N/A	Fog
6:51 PM	**46.4** °F	-	**44.6** °F	93%	**30.27** in	**0.2** mi	Calm	Calm	-	N/A	Fog
6:53 PM	**46.9** °F	-	**44.1** °F	90%	**30.27** in	**0.2** mi	Calm	Calm	-	N/A	Fog
7:51 PM	**44.6** °F	-	**42.8** °F	93%	**30.28** in	**0.2** mi	Calm	Calm	-	N/A	Fog

Time (CST)	Temp.	Windchill	Dew Point	Humidity	Pressure	Visibility	Wind Dir	Wind Speed	Gust Speed	Precip	Events
7:53 PM	**45.0** °F	-	**43.0** °F	93%	**30.28** in	**0.2** mi	Calm	Calm	-	N/A	Fog
8:27 PM	**42.1** °F	-	**39.9** °F	92%	**30.28** in	**0.2** mi	Calm	Calm	-	N/A	Fog
8:34 PM	**42.1** °F	-	**39.0** °F	89%	**30.28** in	**0.2** mi	Calm	Calm	-	N/A	Fog
8:48 PM	**41.0** °F	-	**39.2** °F	93%	**30.28** in	**0.5** mi	Calm	Calm	-	N/A	Fog
8:53 PM	**41.0** °F	-	**37.9** °F	89%	**30.28** in	**0.5** mi	Calm	Calm	-	N/A	Fog
9:28 PM	**39.0** °F	-	**36.0** °F	89%	**30.28** in	**0.2** mi	Calm	Calm	-	N/A	Fog
9:53 PM	**37.0** °F	-	**35.1** °F	93%	**30.29** in	**0.2** mi	Calm	Calm	-	N/A	Fog
10:26 PM	**35.1** °F	-	**33.1** °F	92%	**30.29** in	**0.2** mi	Calm	Calm	-	N/A	Fog
10:53 PM	**35.1** °F	-	**33.1** °F	92%	**30.30** in	**0.5** mi	Calm	Calm	-	N/A	Fog
11:01 PM	**36.0** °F	**33.3** °F	**33.1** °F	89%	**30.29** in	**1.0** mi	NNW	**3.5** mph	-	N/A	
11:14 PM	**36.0** °F	**33.3** °F	**34.0** °F	93%	**30.29** in	**3.0** mi	NNW	**3.5** mph	-	N/A	
11:47 PM	**37.4** °F	-	**35.6** °F	93%	**30.30** in	**1.8** mi	Calm	Calm	-	N/A	
11:53 PM	**39.9** °F	-	**36.0** °F	86%	**30.30** in	**1.5** mi	Calm	Calm	-	N/A	
11:57 PM	**39.9** °F	-	**37.0** °F	89%	**30.29** in	**3.0** mi	Calm	Calm	-	N/A	

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Weather observations for the past three days

Paducah, Barkley Regional Airport

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metric en español

Date	Time (cst)	Wind (mph)	Vis. (mi.)	Weather	Sky Cond.	Temperature (ºF) Air	Dwpt	6 hour Max.	Min.	Relative Humidity	Wind Chill (°F)	Heat Index (°F)	Pressure altimeter (in)	sea level (mb)	Precipitation (in.) 1 hr	3 hr	6 hr
10	18:53	NE 13	7.00	Overcast	OVC016	37	30			76%	29	NA	29.96	1014.8			
10	17:53	NE 16	7.00	Overcast	OVC015	38	30	40	37	73%	29	NA	29.96	1014.8			
10	16:53	NE 12	6.00	Overcast with Haze	OVC016	39	32			76%	32	NA	29.95	1014.4			
10	15:53	N 12	5.00	Overcast with Haze	OVC016	40	31			70%	33	NA	29.97	1014.8			
10	14:53	NE 13	5.00	Overcast with Haze	OVC015	40	32			73%	32	NA	29.96	1014.8			
10	13:53	N 12	5.00	Overcast with Haze	BKN013 OVC023	39	32			76%	32	NA	29.97	1014.9			
10	12:53	N 10	4.00	Overcast with Haze	OVC009	37	32			82%	30	NA	29.97	1014.9			
10	11:53	N 8	2.50	Overcast with Haze	OVC007	38	33	41	37	83%	32	NA	30.03	1017.0			
10	10:53	N 8	1.50	Fog/Mist	OVC007	37	34			89%	31	NA	30.04	1017.5			
10	09:53	NW 10	3.00	Overcast with Haze	OVC011	39	34			82%	32	NA	30.04	1017.4			
10	08:53	N 7	3.00	Overcast with Haze	OVC011	40	35			83%	35	NA	30.03	1016.9			
10	07:53	NE 9	2.00	Fog/Mist	OVC007	39	35			86%	33	NA	30.03	1016.9			
10	06:53	N 12	2.00	Fog/Mist	OVC006	39	36			89%	32	NA	30.04	1017.1			
10	05:53	NW 6	5.00	Fog/Mist	OVC006	41	37	49	41	86%	37	NA	30.02	1016.7			0.18
10	04:53	NW 3	5.00	Fog/Mist	OVC004	47	45			93%	NA	NA	30.00	1015.8			
10	03:53	Calm	1.75	Fog/Mist	BKN006 BKN025 OVC030	47	45			93%	NA	NA	29.98	1015.1	0.02		
10	02:53	Calm	1.00	Light Rain Fog/Mist	FEW026 OVC037	47	45			93%	NA	NA	30.01	1016.0	0.06	0.16	
10	01:53	Calm	3.00	Light Rain Fog/Mist	FEW018 SCT033 OVC042	48	45			89%	NA	NA	30.02	1016.3	0.06		
10	00:53	SW 3	3.00	Light	BKN019	48	45			89%	NA	NA	30.05	1017.4	0.04		

				Rain Fog/Mist	OVC031									
09	23:53	SW 9	10.00	Light Rain	BKN035 OVC060	52	40	56	46	64%	NA	NA	30.05	1017.4
09	22:53	Calm	10.00	Overcast	SCT045 BKN050 OVC095	48	37			66%	NA	NA	30.05	1017.4
09	21:53	Calm	10.00	Mostly Cloudy	BKN065	46	37			71%	NA	NA	30.05	1017.7
09	20:53	Calm	10.00	Overcast	SCT049 OVC060	50	36			59%	NA	NA	30.06	1018.1
09	19:53	S 3	10.00	Overcast	OVC065	51	35			54%	NA	NA	30.07	1018.2
09	18:53	Calm	10.00	Overcast	OVC070	55	35			47%	NA	NA	30.07	1018.2
09	17:53	Calm	10.00	Overcast	OVC070	56	35	59	56	46%	NA	NA	30.07	1018.3
09	16:53	S 5	10.00	Overcast	BKN060 OVC080	58	35			42%	NA	NA	30.07	1018.3
09	15:53	Vrbl 5	10.00	Overcast	FEW040 OVC050	59	35			41%	NA	NA	30.07	1018.3
09	14:53	Vrbl 5 G 16	10.00	Fair	CLR	58	34			41%	NA	NA	30.08	1018.5
09	13:53	S 8	10.00	Fair	CLR	58	34			41%	NA	NA	30.10	1019.3
09	12:53	S 12 G 23	10.00	Fair	CLR	57	33			41%	NA	NA	30.14	1020.6
09	11:53	SW 16 G 24	10.00	Fair	CLR	56	33	56	30	42%	NA	NA	30.19	1022.2
09	10:53	SW 14 G 25	10.00	Fair	CLR	53	31			43%	NA	NA	30.22	1023.6
09	09:53	S 8	10.00	Fair	CLR	49	30			48%	46	NA	30.23	1023.8
09	08:53	S 9	10.00	Fair	CLR	44	27			51%	39	NA	30.23	1023.8
09	07:53	S 7	10.00	Fair	CLR	39	26			60%	34	NA	30.25	1024.4
09	06:53	S 5	10.00	Fair	CLR	37	24			59%	33	NA	30.25	1024.7
09	05:53	Calm	10.00	Fair	CLR	33	24	38	30	70%	NA	NA	30.24	1024.3
09	04:53	Calm	10.00	Fair	CLR	34	24			67%	NA	NA	30.24	1024.2
09	03:53	Calm	10.00	Fair	CLR	33	24			70%	NA	NA	30.24	1024.4
09	02:53	Calm	10.00	Fair	CLR	36	24			62%	NA	NA	30.25	1024.6
09	01:53	S 5	10.00	Fair	CLR	37	24			59%	33	NA	30.27	1025.1
09	00:53	Vrbl 6	10.00	Fair	CLR	38	25			60%	33	NA	30.27	1025.4
08	23:53	S 5	10.00	Fair	CLR	35	25	38	29	67%	31	NA	30.30	1026.2
08	22:53	S 5	10.00	Fair	CLR	32	24			73%	27	NA	30.33	1027.3
08	21:53	Calm	10.00	Fair	CLR	30	24			79%	NA	NA	30.35	1028.2
08	20:53	Calm	10.00	Fair	CLR	29	25			85%	NA	NA	30.36	1028.5
08	19:53	S 3	10.00	Fair	CLR	30	26			85%	NA	NA	30.36	1028.5
08	18:53	SE 3	10.00	Fair	CLR	34	27			76%	NA	NA	30.37	1028.8
08	17:53	SE 3	10.00	Fair	CLR	38	27	43	36	65%	NA	NA	30.37	1028.9
08	16:53	SE 6	10.00	Fair	CLR	41	28			60%	37	NA	30.38	1029.2
08	15:53	S 6	10.00	Fair	CLR	42	29			60%	38	NA	30.40	1029.8

08	14:53	S 5	9.00	Fair	CLR	41	29			62%	38	NA	30.42	1030.4			
08	13:53	S 8	9.00	A Few Clouds	FEW021	40	29			65%	35	NA	30.44	1031.2			
08	12:53	S 6	9.00	Fair	CLR	37	27			67%	32	NA	30.47	1032.4			
08	11:53	Vrbl 6	8.00	Fair	CLR	37	28	37	19	70%	32	NA	30.51	1033.6			
08	10:53	SW 5	8.00	Mostly Cloudy	BKN016	34	27			76%	29	NA	30.55	1034.9			
08	09:53	SW 3	6.00	Fair with Haze	CLR	31	26			82%	NA	NA	30.54	1034.7			
08	08:53	Calm	3.00	Fog/Mist	CLR	28	24			85%	NA	NA	30.56	1035.4			
08	07:53	Calm	3.00	Fog/Mist	BKN002	22	19			89%	NA	NA	30.54	1034.7			
08	06:53	S 3	4.00	Fair with Haze	CLR	19	14			81%	NA	NA	30.51	1033.8			
08	05:53	NA	5.00	Fair with Haze	CLR	20	15	22	20	81%	NA	NA	30.50	1033.2			
08	04:53	Calm	6.00	Fog/Mist	CLR	20	16			85%	NA	NA	30.48	1032.6			
08	03:53	Calm	6.00	Fog/Mist	CLR	20	16			85%	NA	NA	30.47	1032.2			
08	02:53	Calm	6.00	Fog/Mist	CLR	20	16			85%	NA	NA	30.48	1032.7			
08	01:53	Calm	6.00	Fog/Mist	CLR	21	17			85%	NA	NA	30.49	1032.8			
08	00:53	Calm	6.00	Fog/Mist	CLR	21	17			85%	NA	NA	30.49	1032.9			
07	23:53	Calm	6.00	Fog/Mist	CLR	22	18	29	22	85%	NA	NA	30.49	1032.9			
07	22:53	Calm	6.00	Fog/Mist	CLR	22	18			85%	NA	NA	30.49	1033.0			
07	21:53	Calm	6.00	Fog/Mist	CLR	23	19			85%	NA	NA	30.49	1032.9			
07	20:53	Calm	5.00	Fog/Mist	CLR	24	20			84%	NA	NA	30.48	1032.6			
07	19:53	Calm	5.00	Fair with Haze	CLR	25	20			81%	NA	NA	30.48	1032.5			
Date	**Time (cst)**	**Wind (mph)**	**Vis. (mi.)**	**Weather**	**Sky Cond.**	**Air**	**Dwpt**	**Max.**	**Min.**	**Relative Humidity**	**Wind Chill (°F)**	**Heat Index (°F)**	**altimeter (in.)**	**sea level (mb)**	**1 hr**	**3 hr**	**6 hr**
								6 hour									
						Temperature (ºF)							**Pressure**		**Precipitation (in.)**		

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Barkley Regional

Weather History for KPAH - February, 2018

February

12

2018

View
Saturday, February 3, 2018

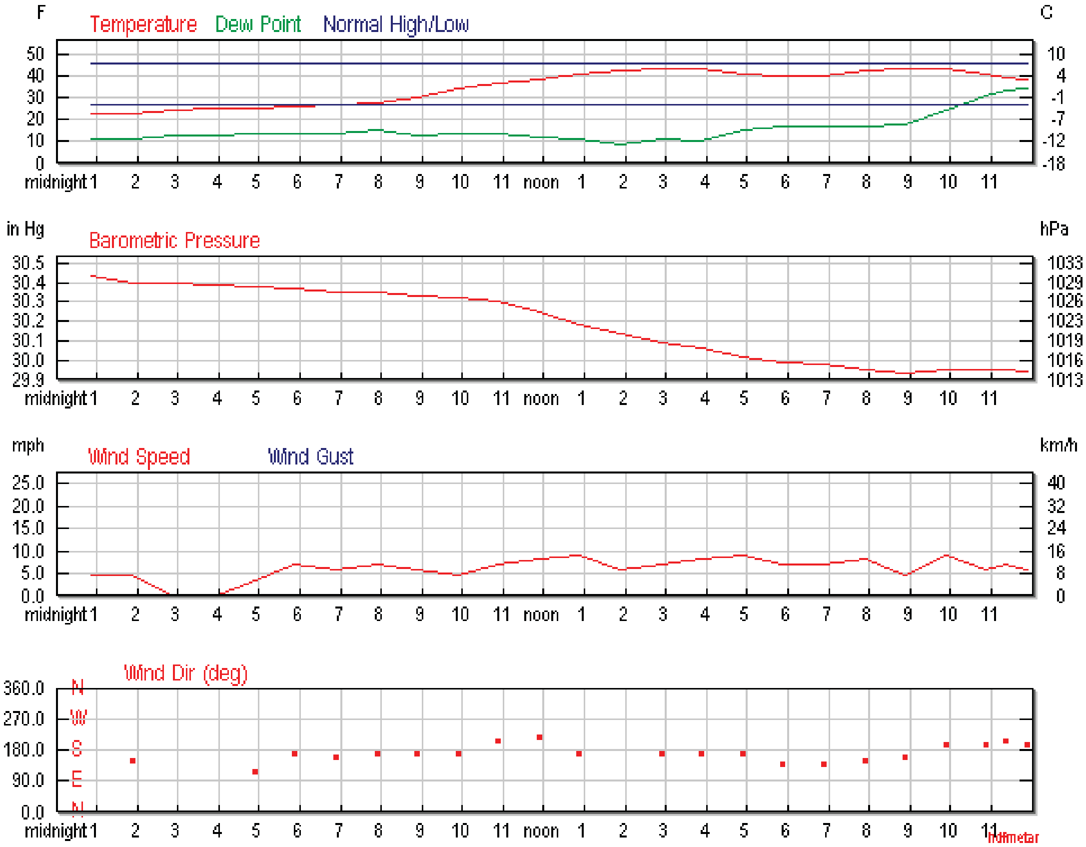
Daily | Weekly | Monthly | Custom

	Actual	Average	Record
Temperature			
Mean Temperature	**33** °F	**36** °F	
Max Temperature	**43** °F	**46** °F	**70** °F (1992)
Min Temperature	**22** °F	**27** °F	**-8** °F (1985)
Degree Days			
Heating Degree Days	32	29	
Month to date heating degree days	104	87	
Since 1 July heating degree days	2678	2660	
Cooling Degree Days	0	0	
Month to date cooling degree days	0	0	
Year to date cooling degree days	0	0	
Moisture			
Dew Point	**17** °F		
Average Humidity	51		

	Actual	Average	Record
Maximum Humidity	77		
Minimum Humidity	24		
Precipitation			
Precipitation	**0.08** in	**0.15** in	**1.68** in (1939)
Month to date precipitation	0.14	0.44	
Year to date precipitation	4.14	4.12	
Snow			
Snow	**T** in	**0.10** in	**3.00** in (1982)
Month to date snowfall	T	0.4	
Since 1 July snowfall	12.4	5.7	
Snow Depth	**0.00** in		
Sea Level Pressure			
Sea Level Pressure	**30.17** in		
Wind			
Wind Speed	**6** mph (South)		
Max Wind Speed	**13** mph		
Max Gust Speed	**18** mph		
Visibility	**10** miles		
Events	Rain		

T = Trace of Precipitation, MM = Missing Value   Source: NWS Daily Summary

Daily Weather History Graph



F
Temperature
Dew Point
Normal High/Low
C
50
40
30
20
10
0
10
4
-1
-7
-12
-18
midnight 1
2
3
4
5
6
7
8
9
10
11
noon
1
2
3
4
5
6
7
8
9
10
11
in Hg
Barometric Pressure
hPa
30.5
30.4
30.3
30.2
30.1
30.0
29.9
1033
1029
1026
1023
1019
1016
1013
mph
Wind Speed
Wind Gust
km/h
25.0
20.0
15.0
10.0
5.0
0.0
40
32
24
16
8
0
Wind Dir (deg)
360.0
270.0
180.0
90.0
0.0
N
W
S
E
N
hdfmetar

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Trip Planner

Search our weather history database for the weather conditions in past years. The results will help you decide how hot, cold, wet, or windy it might be!

Date:

February

3

Submit

Astronomy

Feb. 03, 2018	Rise	Set
Actual Time	6:55 AM CST	5:22 PM CST
Civil Twilight	6:28 AM CST	5:49 PM CST
Nautical Twilight	5:57 AM CST	6:20 PM CST
Astronomical Twilight	5:27 AM CST	6:51 PM CST
Moon	9:08 PM CST (2/3)	9:04 AM CST (2/3)
Length of Visible Light	11h 20m	
Length of Day	10h 26m	

Waning Gibbous, 87% of the Moon is Illuminated

Feb 3	Feb 7	Feb 15	Feb 23	Mar 1
Waning Gibbous	Last Quarter	New	First Quarter	Full

Hourly Weather History & Observations

Time (CST)	Temp.	Windchill	Dew Point	Humidity	Pressure	Visibility	Wind Dir	Wind Speed	Gust Speed	Precip	Events
12:53 AM	**23.0** °F	**17.0** °F	**10.9** °F	60%	**30.43** in	**10.0** mi	SSE	**4.6** mph	-	N/A	
1:53 AM	**23.0** °F	**17.0** °F	**10.9** °F	60%	**30.40** in	**10.0** mi	SSE	**4.6** mph	-	N/A	
2:53 AM	**24.1** °F	-	**12.9** °F	62%	**30.40** in	**10.0** mi	Calm	Calm	-	N/A	
3:53 AM	**25.0** °F	-	**12.9** °F	60%	**30.39** in	**10.0** mi	Calm	Calm	-	N/A	
4:53 AM	**25.0** °F	**20.7** °F	**14.0** °F	63%	**30.38** in	**10.0** mi	ESE	**3.5** mph	-	N/A	
5:53 AM	**26.1** °F	**18.4** °F	**14.0** °F	60%	**30.37** in	**10.0** mi	South	**6.9** mph	-	N/A	
6:53 AM	**27.0** °F	**20.5** °F	**14.0** °F	58%	**30.35** in	**10.0** mi	SSE	**5.8** mph	-	N/A	
7:53 AM	**28.0** °F	**20.8** °F	**15.1** °F	58%	**30.35** in	**10.0** mi	South	**6.9** mph	-	N/A	
8:53 AM	**30.0** °F	**24.1** °F	**12.9** °F	49%	**30.33** in	**10.0** mi	South	**5.8** mph	-	N/A	
9:53 AM	**34.0** °F	**29.8** °F	**14.0** °F	44%	**30.32** in	**10.0** mi	South	**4.6** mph	-	N/A	

Time (CST)	Temp.	Windchill	Dew Point	Humidity	Pressure	Visibility	Wind Dir	Wind Speed	Gust Speed	Precip	Events
10:53 AM	**37.0** °F	**31.6** °F	**14.0** °F	39%	**30.30** in	**10.0** mi	SSW	**6.9** mph	-	N/A	
11:53 AM	**37.9** °F	**32.1** °F	**12.0** °F	35%	**30.25** in	**10.0** mi	SW	**8.1** mph	-	N/A	
12:53 PM	**41.0** °F	**35.2** °F	**10.9** °F	29%	**30.18** in	**10.0** mi	South	**9.2** mph	-	N/A	
1:53 PM	**42.1** °F	**38.4** °F	**9.0** °F	26%	**30.14** in	**10.0** mi	Variable	**5.8** mph	-	N/A	
2:53 PM	**43.0** °F	**38.8** °F	**10.9** °F	27%	**30.09** in	**10.0** mi	South	**6.9** mph	-	N/A	
3:53 PM	**43.0** °F	**38.2** °F	**10.0** °F	26%	**30.06** in	**10.0** mi	South	**8.1** mph	-	N/A	
4:53 PM	**41.0** °F	**35.2** °F	**15.1** °F	35%	**30.02** in	**10.0** mi	South	**9.2** mph	-	N/A	
5:53 PM	**39.9** °F	**35.1** °F	**17.1** °F	40%	**29.99** in	**10.0** mi	SE	**6.9** mph	-	N/A	
6:53 PM	**39.9** °F	**35.1** °F	**17.1** °F	40%	**29.98** in	**10.0** mi	SE	**6.9** mph	-	N/A	
7:53 PM	**42.1** °F	**37.1** °F	**17.1** °F	37%	**29.95** in	**10.0** mi	SSE	**8.1** mph	-	N/A	
8:53 PM	**43.0** °F	**40.3** °F	**18.0** °F	37%	**29.93** in	**10.0** mi	SSE	**4.6** mph	-	N/A	
9:53 PM	**43.0** °F	**37.7** °F	**24.1** °F	47%	**29.95** in	**8.0** mi	SSW	**9.2** mph	**17.3** mph	**0.01** in	Rain
10:53 PM	**41.0** °F	**37.1** °F	**30.9** °F	67%	**29.95** in	**9.0** mi	SSW	**5.8** mph	-	**0.04** in	Rain
11:22 PM	**39.0** °F	**34.0** °F	**33.1** °F	79%	**29.95** in	**7.0** mi	SSW	**6.9** mph	-	**0.02** in	Rain
11:53 PM	**37.9** °F	**33.5** °F	**34.0** °F	86%	**29.94** in	**7.0** mi	SSW	**5.8** mph	-	**0.03** in	Rain

ATTACHMENT D5

ANALYTICAL RESULTS

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ANALYTICAL RESULTS

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