LMS/MND/S14085

Five-Year Review Report

Fourth Five-Year Review for the Mound, Ohio, Site Miamisburg, Ohio

September 2016

U.S. DEPARTMENT OF ENERGY | Legacy Management

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Fourth Five-Year Review for the Mound, Ohio, Site Miamisburg, Ohio

September 2016

Approved by: **Date:**

[signature] 9/12/2016

Susan Smiley
Mound Site Manager
U.S. Department of Energy
Office of Legacy Management

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Abbreviations

AFFF	aqueous film forming foam
ARAR	applicable or relevant and appropriate requirement
BVA	Buried Valley Aquifer
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
COC	contaminant of concern
COPC	contaminant of potential concern
CVOC	chlorinated volatile organic compound
DCE	dichloroethene
DOE	U.S. Department of Energy
EA	enhanced attenuation
EM	Office of Environmental Management
EMCBC	Environmental Management Consolidated Business Center
EPA	U.S. Environmental Protection Agency
ES	environmental summary
FFA	Federal Facility Agreement
ft	feet
ft/ft	foot per foot
FYR	five-year review
gpm	gallons per minute
HEAST	Health Effects Assessment Summary Tables
IC	institutional control
IRIS	Integrated Risk Information System
LM	Office of Legacy Management
LTS&M	Long-Term Surveillance and Maintenance
MCL	maximum contaminant level
MDC	Mound Development Corporation (formerly MMCIC)
MDL	method detection limit
µg/L	micrograms per liter
µg/L/year	micrograms per liter per year

mg/kg	milligram per kilogram
mg/L	milligrams per liter
MMCIC	Miamisburg Mound Community Improvement Corporation (see MDC)
MNA	monitored natural attenuation
Navarro	Navarro Research and Engineering, Inc.
nCi/L	nanocuries per liter
NCP	National Oil and Hazardous Substance Pollution Contingency Plan
NE	Office of Nuclear Energy
NPL	National Priorities List
O&M	Operations and Maintenance
OAC	*Ohio Administrative Code*
ODH	Ohio Department of Health
Ohio EPA	Ohio Environmental Protection Agency
ORP	oxidation–reduction potential
OU	Operable Unit
P&T	pump and treatment
PCE	tetrachloroethene (also known as perchloroethene)
pCi/L	picocuries per liter
pCi/L/yr	picocuries per liter per year
PFASs	Per- and Polyfluoroalkyl Substances
PFOA	perfluorooctanoic acid
PFOS	perfluorooctane sulfonate
PRG	preliminary remediation goal
PRS	potential release site
Ra	radium
RAO	remedial action objective
RBGV	risk-based guideline value
ROD	record of decision
RRE	residual risk evaluation
RREM	residual risk evaluation methodology
RSL	regional screening levels
SARA	Superfund Amendments and Reauthorization Act
Sr	strontium
TCE	trichloroethene

VC	vinyl chloride
VOC	volatile organic compound
WPS	Westover Pump Station
WRF	Water Reclamation Facility

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Executive Summary

The Mound Site (EPA ID OH6890008984 or CERCLIS ID 04935) in Miamisburg, Ohio, was remediated by the U.S. Department of Energy (DOE) in accordance with the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986.

The CERCLA five-year review (FYR) is required by statute. CERCLA Section 121(c) requires that remedial actions resulting in any hazardous substances, pollutants, or contaminants remaining at a site above levels that allow for unlimited use and unrestricted exposure be reviewed every five years to ensure protection of human health and the environment.

This fourth FYR is a statutory review of entire Mound site to ensure that the remedial actions established in the records of decision (RODs) for the following areas have been followed.

- Parcel D (formerly Release Block D)
- Parcel H (formerly Release Block H)
- Parcel 3 (included former buildings GP-1 and GH)
- Parcel 4 (South Property)
- Phase I (Areas A, B, and C)
- Parcels 6, 7, and 8
- Parcel 9 Operable Unit 1 (OU-1) (Former Waste Disposal Site)

The Operable Unit 4 (Miami-Erie Canal) ROD area, an offsite area impacted by former Mound operations, is not evaluated in this FYR because it was remediated to an unrestricted use end state.

This FYR determined that the institutional controls (ICs) remedies for Parcels D, H, 3, and 4 and the IC portion of the remedies for Parcels 6, 7, and 8; Phase I (A, B, and C); and OU-1 are functioning as intended and are protective of human health and the environment.

The remedy for Phase I is currently protective of human health and the environment because exposure pathways that could result in unacceptable risks are being controlled through ICs that prevent use of the groundwater in the restricted area. However, in order for the remedy to be protective in the long term, attainment of the cleanup standards in Phase I groundwater will be required to ensure protectiveness.

The remedy for Parcels 6, 7, and 8 is currently protective of human health and the environment because exposure pathways that could result in unacceptable risks are being controlled through ICs that prevent use of the groundwater in the restricted area. However, in order for the remedy to be protective in the long term, attainment of the cleanup standards in Parcels 6, 7, and 8 groundwater will be required to ensure protectiveness.

The remedy for OU-1 (Parcel 9) is currently protective of human health and the environment because exposure pathways that could result in unacceptable risks are being controlled through containment of the plume and ICs that prevent usage of the groundwater in the restricted area.

However, in order for the remedy to be protective in the long term, attainment of the cleanup standards in OU-1 groundwater will be required to ensure protectiveness. Presently the pump-and-treatment (P&T) system has been placed in standby mode to support an ongoing field demonstration to assess enhanced attenuation (EA) as a viable alternative to hydraulic containment. Discontinuing operation of the P&T system, in order to conduct the field demonstration, was approved by U.S. Environmental Protection Agency (EPA) and Ohio EPA.

Groundwater monitoring in OU-1 during the first 18 months of the field demonstration indicated that the contaminant plume had begun to passively stabilize and shrink, concentrations were decreasing, and no downgradient movement of the plume had occurred. Starting in February 2016, as part of several offsite City projects, groundwater began to be extracted to lower the water table and allow for deep excavations and below-grade construction. The aquifer in OU-1 was affected by the dewatering at these projects. Groundwater sampling of the downgradient sentinel wells and wells along the western boundary of OU-1 are presently sampled more frequently (monthly) until offsite dewatering activities are discontinued to monitor for trends in volatile organic compound (VOC) concentrations or potential offsite migration. To date, none of the concentrations in the downgradient sentinel wells have exceeded maximum contaminant levels (MCLs) or indicated offsite movement of VOC-impacted groundwater. The goal is that EA at OU-1 will provide a transition to natural attenuation and is an alternative to the baseline P&T system. The P&T system remains in standby mode.

The sitewide remedy in place at the Mound site is currently protective of human health and the environment through ICs that are in place to reduce exposure to contaminated soil and groundwater. However, in order for the remedies to be protective in the long term, the determination on complete exposure pathways for vapor intrusion and a determination regarding the use of Per- and Polyfluoroalkyl Substances (PFASs) at the Mound site need to be completed by the Mound Core Team.

This is the fourth statutory FYR for the Mound site. The next FYR will be conducted in 2021.

Five-Year Review Summary Form

SITE IDENTIFICATION		
Site Name: Mound Plant (DOE)		
EPA ID: OH6890008984		
Region: 5	**State:** OH	**City/County:** Miamisburg / Montgomery
SITE STATUS		
NPL Status: Final		
Multiple OUs? Yes	**Has the site achieved construction completion?** Yes	
REVIEW STATUS		
Lead agency: Other Federal Agency **If "Other Federal Agency" was selected above, enter Agency name:** DOE		
Author name (Federal or State Project Manager): Susan Smiley		
Author affiliation: DOE		
Review period: 9/29/2011 – 9/28/2016		
Date of site inspection: 4/14/2016		
Type of review: Statutory		
Review number: 4		
Triggering action date: 9/28/2011		
Due date *(five years after triggering action date)*: 9/28/2016		

Five-Year Review Summary Form (continued)

Issues/Recommendations

OU(s) without Issues/Recommendations Identified in the Five-Year Review:
none

Issues and Recommendations Identified in the Five-Year Review:

OU(s): Sitewide	**Issue Category: Changed Site Conditions**			
	Issue: Evidence indicates the presence of vapor-forming chemicals in the subsurface at the Mound site. Information reviewed to date is not sufficient to evaluate whether complete exposure pathways are present under current or reasonably expected future conditions. However, the information reviewed does not prompt immediate response actions.			
	Recommendation: It is recommended that an assessment of current site data be performed to evaluate if possible exposure pathways are or could be present that would result in potential exposure in existing and future buildings and structures at the Mound site as outlined in the OSWER Technical Guide. The assessment will prioritize areas with existing buildings and may include indoor air quality testing as well as sampling of subsurface vapors in or near existing buildings. If additional work is warranted, this assessment will include a proposal for additional work and associated schedule. If it is determined during this assessment that conditions exist that may pose a health risk to building occupants, the Mound Core Team will be contacted immediately, and a course of action will be developed.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	Federal Facility	EPA	5/30/2017

Five-Year Review Summary Form (continued)

OU(s): Sitewide	**Issue Category: Changed Site Conditions**			
	Issue: A significant body of historical documentation and chemical inventories has been compiled regarding the use of PFASs or aqueous film forming foam (AFFF) at the Mound site. Results of this review indicate that these chemicals or materials were not used at the Mound site as fire suppressants although small quantities were used as calibration standards. An evaluation of this information needs to be completed by the Mound Core Team (DOE, EPA, and Ohio EPA) and a determination regarding the protectiveness of the site conditions needs to be established.			
	Recommendation: It is recommended that the results of the PFAS research be presented, along with a written summary, to the Mound Core Team.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	Federal Facility	EPA	01/30/2017

Protectiveness Statement(s)

Operable Unit: IC remedies for Parcels D, H, 3, and 4 and the IC portion of the remedies for Phase I (A, B, C); Parcels 6, 7, and 8; and OU-1	*Protectiveness Determination:* Protective
Protectiveness Statement: The IC remedies for Parcels D, H, 3, and 4 and the IC portion of the remedies for Phase I (A, B, C); Parcels 6, 7, and 8; and OU-1 are protective of human health and the environment because ICs are in place and functioning as intended.	

Five-Year Review Summary Form (continued)

Operable Unit: OU-1 (Parcel 9)	*Protectiveness Determination:* Short-term Protective

Protectiveness Statement:
The remedy for OU-1 (Parcel 9) is currently protective of human health and the environment because exposure pathways that could result in unacceptable risks are being controlled through containment of the plume and ICs that prevent usage of the groundwater in the restricted area. However, in order for the remedy to be protective in the long term, attainment of the cleanup standards in OU-1 groundwater will be required to ensure protectiveness. A field demonstration was initiated in 2014 to evaluate whether enhanced attenuation could expedite the remediation of tetrachloroethene (PCE), trichloroethene (TCE), and daughter products in groundwater impacted by the former OU-1 landfill. DOE temporarily ceased operation of the P&T system and placed it into standby mode in September 2014 with the concurrence of EPA and Ohio EPA. Groundwater monitoring in OU-1 during the first eighteen months of the field demonstration indicated that the contaminant plume had begun to passively stabilize and shrink, concentrations were decreasing, and no downgradient movement of the plume had occurred. Starting in February 2016, as part of several offsite City projects, groundwater began to be extracted to lower the water table and allow for deep excavations and below grade construction. The aquifer in OU-1 was affected by the dewatering at these projects. Groundwater sampling of the downgradient sentinel wells and wells along the western boundary of OU-1 are presently sampled more frequently (monthly) until offsite dewatering activities are discontinued to monitor for trends in VOC concentrations or potential offsite migration. To date, none of the concentrations in the downgradient sentinel wells have exceeded MCLs or indicated offsite movement of VOC-impacted groundwater. The goal is that EA at OU-1 will provide a transition to natural attenuation and is an alternative to the baseline P&T system. The P&T system remains in standby mode.

Operable Unit: Phase I	*Protectiveness Determination:* Short-term Protective

Protectiveness Statement:
The remedy for Phase I is currently protective of human health and the environment because exposure pathways that could result in unacceptable risks are being controlled through ICs that prevent use of the groundwater in the restricted area. However, in order for the remedy to be protective in the long term, attainment of the cleanup standards in Phase I groundwater will be required to ensure protectiveness. Monitoring of bedrock groundwater will continue to demonstrate that MNA is effectively reducing TCE to concentrations below the MCL. Monitoring of the BVA will continue to demonstrate the aquifer is not affected by TCE impacted groundwater originating from Phase I.

Five-Year Review Summary Form (continued)

Operable Unit: Parcels 6, 7, and 8	*Protectiveness Determination:* Short-term Protective
Protectiveness Statement: The remedy for Parcels 6, 7, and 8 is currently protective of human health and the environment because exposure pathways that could result in unacceptable risks are being controlled through ICs that prevent use of the groundwater in the restricted area. However, in order for the remedy to be protective in the long term, attainment of the cleanup standards in Parcels 6, 7, and 8 groundwater will be required to ensure protectiveness. Monitoring of seeps and onsite wells will continue to demonstrate that with the removal of PCE, TCE and tritium sources, natural degradation will result in these constituents reducing to concentrations below the MCLs. Monitoring of the BVA will continue to demonstrate the aquifer is not affected by impacted groundwater originating from Parcels 6, 7 and 8.	

Sitewide Protectiveness Statement
Protectiveness Determination: Short-term Protective
Protectiveness Statement: The remedies in place at the Mound site currently protect human health and the environment through ICs that are in place to reduce exposure to contaminated soil and groundwater. However, in order for the remedies to be protective in the long term, the determination on complete exposure pathways for vapor intrusion and a determination regarding the use of PFASs at the Mound site need to be completed by the Mound Core Team.

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1.0 Introduction

The U.S. Department of Energy (DOE) Office of Legacy Management (LM) has conducted a fourth five-year review (FYR) of the remedial actions implemented at the Mound site[1] (EPA ID OH6890008984) in Miamisburg, Ohio.

1.1 Purpose

The FYR determines whether the remedies at a site are protective of human health and the environment by evaluating the implementation and performance of the selected remedies. A FYR report documents the review methods, findings, and conclusions; identifies issues found during the review, if any; and recommends actions to address any issues.

1.2 Authority

This FYR was conducted in accordance with the *Comprehensive Five-Year Review Guidance* (EPA 2001), which states that Section 121 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986,

> Requires that remedial actions which result in any hazardous substances, pollutants, or contaminants remaining at the site be subject to a FYR. The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) further provides that remedial actions which result in any hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure be reviewed every five years to ensure protection of human health and the environment.

FYRs are required by statute. Their implementation must be consistent with CERCLA and NCP. CERCLA Section 121(c), as amended, states:

> If the President selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the site, the President shall review such remedial action no less often than five years after the initiation of such remedial action to ensure that human health and the environment are being protected by the remedial action being implemented.

Title 40, *Code of Federal Regulations* (CFR), Part 300, NCP, states:

> If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such action no less often than every five years after the initiation of the selected remedial action" [40 CFR 300.430(f)(4)(ii)].

[1] The Mound site has also been called the Mound Laboratory, Mound Laboratories, the Mound Plant (EPA ID OH6890008984 or CERCLIS ID 04935), the USDOE Mound Plant, the Mound Facility, the USDOE Mound Facility, the Miamisburg Environmental Management Project (MEMP), and Miamisburg Closure Project (MCP). Currently, LM uses "Mound, Ohio, Site" as the formal name of the site.

1.3 Review Information

DOE is responsible for conducting the FYR at sites under its jurisdiction, while the U.S. Environmental Protection Agency (EPA) is responsible for concurrence with the review or issuing independent findings. DOE and its contractor, Navarro Research and Engineering, Inc. (Navarro), conducted a fourth FYR of the remedies implemented at the Mound site (EPA ID OH6890008984) in Miamisburg. This report documents the results of the review.

This fourth FYR is a statutory review of the entire Mound site to ensure that the remedial actions established in the records of decision (RODs) for the following areas have been followed:

- Parcel D (formerly Release Block D) (DOE 1999b)
- Parcel H (formerly Release Block H) (DOE1999d)
- Parcel 3 (included former buildings GP-1 and GH) (DOE 2001c)
- Parcel 4 (South Property) (DOE 2001a)
- Phase I (Areas A, B, and C) (DOE 2003b)
- Parcels 6, 7, and 8 (DOE 2009)
- Parcel 9 Operable Unit 1 (OU-1) (Former Waste Disposal Site) (DOE 1995; DOE 2011b)

The Operable Unit 4 (Miami-Erie Canal (DOE 2004b) is not included in this FYR because it was remediated to an unlimited use end state.

1.4 Site Status

The DOE Office of Environmental Management (EM) completed the CERCLA soil and building remediation on the entire 305.063 acres of the original 1998 property at the Mound site and implemented the remedies in the RODs. The site was remediated to an industrial/commercial use only end state.

EM transferred ownership of 184.178 acres to the Mound Development Corporation (MDC, formerly the Miamisburg Mound Community Improvement Corporation [MMCIC]). MDC replatted this acreage and conveyed portions to third parties. EM retains ownership of the remaining 120.885 acres that are leased to MDC, who manages the site as the Mound Business Park. EM; MDC and the City of Miamisburg; BOI Solutions, Inc.; and Dyrdek all own property on the site.

LM has responsibility for maintaining and monitoring the remedies following the requirements in three documents that make up the Long-Term Stewardship Plan for the Mound site. The Long-Term Stewardship Plan consists of the following documents:

- Operations and Maintenance Plan for the U.S. Department of Energy Mound, Ohio, Site (DOE 2015c) (O&M Plan). The O&M Plan Section 3.0 contains information similar to an Institutional Control (IC) Implementation and Assurance Plan, as described in the EPA guidance, *Institutional Controls: A Guide to Preparing Institutional Control Implementation and Assurance Plans at Contaminated Sites.*

- Long-Term Surveillance and Maintenance Plan for the U.S. Department of Energy Mound, Ohio, Site (DOE 2015b) (LTS&M Plan).
- Community Involvement Plan for the U.S. Department of Energy Mound, Ohio, Site (DOE 2015a) (Community Involvement Plan).

In 2012, EM amended the site sales contract with MDC (DOE 2012c) and amended the general purpose lease with MDC (DOE 2012d) for a 5-year period ending on September 30, 2017; on or before this date, MDC is expected to assume ownership of the remaining (120.885 acres of the original Mound site footprint). In 2013, EM added an appendix to the general purpose lease (DOE 2013b) that formalized MDC's responsibility for IC compliance during the lease period.

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2.0 Site Chronology

1946:

- Construction of the Mound facility was started to support the early atomic weapons programs. The original footprint of the facility was 182 acres.

1948–1995:

- The plant grew into an integrated research, development, and production facility performing work in support of the nation's weapons and energy programs, with emphasis on explosives and nuclear technology.

1981:

- DOE purchased an additional 124 acres of land south of the original property. The property remained undeveloped.

1984:

- DOE established the Environmental Restoration Program at the Mound site to collect and assess environmental data to evaluate both the nature and extent of contamination and to identify potential exposure pathways and potential human and environmental receptors. This was done to develop a conceptual site model.

1989:

- EPA placed the Mound site on the National Priorities List (NPL) in November because of chemical contamination present in the site groundwater and the site's proximity to a sole-source aquifer.

1990:

- DOE and EPA signed a Federal Facility Agreement (FFA) in October.

1991:

- The DOE Nuclear Weapons Complex Reconfiguration Study recommended closure of many DOE sites (including the Defense Programs mission at the Mound site) and consolidation of workload. The Office of Nuclear Energy [NE] mission was to remain.

1993:

- Ohio EPA was added to the FFA, making it a tripartite agreement.

1995:

- Regulators approved the Operable Unit 1 ROD. The selected remedy of controlling contamination from the soils and groundwater comprises (1) collection, treatment, and disposal of groundwater and (2) ICs.
- DOE and its regulators developed an approach to making decisions about the environmental restoration of the Mound site and its facilities. This approach is known as the Mound 2000

Process (DOE 1999c), which meets the requirements of CERCLA Section 120(h), "Property Transferred by Federal Agencies." DOE and its regulators used the Mound 2000 Process to address the environmental issues associated with the restoration of the site, completion of work at the site, and deletion of the site from the NPL.

1997:

- DOE began operation of the OU-1 pump-and-treatment (P&T) system.

1998:

- The Miami-Erie Canal included in OU-4 underwent a soil cleanup, primarily for plutonium. The canal, lying outside the Mound property boundary, was included on the NPL due to the impacts of operational and accidental releases from the Mound facility.
- DOE and MDC signed a sales contract establishing how DOE would convey the entire Mound site by discrete parcels, subject to CERCLA Section 120(h), "Property Transferred by Federal Agencies."

1999:

- Regulators approved the Release Block D ROD. The selected remedy for Release Block D is ICs.
- Regulators approved the Release Block H ROD. The selected remedy for Release Block H is ICs.
- The deed for Release Block H was filed with Montgomery County, Ohio, on August 8.
- The deed for Release Block D was filed with Montgomery County, Ohio, on November 19.

2001:

- Regulators approved the Parcel 4 ROD. The selected remedy for Parcel 4 is ICs.
- EPA deleted Release Blocks D and H from the NPL on April 16.
- The deed for Parcel 4 was filed with Montgomery County, Ohio, on April 19.
- Regulators approved the Parcel 3 ROD. The selected remedy for Parcel 3 is ICs.
- DOE conducted a five-year review of the OU-1 remedy.

2002:

- The deed for Parcel 3 was filed with Montgomery County, Ohio, on August 2.
- EPA deleted Parcel 4 from the NPL on December 2.

2003:

- Regulators approved the Phase I ROD. The selected remedy for trichloroethene (TCE) contamination in Phase I is monitored natural attenuation (MNA) with ICs.
- DOE ended the NE Program mission at Mound.

2004:

- Regulators approved the no-action Miami-Erie Canal ROD for OU-4 regarding the soil/sediment in the Miami-Erie Canal. The area was remediated to an unlimited use end state.

2006:

- Site contractor completed the CERCLA remediation (except for potential release sites [PRSs] 7 and 441) in July.
- Congressional funding obtained to remove priority areas of OU-1. This was referred to as the first phase of OU-1 excavation.
- DOE conducted a five-year review that included OU-1, Parcels 3, 4, D, H, Phase 1 (A, B, and C).

2008:

- DOE and MDC updated the *Sales Contract by and between the United States Department of Energy and the Miamisburg Mound Community Improvement Corporation* (DOE 2008b) on August 28.

2009:

- Competed remediation of PRS 7.
- Competed remediation of PRS 441, which was the final CERCLA remediation for the site.
- Completed Phase I excavation of OU-1, which was non-CERCLA, congressionally funded.

2010:

- Regulators approved the Parcels 6, 7, and 8 ROD. The selected remedy for Parcels 6, 7, and 8 is ICs in the form of deed restrictions on future land and groundwater use and Monitored Natural Attenuation (MNA).
- Completed Phase II excavation of OU-1, which was non-CERCLA, American Recovery and Reinvestment Act of 2009–funded project.

2011:

- Regulators approved the Amendment of the Operable Unit 1 ROD which expanded the OU-1 area into Parcel 9 and applied all site ICs.
- MMCIC was renamed MDC.
- EM transferred responsibility for the site's long-term surveillance and maintenance to LM.
- MDC demolished Buildings 2, 63, and 63W and added parking areas. This work was funded by a state grant and overseen by MDC.
- DOE conducted a five-year review that that included OU-1, Parcels 3, 4, D, H, Phase 1 (A, B, and C), and Parcels 6, 7, and 8.

2012:

- EM, EPA, and Ohio EPA registered the *Environmental Covenant for Parcel 9* (DOE 2012a) as a Special Instrument Deed covering the entire original Mound site boundary with Montgomery County, Ohio.
- EM and MDC signed the *Amendment to the Sales Contract dated August 28, 2008* (DOE 2012c) that extended the contract for 5 years.
- EM and MDC signed a 5-year lease amendment on December 14, *U.S. Department of Energy Amendment Number 24 to the General Purpose Lease* (DOE 2012d). The lease stated that the Environmental Management Consolidated Business Center (EMCBC) retains ownership of Parcels 6–9 and MDC is responsible for the maintenance and management of buildings and facilities within Parcels 6–9.
- EM transferred 5.561 acres from Parcel 7 to MDC.
- MDC sold the former Building 126 and surrounding 5.621 acres at 955 Mound Road to BOI Solutions. This was done in accordance with the *U.S. Department of Energy Amendment Number 24 to the General Purpose Lease* (DOE 2012c) under the Interim Sales section.

2013:

- MDC and City of Miamisburg signed an agreement to transfer MDC-owned parcels to the City of Miamisburg to hold until they are sold.
- MDC completed the construction of Vanguard Boulevard and demolished Building 28 and the Guard House. This work was funded by state and local grants.
- MDC subdivided their parcels and transferred ownership of Lots 7994, 7995, 7996, 7997, 7998, 7999, 8000, 8002, 8003, 8005, and 8006 to the City with a quitclaim deed dated November 13.
- EMCBC and MDC signed *Appendix #1 to the General Purpose Lease Agreement* (DOE 2013b) that formalized IC compliance during the lease period for property leased to MDC.

2014:

- DOE initiated the OU-1 Enhanced Attenuation (EA) Field Demonstration in August (DOE 2014c; DOE 2014d; DOE 2014e; DOE 2014f).
- DOE temporarily ceased operation of the OU-1 P&T system and placed it into standby mode during the field demonstration in September, with approval of EPA and Ohio EPA.
- MDC sold the former Building 100 at 790 Enterprise Court and 5.5191 surrounding acres to Dyrdek Group, Inc. This area was part of Parcel D owned by MDC.
- LM consolidated all previous operation and maintenance (O&M) and groundwater monitoring plans into a three-volume Long-Term Surveillance Plan. Section 3.0 of the O&M Plan contains information similar to an Institutional Control Implementation and Assurance Plan, as described in the EPA guidance, *Institutional Controls: A Guide to Preparing Institutional Control Implementation and Assurance Plans at Contaminated Sites.* See “2015” just below for the latest versions.

2015:

- MDC revised plat boundaries 8021, 8025, 8026, 8027, and 8028.
- LM updated the three parts of the Long-Term Stewardship Plan:
  - — O&M Plan (DOE 2015c)
  - — LTS&M Plan (DOE 2015b)
  - — Community Involvement Plan (DOE 2015a)

2016:

- DOE conducted a five-year review that included OU-1 (Parcel 9), Parcels 3, 4, D, H, Phase 1 (A, B, and C), and Parcels 6, 7, and 8.

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3.0 Background

3.1 Physical Characteristics

The Mound site, named after the neighboring historic Adena Indian Mound, is located in Miamisburg, Ohio, approximately 10 miles southwest of Dayton (Figure 1). The Great Miami River west of the site flows from northeast to southwest through Miamisburg and dominates the geography of the region surrounding the Mound site.

The Mound site sits atop an elevated area overlooking the city of Miamisburg, the Great Miami River, and the river plain area to the west. An intermittent stream runs through the plant valley and drains to the river. Site elevations vary from 700 feet (ft) to 900 ft above sea level; most of the site is above 800 ft. The typical non-flood stage of the Great Miami River is 682 ft. The highest floodwater levels that can be reasonably postulated for the Great Miami River basin (100-year storm event) would result in flooding to 700 ft. A southwest portion of the Mound site lies within the 100-year floodplain of the Great Miami River.

The geologic record preserved in the rocks underlying the site indicates that the area has been relatively stable since the beginning of the Paleozoic era more than 500 million years ago. There is no evidence indicating subsurface structural folding, significant stratigraphic thinning, or subsurface faulting in the underlying bedrock. Limestone, which is interbedded with shale layers, is the uppermost bedrock units at the site. No evidence of solution cavities or cavern development has been observed in any borings or outcrops in the Miamisburg area.

The aquifer system located under areas of the Mound site consists of two different hydrogeologic environments: groundwater flow through the bedrock beneath the hills, and groundwater flow within the unconsolidated glacial deposits and alluvium associated within the Buried Valley Aquifer (BVA) in the Great Miami River valley. The bedrock flow system is dominated by fracture flow and is not considered a highly productive aquifer. The Buried Valley Aquifer is dominated by porous flow with interbedded gravel deposits providing the major pathway for water movement. The unconsolidated deposits are Quaternary Age sediments consisting of both glacial and fluvial deposits. The BVA is a highly productive aquifer capable of yielding a significant quantity of water and is designated a sole-source aquifer.

Population information extracted from the 2010 Census shows that within a 10-mile radius of the Mound site there are 336,956 residents, and within a 50-mile radius of the site there are 3,183,953 residents. The primary agricultural activity in the area is raising field crops such as corn and soybeans. Approximately 10 percent of the agricultural land is devoted to livestock.

3.2 Land and Resource Use

The Mound site operated from 1948 to 2003 as an integrated research, development, and production facility that supported the nation’s weapons and energy programs, with emphasis on explosives and nuclear technology.

The site is now the Mound Business Park managed by MDC. There are no restrictions on future sales of property. To date, the MDC has sold two lots totaling 11.1401 acres to private businesses and transferred ownership of 144.0514 acres to the City of Miamisburg.

Future use of the site is restricted by the ICs to industrial/commercial use only. The ICs are described as restrictions and covenants in the quitclaim deeds or as activity and use limitations in the Environmental Covenant. ICs are included in the EM–MDC lease agreement. ICs run with the land through subsequent property transfers. Quitclaim deeds with environmental summaries (ESs) and the Environmental Covenant are recorded with the Montgomery County, Ohio, Recorders Office to ensure that future property owners are aware of the rationale behind each deed restriction.

The area surrounding the site is currently a mix of farmland, residential area, small communities, and light industry. Many city and township residences, five schools, the Miamisburg downtown area, and 6 of the city’s 17 parks are located within 1 mile of the Mound site. The City of Miamisburg and Miami Township are actively developing the areas near Interstate 75, and there are plans to improve access to the site from Interstate 75 when funding becomes available.

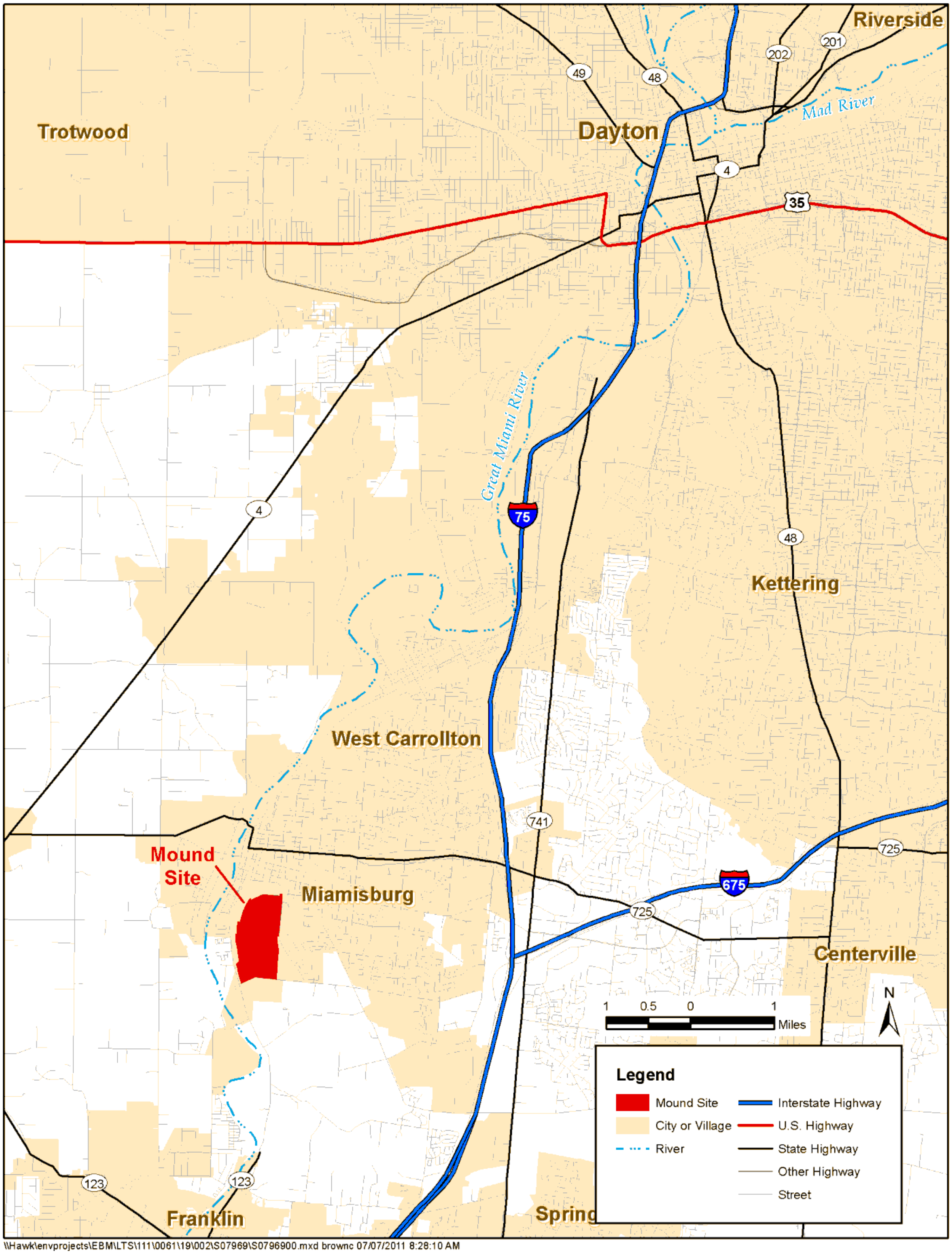

Figure 1. Mound Site Location Map

3.3 Site History and Enforcement Activities

3.3.1 History of Contamination

The Mound site was established in 1948 by the U.S. Atomic Energy Commission, a predecessor to DOE, as an integrated research, development, and production facility that supported the nation's weapons and energy programs.

Early programs at the Mound site investigated the chemical and metallurgical properties of polonium-210 and its applications, particularly the fabrication of neutron and alpha sources for weapon and nonweapon use. Investigations involving uranium, protactinium-231, and plutonium-239 were performed from 1950 to 1963 as part of the national civilian power reactor program. In 1954, the separation of stable isotopes began at the Mound site.

In the mid-1950s, Mound initiated efforts to develop a large-scale process for the recovery of thorium from a variety of thorium-bearing ores. Even though this project was canceled prior to full-scale operation, approximately 1,650 tons of thorium-containing sludge was received at the Mound site. Because of its corrosivity, the thorium sludge was continually repackaged and relocated. This resulted in a number of thorium-contaminated areas around the site.

Plutonium-238 research and development activity began at the Mound site in the mid-1950s. From the early 1960s to the late 1970s, the Mound facility processed plutonium-238 for use in heat sources within radioisotopic thermal generators. The fabrication of heat sources from plutonium metal was terminated in the mid-1960s. Plutonium oxide processes continued into the late 1970s. After early 1979, Mound did not handle unencapsulated plutonium-238.

As a result of the discovery of volatile organic compounds (VOCs) in groundwater, the Mound site was placed on the NPL on November 21, 1989.

3.3.2 Enforcement and Agreements—Mound 2000 Process

DOE signed a CERCLA Section 120 FFA with EPA, effective October 1990, and modified and expanded this agreement to include Ohio EPA in 1993 (EPA 1993).

DOE, EPA, and Ohio EPA had originally planned to address the environmental restoration issues under a set of OUs, each of which would include a number of PRSs. For each OU, the site would follow the traditional CERCLA process: a remedial investigation and feasibility study followed by a ROD, followed by remedial design and remedial action. After initiating remedial investigations for several OUs, during a strategic review in 1995 DOE and its regulators concluded that the OU approach was inefficient for Mound. DOE and its regulators agreed that it would be more appropriate to evaluate each PRS or building separately, use removal action authority to remediate them as needed, and establish a goal for no additional remediation other than ICs for the final remedy documented in the ROD. To evaluate any residual risk after all removals have been completed, a residual risk evaluation (RRE) was to be conducted to ensure the conditions would not pose an unacceptable risk to human health when the parcel is used for industrial/commercial purposes. This process was named the Mound 2000 Process. DOE and its regulators pursued this approach with the understanding that (1) EPA and Ohio EPA reserve all rights to enforce all provisions of the FFA and (2) participation in the Mound 2000 Process does not constitute a waiver of EPA and Ohio EPA rights to enforce the FFA.

The Mound 2000 Process established a Mound Core Team consisting of representatives of the DOE Miamisburg Closure Project, EPA, and Ohio EPA. The Mound Core Team evaluated each of the PRSs and recommended the appropriate response. The Mound Core Team used process knowledge, site visits, and existing data to determine whether or not any action was warranted concerning each PRS. The PRSs at Mound were identified based on knowledge of historical land use that was considered potentially detrimental, an actual sampling result showing elevated concentrations of contaminants, or both. If a decision could not be made, the Mound Core Team identified specific information needed to make a decision (e.g., data collection, investigations). The Mound Core Team also received input from technical experts as well as the general public and public interest groups. Thus, all stakeholders had the opportunity to express their opinions or suggestions involving each PRS. The details of this process are explained in the *Work Plan for Environmental Restoration of the Mound Plant, The Mound 2000 Approach* (DOE 1999c).

Originally, the Mound property was divided into 19 "release blocks," which were contiguous tracts of property designated for transfer of ownership. Release Blocks D and H were transferred to MDC in 1999. The remaining release blocks were reconfigured and renamed parcels. Parcel 4 was transferred to MDC in 2001. Parcel 3 was transferred to MDC in 2002.

The *Mound 2000 Residual Risk Evaluation Methodology* (RREM) (DOE 1997a) was developed as a framework for evaluating human health risks associated with residual levels of contamination. The RREM was applied to a parcel after remediation, and the remaining PRSs or buildings in the parcel were designated as No Further Action. An RRE was performed after the identified environmental concerns were adequately addressed by the Mound Core Team. The RRE documented that the parcel was acceptable for industrial/commercial use.

The ROD for a given parcel documented the most appropriate remedy that met statutory requirements and ensured protection of human health and the environment.

After a ROD was final, DOE submitted documentation including an environmental summary to EPA and Ohio EPA that showed the property met CERCLA Section 120(h)(3) requirements. When the property was transferred to MDC, the EM quitclaim deed contained the use restrictions and a copy of the environmental summary committing the landowner to abiding by ICs specified in the ROD.

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4.0 Remedial Actions

4.1 Sitewide

Through the use of removals as outlined in the Mound 2000 process, DOE removed buildings, slabs, soils, underground tanks and lines to remediate the former DOE Mound site 1998 Property (Figure 2) to EPA's risk-based standards for industrial/commercial use only. The off-site OU-4 Miami Erie Canal was remediated to unrestricted use. Remediation and waste disposal cost over $1B and took almost 20 years.

The remedies evaluated the conditions post-removal and documented the remediation goals used for the prior cleanups were sufficient, applied ICs prohibiting groundwater use and the removal of soil from the Mound Site, and limiting the use of the site to commercial/industrial uses. The Phase I (A, B, C) and Parcels 6, 7, and 8 remedies include monitored natural attenuation for those contaminants that exceed maximum contaminant levels (MCLs). The OU-1 remedy contains a P&T system to control groundwater contamination and to minimize exposure to potential receptors by minimizing the migration of contaminated groundwater.

4.1.1 Remedial Action Objectives

The primary remedial action objective (RAO) for residual contaminated soil within the 1998 Mound site property boundary (Figure 2) is to ensure that exposures to soil do not result in an aggregate excess cancer risk greater than the upper end of EPA's acceptable risk range of 1×10^{-4} to 1×10^{-6} or a hazard index greater than 1. This is accomplished primarily through the use of ICs at the site which:

- Limit land use to industrial/commercial only.
- Prohibit the removal of soil from the property boundaries unless prior written approval from Ohio EPA and the Ohio Department of Health (ODH) is obtained.

The long-term RAO for groundwater is to meet MCLs through MNA in the Phase I and Parcels 6, 7, and 8 areas and through hydraulic containment in the OU-1 area. Until these goals are achieved, the near-term RAO is to prohibit the extraction and use of groundwater underlying the premises unless prior written approval is obtained from Ohio EPA and ODH.

Presently, a three-year demonstration is being performed in the OU-1 area in Parcel 9 to assess enhanced attenuation as a viable alternative to P&T to address VOC-impacted soil and groundwater. As part of this field demonstration, DOE temporarily ceased operating the P&T system and placed it into standby mode in September 2014 with the concurrence of EPA and Ohio EPA. Ongoing monitoring in OU-1 confirms that the movement of contaminants in the groundwater has not resulted in concentrations of chlorinated volatile organic compounds (cVOCs) that exceed the MCLs at downgradient sentinel wells or offsite.

The following sections contain general information about remedial actions at the Mound site and specific remedies for OU-1, Phase I, and Parcels 6, 7, and 8, which have additional groundwater monitoring requirements. The overall O&M costs are presented for the Mound site as a whole and are discussed at the end of this section.

4.1.2 Regulatory Actions

Table 1 lists the RODs and ESs that apply to the Mound site, and Figure 2 shows the outlines of the ROD parcels within the original 1998 Mound site property boundary. All of these documents are available on the LM Mound, Ohio, Site webpage http://www.lm.doe.gov/CERCLA_Home.aspx.

Table 1. Mound Site ROD and CERCLA 102(h) ES Information

ROD Parcel ID	Document	Approval Date
D	*Record of Decision for Release Block D, Mound Plant, Miamisburg, Ohio,* Final (DOE 1999b)	February 1999
	CERCLA 120(h) Summary Notice of Hazardous Substances, Release Block D, Mound Plant, Miamisburg, Ohio, Final (DOE 1999a)	
H	*Record of Decision for Release Block H, Mound Plant, Miamisburg, Ohio,* Final (DOE 1999d)	June 1999
	CERCLA 120(h) Summary Notice of Hazardous Substances for Release Block H, Mound Plant, Miamisburg, Ohio, Final (DOE 1999e)	July 1999
3	*Parcel 3 Record of Decision, Mound Plant, Miamisburg, Ohio,* Final (DOE 2001d)	September 2001
	Parcel 3 Environmental Summary, CERCLA 120(h) Summary Notice of Hazardous Substances, Mound Plant, Miamisburg, Ohio, Final (DOE 2001c)	
4	*Parcel 4 Record of Decision, Mound Plant, Miamisburg, Ohio,* Final (DOE 2001a)	February 2001
	Parcel 4 Environmental Summary, CERCLA 120(h) Summary Notice of Hazardous Substances, Mound Plant, Miamisburg, Ohio, Final (DOE 2001b)	March 2001
6, 7, 8 (includes former Parcel 6A)	*Parcels 6, 7, and 8 Record of Decision, Ohio,* Final (DOE 2009)	August 2009
	Parcels 6, 7, and 8 Environmental Summary, CERCLA 120(h) Summary Notice of Hazardous Substances, Final (DOE 2010)	August 2010
9 (OU-1 and expanded area)	*Operable Unit 1 Record of Decision,* Final (DOE 1995)	June 1995
	Parcel 9 Environmental Summary, CERCLA 120(h) Summary Notice of Hazardous Substances, Final (DOE 2011a)	July 2011
	Amendment of the Operable Unit 1 Record of Decision, U.S. Department of Energy, Mound Closure Project, Final (DOE 2011b)	August 2011
Phase I (A, B, C)	*Phase I Record of Decision, Miamisburg Closure Project,* Final (DOE 2003b)	July 2003
	Phase I Environmental Summary, CERCLA 120(h) Summary Notice of Hazardous Substances, Miamisburg Closure Project, Final (DOE 2003c)	December 2003
OU-4	*Miami-Erie Canal Record of Decision, Miamisburg Closure Project,* Final, Revision 0 (DOE 2004b)	September 2004
	OU-4, located on City of Miamisburg property, was remediated to an unlimited use end state. No ES was required or issued	

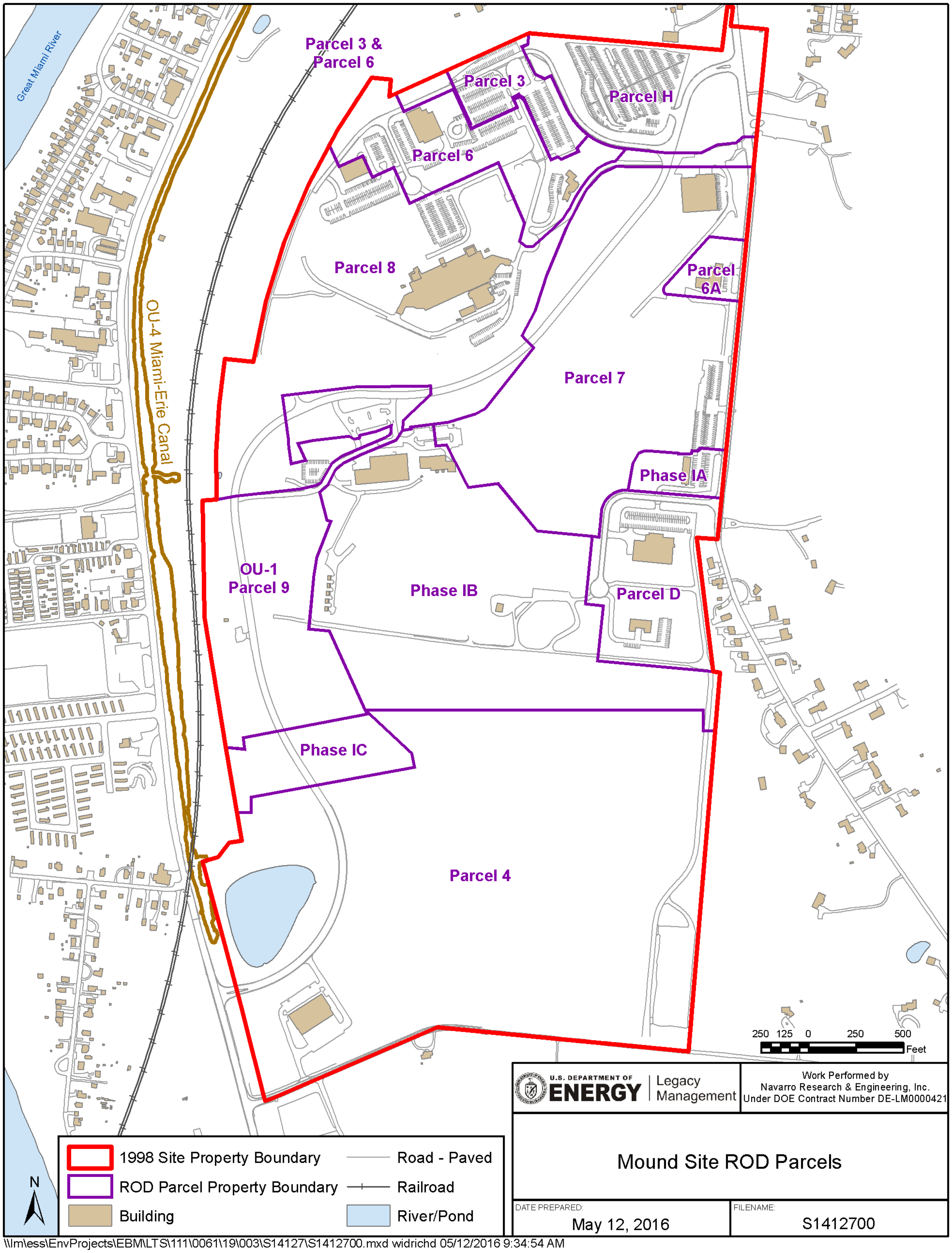

Figure 2. ROD Parcels at the Mound Plant Site

4.1.3 Remedy Selection

The primary remediation objective was to ensure that any residual risk associated with each parcel was acceptable based on the agreed-upon industrial/commercial end use as the only use. Remedies for each parcel were developed in accordance with that agreement. Evaluation of residual soil and groundwater contaminants within each land parcel determined that future users of the land will not be exposed to contaminant levels that would pose unacceptable risks as long as compliance with the deed restrictions is maintained.

The soil within each land parcel was not evaluated for any use other than onsite industrial or commercial use. Any offsite disposition of the soil from a land parcel without proper handling, sampling, and management could create an unacceptable risk to offsite receptors.

Additional groundwater monitoring was imposed for OU-1 (Parcel 9), Phase I, and Parcels 6, 7, and 8, where groundwater contamination had not reached acceptable levels.

ICs are part of the selected remedy for each parcel. Additional building-specific ICs apply to the T-Building located in Parcel 8.

4.2 Institutional Controls

4.2.1 Remedy Selection

ICs are an important component of all of the remedies selected for the Mound site. ICs are nonengineered instruments, such as administrative and legal controls, that help to minimize the potential for exposure to contamination and/or protect the integrity of a response action. The parcel RODs and ESs listed in Table 1 provide detailed information on the remedies and associated ICs. Table 2 summarizes those remedies.

The following Mound site ICs run with the land in the form of restrictions and covenants in quitclaim deeds or activity and use limitations in the environmental covenant:

- Maintenance of industrial or commercial land use and prohibition against residential land use
- Prohibition against the use of groundwater without prior written approval from EPA and Ohio EPA
- Prohibition against the removal of soil from within the original (i.e.,. as of 1998) site boundary to offsite locations without prior written approval from EPA, Ohio EPA, and ODH
- Prohibition against the removal of concrete floor material in specified rooms of T Building to offsite locations without prior written approval from EPA, Ohio EPA, and ODH (see Figure 3)
- Prohibition against the penetration of concrete floors in specified rooms of T Building locations without prior written approval from EPA, Ohio EPA, and ODH (Figure 3)
- Allowing site access for federal and state agencies for the purpose of sampling and monitoring

Table 2. Mound Site CERCLA Remedy Summary

<table>
<tr><th>Parcel</th><th>Former ID or other names</th><th>ROD Date</th><th>Remedy</th><th>Objectives of ICs</th><th>Instrument</th></tr>
<tr><td>D</td><td>Release Block D</td><td>1999</td><td>ICs</td><td>Prohibit the removal of soil.
Prohibit the use of groundwater.
Restrict land use to industrial/commercial only.</td><td rowspan="7">Quitclaim deed
EM to MDC
DEED-09-011643
February 24, 2009

Environmental Covenant
EM filed as Special Instrument (Deed) 2012-00004722 on January 24, 2012, to cover all of the original Mound site boundary parcels.</td></tr>
<tr><td>H</td><td>Release Block H</td><td>1999</td><td>ICs</td><td>Prohibit the removal of soil.
Prohibit the use of groundwater.
Restrict land use to industrial/commercial only.</td></tr>
<tr><td>3</td><td>None</td><td>2001</td><td>ICs</td><td>Prohibit the removal of soil.
Prohibit the use of groundwater.
Restrict land use to industrial/commercial only.</td></tr>
<tr><td>4</td><td>South property</td><td>2001</td><td>ICs</td><td>Prohibit the removal of soil.
Prohibit the use of groundwater.
Restrict land use to industrial/commercial only.</td></tr>
<tr><td rowspan="3">Phase I</td><td>A</td><td rowspan="3">2003</td><td rowspan="3">ICs and MNA</td><td rowspan="3">Prohibit the removal of soil.
Prohibit the use of groundwater.
Restrict land use to industrial/commercial only.</td></tr>
<tr><td>B</td></tr>
<tr><td>C</td></tr>
<tr><td>6 and 6A</td><td rowspan="3">Parcels 6, 7, and 8</td><td rowspan="3">2010</td><td rowspan="3">ICs and MNA</td><td rowspan="3">Prohibit the removal of soil.
Prohibit the use of groundwater.
Restrict land use to industrial/commercial only.
Prohibit the removal of concrete floor material in specified rooms of T Building.
Prohibit the penetration of concrete floor material in specified rooms of T Building.</td><td rowspan="4">EM leases property to MDC under these agreements until September 30, 2017:
• Amendment to 2008 Sales Contract
• General Purpose Lease Amendment No. 24
• General Purpose Lease Appendix No. 1

Environmental Covenant
EM filed as Special Instrument (Deed) 2012-00004722 on January 24, 2012, to cover all of the original Mound site boundary parcels.</td></tr>
<tr><td>7</td></tr>
<tr><td>8</td></tr>
<tr><td>9</td><td>OU-1</td><td>1995 and 2011 amend.</td><td>ICs; hydraulic containment; surface water controls; long-term groundwater monitoring</td><td>Prohibit the removal of soil.
Prohibit the use of groundwater.
Restrict land use to industrial/commercial only.</td></tr>
<tr><td>OU-4</td><td>Miami Erie Canal</td><td>2004</td><td>No action</td><td>Not applicable.</td><td>None required.</td></tr>
</table>

4.2.1.1 Maintain Industrial/Commercial Land Use and Prohibit Residential Land Use

The RODs state that land use will be industrial/commercial only. The RODs detail specific land uses that will not be permitted onsite, but the list in the RODs is not all-inclusive. Land parcels may not be used for any residential or farming activities or for any other activities that could result in the chronic exposure of children less than 18 years of age to soil or groundwater from the premises. Prohibited land uses listed in the RODs include, but are not limited to, single or multifamily dwellings or rental units; schools or other educational facilities for children under 18 years of age; childcare facilities; and community centers, playgrounds, or other recreational or religious facilities for children less than 18 years of age.

4.2.1.2 Prohibit Use of Groundwater from Within the Site Boundary

The RODs prohibit the extraction, consumption, exposure, or use in any way of the groundwater underlying the Mound site without prior written approval of EPA and Ohio EPA. Until portions of the Mound site property site transfer to MDC, the protocol for obtaining approval to install a groundwater well is to contact the LM office, which will coordinate EPA and Ohio EPA's review of the proposal. After the land transfers to MDC, the new landowner will need to obtain written approval from EPA and Ohio EPA to install a new well.

4.2.1.3 Prohibit Removal of Soil from Site to Offsite Locations

The RODs prohibit the removal of soil from the Mound site without prior written approval from EPA, Ohio EPA, and ODH. The soil at the site has not been evaluated for any use other than onsite industrial/commercial use. Any offsite use or disposal without proper handling, sampling, and management could create an unacceptable risk to offsite receptors. Because the Mound Business Park site boundary could change over time, the restriction applies to soil within the 1998 Mound site boundary except for three areas exempted in the EM 2009 quitclaim deed DEED-09-011643(Appendix D).

The Core Team developed the soil protocol provided in Appendix C of the O&M Plan for guidance during normal construction activities onsite. Until property transfers to MDC, the protocol for obtaining approval for removing soil from the site is to contact the LM office, which will coordinate an EPA, Ohio EPA, and ODH review of the proposal. Once the land transfers to MDC, the new landowner will need to obtain written approval from EPA and Ohio EPA to remove soil from within the site boundary to an offsite location (as Ohio EPA was structured at the time the RODs were issued, the decision authority for removing soil from the site resided within the Division of Environmental Response and Revitalization at the Southwest District Office in Dayton, Ohio). Information about the cleanup process, background levels, and toxicology data is contained in or referenced in the MOUND 2000 Residual Risk Evaluation Methodology (DOE 1997a).

4.2.1.4 Prohibit Removal of Concrete from Floor in Specified Rooms of T Building

The Parcels 6, 7, and 8 ROD prohibits the removal of concrete from the floor in T Building controlled areas with special ICs (Figure 3) to offsite locations without prior written approval from EPA, Ohio EPA, and ODH. Removing concrete from these areas could result in an unacceptable exposure. The Core Team developed the protocol provided in Appendix B of the O&M Plan, in the event a property owner wishes to remove concrete.

4.2.1.5 Prohibit Penetration of Concrete Floors in Specified Rooms of T Building

The Parcels 6, 7, and 8 ROD prohibits penetration of the concrete floor in T Building controlled areas with special ICs (Figure 3) without prior written approval from EPA, Ohio EPA, and ODH.

Drilling, sawing, or otherwise penetrating concrete from these areas could result in an unacceptable exposure to the equipment operator and other workers in the area. The Core Team developed the protocol provided in Appendix B of the O&M Plan, in the event a property owner wishes to penetrate concrete.

4.2.1.6 Allow Site Access for Federal and State Agencies for Sampling and Monitoring

The RODs require continued site access by DOE, EPA, Ohio EPA, and ODH to conduct inspections and to perform the monitoring required by the ROD remedies. The deeds and environmental covenant grant the right of access for environmental investigation or remedial action.

4.2.2 Remedy Implementation

The sales contract between DOE and MDC, dated January 23, 1998, and revised in 2008 and 2012, established that DOE would convey the entire Mound site by discrete parcels, subject to the CERCLA Section 120(h), "Property Transferred by Federal Agencies."

Each parcel can be transferred via quitclaim deed after regulatory approval of the CERCLA Section 120(h) Summary Notice (also called the environmental summary). The quitclaim deed contains use restrictions (i.e., ICs) to ensure that the parcel remains protective of human health and the environment. DOE maintains responsibility for cleanup if contamination resulting from previous DOE activities (that pose a risk to human health and the environment) is discovered in the future.

The quitclaim deed transfers ownership of the land from EM to MDC and establishes that MDC will take the land "as is" and "where is." EM records the quitclaim deed containing the deed restrictions and the CERCLA Summary Notice with Montgomery County, Ohio.

In addition, EM recorded an Environmental Covenant as a Special Instrument Deed 2012-00004722 with Montgomery County, Ohio, January 2012 (DOE 2012a), to cover all the lots within the Mound site original 1998 boundary.

4.2.3 Operations and Maintenance

O&M requirements for monitoring IC compliance are detailed in the site O&M Plan. DOE publishes the results of the IC assessments in an annual report published in June.

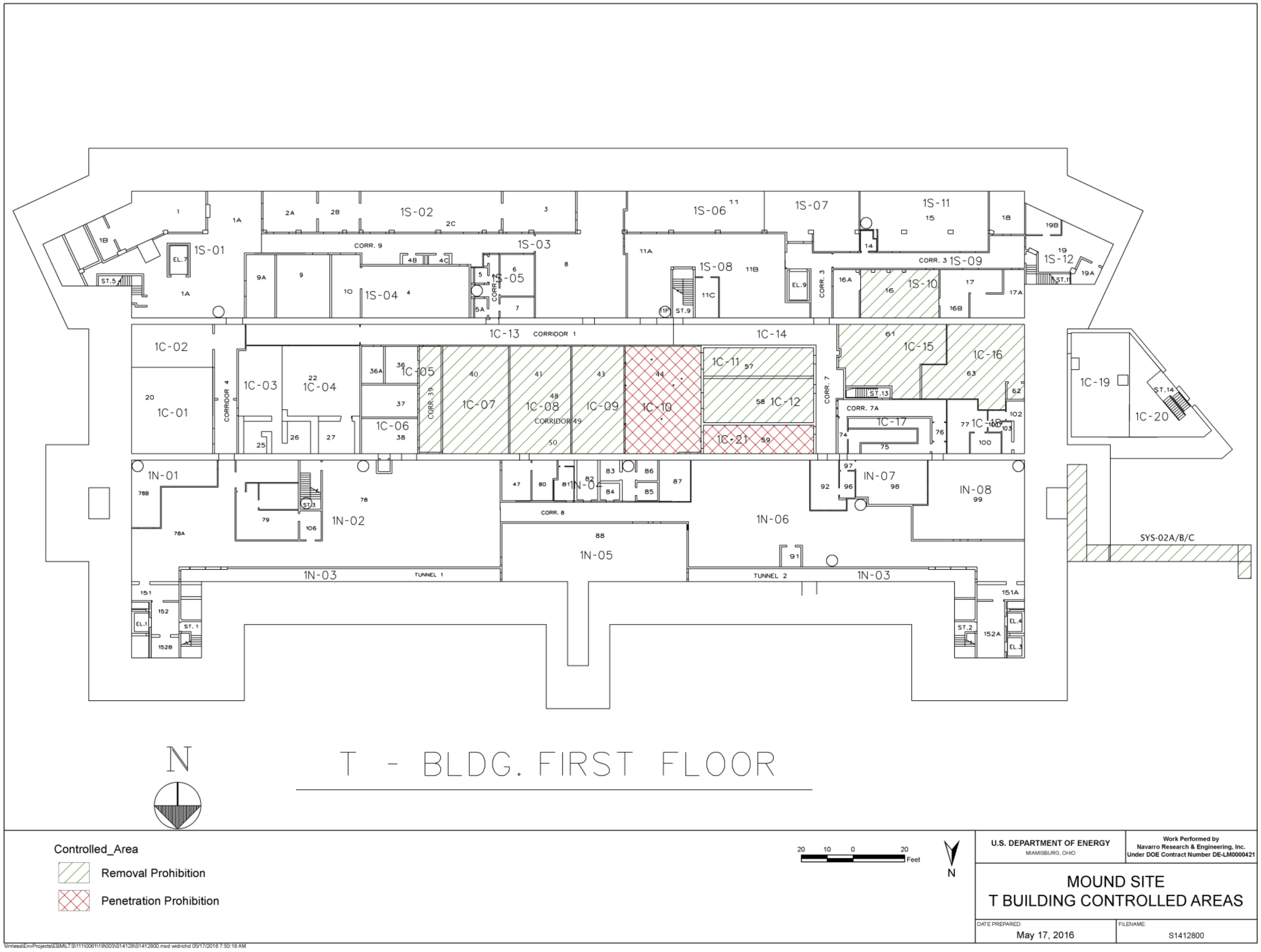

Figure 3. Mound Site T Building Special IC Controlled Areas

4.3 Operable Unit 1

In June 1995, DOE finalized the OU-1 ROD (DOE 1995) to address contaminated groundwater in this discrete portion of the Mound Plant Site. OU-1 is located in the southwestern portion of the Mound site (Figure 4) and formerly contained a historical waste disposal area (landfill) and the plant production wells (for onsite potable and process water supply). The OU-1 remedial action in the ROD was designed to control groundwater contamination (primarily low-level VOCs) to prevent migration of contamination toward the plant production wells, and to minimize exposure to potential receptors. The pathway of concern consisted of leaching of contaminants from site soils or disposed wastes; entrainment in the groundwater flow; and withdrawal by the Mound Plant production wells or by other future wells.

The plant production wells were abandoned in October 2005, when the facility was connected to the City of Miamisburg municipal water supply. The OU-1 landfill was excavated in two phases from 2007 through 2010. These excavations were not required by the decision documents (ROD, ESD) but were undertaken to support future redevelopment of the property by MDC.

In August 2011, an OU-1 ROD Amendment was approved that expanded the area to include all of Parcel 9 and updated the ICs in an Environmental Covenant (DOE 2012a).

A field demonstration was initiated in 2014 (DOE 2014c) to evaluate whether enhanced attenuation could expedite the remediation of tetrachloroethene (PCE), trichloroethene (TCE), and daughter products in groundwater impacted by the former OU-1 landfill. DOE temporarily ceased operation of the P&T system and placed it into standby mode in September 2014 with the concurrence of EPA and Ohio EPA.

Groundwater monitoring in OU-1 during the first 18 months of the field demonstration indicated that the contaminant plume had begun to passively stabilize and shrink, concentrations were decreasing, and no downgradient movement of the plume had occurred. The goal is that EA at OU-1 will provide a transition to natural attenuation and is a viable alternative to the baseline P&T system. The P&T system remains in standby mode.

Starting in February 2016, as part of several offsite City projects to upgrade their water and sewer systems, groundwater began to be extracted to lower the water table and allow for deep excavations and below-grade construction. The aquifer in OU-1 was affected by the dewatering at these projects. Groundwater levels began to decline in May 2016 and gradients across OU-1 increased. In June 2016, when two City projects were underway, groundwater flow shifted to the west for a short period, but returned to typical southern flow.

Sampling results suggest that the anaerobic treatment zones, created by the injection of the emulsified oil, are becoming less structured. Also, the distribution of TCE from the August 2016 sampling event indicates that some lateral spread has occurred. Concentrations of *cis*-1,2-dichloroethene (*cis*-1,2-DCE) have increased and vinyl chloride (VC) has been detected in the southern half of the plume. Groundwater sampling of the downgradient sentinel wells and wells along the western boundary of OU-1 are presently sampled more frequently (monthly) than usual until offsite dewatering activities are discontinued to monitor for trends in VOC concentrations or potential offsite migration. To date, none of the concentrations in the downgradient sentinel wells have exceeded MCLs or indicated offsite movement of VOC-impacted groundwater.

ICs associated with OU-1 are discussed in Section 4.2.

4.3.1 Remedy Selection

The selected remedy in the 1995 ROD for controlling contamination from the soils and groundwater at OU-1 was the collection, treatment, and disposal of groundwater; surface water controls; ICs to limit site access; and long-term groundwater monitoring. The major components of the 1995 remedy included:

- Extracting groundwater, using conventional wells
- Treating the extracted groundwater to remove the VOCs, using air stripping
- Discharging the treated groundwater to the Great Miami River
- Monitoring the chemical properties of the groundwater system
- Monitoring the hydraulic behavior of the groundwater system
- Monitoring the discharge effluent
- Periodically testing the OU-1 extraction system (rebound testing)
- Controlling surface water to reduce infiltration into the landfill
- Restricting access to minimize contact with the soils

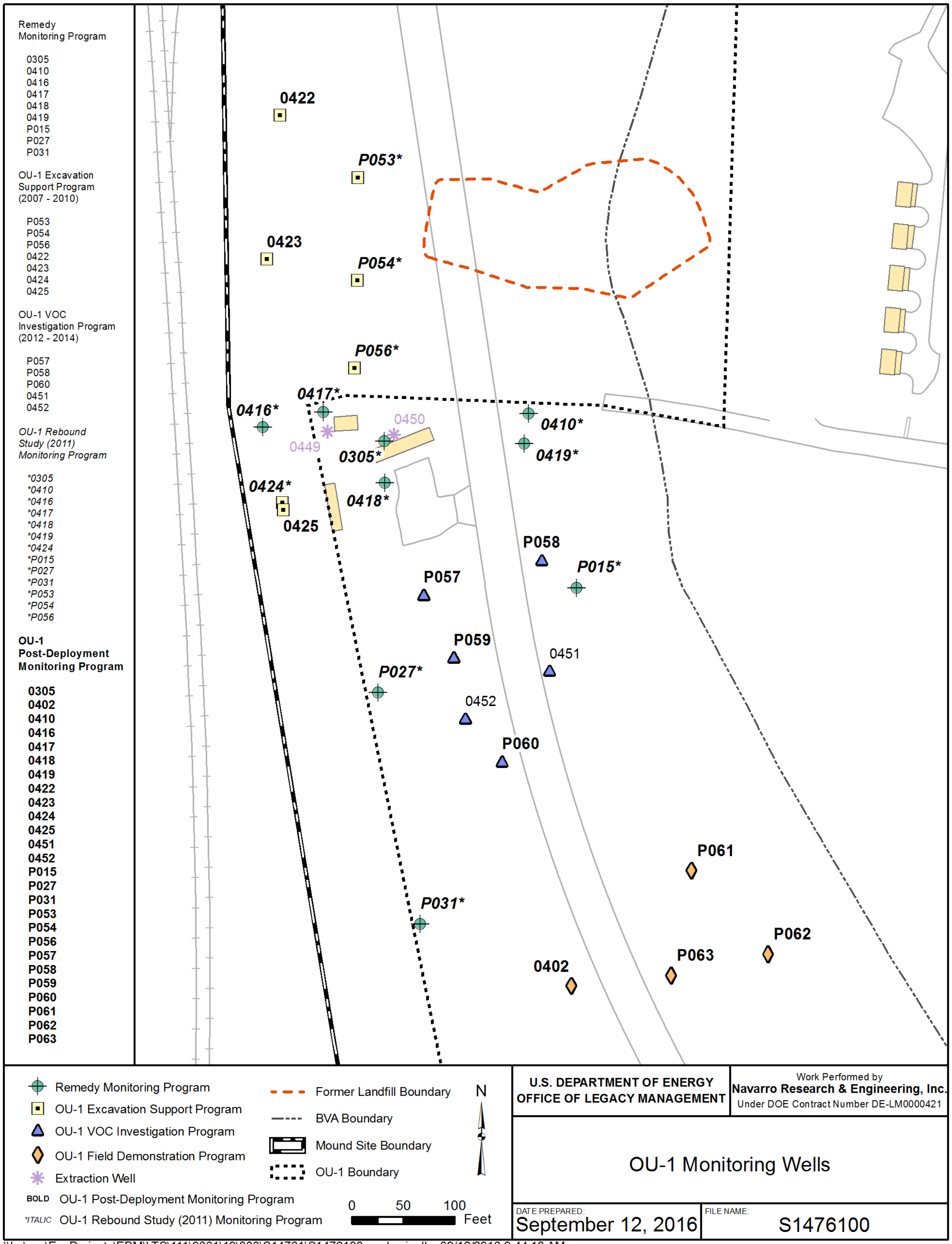

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Figure 4. Operable Unit 1 Performance Monitoring Locations

In 2007, the three original OU-1 P&T extraction wells were removed to allow for excavation of the OU-1 landfill. Two extraction wells were installed south of the landfill to provide hydraulic containment of the impacted groundwater. A more frequent groundwater monitoring program has been implemented since 2007. Surface water controls were modified during that time to direct water away from the excavation area. Also, the pond on the north end of the OU-1 landfill area was removed to allow for excavation below the footprint of the pond. The OU-1 landfill, including the pond area, was backfilled to allow for future reuse.

Since the landfill has been removed, access restriction and fencing have been removed, and Vanguard Boulevard was routed through the OU-1 area, ICs were implemented that control land and groundwater use, and those ICs were implemented in the OU-1 ROD Amendment (DOE 2011b) and the Environmental Covenant (DOE 2012a).

A contaminant rebound test was performed from May 2003 through February 2004. The system was restarted due to increases in TCE above trigger levels in downgradient wells. The 2003 test was performed prior to the removal of the landfill; therefore, materials were still present that provided a VOC source to groundwater. It was concluded from this initial rebound test that increases and decreases in VOC concentrations in groundwater may have been linked to fluctuations in the groundwater table rather than being caused by classical rebound of concentrations over time.

After completion of the landfill excavation, a second contaminant rebound test was performed from June to December 2011. The test was stopped when VOC concentrations in two downgradient wells exceeded the MCL for TCE. The result from this second test indicated that concentrations greater than the MCL were present downgradient of the hydraulic barrier created by the extraction well system.

Information from historical investigations and the studies performed after the second rebound test led to the recommendation that more passive methods should be considered to address the current VOC impact in OU-1 groundwater. The recommendation suggested that the methods could also include limited treatment of "hot spots" to reduce VOC concentrations in portions of the soil or groundwater and to create an environment more conducive to the destruction of VOCs.

In 2014, the regulators gave approval to place the P&T in standby mode in order to perform a field demonstration of enhanced attenuation to address VOCs in soil and groundwater beneath the former landfill and VOCs in groundwater downgradient of the landfill. The design for the enhanced attenuation field demonstration focused on transition from active remediation of VOCs in OU-1 groundwater to an attenuation-based remedy.

The primary goal of the field demonstration is to determine whether the use of edible oils can establish and stimulate discrete treatment zones that expedite the attenuation of cVOCs in the OU-1 groundwater. Edible oils (neat and emulsified) were deployed into the subsurface to create treatment zones to reduce the concentrations of PCE and TCE in groundwater and enhance the ongoing attenuation of these parent compounds and degradation (daughter) products. The design criteria for implementing this approach are outlined in the *Field Demonstration Work Plan for Using Edible Oils to Achieve Enhanced Attenuation of cVOCs and a Groundwater Exit Strategy for the OU-1 Area, Mound, Ohio* (DOE 2014e). The final deployment design (Figure 5) consisted of neat oil injection at 6 locations within the OU-1 landfill footprint and emulsified oil injection at 19 locations throughout the OU-1 area (reference the design plan). The key factors considered in the site-specific implementation for the field demonstration were:

1. Former Source Area—Soil: Strategic deployment of neat oil into the lower portion of the vadose zone in the areas with elevated measured soil concentrations of TCE or PCE greater than 1 milligram per kilogram (mg/kg).
2. Former Source Area—Groundwater: Strategic emulsified oil injection in the groundwater to form treatment zones that address key flow lines in the aquifer beneath the former landfill area.
3. Downgradient of Former OU-1 Landfill—Groundwater: Intensive emulsified oil injection in multiple locations to address the cVOC-impacted groundwater downgradient of the former landfill.

Ongoing monitoring of VOC concentrations and geochemical indicators as well as microbial type and abundance indicate the formation of discrete zones conducive to the reduction of PCE and TCE and support increased microbial activity. These zones (Figure 6) display:

- Increased concentrations of *cis*-1,2-DCE
- Negative oxidation–reduction potential values and declining dissolved oxygen concentrations
- Increased concentrations in metabolic byproducts (acetone, 2-butanone, and alkalinity)
- Wells exhibiting foul odor and changes in water color that are indicative of reduced conditions
- Increased bacterial count

Starting in February 2016, as part of several offsite City projects to upgrade their water and sewer systems, groundwater began to be extracted to lower the water table and allow for deep excavations and below-grade construction. The aquifer in OU-1 was affected by this offsite extraction of groundwater. Groundwater levels began to decline in May 2016, and gradients across OU-1 had increased by two times the typical gradient of 0.0002 foot per foot (ft/ft). In June 2016, when two City projects were dewatering simultaneously, groundwater flow shifted to the west for a short period. Groundwater quality to date suggests that the anaerobic treatment zones, created by the injection of the emulsified oil, may be becoming less structured. This may be the result of the lowering of the water table, increased gradients, or periodic changes in groundwater flow direction.

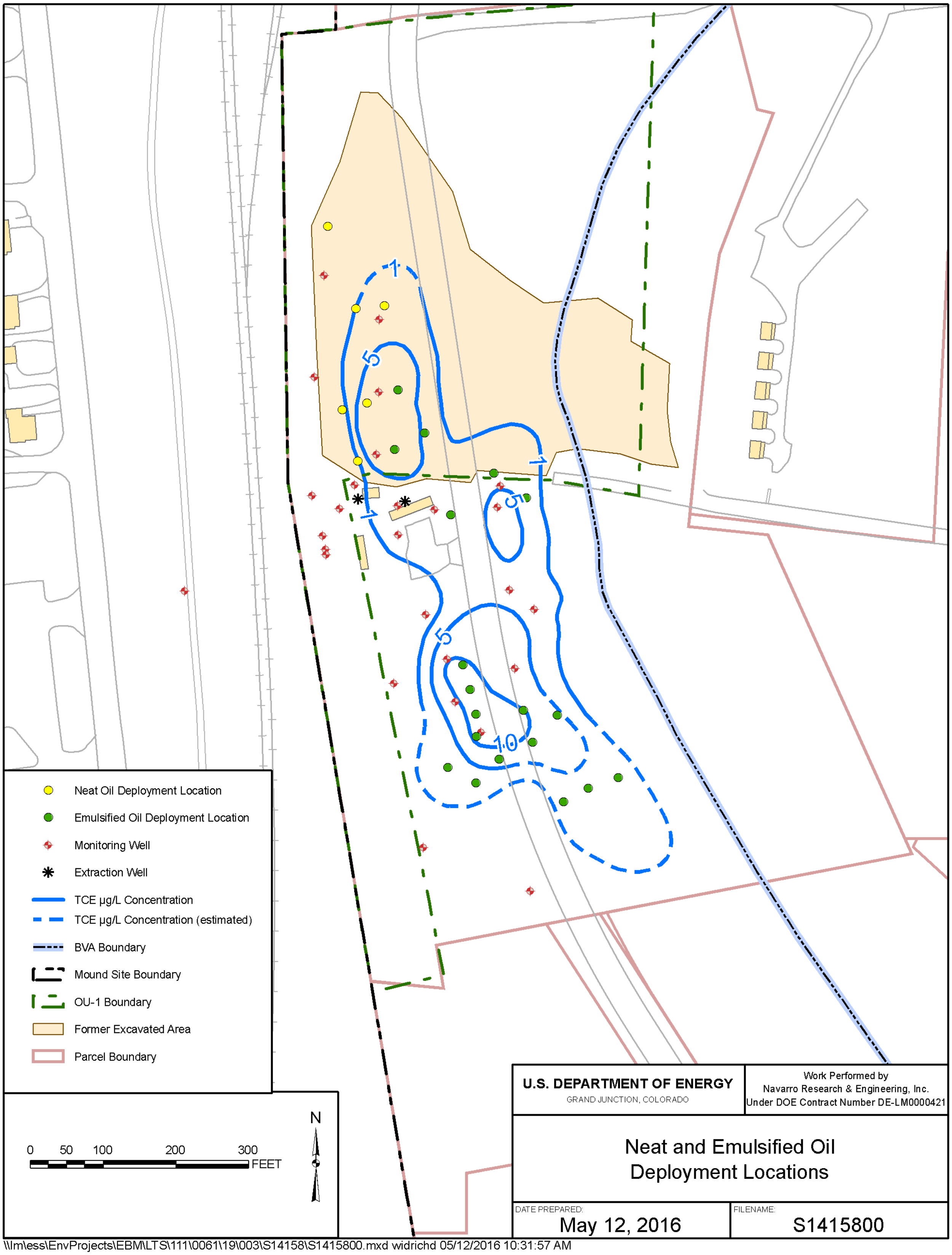

Figure 5. Neat and Emulsified Oil Deployment Locations

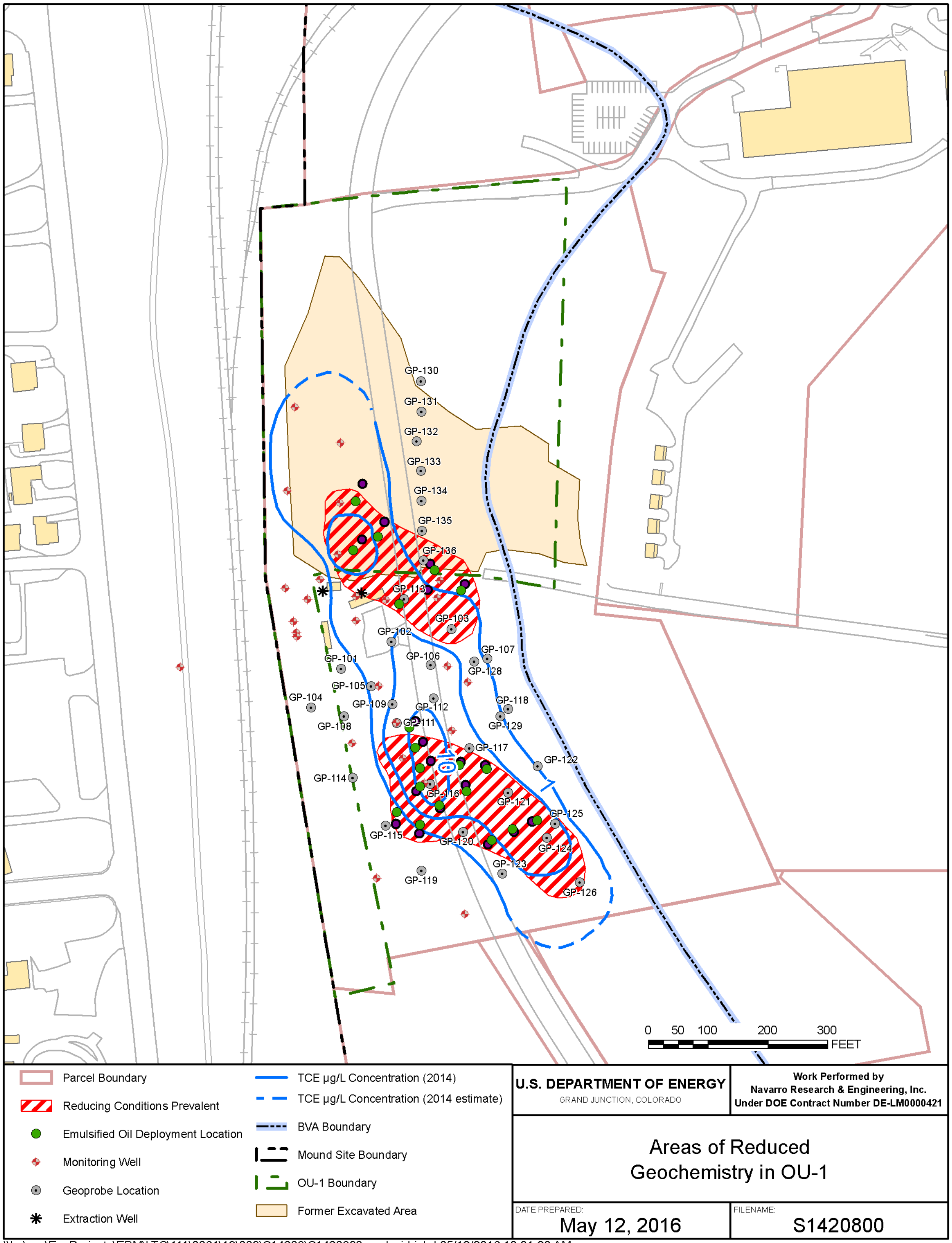

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Figure 6. Areas of Reduced Geochemistry in OU-1

4.3.2 Remedy Implementation

The components of the remedy that have been ongoing since the first OU-1 five-year review in 2001 are groundwater extraction, treatment, and discharge; groundwater monitoring for chemical and hydraulic behavior; and monitoring of the P&T discharge effluent. The P&T system was placed in standby mode in September 2014 to support a multi-year field demonstration.

4.3.2.1 During OU-1 P&T System Operation

The P&T system was designed to gain control of groundwater flow and contaminant transport beneath the OU-1 landfill footprint. The primary objectives of the sampling during its operation were as follows:

- Provide evidence during the remedial action that the P&T system is capturing the contaminant plume, as intended
- Obtain information that will allow the P&T system to be fine-tuned throughout the remedial action so that groundwater extraction rates are high enough to capture the plume, but not so high that they extract unnecessary amounts of groundwater
- Provide evidence that the air stripper protectively removes all contaminants of concern to acceptable levels prior to discharge

Two approaches were used to evaluate the capture of contaminated groundwater in OU-1. The short-term assessment of capture relied on groundwater-level measurements in selected wells and piezometers. Water levels were measured in a small set of wells to verify inward gradients across the western and southern boundaries of the landfill. The long-term assessment of capture relies on monitoring the concentrations of contaminants in nearby wells. These data are complementary. The hydraulic measurements are immediate but indirect evidence of capture, and the groundwater quality data are delayed but definitive proof of successful capture.

Sampling of selected groundwater monitoring wells for volatile organic compounds was performed quarterly as specified in the *OU-1 Pump and Treatment Operation and Maintenance Plan* (DOE 2000). Nine wells downgradient of OU-1 (Table 3 and Figure 4) were sampled to evaluate the changes in concentrations in the area of groundwater contamination that has been isolated from its source by the operation of the P&T system. These wells were sampled quarterly for VOCs. This monitoring network is smaller than the one initially used to monitor groundwater quality. Reducing the monitoring network was the result of decommissioning wells in the OU-1 area during excavation activities performed from 2007 through 2010. Data were analyzed to determine sustained downward trends in VOC concentrations as proof of successful capture of the plume. An upward trend might indicate that the extraction rates in the wells needed to be increased to maintain the capture zone of the VOC-impacted groundwater.

Table 3. Groundwater Quality and Hydraulic Monitoring for OU-1

Location	VOC Analysis	Water-Level Measurement	Location	VOC Analysis	Water-Level Measurement
0305	X	X	0419	X	
0410	X	X	P015	X	
0416	X		P027	X	
0417	X		P031	X	
0418	X		P043		X

Static water-level measurements were performed quarterly in the three wells specified in Table 3. Initially, the head measurements were made using a network of 16 wells. It was later determined that hydraulic capture could be determined through the use of a small network of wells located on the compliance boundary. These wells were used to perform a three-point evaluation for determining the gradient immediately downgradient of the P&T system. An average inward gradient of 0.002 ft/ft is necessary to demonstrate containment of the contaminated groundwater.

Influent and effluent samples were collected monthly as part of the Authorization to Discharge and to assess the performance of the P&T system. Data from these two samples were used to determine removal efficiencies. Furthermore, the treated effluent chemistry was compared to Ohio EPA discharge standards to determine whether the water was suitable for discharge.

In support of the OU-1 landfill excavation project (which was performed to support future reuse of the OU-1 area), a more frequent monitoring program was implemented. Starting in January 2007, sampling was performed in nine remedy monitoring wells to assess the groundwater quality in the BVA and the distribution of TCE closer to the landfill area and extraction wells. Sampling was performed according to the requirements in the *Work Plan for the Replacement of the OU-1 Extraction Wells*, which was developed to address the removal of the remaining two extraction wells (0413 and 0414) to accommodate additional source removal (i.e., the excavation of contaminated soil and debris from the landfill area). This sampling program changed over time to address changing conditions as excavation activities progressed. The program, consisting of 16 wells (Figure 4), remained in place after completion of the excavation activities in 2011.

In 2011, the monitoring program was modified to support the second contaminant rebound study. Groundwater samples were collected for VOC analysis from select wells in the OU-1 area as described in the *Operable Unit 1 Rebound Study Work Plan and Groundwater Exit Strategy* (DOE 2011d). Thirteen wells (Figure 4) were sampled to monitor the changes in VOC distribution after the extraction wells were turned off and to ensure that unacceptable migration of VOC-impacted groundwater did not occur. Monitoring wells were divided into the following categories: source area, capture zone, and downgradient. Contingency actions were established for each category.

4.3.2.2 During OU-1 EA Field Demonstration

Starting in August 2014, performance monitoring is being conducted based on the *OU-1 Enhanced Attenuation Field Demonstration Sampling and Analysis Plan Mound, Ohio, Site*

(DOE 2014d). Three sampling programs were performed during the EA field demonstration: baseline, oil deployment, and post-deployment. Post-deployment will be performed for 3 years after completion of the oil injection. The post-deployment network consists of 18 monitoring wells (Figure 4). If the P&T system is restarted, the monitoring program described above will be reinstated.

4.3.3 Operations and Maintenance

The OU-1 performance monitoring requirements and evaluation on ICs are documented in the O&M Plan. This document incorporated the requirements outlined in the *OU-1 Pump and Treatment Operational and Maintenance Plan* (DOE 2000).

4.4 Phase I Groundwater (MNA) Remedy

The Phase I ROD was finalized in July 2003 to address groundwater contaminated with TCE in this discrete area through MNA and ICs. Phase I is an approximately 52-acre area. It lies on the southern border of the plant and is made up of three distinct sections of the site property (Figure 2). This area contains monitoring wells that are screened in both the BVA and the bedrock aquifer system.

MNA is being utilized as a remedy for a small section of the bedrock groundwater system contaminated with TCE to ensure the concentration of TCE within the bedrock groundwater is decreasing to levels below the MCL and does not impact the downgradient BVA. ICs associated with Phase I are discussed in Section 4.2.

4.4.1 Remedy Selection

Groundwater in Phase I is monitored for TCE and its degradation products to verify that the concentration of TCE is decreasing due to natural attenuation and is not impacting the BVA. A groundwater monitoring program was established to ensure that the BVA is not negatively impacted by TCE-contaminated groundwater within the Phase I bedrock aquifer system. The objective of this monitoring is to protect the BVA by verifying that the concentrations of TCE in the vicinity of well 0411, well 0443, and seep 0617 are decreasing and that TCE is not impacting the BVA. This program may be decreased or terminated if the TCE concentrations observed in well 0411, well 0443, and seep 0617 meet the MCL for four consecutive sampling events.

The remedial action objectives include the following:

- Protect the BVA by verifying that the concentrations of TCE in the vicinity of well 0411, well 0443, and seep 0617 are decreasing and that TCE is not impacting the BVA
- Demonstrate the reduction of TCE to concentrations below the MCL in well 0411, well 0443, and seep 0617

Although not part of the selected remedy, monitoring was performed to evaluate barium, radium (Ra), chromium, and nickel impact in the Phase I groundwater. On the basis of investigations, none of these parameters were considered to be a contaminant of concern in Phase I. The monitoring program for chromium and nickel was discontinued in 2009.

Monitoring of groundwater for barium, Ra-226, and Ra-228 was continued to provide assurance that the understanding of the barium and radium in groundwater was correct. The confirmatory sampling program for radium and barium was discontinued in 2013; data supported the conclusion that a salt source located on the surface leached into the bedrock formation, dissolving naturally occurring barium and radium in a low-flow area of the bedrock aquifer.

4.4.2 Remedy Implementation

Under the MNA monitoring program, samples are collected from selected wells and a seep and analyzed as outlined in Table 4 and shown in Figure 7. Bedrock wells 0411 and 0443 are monitored to provide spatial coverage of flow paths in the immediate vicinity of the well 0411 area. Bedrock wells 0353, 0444, and 0445 and seep 0617 are monitored to provide spatial coverage of flow paths downgradient of the well 0411 area. In conjunction with the bedrock wells, BVA wells 0400, 0402, and P033 are monitored to assess potential movement of TCE from the bedrock system to the BVA.

Table 4. Remedy (MNA) Monitoring for Phase I

Monitoring Location	Area	Sampling Frequency	Parameters
Well 0411	Well 0411 Area	Semiannual (First and third quarter of each calendar year)	TCE DCE VC
Well 0443			
Well 0353	Downgradient Bedrock Monitoring		
Well 0444			
Well 0445			
Seep 0617			
Well 0400	BVA Monitoring		
Well 0402			
Well P033			

Notes:
Samples are collected and analyzed as outlined in the O&M Plan. Sampling frequency for the MNA program was reduced to semiannually in 2007 with the approval of the Mound Core Team.

The primary contaminant of concern in Phase I groundwater is TCE. However, VC, *cis*-1,2-DCE, and *trans*-1,2-DCE are also analyzed. The field parameters of dissolved oxygen, temperature, oxidation–reduction potential (ORP), and pH are also measured for each sampling event.

The contaminant data is evaluated against previous data collected at each location to determine if MNA is adequately addressing groundwater impact and to monitor the geochemical conditions in the aquifer. Trigger levels (Table 5) have been established for each contaminant as presented in the O&M Plan. The objective of the trigger level is to provide a threshold level that is indicative of a definitive change in the groundwater quality that would result in a response action. EPA and Ohio EPA must be notified if these trigger levels or levels of concern are exceeded. After notification, the Mound Core Team (EPA, Ohio EPA, and DOE) would determine an appropriate course of action.

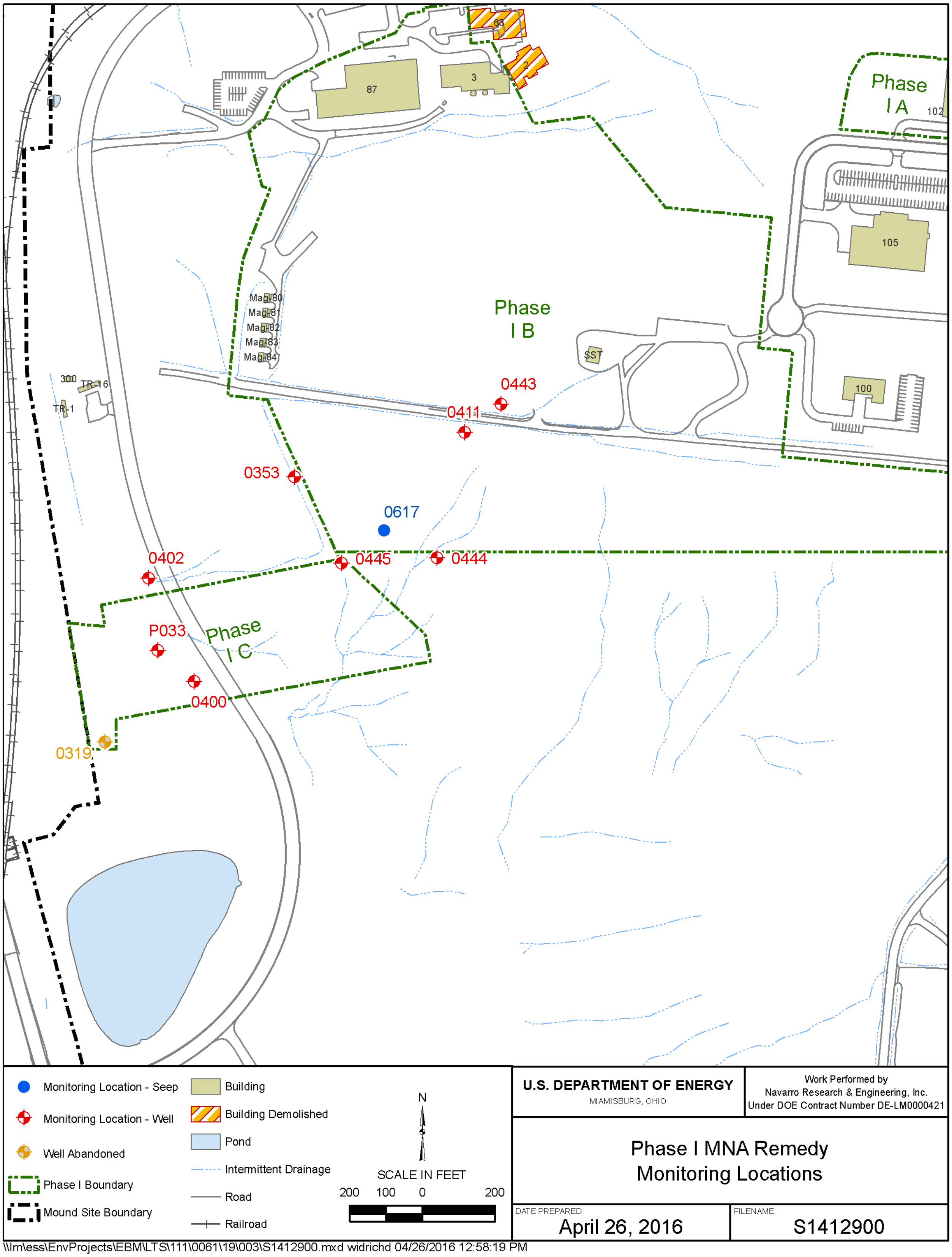

Figure 7. Monitoring Network for Phase I Groundwater (MNA) Remedy

Table 5. Trigger Levels and Levels of Concern for Phase I MNA Remedy

Location	Trigger Levels		
	TCE (µg/L)	DCE (µg/L)	VC (µg/L)
0353	5	70	2
0400	5	70	2
0402	5	70	2
0411	30	70	2
0443	30	70	2
0444	5	70	2
0445	5	70	2
P033	5	70	2
0617 (seep)	16	70	2

Abbreviation:
µg/L = micrograms per liter

4.4.3 Operations and Maintenance

The sampling program to support MNA for the groundwater in Phase I and the evaluation of ICs is documented in the O&M Plan. This document incorporated the requirements outlined in the Phase I Remedy (Monitored Natural Attenuation) Groundwater Monitoring Plan (DOE 2004c) and the Operation and Maintenance Plan for the Implementation of Institutional Controls at the 1998 Mound Plant Property (DOE 2004a).

4.5 Parcels 6, 7, and 8 Groundwater (MNA) Remedy

The Parcels 6, 7, and 8 ROD (DOE 2009) was finalized in August 2009 to address groundwater and seeps associated with the Main Hill contaminated with TCE and its breakdown products or tritium and radionuclides through MNA and ICs. Parcels 6, 7, and 8 occupy approximately 101 acres of the northern portion of the Mound Plant site. The main production facilities were located within Parcels 6 and 8, and this area is called the Main Hill area (Figure 2). Significant soil contamination was present beneath the major production facilities located on the Main Hill.

This area contains monitoring wells that are screened in the BVA and seeps. Groundwater within the fractured bedrock beneath the Main Hill area flows along horizontal bedding planes and fractures and ultimately discharges to seeps or to the downgradient BVA.

MNA is being utilized as a remedy for the bedrock groundwater system and BVA contaminated with TCE and its breakdown products, tritium, and radionuclides to ensure the concentrations of these constituents within the groundwater are decreasing to levels below the MCL and do not impact the downgradient BVA offsite. ICs associated with Parcels 6, 7, and 8 are discussed in Section 4.2.

4.5.1 Remedy Selection

Groundwater in Parcels 6, 7, and 8 is monitored for TCE and its degradation products to verify that the downgradient BVA is not affected and concentrations are decreasing. In addition, groundwater discharging from seeps is monitored for TCE and its degradation products, tritium, and radioisotopes (strontium-90 [Sr-90], Ra-226, and Ra-228) to verify that source removal results in decreasing concentrations.

The sampling is separated into two programs that relate to the areas of impact. These areas are:

- **Wells 0315/0347 Area:** Wells at the edge of the BVA on the southwestern corner of Parcel 8 that have elevated concentrations of VOCs. The program consists of wells that have TCE greater than the MCL and downgradient wells to the west.
- **Main Hill Seeps:** Seeps on the northern and southern sides of the Main Hill that have elevated concentrations of VOCs and tritium. The program consists of seeps and downgradient wells to the west.

The remedial action objectives include the following:

- Protect the downgradient BVA by verifying that TCE concentrations in the vicinity of wells 0315 and 0347 are decreasing and not impacting the BVA.
- Monitor the reduction of TCE concentrations to determine if they fall below the MCL in wells 0315 and 0347 and to verify the hypothesis that natural decomposition of TCE will result in concentrations below the MCL over time.
- Monitor the reduction of TCE and PCE concentrations and tritium activity to determine if those parameters fall below the MCLs in seeps 0601, 0602, 0605, 0606, and 0607 and to verify the hypothesis that—with the removal of the TCE, PCE, and tritium sources—natural decomposition of TCE and PCE and decay of tritium will result in concentrations below the MCL over time.

The monitoring of Sr-90, Ra-226, and Ra-228 in Seep 0601 was discontinued in 2011. The levels of Sr-90 measured in the seep were similar to those measured in background seeps since monitoring was started for this program. The activity levels of combined Ra-226/Ra-228 have been less than 5 picocuries per liter (pCi/L) since 2006.

4.5.2 Remedy Implementation

Wells 0315/0347 Area

Under the Parcels 6, 7, and 8 MNA monitoring program for the well 0315/0347 area, samples are collected from selected wells as outlined in Table 6 and shown on Figure 8. Wells 0315 and 0347 were sampled to provide spatial monitoring coverage of a zone of localized TCE groundwater contamination, which could act as a potential source to the downgradient BVA. Wells 0124, 0126, 0386, 0387, 0389, and 0392 are sampled to provide spatial coverage of groundwater flow paths downgradient of the wells 0315/0347 area. All of the wells in this program are screened within the BVA.

Table 6. Monitoring for Wells 0315/0347 Area

Monitoring Location	Area	Sampling Frequency	VOC
Well 0315	Source Wells	Quarterly	PCE TCE DCE VC
Well 0347			
Well 0124	Downgradient BVA		
Well 0126			
Well 0386			
Well 0387			
Well 0389			
Well 0392			

The primary contaminant of interest in the well 0315/0347 area is TCE. VC, *cis*-1,2-DCE, and *trans*-1,2-DCE are degradation products of TCE, and their presence indicates that TCE is being decomposed. Samples collected from the wells identified in Table 6 are analyzed for TCE, *cis*-1,2-DCE, *trans*-1,2-DCE, and VC. The field parameters of dissolved oxygen, temperature, ORP, and pH are also measured during each sampling event.

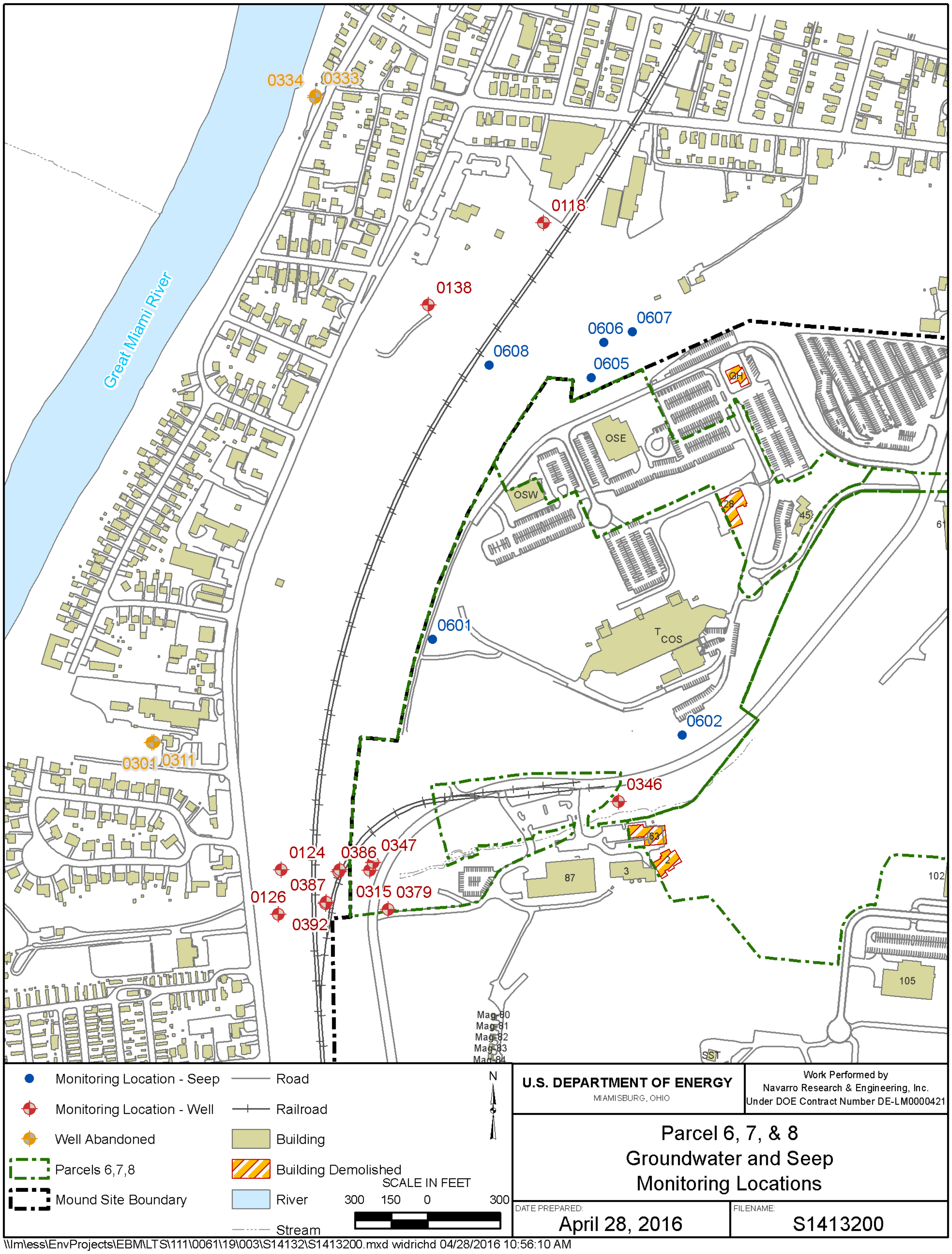

Figure 8. Parcels 6, 7, and 8 Groundwater and Seep Monitoring Locations

Main Hill Seeps

Water from selected seeps along the Main Hill and wells screened within the BVA are sampled to support the MNA remedy for the Main Hill seeps (Table 7) and are shown in Figure 8. Seeps 0601, 0602, 0605, 0606, and 0607 are sampled to determine contaminant levels in these direct groundwater discharge points. Wells 0346, 0347, and 0379 are sampled to evaluate the changes in contaminant levels in the tributary valley. Wells 0118, 0138, 0301, 0346, and 0379 are sampled to provide spatial coverage of groundwater flow paths downgradient of the Main Hill.

The primary contaminants of interest in the Main Hill seeps and downgradient groundwater are PCE, TCE, and tritium. VC, *cis*-1,2-DCE, and *trans*-1,2-DCE are degradation products of TCE, and their presence indicates that TCE is being degraded. Samples collected from the wells are sampled for the analytes outlined in Table 7. The field parameters dissolved oxygen, temperature, ORP, and pH are also measured during each sampling event.

Table 7. Monitoring for Main Hill Seeps and Groundwater

Monitoring Location	Area	Sampling Frequency	Parameters
Seep 0601	Main Hill Seeps	Quarterly—VOCs Semiannual—Tritium	PCE TCE DCE VC Tritium
Seep 0602			
Seep 0605			
Seep 0606			
Seep 0607			
Well 0118	Downgradient BVA		
Well 0138			
Well 0346			
Well 0347			
Well 0379			

Notes:
In 2012, the sampling frequency for the tritium monitoring was reduced to semiannual with the approval of the Mound site Core Team.

The contaminant data are evaluated against previous data collected at each location to determine if downward trends are occurring. Trigger levels and response actions have been established at specified locations for select contaminants as presented in the O&M Plan. The objective of the trigger level is to provide a threshold level that is indicative of a definitive change in the groundwater quality that would result in a response action. The triggers are summarized in Table 8. EPA and Ohio EPA must be notified if these trigger levels are exceeded. After notification, the Mound Core Team (EPA, Ohio EPA, and DOE) would determine an appropriate course of action.

Table 8. Trigger Levels for Parcels 6, 7, and 8 Monitoring Locations

Location	TCE (µg/L)	PCE (µg/L)	Tritium (nCi/L)
0315	30		
0347	30		
0124	5		
0126	5		
0386	5		
0387	5		
0389	5		
0392	5		
0601 (seep)		75	1,500
0605 (seep)	150		

Abbreviations:
µg/L = micrograms per liter
nCi/L = nanocuries per liter

4.5.3 Operations and Maintenance

The sampling program to support MNA for the groundwater in Phase I and the evaluation of ICs is documented in the O&M Plan. This document incorporated the requirements outlined in the *Parcel 6, 7, and 8 Remedy (Monitored Natural Attenuation) Groundwater Monitoring Plan* (DOE 2006c) and the *Operations and Maintenance Plan for the Implementation of Institutional Controls at the 1998 Mound Plant Property* (DOE 2004a).

4.6 O&M Costs for the Mound Site

Costs associated for each remedy are not tracked separately. The total O&M costs for groundwater monitoring, sample analysis, data management, reporting, and operation of the OU-1 P&T system are included in Table 9. In addition, Table 9 provides the cost of the OU-1 Field Demonstration project that occurred in 2014 and 2015.

Table 9. General O&M Costs for the Mound Site

Year	O&M Cost	OU-1 Field Demonstration Cost	Combined O&M Cost
2011	$614,208	n/a	$614,208
2012	$557,879	n/a	$557,879
2013	$766,757	n/a	$766,757
2014	$484,191	$500,857	$985,048
2015	$342,820	$242,401	$585,221
Total	$2,765,855	$743,258	$3,509,113

Abbreviation:
n/a = not applicable

5.0 Progress Since Last Five-Year Review

5.1 Institutional Controls

Institutional controls were standardized for the entire Mound site during this FYR period. The IC language in the OU-1 ROD Amendment for Parcel 9 (DOE 2011b) was modified to match the other site IC wording.

Because Parcels 6, 7, 8, and 9 are leased to MDC through no later than September 2017 under the General Purpose Lease Amendment 24, EM added Appendix #1 to assure IC compliance during the lease period:

> "This Appendix Number 1, brings the aforementioned lease into compliance with the Environmental Protection Agency's guidance for Institutional Control Implementation and Assurance Plans (ICIAPs) issued in December 2012, and reiterates to new management and those whom succeed the current management, of the required Institutional Controls covering the remaining land parcels and buildings as stated in the subject lease…"

5.1.1 Protectiveness Statement from Last Review

The IC remedy for Parcels D, H, 3, and 4 and the ICs associated with Phase I and Parcels 6, 7, and 8 are protective of human health and the environment because controls are functioning as intended.

5.1.2 Status of Recommendations from Last Review

Two EPA recommendations from the 2011 FYR regarding ICs were:

1. Verify recording of Parcels 6, 7, and 8 quitclaim deed.

   Parcels 6, 7, and 8 and Parcel 9 are still owned by EM and leased to MDC under the amended site sales agreement and amended general purpose lease.

2. Finalize the sitewide IC Management/Land Use Control Plan (with CERCLA Summary).

   LM finalized the CERCLA summary and incorporated it into Section 2 of the 2014 update of the O&M Plan.

   LM finalized the IC management and land use control information and incorporated it into Section 3 of the 2014 update of the O&M Plan.

5.1.3 Status of Other Prior Issues

No other issues related to the ICs were identified.

5.2 Operable Unit 1

Since the previous FYR, performance monitoring has been ongoing. More rigorous sampling has been performed to support ongoing studies. Numerous wells were added to support continuing field studies.

The following has been completed for OU-1:

- The OU-1 ROD was amended in August 2011 to expand the area and document the changes resulting from the excavation of the landfill. This expanded area is designated as Parcel 9. This amendment included the removal of ICs specifying fencing controls around the OU-1 landfill area and access controls to minimize contact with those soils. The ICs were adjusted to match those for the rest of the site.
- A second contaminant rebound test was completed in 2011. Results indicated that contaminant concentrations greater than the MCLs for PCE and TCE were present downgradient of the hydraulic barrier created by the P&T extraction wells.
- Information from historical investigations and the studies performed after the second rebound test led to the recommendation that more passive methods should be considered to address the VOC impact in OU-1 groundwater. Within the areas of impact, characterization data indicated that reductive dechlorination of PCE and TCE occurred; however, subsequent reductive dechlorination of TCE to *cis*-1,2-DCE was limited. Overall, aerobic conditions dominate the OU-1 groundwater system, indicating that the cometabolic aerobic oxidation of TCE and *cis*-1,2-DCE was feasible based on organic carbon and dissolved oxygen results.
- A field demonstration was initiated in 2014 to evaluate whether EA could expedite the remediation of PCE, TCE, and daughter products in groundwater impacted by the former OU-1 landfill. EA uses active engineering solutions to alter the target site so that the contaminant plume will passively stabilize and shrink. For OU-1, the EA was implemented by target injection of an electron donor (soybean oil) to created "structured geochemical zones." VOCs in the altered subsurface system encounter alternating anaerobic and aerobic environments along the plume flow path. The goal is that EA at OU-1 will provide a transition to natural attenuation and become an alternative to the baseline P&T system.
- The P&T system was placed in standby mode on September 15, 2014, to support the EA Field Demonstration project, as approved by the Mound Core Team.

5.2.1 Protectiveness Statement from Last Review

The remedy at OU-1 currently protects human health and the environment because containment of the plume is functioning as intended. Exposure pathways that could result in unacceptable risks are being controlled through containment of the plume and federal ownership of the land. However, in order for the remedy to be protective in the long term, ICs to restrict soil removal and groundwater use need to be implemented. The OU-1 ROD is being amended to expand the area and document the changes resulting from the excavation of the landfill. This expanded area is designated as Parcel 9. As stated in the OU-1 ROD, the ICs for OU-1 would be developed prior to transfer and, therefore, will be outlined in future documentation for Parcel 9.

5.2.2 Status of Recommendations from Last Review

No recommendations regarding OU-1 were made in the last review.

5.2.3 Status of Other Prior Issues

As identified in the protectiveness statement from the last FYR, the OU-1 ROD Amendment expanded the area and implemented the Environmental Covenant (DOE 2012) that added ICs to restrict soil removal and groundwater use. No other issues related to the remedy for OU-1 have been identified. Presently, the P&T system is in standby mode to support the EA Field Demonstration; the system is inspected monthly and is able to be brought back online, if deemed necessary.

5.3 Phase I Groundwater (MNA) Remedy

Since the previous five-year review, monitoring has been ongoing. The sampling frequency for the Phase I MNA remedy remains semiannual. No changes were made to the monitoring network.

5.3.1 Protectiveness Statement from Last Review

The remedy for Phase I is expected to be protective of human health and the environment upon attainment of groundwater cleanup goals through MNA. In the interim, exposure pathways that could result in unacceptable risks are being controlled through ICs that prevent use of the groundwater in the restricted area.

5.3.2 Status of Recommendations from Last Review

The recommendation regarding the Phase I MNA remedy from the last FYR was:

- Finalize the sitewide O&M Plan for groundwater remedies.

The O&M Plan was completed in 2014 and updated in 2015. The O&M Plan is Volume 2 of a three-volume Long-Term Stewardship Plan for the Mound Site. The multi-volume plan explains how DOE LM will fulfill its surveillance and maintenance obligations at the Mound site to ensure that the selected remedies remain functional and effective so that conditions at the site remain protective of human health and the environment.

The O&M Plan which contains the O&M and IC requirements was developed by the DOE Office of Environmental Management (EM) and approved by the regulators with input from the stakeholders. The activities described are required to maintain the remedies and controls for the site under CERCLA. Volume 2 replaced four previous documents: the *Operations and Maintenance (O&M) Plan for the Implementation of Institutional Controls at the 1998 Mound Plant Property, Phase I Parcel* (DOE 2004a); the *OU-1 Pump and Treatment Operation and Maintenance Plan* (DOE 2000); the *Phase I Remedy (Monitored Natural Attenuation) Groundwater Monitoring Plan* (DOE 2004c); and the *Parcel 6, 7, and 8 Remedy (Monitored*

*Natural Attenuation) Groundwater Monitoring Plan, Final (*DOE 2006c). Except for the CERCLA overview section, updates to Volume 2 (O&M Plan) will require regulatory approval.

5.3.3 Status of Other Prior Issues

No other issues related to the Phase I MNA remedy have been identified.

5.4 Parcels 6, 7, and 8 Groundwater (MNA) Remedy

Since the previous five-year review, monitoring has been ongoing. The sampling frequency for the Parcels 6, 7, and 8 MNA remedy remained quarterly for VOCs and was reduced to semiannual for tritium. Monitoring for Sr-90 and combined Ra-226/Ra-228 was discontinued. Four offsite monitoring wells were removed from the monitoring network and abandoned with approval of the Mound Core Team.

5.4.1 Protectiveness Statement from Last Review

The remedy for Parcels 6, 7, and 8 is expected to be protective of human health and the environment upon attainment of groundwater cleanup goals, through MNA. In the interim, exposure pathways that could result in unacceptable risks are being controlled through ICs that prevent the use of groundwater in the restricted area.

5.4.2 Status of Recommendations from Last Review

The recommendation regarding Parcels 6, 7, and 8 MNA remedy from the last review was:

- Finalize the sitewide O&M Plan for groundwater remedies.

The O&M Plan was completed in 2014 and updated in 2015.

The O&M Plan, which contains the O&M and IC requirements developed by the DOE Office of Environmental Management, was approved by the regulators with input from the stakeholders. The activities described are required to maintain the remedies and controls for the site under CERCLA.

5.4.3 Status of Other Prior Issues

No other issues related to the Parcels 6, 7, and 8 MNA remedy have been identified.

5.5 Operable Unit 4—Miami-Erie Canal

A no-action ROD was approved for the soil in the Miami-Erie Canal in 2004. The Miami-Erie Canal was never owned by DOE; however, the canal was included on the NPL due to impact from operational and accidental releases from the facility. Remediation of the canal soil attained risk levels that were acceptable for residential use. No property transfer was necessary. Since this was a no-action ROD, further evaluation of the canal was not performed for this FYR report.

6.0 FYR Process

6.1 Administrative Components

LM began the Mound Site FYR process in October 2015 by notifying regulatory agencies, the community, and other interested parties; establishing the review team in consultation with EPA and Ohio EPA; reviewing relevant documents and data; conducting physical inspections; analyzing monitoring data; and developing this fourth FYR report.

The CERCLA FYR team included: Gwen Hooten, LM; Sue Smiley, LM; Rebecca Cato, Melissa Lutz, Laura Cummins, Navarro; Joyce Massie, Navarro LMS Team; David Seely, EPA-Region 5; and Brian Nickel, Ohio EPA.

6.2 Community Notification and Involvement

LM placed a public notice of the FYR in the *Dayton Daily News* on February 6–9, 2016, that described the review process including the ICs. DOE also created a CERCLA FYR page (http://www.lm.doe.gov/Mound_CERCLA.pdf) including a survey form for the public, on the LM Mound website. LM also e-mailed 37 local stakeholders directing them to the website and inviting them to complete the survey. LM distributed survey copies at the February, March, and April Mound Science and Energy Museum evening programs. As of the end of the review period, 2 surveys were received. Copies of the public notices and survey are included in Appendix A.

Representatives of the City of Miamisburg and MDC accompanied the review team during every annual IC assessment walkdown, including the combined IC/FYR walkdown on April 14, 2016. Also, personnel from both organizations as well as other landowners were interviewed during the annual IC assessments.

6.3 Interviews, Surveys, and Record Reviews

The FYR review team participated in interviews conducted for the annual IC assessment and conducted other interviews with O&M managers from its oversight contractor, Navarro. These interviews are included with the Site Inspection Checklist (Appendix B).

6.4 Site Inspections

6.4.1 Annual Assessments of IC Effectiveness

DOE conducts annual assessments of the effectiveness of the Mound site's ICs to determine whether the ICs continue to function as designed, adequate oversight mechanisms are in place to identify possible violations of ICs, and adequate resources are available to correct or mitigate any problems if violations occur. Section 3.7.1 of the O&M Plan provides the specific inspection requirements.

These assessments examine changes that could indicate an IC violation, such as nonindustrial use, unapproved use of groundwater, unapproved soil removal, or unapproved penetration or removal of concrete from special T Building areas. The assessments include physical inspections, discussions with property owners, records reviews, with a checklist that details observations. The checklists are reviewed periodically and revised as necessary. Starting in 2014, LM asks property owners to complete and return a *Mound Site Landowners – Institutional Controls Compliance Form*, which is included in each annual report.

Groundwater monitoring is not an IC, so the IC assessments do not address the effectiveness of groundwater remedies. Annual IC assessments may include conditions and accessibility to monitoring wells.

Aerial photographs included in the assessment reports are updated for FYRs.

The following sections summarize the IC assessments conducted during the FYR period from 2012 through 2016, which concluded that the ICs for the Mound site continue to function as designed, adequate oversight mechanisms appear to be in place to identify possible violations of ICs, and adequate resources are available to correct or mitigate any problems if violations occur.

6.4.1.1 2012 Annual IC Assessment

The 2012 annual IC assessment was the first assessment to cover the entire Mound site including the OU-1 (Parcel 9). The *Annual Assessment of the Effectiveness of Sitewide Institutional Controls Applied to the Former DOE Mound Site Property*, *Miamisburg, Ohio* (DOE 2012b) contained three recommendations:

- Install a permanent marker for well 0451
- Work with the City to ensure that permit and zoning systems that capture future site work involving soil removal, regardless of property ownership, will be maintained
- Complete a soil removal white paper, which will become part of the O&M Plan

The Core Team issued guidance in September 2012 to assist future landowners with compliance with the Mound site ICs. The *ICs Guidance by Core Team (Including Soil Handling Protocol)* and *Site Use Request Form* in Appendix C of the O&M Plan is not all inclusive and can be updated based on site activities, future remedy changes, or changes to existing environmental laws.

6.4.1.2 2013 Annual IC Assessment

The *Annual Assessment of the Effectiveness of Institutional Controls at the Mound Site, Miamisburg, Ohio* (DOE 2013a) contained two recommendations relating to the cracks observed in the red concrete cap in the special IC area of T Building:

- Review the records regarding the purpose of the red concrete. Discuss with Core Team.
- Repeat the photographs of the cracks in the red concrete in 2014.

The 2013 assessment recorded the November 2012 changes to the Site Sales Contract that allowed MDC to lease Parcels 6, 7, 8, and 9 from EMCBC until September 2017. LM noted property ownership changes as MDC sold property to BOI Solutions and transferred ownership of areas to the City of Miamisburg.

During the walkdown, standing water was observed in the T Building special IC areas, rooms 57 and 58.The cause was identified as a rusted float valve on the sump pump for those rooms. MDC subsequently replaced the float, pumped out the water, and dried the area with fans.

In 2013, LM reviewed T Building documents relating to the special IC areas and the red concrete cap and presented the results to the Core Team in the *Technical (T) Building Red Concrete Cracks White Paper*, and added the white paper to LM records.

6.4.1.3 2014 Annual IC Assessment

The *Annual Assessment of the Effectiveness of Institutional Controls at the Mound, Ohio, Site, Miamisburg, Ohio* (DOE 2014b) contained four recommendations:

- Continue to address erosion issues affecting wells or access to wells
- Address water in T Building rooms 57 and 58
- Replace missing sign from pond area near bike path
- Develop a crosswalk list of Mound LM well numbers versus Ohio Department of Natural Resources numbers

There was standing water in T-Building rooms 57 and 58 and in several areas west of rooms 57 and 58. MDC's maintenance contractor identified a malfunctioning sump pump as the source of the water. MDC repaired the pump, pumped out the water, and dried the area with fans.

In 2014, LM developed the *Mound Site Landowners – Institutional Control Compliance Form* to reinforce the IC requirements with all of the landowners during the annual meetings. LM requested the landowners to sign and return the form, which was then included in the annual IC assessment report. This form is included in Appendix A of the O&M Plan, and completed forms are included in annual IC assessment reports starting in 2014.

6.4.1.4 2015 Annual IC Assessment

The *Annual Assessment of the Effectiveness of Institutional Controls at the Mound, Ohio, Site, Miamisburg, Ohio* (DOE 2015d) contained two recommendations:

- Continue to remove debris from grate leading to storm drains uphill of OU-1.
- Core Team discuss and recommend how the road and "right of way" acreage within the 1998 site boundary should be handled with regard to property ownership and IC compliance.

There was no water observed in the special IC areas of T Building.

The second recommendation was issued to resolve acreage discrepancies after property was transferred to the City of Miamisburg. During MDC's 2013 and 2015 replatting of their parcels, the roads within the 1998 site boundaries became the responsibility of the City. These roads and their acreage are not separated from the other City roads on Montgomery County property records. LM is working with MDC and the City of Miamisburg to resolve this recommendation to ensure that the Mound ICs continue to be applied to the roads that transect the original Mound site footprint.

6.4.1.5 2016 Annual IC Assessment

The annual assessment of the effectiveness of the institutional controls for the Mound site, as required by the O&M Plan, was conducted in March and April of 2016. The physical walkdown was held on April 14, with representatives of EPA, Ohio EPA, MDC, ODH, and the City of Miamisburg participating in the inspection.

The *Annual Assessment of the Effectiveness of Institutional Controls at the Mound, Ohio, Site, Miamisburg, Ohio* (DOE 2016a) contained the following recommendations:

- Send notification of property ownership transfer of Parcel K46015070030 from the City of Miamisburg to MDC to Ohio EPA per the requirements of the quitclaim deed.
- Revise the legal property descriptions for parcels K46 01507 0041 and K46 01507 0042 to define the areas that were not part of the original Mound site boundary and are not covered by ICs.
- Clarify that onsite roadways transferred to the City of Miamisburg remain covered by the site ICs. Consider a procedure that will ensure that any repairs of the roads or adjacent utility corridors within the right-of-way comply with the ICs.
- Clarify that the two areas in Phase I and BOI Tract 2 to the center line of Mound Road are exempted from the soil-removal IC.
- Determine if water that has passed under red concrete in the T Building IC area causes fixed contamination under the red concrete to migrate.
- Identify and remedy source of water in T Building special IC areas, and dry those areas.

Water was observed in the special IC areas of T Building during the LM contractor's early physical inspections on March 8 and April 7 and during the walkdown with the regulators on April 14. Analytical testing of the T Building area near the red concrete determined that the fixed contamination was not migrating beyond the red concrete as a result of the water. MDC advised that the source of the water was a malfunctioning pump in the west head house. MDC replaced the pump and installed a new PVC drain line to the outside.

The 2016 IC assessment report also noted that Ohio EPA's Resource Conservation and Recovery Act (RCRA) organization memorialized its decision to not continue a separate IC inspection at the Mound site. This decision was documented in the Ohio EPA letter to Gwen Hooten, LM, with the subject line "U.S. DOE Mound Plant Burn Area Closure and Annual RCRA Institutional Control Inspection," dated April 19, 2016, that was included in an appendix to the 2016 IC assessment report (DOE 2016a).

The 2017 annual IC assessment will document the status of all of these recommendations.

6.4.2 2016 FYR Inspections

The 2016 FYR physical inspections are summarized in the following sections. The FYR Site Inspection Checklist is in Appendix B. Photographs from the walkdown performed for the FYR are contained in Appendix C.

LM combined some of the FYR inspection activities with the 2016 annual IC assessment activities, including interviews with property owners and the April 14, 2016, site walkdown with the regulators. During the site walkdown, inspectors observed water in the T Building special IC areas as detailed in Section 6.4.1.5.

6.4.2.1 Phase I and Parcels 6, 7, 8 Groundwater Monitoring Wells and Seeps

All Phase I and Parcels, 6, 7, and 8 wells were locked, had permanent markers, and were in good condition. All seeps were accessible and exhibited flow.

Four monitoring wells in the Parcels 6, 7, and 8 sampling program were abandoned in 2015. The Mound Core team gave approval to discontinue sampling and abandoning these locations.

6.4.2.2 OU-1 Area and P&T System (Parcel 9)

This walkdown consisted of a visual survey of the monitoring wells and the OU-1 P&T system. All OU-1 performance monitoring wells were locked and in good condition. The P&T system is in safe standby mode and is being inspected monthly by Navarro personnel according to the P&T maintenance procedure.

6.5 Documents Reviewed for FYR

6.5.1 Basis for Response Action

The documents listed in Table 10 identify the background and goals of the remedies and any changes in laws and regulations that could affect the response action. These documents also (1) address community concerns and preferences and (2) provide background information on the remedial actions, basis for action, cleanup levels, and applicable or relevant and appropriate requirements (ARARs).

Table 10. Documents Supporting Basis for Response Action at the Mound Site

Document	Purpose	Use for Review
Operable Unit 1 Record of Decision, Mound Plant, Miamisburg, Ohio, June 1995	Record selected remedial decision	Remediation Goals Background Basis for Action Community Concerns Cleanup Levels Operational Criteria ICs ARARs
Amendment of the Operable Unit 1 Record of Decision, U.S. Department of Energy, Mound Closure Project, August 2011	Record amendments to ROD. Expanded ROD area	Remediation Goals Background Basis for Action Community Concerns Operational Criteria ICs ARARs
Record of Decision for Release Block D, Mound Plant, Miamisburg, Ohio, February 1999	Record selected remedial decision	Remediation Goals Background Basis for Action Community Concerns ICs ARARs
Record of Decision for Release Block H, Mound Plant, Miamisburg, Ohio, June 1999	Record selected remedial decision	Remediation Goals Background Basis for Action Community Concerns ICs ARARs
Parcel 4 Record of Decision, Mound *Plant, Miamisburg, Ohio*, February 2001	Record selected remedial decision	Remediation Goals Background Basis for Action Community Concerns ICs ARARs
Parcel 3 Record of Decision, Mound Plant, Miamisburg, Ohio, August 2001	Record selected remedial decision	Remediation Goals Background Basis for Action Community Concerns ICs ARARs
Phase I Record of Decision, Miamisburg Closure Project, July 2003	Record selected remedial decision	Remediation Goals Background Basis for Action Community Concerns Cleanup Levels ICs ARARs
Parcels 6, 7, 8 Record of Decision, Mound Plant, Miamisburg, Ohio, September 2009	Record selected remedial decision	Remediation Goals Background Basis for Action Community Concerns ICs ARARs

6.5.2 Operations and Maintenance

O&M documents listed in Table 11 describe the ongoing measures at the Mound Site to ensure that the remedy remains protective. These three (3) plans provide the structure for O&M at the site.

Table 11. Documents Supporting Operations and Maintenance at the Mound Site

Document	Purpose	Use for Review
Operations and Maintenance Plan for the U.S. Department of Energy Mound, Ohio, Site, January 2015	The activities required to maintain the remedies and controls for the site under CERCLA.	O&M Requirements Monitoring Requirements Reporting
Long-Term Surveillance and Maintenance Plan for the U.S. Department of Energy Mound, Ohio, Site, January 2015	Provides background and summarizes LM's plans for long-term surveillance, maintenance, and monitoring.	Roles and responsibilities
Community Involvement Plan for the U.S. Department of Energy Mound, Ohio, Site, January 2015	Documents how LM will ensure public involvement in post-closure activities at the Mound site.	Public involvement requirements

6.5.3 Remedy Performance

Monitoring data, progress reports, and performance evaluation reports listed in Table 12 provide information to determine whether the remedial actions continue to operate and function as designed and have achieved, or are expected to achieve, cleanup levels.

Table 12. Documents Supporting Remedy Performance at the Mound Site

Document	Purpose	Use for Review
CERCLA Five-Year Review reports, multiple documents for 2001, 2006, 2011	Records status and protectiveness of remedy.	History Update status
Annual Assessments of the Effectiveness of Site-Wide Institutional Controls multiple annual documents, June 2012–June 2016	Documents results of annual inspection and IC status.	IC status
Phase I Groundwater Monitoring Report, 2011	Documents sampling results and conclusions regarding the effectiveness of the MNA remedy.	Site status Monitoring results
Parcel 6, 7, and 8 Groundwater Monitoring Report, 2011		
Sitewide Groundwater Monitoring Reports, combined Phase I and Parcel 6, 7, and 8. 2012–2015		
OU-1 Monthly Summaries in the ER Monthly reports, July 2011–June 2016	Documents the monthly operation and performance of the OU-1 system.	System performance
OU-1 Enhanced Attenuation Field Demonstration Edible Oil Deployment Design, Mound, Ohio, Site, June 2014 (DOE 2014c)	Documents design of OU-1 demonstration.	History
OU-1 Enhanced Attenuation Field Demonstration Sampling and Analysis Plan, Mound, Ohio, Site, June 2014 (DOE 2014d)	Documents sampling and analysis plan.	History

Table 12 (continued). Documents Supporting Remedy Performance at the Mound Site

Document	Purpose	Use for Review
Field Demonstration Work Plan for Using Edible Oils to Achieve Enhanced Attenuation of cVOCs and a Groundwater Exit Strategy for the OU-1 Area, Mound, Ohio, July 2014 (DOE 2014e)	Documents planning for OU-1 demonstration.	History
Evaluation of Volatile Organic Compounds in Operable Unit 1 of the Mound, Ohio, Site, July 2014 (DOE 2014f)	Analysis of OU-1 VOCs used to create demonstration plan.	History

6.5.4 Legal Standard Regarding Remedial Action

The legal documentation listed in Table 13 includes information about specified responsibilities for conducting remedial action, implementing institutional and access controls, and O&M activities at the Mound Site.

Table 13. Documents Supporting Legal Standards Regarding Remedial Action at the Mound Site

Document	Purpose	Use for Review
FFA under CERCLA Section 120; In the Matter of the U.S. DOE's Mound Plant (1993)	Documents the commitments and agreements regarding the implementation and operation of remedies. Also documents the responsibilities of other agencies.	Required actions Roles of other agencies
Work Plan for Environmental Restoration of the DOE Mound Site, The Mound 2000 Approach, 1999	Documents the process for evaluating PRSs.	Site conditions
Mound 2000 Residual Risk Evaluation Methodology, Mound Plant, 1997	Documents the methodology for evaluating the residual risk remaining for each parcel.	Site conditions
Site Sales Agreement (updated 2008 and 2012)	Documents (1) how DOE will convey the Mound Plant property to MDC by discrete parcels, subject to CERCLA Section 120(h) and (2) the condition the property will be left in upon completion of remedial actions. 2012 update extended agreement until 2017 and allowed MDC to lease Parcels 6, 7, 8, and 9.	Background info Required actions

6.6 Risk Information Review

A risk information review was conducted in 2016 for this FYR to determine if the site remedies remain protective based on an updated consideration of residual site risks. Table 14 lists the key documents that were reviewed. The documents surveyed included RRE documentation (general and parcel-specific), groundwater monitoring reports, and ICs monitoring reports, among others. Toxicity information sources (e.g., Integrated Risk Information System [IRIS], EPA Preliminary Remediation Goals [PRG] and Regional Screening Levels [RSL] websites) were consulted for the main site risk drivers to determine whether there have been significant changes in the understanding of health-related effects since the last five-year review and since the RREs were completed. Per EPA five-year review guidance (EPA 2001), the review of site-specific risk information included an evaluation of ARARs, toxicity values, exposure assumptions, and remedial action objectives (RAOs).

Table 14. Documents Supporting the Risk Information Review

Document	Purpose	Use for Review
Mound 2000 Residual Risk Evaluation Methodology*,* Mound Plant, 1997	Documents the methodology for evaluating the residual risk remaining for each parcel.	Assess continued validity of exposure assumptions, remedial action objectives
Residual Risk Evaluation—Release Block D, Revision Summary—Final (1998)	Documents residual risks after site remediation, including data used to calculate risks.	Identify major constituents contributing to residual risks and assess whether toxicity data are still valid
Residual Risk Evaluation—Release Block H—Final (1997)	Documents residual risks after site remediation, including data used to calculate risks.	Identify major constituents contributing to residual risks and assess whether toxicity data are still valid
Residual Risk Evaluation, Parcel 3, Final (2001)	Documents residual risks after site remediation, including data used to calculate risks.	Identify major constituents contributing to residual risks and assess whether toxicity data are still valid
Residual Risk Evaluation, Parcel 4, Final (2001)	Documents residual risks after site remediation, including data used to calculate risks.	Identify major constituents contributing to residual risks and assess whether toxicity data are still valid
Phase I Residual Risk Evaluation, Final (2003)	Documents residual risks after site remediation, including data used to calculate risks.	Identify major constituents contributing to residual risks and assess whether toxicity data are still valid
Parcel 6, 7, and 8, Residual Risk Evaluation, Public Review Draft (2007) Parcel 6, 7, and 8 RRE response to comments (2007)	Documents residual risks after site remediation, including data used to calculate risks.	Identify major constituents contributing to residual risks and assess whether toxicity data are still valid
Parcel 9 Residual Risk Evaluation, Final (2011)	Documents residual risks after site remediation, including data used to calculate risks.	Identify major constituents contributing to residual risks and assess whether toxicity data are still valid
Operations and Maintenance Plan for the U.S. Department of Energy Mound, Ohio, Site (2015)	Includes procedure for evaluating acceptability of site uses that were not explicitly evaluated in RREs.	Evaluate continued validity of exposure assumptions
Annual Assessment of the Effectiveness of Institutional Controls at the Mound, Ohio, Site, Miamisburg, Ohio (2015)	Describes effectiveness of institutional controls at the site.	Protectiveness of site conditions
Sitewide Groundwater Monitoring Report Mound, Ohio, Site, Calendar Year 2014 (2015)	Includes recent groundwater and seep monitoring data.	Protectiveness of site conditions

6.6.1 Applicable or Relevant and Appropriate Requirements

The chemical-specific ARARs for groundwater identified in the RODs for the site are maximum contaminant levels (MCL) specified in the Safe Drinking Water Act and MCLs identified in State of Ohio regulations (*Ohio Administrative Code* [OAC] parts 3745-81-11 through 3745-81-13 and OAC part 3745-81-15). Numerical standards for the primary constituents of concern at the site are listed in Table 15. There have been no changes in these numerical values for the constituents that are the main drivers for remediation at the site since issuance of the

RODs that would call into question the protectiveness of the remedies selected for groundwater at the Mound Site.

Table 15. Applicable Groundwater Standards for the Mound Site

Constituent	Standard	ARAR
Tritium	20,000 pCi/L= 20 nCi/L 4 millirem/year	OAC-3745-81-15 40 CFR 141
Radium-226 + radium-228	5 pCi/L	OAC-3745-81-15 40 CFR 141
PCE	5 µg/L	OAC-3745-81-12 40 CFR 141
TCE	5 µg/L	OAC-3745-81-12 40 CFR 141
cis-1,2,-DCE	70 µg/L	OAC-3745-81-12 40 CFR 141
trans-1,2-DCE	100 µg/L	OAC-3745-81-12 40 CFR 141
Vinyl chloride	2 µg/L	OAC-3745-81-12 40 CFR 141

Abbreviations:
µg/L = micrograms per liter
nCi/L = nanocuries per liter
pCi/L = picocuries per liter

6.6.2 Exposure Pathways

As discussed previously, future land use at the Mound site is expected to be industrial/commercial in perpetuity. The first ROD for the site was the OU-1 ROD in 1995. The risk assessment completed in support of that ROD considered a variety of exposure pathways and assumed exposures to both contaminated soils and groundwater. Risks were largely dominated by the use of groundwater as the primary source of drinking water for industrial workers.

As discussed in Section 3.3.2, the traditional CERCLA remediation approach was replaced with the Mound 2000 Process (DOE 1999c), which includes the preparation of an RRE to document the residual contamination and support the ROD for each parcel. A RRE is completed for a parcel to demonstrate that remedial action goals were met and that a parcel is suitable for industrial/commercial purposes. The site conceptual model for Mound was defined in the Residual Risk Evaluation Methodology (DOE 1997a) and includes assumptions regarding relevant exposure pathways at the Mound Site. An industrial/commercial land use scenario was assumed with future construction workers and office workers as the primary receptors. Exposure pathways for both types of receptors included ingestion and inhalation of fugitive dust and external radiation from surface soil and ingestion of groundwater. In addition to the use of groundwater for drinking water, the construction worker was assumed to be exposed to vapors from groundwater during showering with water from a well on the property.

Total risks calculated in some RREs (e.g., Release Blocks D and H, Parcels 3 and 4) exceeded the acceptable risk range (1×10^{-4} to 1×10^{-6}); as with OU-1, these were due primarily to the inclusion of the groundwater ingestion pathway. Subsequently, production wells at the site were removed and prohibitions were placed on groundwater use. As a result, the more recent RREs prepared for Parcels 6, 7, and 8 (DOE 2007b) and Parcel 9 (DOE 2011) did not include the groundwater pathways. For purposes of this five-year review, the groundwater pathways are currently considered incomplete across the site. The other exposure pathways for construction and office workers from the original RRE methodology are still considered valid.

The original RRE methodology did not include the dermal pathway for soils for the site employee scenario. This pathway was subsequently added in the RREs for Parcels 6, 7, and 8 and for Parcel 9. Results of these analyses indicate that risks associated with dermal exposure are typically less than those associated with ingestion, though in some instances they are roughly equivalent to ingestion risks. Therefore, it appears that the inclusion of dermal exposures can increase total risks in some cases, although oral and external exposure pathways tend to dominate. In these instances incremental risks were doubled, but because they were at the low end of the risk range (e.g., 1×10^{-6} to 1×10^{-7}), total risks were only marginally affected and remained within the acceptable risk range. Exclusion of the dermal pathway in the assessment of residual risks for some portions of the Mound site may have slightly underestimated potential risks for site employees. The dermal pathways were not considered to be significant based on the conservative exposure scenarios.

The RRE for Parcels 6, 7, and 8 did not address exposure to seep water because it was considered insignificant. However, because there are no controls on access to seeps, this does constitute a complete exposure pathway and is considered briefly in this five-year review for the sake of completeness. Tritium and TCE have been the most consistently elevated constituents in the seeps, though concentrations have been decreasing over time. Based on the most recent seep data for the site (calendar year 2015), tritium concentrations (activity) have declined to below the drinking water standard of 20,000 pCi/L at all but one location (Seep 0601 at 22,300 pCi/L). Data for TCE range from below detection limits to slightly more than 4 times the drinking water standard. Concentrations at all locations for all contaminants of concern (COCs) have remained well below trigger levels established in the O&M Plan. Because exposures would be expected on an infrequent basis, risks due to incidental contact with contaminated seep water are negligible.

Over the last several years, activities have been proposed at the Mound site that were not specifically evaluated under the Mound 2000 methodology. As a result, the suitability of the site for these uses has been questioned. Examples include use of the site as a location for an annual student science fair or for occasional recreational use (e.g., jogging, biking). To determine if these uses are acceptable, an evaluation process has been developed and incorporated into the site O&M Plan. The process uses the exposure assumptions in the Mound 2000 methodology as a point of departure to evaluate the proposed uses. If necessary, a risk assessment may be performed using data from the RREs as a starting point. This process ensures that all relevant exposure pathways for a given site use are considered.

Vapor intrusion was not evaluated in the RRE as a potential exposure pathway at the Mound site, however, vapor intrusion was evaluated as part of the technical assessment of the Facility Remedy in Section 7.5.6. Reliable evidence indicates the presence of vapor-forming chemicals in the subsurface at the Mound site; however, it is not known if complete exposure pathways for existing and future buildings are present.

6.6.3 Toxicity Values

Five-year reviews require an assessment of toxicity data to determine if there have been any changes that would alter the protectiveness of the remedy. The RRE methodology (DOE 1997b) uses risk-based guideline values (RBGVs) as a screening tool for identifying COCs to continue assessing under the RRE for a given parcel. The RBGVs are based, in part, on toxicity values. These values have been adjusted over time as new toxicity data have become available. The RRE methodology calls for using an RBGV equivalent to a 10^{-6} risk for carcinogens and for using a value of 1/10 the noncarcinogenic RBGV as an initial screen for inclusion of constituents for further evaluation. In addition, constituents were retained for screening if they had a frequency of detection of 5% or higher; the 95% upper confidence limit of the mean concentration for each constituent was used as the screening concentration and for residual risk calculations. Because of this conservative approach, it is highly unlikely that any constituents were eliminated from consideration through the RRE process in the past that would warrant inclusion based on changed toxicity values.

Shortly after the development of the RGBVs, EPA completed an update of radionuclide slope factors in their Health Effects Assessment Summary Tables (HEAST) based on Federal Guidance Report No. 13 (EPA 1999). A comparison of risks calculated using the original RBGVs and updated data from HEAST was included as part of the Parcel 3 RRE (DOE 2001c), which was completed shortly after the HEAST update. This comparison indicated that the new toxicity data had little effect on the overall calculated risks (some risk estimates were slightly higher, some lower). Since that time, EPA has issued additional guidance for radiation risk assessments at CERCLA sites (EPA 2014). This guidance recommends that risk assessments use slope factors included in EPA's PRG calculators. The slope factors currently provided in the PRG calculator are from Oak Ridge National Laboratory (from year 2014).

Table 16 shows toxicity values that were used to calculate residual risks in the RREs for each parcel for the main risk drivers in soil. To be conservative, constituents included in this table are those which had an incremental hazard quotient $\geq$0.1 or an incremental risk $\geq 1 \times 10^{-7}$ for any exposure route for either construction workers or site workers. (An exception to this is TCE, which was included because of the very large change in noncancer toxicity value.) This table also includes current toxicity values. Current radionuclide values are from EPA's PRG calculator; chemical toxicity values are from the sources identified in EPA's RSL tables (mostly IRIS).

Except for TCE, toxicity values for the chemical constituents listed in Table 16 have not changed since the original RBGVs (and subsequent RREs) were developed and do not affect the remedy protectiveness. For TCE, the oral reference dose is lower by 3 orders of magnitude; the slope factor is 3.5 times higher. This means that residual risk estimates today would be 1000 times higher for noncarcinogenic effects and 3.5 times higher for carcinogenic effects than calculated in the past. Parcels 7, 8, and 9 are the only parcels for which TCE was identified as a contaminant of potential concern (COPC) in soil. For all other parcels, TCE was either not detected or detected in very low concentrations (<0.01 mg/kg). For example, TCE was detected in Block D at very low concentrations [0.00175 mg/kg] and in only 3/63 samples. Changes in toxicity of TCE would not affect its identification as a COPC for these parcels.

For parcels where TCE was identified as a COPC, the highest risks associated with ingestion of residual TCE-contaminated soils by a construction worker were calculated to be a hazard quotient of 1.5×10^{-4} (noncarcinogenic risks) and a carcinogenic risk level of 5.6×10^{-9}. Based on updated toxicity values, revised residual risks in these areas would equate to a hazard quotient of about 1.5×10^{-1} and a carcinogenic risk level of about 2×10^{-8}. Both of these are within acceptable levels and, therefore, changes in TCE toxicity values do not affect remedy protectiveness.

Toxicity values for radionuclides have changed over time—sometimes several times as observed in the multiple slope factors listed in Table 16 for some constituents (e.g., plutonium-238). Most radionuclide slope factors have decreased (meaning that RREs overestimated residual risks), though a number have increased (indicating underestimated risks). Values of slope factors that are currently higher than those used in RREs have increased less than 1 order of magnitude. For constituents with incremental risk estimates greater than 1×10^{-5}, slope factors are currently lower than those used in RREs (as shown in Table 16). Toxicity values for most radionuclides listed in Table 16 have declined (17 out of 25 values). For those radionuclides with increased values, 5 were by less than a factor of 2. Only 5 toxicity values increased for the main radionuclide risk drivers (red and green designations in Table 16 that correspond to residual incremental risks of greater than 1×10^{-6}), all by a factor of 2.5 or less. The increases in slope factors are not sufficiently high to elevate residual incremental risks into the unacceptable risk range. These increases are likely offset by decreases in slope factors that lower overall residual risks. However, a formal reassessment of site risks is not warranted at this time. While a review was not conducted of the toxicity values used for every constituent in past assessments at the site, there have been no recent changes in the understanding of the major site-related constituents in soils that would call into question the protectiveness of the remedy.

Table 16. Evaluation of Toxicity Values for Residual Soil at the Mound Site

Constituent	Parcel(s)[e]	Toxicity value(s) from RRE(s)	Current Toxicity Value	Change
Chemicals—Carcinogens[a]				
2,3,7,8-TCDD	9	1.3E+5	1.3E+5	None
Aroclor-1248	9	2.00	2.00	None
Arsenic	H	15	15	None
Benzo(*a*)pyrene	D, H, 4, P1, 6, 7, 8, 9	7.3	7.3	None
Benzo(*a*)anthracene	D, P1, 8	0.73	0.73	None
Benzo(*b*)fluoranthene	D, 4, 8	0.73	0.73	None
Dibenz(*a,h*)anthracene	6, 8	7.3	7.3	None
Indeno(1,2,3-*cd*)pyrene	D, 8	0.73	0.73	None
TCE	7, 8, 9	1.3E-02	4.6E-02	Higher
Chemicals—Noncarcinogens[b]				
Antimony	D, 4, 9	4.0E-04	4.0E-04	None
Arsenic	H	3.00E-04	3.00E-04	None
TCE	7, 8, 9	5.00E-01	5.00E-04	Lower
Radionuclides—Soil Ingestion[c]				
Ac-227	4	6.26E-10	2.90E-10	Lower
	P1, 8	1.2E-9		Lower

Table 16 (continued). Evaluation of Toxicity Values for Residual Soil at the Mound Site

Constituent	Parcel(s)[e]	Toxicity value(s) from RRE(s)	Current Toxicity Value	Change
Pb-210	D	1.10E-9	1.72E-09	Higher
	4	6.75E-10		Higher
Pu-238	D, H	3.0E-10	2.25E-10	Lower
	3, 4	2.95E-10		Lower
	P1	1.3E-10		Higher
	6, 7, 8, 9	2.72E-10		Lower
Ra-228+D	4	4.79E-10	1.98E-09	Higher
	7, 8, 9	2.29E-09		Lower
Th-228	D	2.3E-10	2.43E-10	Higher
Th-230	6	2.31E-10	1.66E-10	Lower
Th-232+D	P1	1.4E-09	2.17E-09	Higher
U-233/U-234	7, 8	1.6E-10	1.50E-10	Lower
U-238+D	P1	4.0E-09	1.97E-10	Lower
Radionuclides—External Exposure[d]				
Ac-227	4	9.30E-7	1.98E-10	Lower
	P1, 7, 8	1.5E-06		Lower
Cs-137	H	2.10E-06	2.53E-06	Higher
Ra-228+D	4	9.48E-06	4.04E-06	Lower
	7, 8, 9	4.53E-06		Lower
Th-228	D	6.2E-06	5.64E-09	Lower
Th-230	4, 6	3.42E-10	8.45E-10	Higher
Th-232+D	P1	1.2E-05	4.04E-06	Lower
U-233/U-234	7, 8	9.82E-10	7.11E-10	Lower
U-238+D	P1	8.6E-06	1.19E-07	Lower

Notes:

[a] Toxicity values are oral slope factors $(mg/kg/d)^{-1}$.
[b] Toxicity values are oral reference doses (mg/kg-d).
[c] Toxicity values are soil ingestion slope factors (risk/pCi).
[d] Toxicity values are external exposure slope factors (risk/year per pCi/g).
[e] For radionuclides, red = incremental risk between 1×10^{4} and 1×10^{-5}; green = incremental risk between 1×10^{-5} and 1×10^{-6}; black = incremental risk between 1×10^{-6} and 1×10^{-7}; no incremental risks exceeded 1×10^{-4}.

Abbreviation:
P1 = Phase I

6.6.4 Remedial Action Objectives

Through the use of removals as outlined in the Mound 2000 process, DOE removed contaminated materials (buildings, slabs, soils, underground tanks and lines) to EPA's risk-based standards for industrial/commercial use only. The remedies evaluated the conditions post-removal and documented the remediation goals used for the prior cleanups were sufficient, applied ICs prohibiting groundwater use and the removal of soil from the Mound Site, and limiting the use of the site to commercial/industrial uses. The Phase I (A, B, C) and Parcels 6, 7, and 8 remedies include monitored natural attenuation for those contaminants that exceed maximum contaminant levels (MCLs). The OU-1 remedy contains a P&T system to control groundwater contamination and to minimize exposure to potential receptors by minimizing the migration of contaminated groundwater.

The primary RAO for residual contaminated soil within the 1998 Mound site property boundary (Figure 2) is to ensure that exposures to soil do not result in an aggregate excess cancer risk of greater than the upper end of EPA's acceptable risk range of 1×10^{-4} to 1×10^{-6} or a hazard index greater than 1. This is accomplished primarily through the use of ICs at the site that:

- Limit land use to industrial/commercial usage only.
- Prohibit the removal of soil from the property unless prior written approval from Ohio EPA and ODH is obtained.

These RAOs are still valid based on existing regulations and guidance. The risk review supports the conclusion that these objectives continue to be met for site soils.

The long-term RAO for groundwater is to meet MCLs (1) through MNA in the Phase I and Parcels 6, 7, and 8 areas and (2) through hydraulic containment in the OU-1 area. Until these goals are achieved, the near-term RAO is to prohibit the extraction and use of groundwater underlying the premises unless prior written approval is obtained from Ohio EPA and ODH. The annual assessment of ICs ensures that controls remain in place and are effective.

6.6.5 Changes in Risk Assumptions Since Last Five-Year Review

There have been no changes in risk assumptions since the last five-year review.

6.7 Data Review

Groundwater data from calendar years 2011–2015 are discussed below for each of the three remedies (i.e., Phase I groundwater; Parcels 6, 7, and 8 groundwater; and the OU-1 P&T system). Annual reports were prepared for the Phase I MNA Groundwater Remedy since 2004 and for the Parcels 6, 7, and 8 MNA Groundwater Remedy since 2006. Data for the OU-1 P&T system has been reported in monthly project reports. Historical water quality and water-level data for existing wells can be found on the LM GEMS website: http://gems.lm.doe.gov/. Photographs, maps, and physical features can also be viewed on this website.

The monitoring programs at the Mound Site include sampling and analysis of water collected from onsite and offsite wells and onsite seeps. The monitoring programs are currently defined in the O&M Plan. This plan incorporated the previous plans *Phase I Remedy (Monitored Natural Attenuation) Groundwater Monitoring Plan* (DOE 2004c); *Parcel 6, 7, and 8 Remedy (Monitored Natural Attenuation) Groundwater Monitoring Plan* (DOE 2006c); and *OU-1 Pump and Treatment Operation and Maintenance Plan* (DOE 2000).

6.7.1 Phase I Groundwater

Groundwater in Phase I is monitored for TCE and its degradation products to verify that the concentration of TCE is decreasing by natural attenuation to concentrations less than the MCL. This groundwater monitoring program was established to ensure that the BVA is not negatively affected by TCE-contaminated groundwater within the Phase I bedrock aquifer system. The remedial action objectives are:

- Protect the BVA by verifying that the concentrations of TCE in the vicinity of well 0411, well 0443, and seep 0617 are decreasing and that TCE is not impacting the BVA.
- Demonstrate the reduction of TCE to concentrations below the MCL in well 0411, well 0443, and seep 0617.

Although not part of the selected remedy, monitoring was performed to evaluate the impact of barium, radium, chromium, and nickel on the Phase I groundwater. On the basis of investigations, none of these parameters were considered to be contaminants of concern in Phase I. The monitoring program for chromium and nickel was discontinued in 2009. The confirmatory sampling program for radium and barium was discontinued in 2013.

6.7.1.1 Contaminants of Interest

During the remedial investigation program for the project, VOC contamination was identified in the Phase I area. Concentrations of TCE greater than the MCL of 5 milligrams per liter (mg/L) were identified in well 0411 and seep 0617. Soil and groundwater data from the wells in the vicinity of well 0411 suggest that the TCE contamination is most likely limited to the area adjacent to the well. There is no known continuing source of TCE contamination in the soil in Phase I; however, TCE was widely used in plant operation.

6.7.1.2 Monitoring Program

Under the Phase I MNA monitoring program, samples are collected from selected wells and a seep (Figure 9) and analyzed as outlined in Table 17. Bedrock wells 0411 and 0443 are monitored to provide spatial coverage of flow paths in the immediate vicinity of the well 0411 area. Bedrock wells 0353, 0444, and 0445 and seep 0617 are monitored to provide spatial coverage of flow paths downgradient of the well 0411 area. In conjunction with the bedrock wells, BVA wells 0400, 0402, and P033 are monitored to assess potential movement of TCE from the bedrock system to the BVA.

Table 17. Remedy (MNA) Monitoring for Phase I

Monitoring Location	Area	Sampling Frequency	Parameters
Well 0411	Well 0411 Area	Semiannual (First and third quarter of each calendar year)	TCE DCE VC
Well 0443			
Well 0353	Downgradient Bedrock Monitoring		
Well 0444			
Well 0445			
Seep 0617			
Well 0400	BVA Monitoring		
Well 0402			
Well P033			

Notes:
Samples are collected and analyzed as outlined in the O&M Plan.
Sampling frequency for the MNA program was reduced to semiannually in 2007 with the approval of the Mound Core Team.

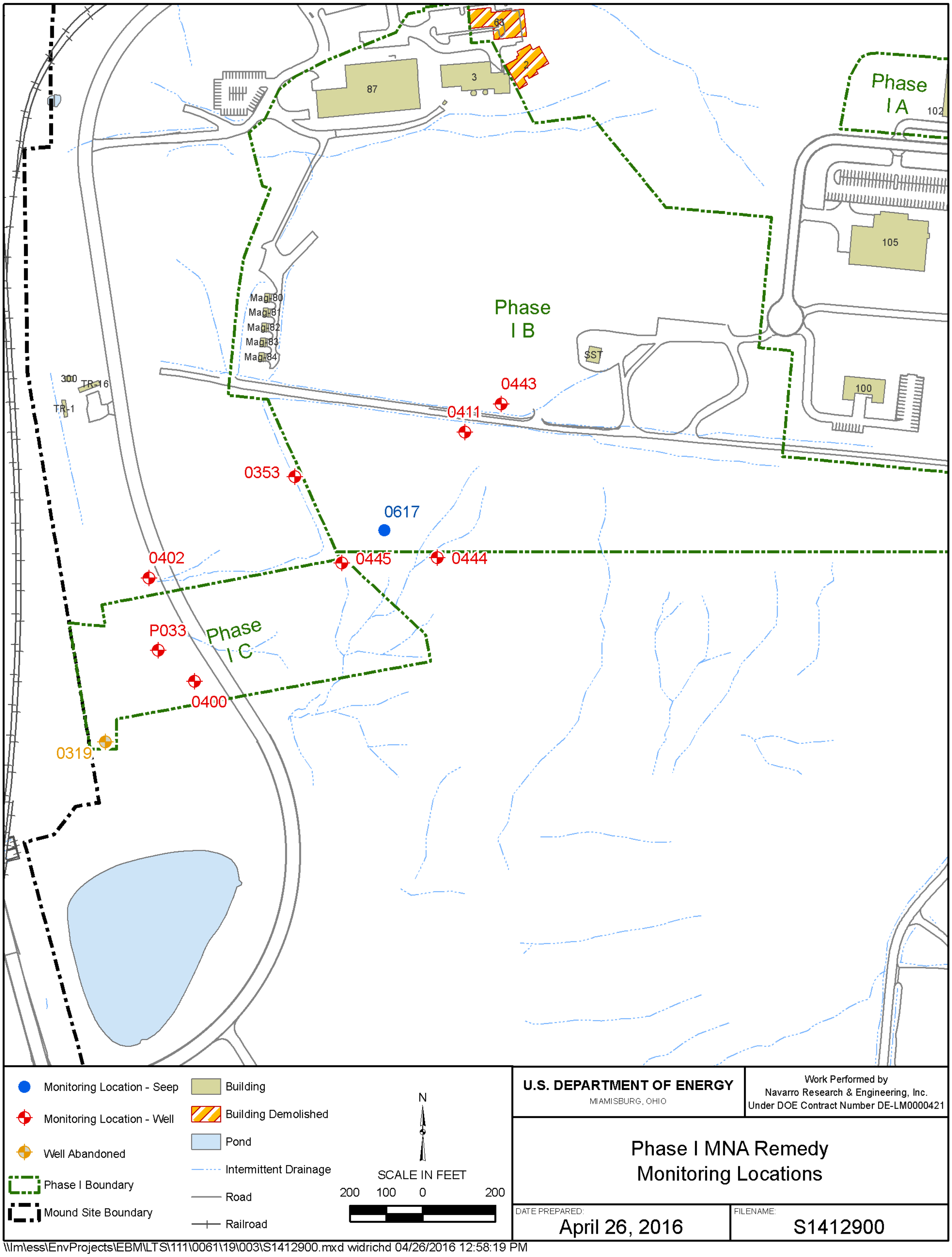

Figure 9. Phase I MNA Remedy Monitoring Locations

6.7.1.3 MNA Remedy Monitoring

Monitoring results (Table 18) continued to show low-level detections of TCE and *cis*-1,2-DCE, a TCE degradation product, in wells 0411 and 0443 and in seep 0617. All VOC concentrations were below the applicable trigger levels. Concentrations of TCE in wells 0411 and 0443 and seep 0617 continue to exceed the MCL of 5 µg/L. Sporadic low concentrations of *trans*-1,2-DCE have been reported in wells 0411 and 0443. No concentrations of VC were reported at these three monitoring locations. None of the BVA wells or downgradient bedrock wells indicated impact attributable to VOCs originating from the Phase I area. An estimated detection of TCE was reported in BVA well 0402; however, the value was within historical ranges and is attributable to VOC impact in OU-1. No detectable concentrations of *cis*-1,2-DCE, *trans*-1,2-DCE, or VC were reported in the BVA wells and downgradient bedrock wells.

Table 18. Summary of VOC Monitoring Results in Phase I—2011 through 2015

Well ID	Location	Parameter	2011	2012	2013	2014	2015
Source Area Wells							
0411	0411 Area	TCE (µg/L)	**10.0**	**13.0**	**12.9**	**11.3**	**10.6**
		cis-1,2-DCE (µg/L)	3.1	2.0	4.1	2.3	2.5
		trans-1,2-DCE (µg/L)	ND (< 1)	ND (< 1)	0.14 (J)	ND (< 1)	ND (< 1)
		VC (µg/L)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)
0443	0411 Area	TCE (µg/L)	**6.6**	**9.7**	**8.0**	**9.3**	**6.0**
		cis-1,2-DCE (µg/L)	0.36 (J)	0.51 (J)	0.48 (J)	0.45 (J)	0.30 (J)
		trans-1,2-DCE (µg/L)	ND (< 1)	0.25 (J)	ND (< 1)	0.19 (J)	ND (< 1)
		VC (µg/L)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)
0617	Seep/ Bedrock	TCE (µg/L)	**8.2**	4.8	**8.6**	**5.4**	**8.2**
		cis-1,2-DCE (µg/L)	1.8	1.2	2.0	1.2	1.2
		trans-1,2-DCE (µg/L)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)
		VC (µg/L)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)
Downgradient Wells							
0353	Bedrock	TCE (µg/L)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)
		cis-1,2-DCE (µg/L)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)
		VC (µg/L)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)
0444	Bedrock	TCE (µg/L)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)
		cis-1,2-DCE (µg/L)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)
		VC (µg/L)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)
0445	Bedrock	TCE (µg/L)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)
		cis-1,2-DCE (µg/L)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)
		VC (µg/L)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)
BVA Wells							
0400	BVA	TCE (µg/L)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)
		cis-1,2-DCE (µg/L)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)
		VC (µg/L)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)

Table 18 (continued). Summary of VOC Monitoring Results in Phase I—2011 through 2015

Well ID	Location	Parameter	2011	2012	2013	2014	2015
0402	BVA	TCE (μg/L)	ND (< 1)	1.8 (J)	ND (< 1)	0.71 (J)	ND (< 1)
		cis-1,2-DCE (μg/L)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)
		VC (μg/L)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)
P033	BVA	TCE (μg/L)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)
		cis-1,2-DCE (μg/L)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)
		VC (μg/L)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)

Note:
Values in **bold** exceed the MCL of 5 μg/L for TCE.

Abbreviations:
J = estimated value less than the reporting limit
μg/L = micrograms per liter
ND = not detected

TCE concentrations in well 0411 (Figure 10) generally have decreased since monitoring began in 1999. Since 2002, the concentrations of TCE in well 0411 have ranged between 9 and 15 μg/L. Concentrations of TCE in well 0443 and seep 0617 have varied since monitoring of these locations started in 2002. Concentrations of TCE in well 0443 have been consistently greater than the MCL since 2010. The time–concentration plots for well 0443 and seep 0617 indicate that concentrations vary and are less than those in well 0411.

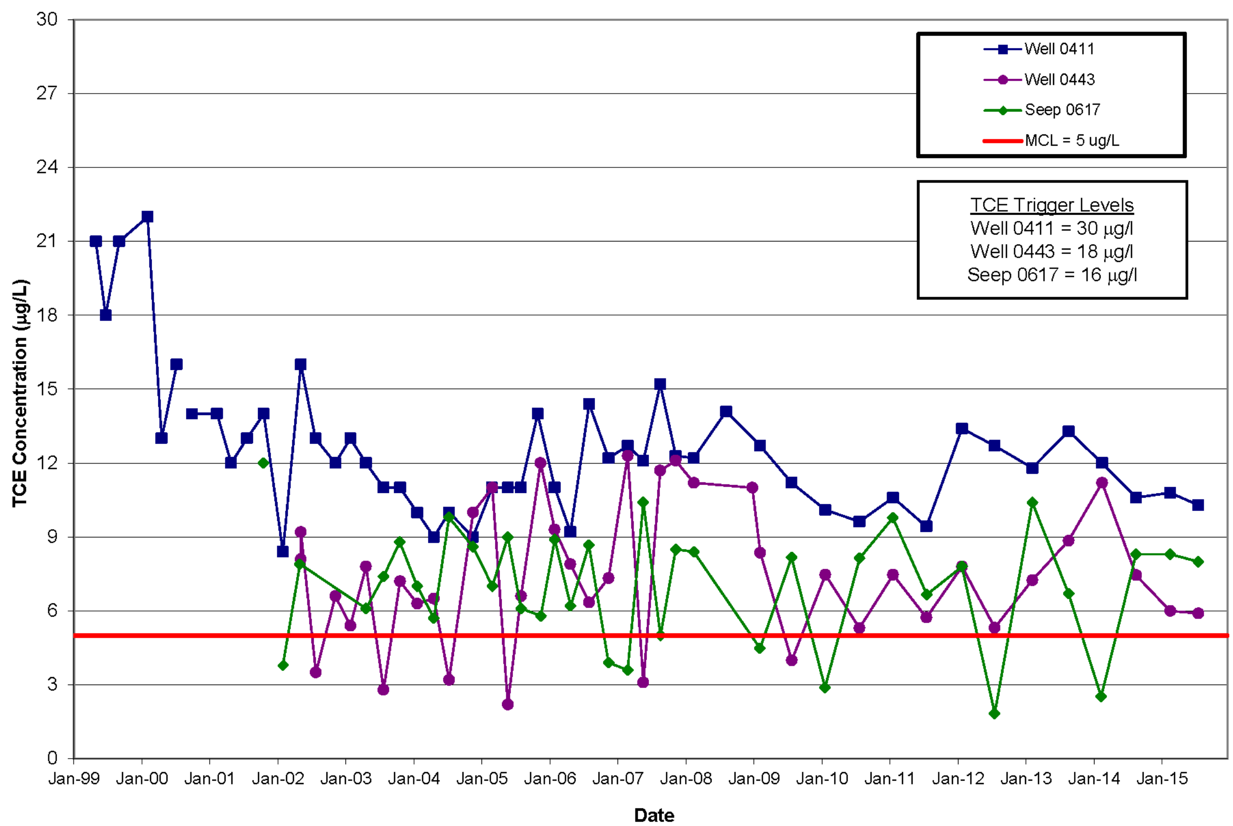

Figure 10. TCE Concentrations in Wells 0411 and 0443 and Seep 0617 (1999–2015)

The concentrations of *cis*-1,2-DCE in groundwater (Figure 11) have varied. Detectable concentrations have consistently been reported in well 0411 and seep 0617. Concentrations of *cis*-1,2-DCE in well 0411 have increased compared to monitoring results reported prior to 2009. Estimated detections less than 1 µg/L have been reported in well 0443 during the same period. None of the locations had concentrations of *cis*-1,2-DCE that exceeded the MCL of 70 µg/L.

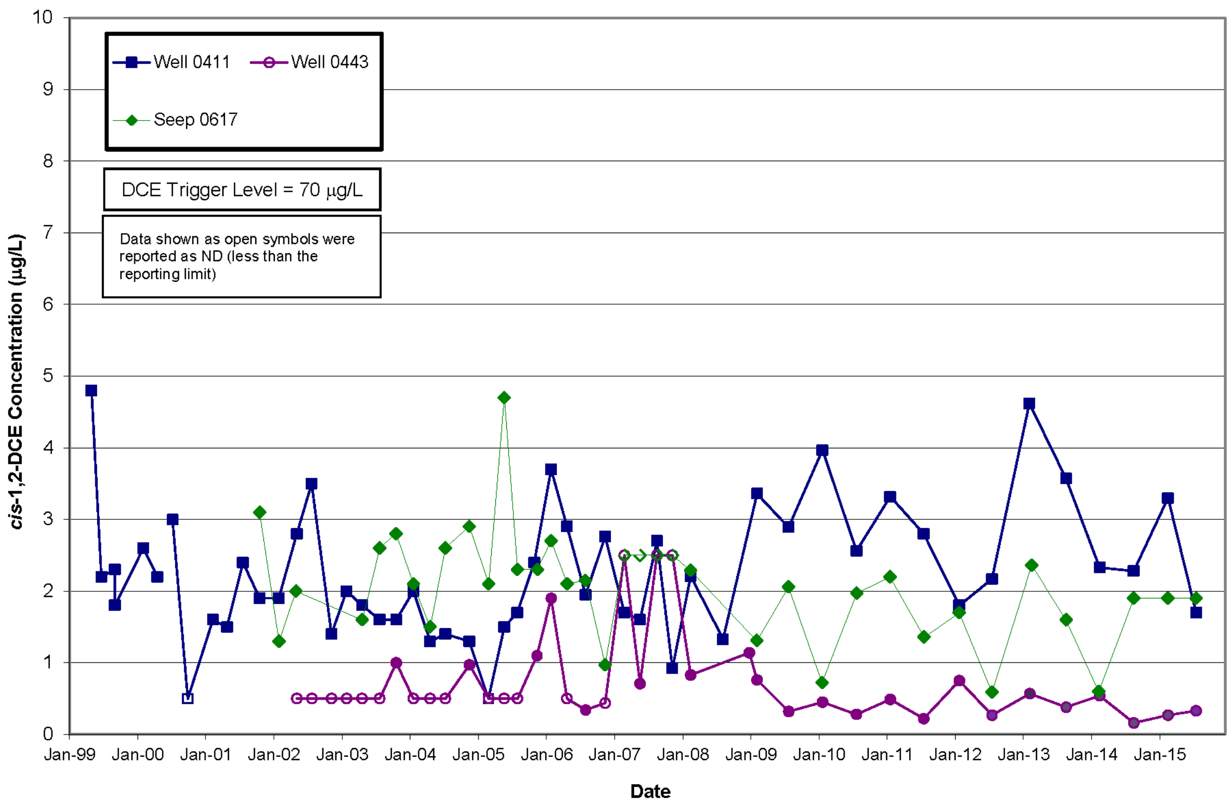

Figure 11. cis-1,2-DCE Concentrations (1999–2010)

Trend analysis was performed on TCE and *cis*-1,2-DCE data using the nonparametric Mann-Kendall test (DOE 2011b). This test is used for temporal trend identification, because it does not require the data to conform to a particular distribution (such as a normal or log-normal distribution). This type of long-term trend analysis can be used to confirm trends in contaminant concentrations over time.

A statistical downward trend was calculated for TCE in well 0411 (Table 19). No statistical trend, either upward or downward, was evident in the data for TCE in well 0443 and seep 0617.

Table 19. Summary of Trend Analysis Results for TCE in Phase I for 2015

Location	Analyte	No. of Samples	Trend	Trend Line Slope (μg/L/year)
0411	TCE	51	**Down**	–0.22
0443		39	None	0.10
0617		37	None	–0.06
0411	*cis*-1,2-DCE	51	**Up**	0.04
0443		39	**Down**	–0.05
0617		37	**Down**	–0.07

Abbreviation:
μg/L/year = micrograms per liter per year

Decreasing *cis*-1,2-DCE concentrations, although small, are present in well 0443 and seep 0617, as indicated by negative slopes. Statistical downward trends were calculated for *cis*-1,2-DCE at both locations. A small statistical upward trend was determined for the *cis*-1,2-DCE data in well 0411.

Evaluation of the slope of the downward trend in TCE concentrations in well 0411 may indicate the time frame when concentrations may approach the MCL of 5 μg/L. The nonparametric slope calculated for the trend analysis continues to suggest that the MCL may be reached by 2034. The nonparametric analysis typically represents the decrease of contaminant concentrations in groundwater over time and provides good estimates of cleanup time frames.

6.7.2 Parcels 6, 7, and 8 Groundwater

Groundwater in Parcels 6, 7, and 8 is monitored for TCE and its degradation products to verify that the downgradient BVA is not affected and concentrations are decreasing. In addition, groundwater discharging from seeps is monitored for TCE and its degradation products, tritium, and radioisotopes (strontium-90 [Sr-90], Ra-226, and Ra-228) to verify that source removal results in decreasing concentrations. The monitoring of Sr-90, Ra-226, and Ra-228 in Seep 0601 was discontinued in 2011.

The remedial action objectives include the following:

- Protect the downgradient BVA by verifying that TCE concentrations in the vicinity of wells 0315 and 0347 are decreasing and not impacting the BVA.
- Monitor the reduction of TCE concentrations to determine if they fall below the MCL in wells 0315 and 0347 and to verify the hypothesis that natural decomposition of TCE will result in concentrations below the MCL over time.
- Monitor the reduction of TCE and PCE concentrations and tritium activity to determine if those parameters fall below the MCLs in seeps 0601, 0602, 0605, 0606, and 0607 and to verify the hypothesis that—with the removal of the TCE, PCE, and tritium sources—natural decomposition of TCE and PCE and decay of tritium will result in concentrations below the MCL over time.

6.7.2.1 Contaminants of Interest

The primary contaminant of interest in the well 0315/0347 area is TCE. The primary contaminants of interest in the Main Hill seeps and downgradient groundwater are PCE, TCE, and tritium. The degradation products VC, *cis*-1,2-DCE, and *trans*-1,2-DCE are also monitored.

6.7.2.2 Monitoring Program

The sampling is separated into two programs that relate to the areas of impact. These areas are:

- **Wells 0315/0347 Area:** Wells at the edge of the BVA on the southwestern corner of Parcel 8 that have elevated concentrations of VOCs. The program consists of wells that have TCE greater than the MCL and downgradient wells to the west.
- **Main Hill Seeps:** Seeps on the northern and southern sides of the Main Hill that have elevated concentrations of VOCs and tritium. The program consists of seeps and downgradient wells to the west.

Under the Parcels 6, 7, and 8 MNA monitoring program, samples are collected quarterly for VOCs and semiannually for tritium in selected wells and seeps (Figure 12). Table 20 provides a summary of the monitoring locations as specified in the O&M Plan.

Table 20. Monitoring for Parcels 6, 7, and 8 Area (indicated by an "X")

Monitoring Location	Area	VOC	Tritium
Well 0315	Source wells	X	
Well 0347		X	
Well 0118	Downgradient BVA monitoring	X	X
Well 0124		X	
Well 0126		X	
Well 0138		X	X
Well 0301		X	X
Well 0346		X	X
Well 0379		X	X
Well 0386		X	
Well 0387		X	
Well 0389		X	
Well 0392		X	
Seep 0601	Main Hill seeps	X	X
Seep 0602		X	X
Seep 0605		X	X
Seep 0606		X	X
Seep 0607		X	X

Note:
In 2012, the sampling frequency for the tritium monitoring was reduced to semiannual with the approval of the Mound site Core Team (DOE 2014a).

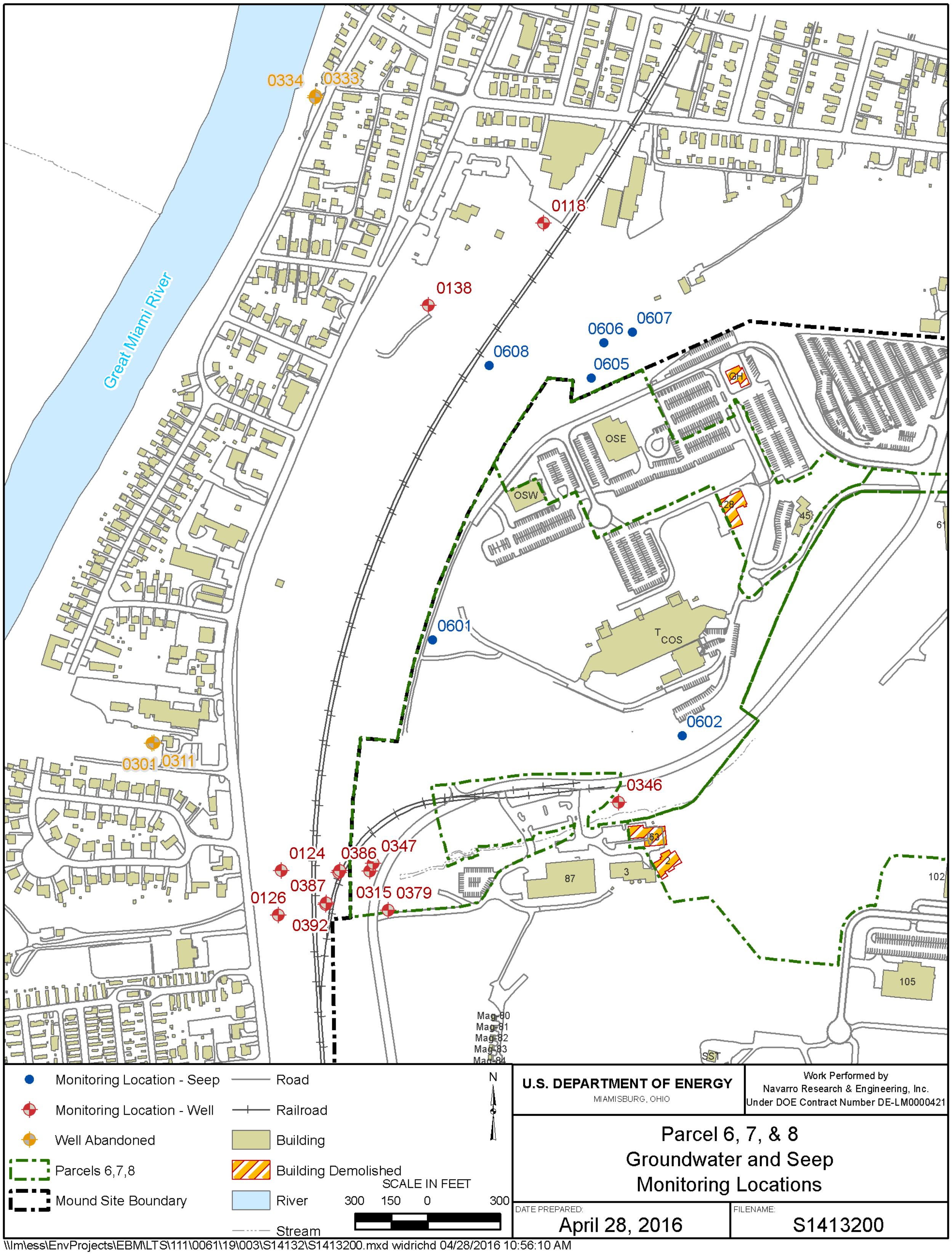

Figure 12. Parcels 6, 7, and 8 Groundwater and Seep Monitoring Locations

6.7.2.3 Monitoring Results, VOCs

Seeps

Concentrations of TCE in all Main Hill seeps continued to exceed the MCL (Table 21). However, no locations had concentrations that exceeded the trigger level of 150 µg/L (established for seep 0605). The highest concentrations of TCE continued to be measured in seep 0602, which is onsite. Seep 0602 was dry several times this reporting period and was not sampled during some quarters. PCE concentrations continued to exceed the MCL of 5 µg/L in seep 0601; however, PCE concentrations at this location did not exceed the trigger level of 75 µg/L. Low-level detections of PCE were reported in seeps 0602, 0605, and 0607. The VOC of *cis*-1,2-DCE was reported in seeps 0602, 0605, and 0607; seep 0602 had the highest concentrations. Estimated detections of *cis*-1,2-DCE (less than 1 µg/L) were reported in remainder of the seeps. Estimated detections of *trans*-1,2-DCE (less than 1 µg/L) were reported in seep 0602 and 0605. No VC was detected in the seeps.

Table 21. Summary of VOC Results in the Main Hill Area Seeps (2011–2015)

Location	Area	VOC	Average Concentrations (µg/L)				
			2011	2012	2013	2014	2015
Seeps							
0601	Onsite	TCE	4.8	3.7	**6.6**	4.9	4.7
		PCE	**8.7**	4.4	**7.6**	**6.5**	**10.3**
		cis-1,2-DCE	0.57 (J)	0.43 (J)	0.64 (J)	0.53 (J)	0.52 (J)
		trans-1,2-DCE	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)
0602	Onsite	TCE	**69.0**	**22.2**	**18.6**	**23.6**	**18.4**
		PCE	0.29 (J)	ND (< 1)	ND (< 1)	ND (< 1)	0.16 (J)
		cis-1,2-DCE	24.8	14.9	27.2	17.3	7.3
		trans-1,2-DCE	0.30 (J)	0.34 (J)	0.46 (J)	0.37 (J)	0.43 (J)
0605	Offsite	TCE	**13.2**	**14.8**	**13.3**	**11.2**	**10.9**
		PCE	0.22 (J)	0.20 (J)	0.18 (J)	0.17 (J)	0.23 (J)
		cis-1,2-DCE	4.1	2.1	2.0	4.4	2.2
		trans-1,2-DCE	0.25 (J)	0.30 (J)	0.29 (J)	0.20 (J)	0.20 (J)
0606	Offsite	TCE	2.9	**5.5**	**5.4**	3.5	3.2
		PCE	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)
		cis-1,2-DCE	0.52 (J)	0.68 (J)	0.64 (J)	0.71 (J)	0.39 (J)
		trans-1,2-DCE	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)
0607	Offsite	TCE	**5.7**	**6.5**	**7.2**	**5.6**	**4.8**
		PCE	ND (< 1)	0.17 (J)	0.11 (J)	0.17 (J)	0.18 (J)
		cis-1,2-DCE	1.0	0.68 (J)	0.88 (J	1.1	0.60 (J)
		trans-1,2-DCE	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)
0608	Offsite	TCE	0.94	1.5	0.66 (J)	0.68 (J)	0.80 (J)
		PCE	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)
		cis-1,2-DCE	0.15 (J)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)
		trans-1,2-DCE	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)

Notes:
PCE trigger level at 0601 = 75 µg/L.
TCE trigger level at the seeps = 150 µg/L.
Values in **bold** exceed the MCL.

Abbreviations:
ND = not detected
J = estimated value that is less than the reporting limit

A graph of TCE concentrations (Figure 13) measured in the seeps since the remediation of contaminated buildings and soil on the Main Hill (completed in mid-2006) shows that the highest concentrations of TCE were measured in seeps 0602 and 0605. Concentrations of TCE have varied significantly in seep 0602, ranging from 15 to 139 µg/L. Concentrations of TCE in seep 0605 are relatively stable, and the remainder of the seeps follow a similar fluctuation. TCE concentrations in seep 0605 have been consistently less than 20 µg/L, and the concentrations in the remainder of the seeps have been less than 10 µg/L.

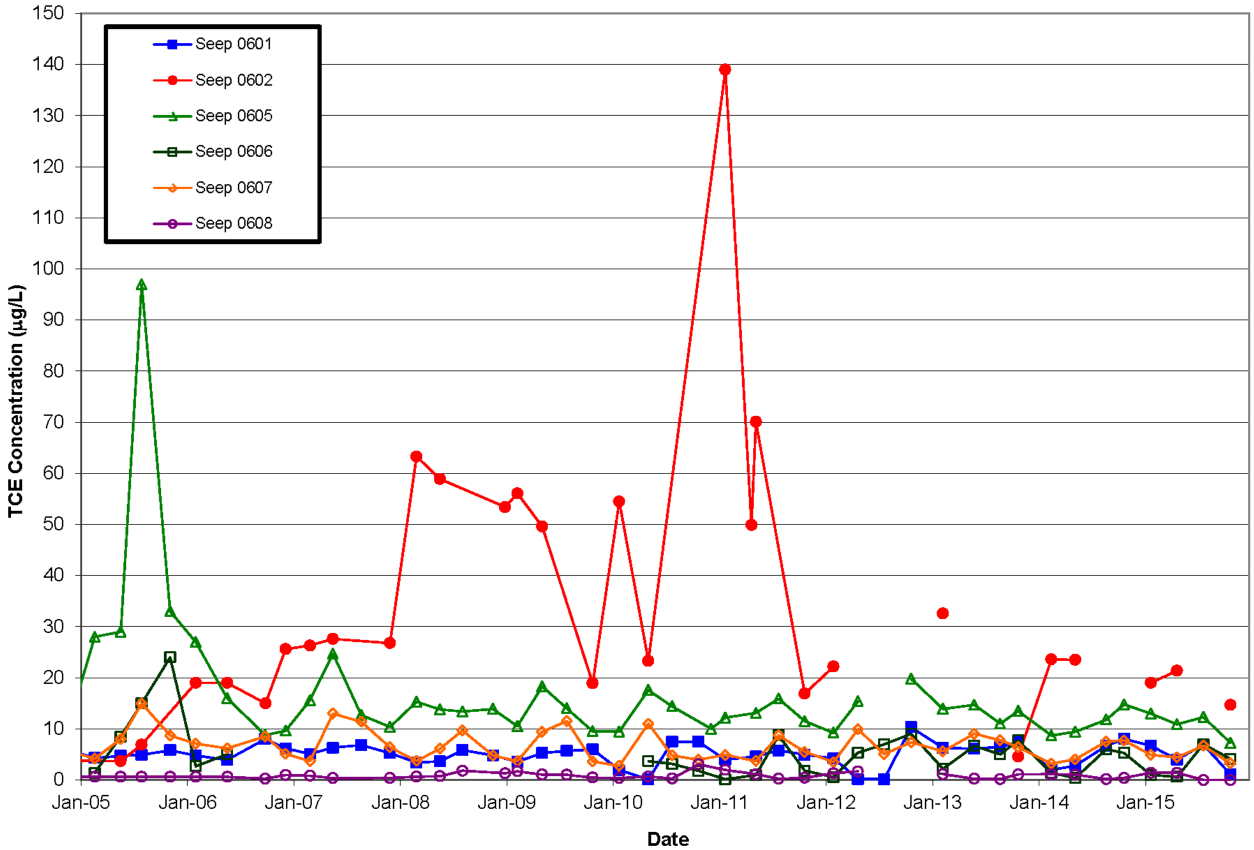

Figure 13. TCE Concentrations in Parcels 6, 7, and 8 Main Hill Seeps

Seep 0601 is the only location where detectable concentrations of PCE were reported. PCE concentrations in this seep (Figure 14) have decreased since remediation on the Main Hill. Estimated detections of PCE (less than 1 µg/L) have been reported in seeps 0602, 0605, and 0607.

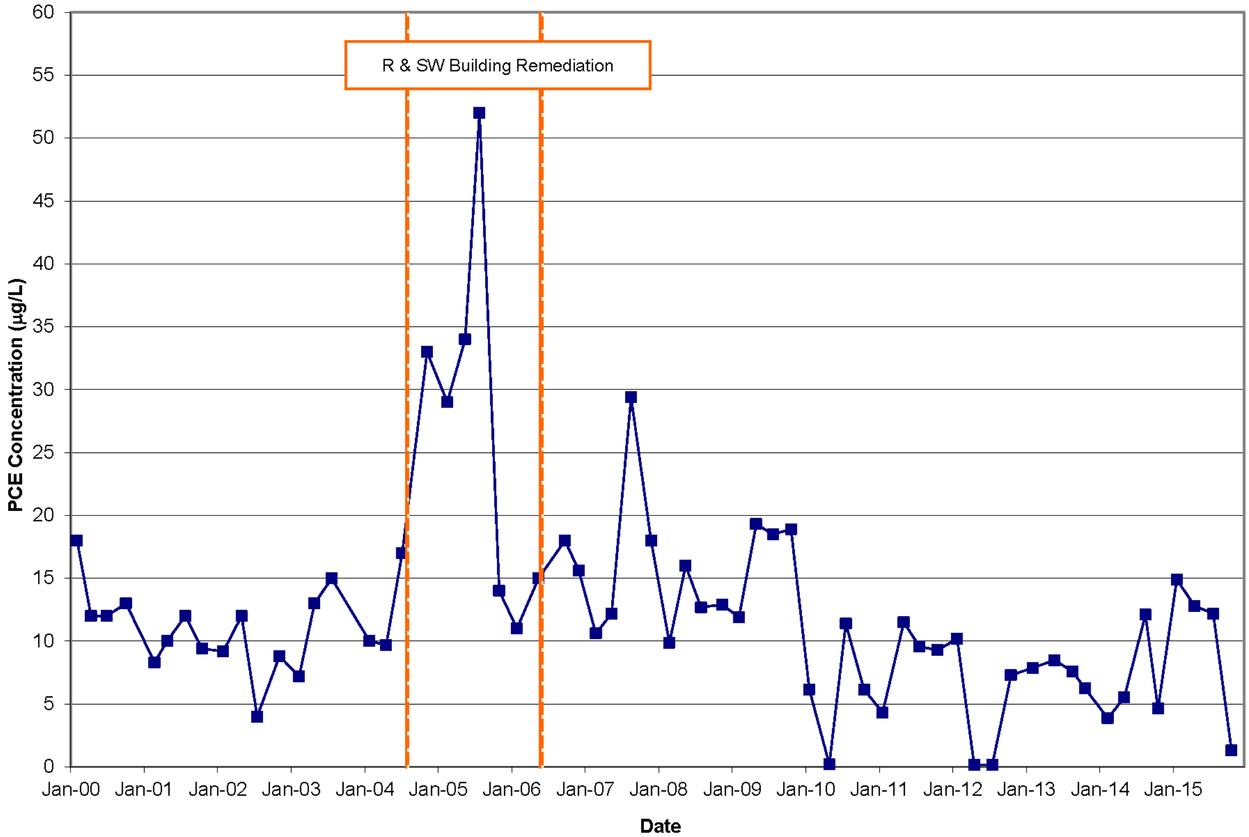

Figure 14. PCE Concentrations in Parcels 6, 7, and 8 Seep 0601

Groundwater

Monitoring results (Table 22) continue to show TCE in wells 0315, 0347, 0379, and 0386; the highest concentrations are detected in wells 0315 and 0347 (source area wells), where concentrations also exceed the MCL. The concentrations of TCE reported in wells 0315 and 0347 were less than the trigger level of 30 µg/L established for these source area wells, except for one time (third quarter 2012) in well 0347. Well 0386 is located downgradient of wells 0315 and 0347 just outside the Mound site boundary. Well 0379 is located onsite within the tributary valley, where wells 0315 and 0347 are also located. Estimated detections of TCE were reported in wells 0387, 0389, and 0392. No detectable concentrations of TCE were measured in the other wells. All TCE concentrations were below applicable trigger levels.

Estimated detections of PCE less than 1 µg/L were reported in wells 0126, 0379, 0386, 0387, 0389, and 0392. All of these wells are located where the tributary valley enters into the BVA. No trigger levels for PCE have been set for these locations. No detectable concentrations of *cis*-1,2-DCE, *trans*-1,2-DCE, or VC were reported in any of the wells monitored as part of this program.

Table 22. Summary of VOC Results in the Main Hill Area Groundwater (2011–2015)

Location	Area	VOC Concentrations					
		VOC	**2011**	**2012**	**2013**	**2014**	**2015**
Onsite Wells							
0315	Source Area	PCE (µg/L)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)
		TCE (µg/L)	**9.7**	**12.5**	**10.7**	**10.0**	**7.6**
0347	Source Area	PCE (µg/L)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)
		TCE (µg/L)	**24.4**	**27.2**	**25.2**	**21.5**	**21.8**
0346	Onsite	PCE (µg/L)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)
		TCE (µg/L)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)
0379	Onsite	PCE (µg/L)	0.37 (J)	0.34 (J)	0.34 (J)	0.34 (J)	0.33 (J)
		TCE (µg/L)	1.6	1.9	1.9	2.0	1.6
Downgradient Wells—Near							
0386	BVA	PCE (µg/L)	ND (< 1)	0.19 (J)	0.17 (J)	0.16 (J)	0.16 (J)
		TCE (µg/L)	1.7	2.7	2.7	2.1	2.1
0387	BVA	PCE (µg/L)	0.21 (J)	0.25 (J)	0.23 (J)	0.21 (J)	0.26 (J)
		TCE (µg/L)	ND (< 1)	ND (< 1)	0.39 (J)	0.13 (J)	0.12 (J)
0389	BVA	PCE (µg/L)	0.30 (J)	0.23 (J)	0.22 (J)	0.17 (J)	ND (< 1)
		TCE (µg/L)	0.62 (J)	0.42 (J)	0.35 (J)	0.35 (J)	0.22 (J)
0392	BVA	PCE (µg/L)	0.28 (J)	0.28 (J)	0.31 (J)	0.29 (J)	0.28 (J)
		TCE (µg/L)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)
Downgradient Wells—Far							
0118	BVA	PCE (µg/L)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)
		TCE (µg/L)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)
0124	BVA	PCE (µg/L)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)
		TCE (µg/L)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)
0126	BVA	PCE (µg/L)	0.89 (J)	0.91 (J)	0.92 (J)	0.85 (J)	0.92 (J)
		TCE (µg/L)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)
0138	BVA	PCE (µg/L)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)
		TCE (µg/L)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)	ND (< 1)

Notes:
PCE trigger level at 0601 = 75 µg/L.
TCE trigger level at the seeps = 150 µg/L.
Values in **bold** exceed the MCL.

Abbreviations:
ND = not detected
J = estimated value that is less than the reporting limit

A graph of TCE concentrations measured in select wells shows that concentrations in wells 0315 and 0347 have consistently been greater than the MCL of 5 µg/L (Figure 15). The concentrations of TCE in the downgradient wells have been less than the MCL since 2000.

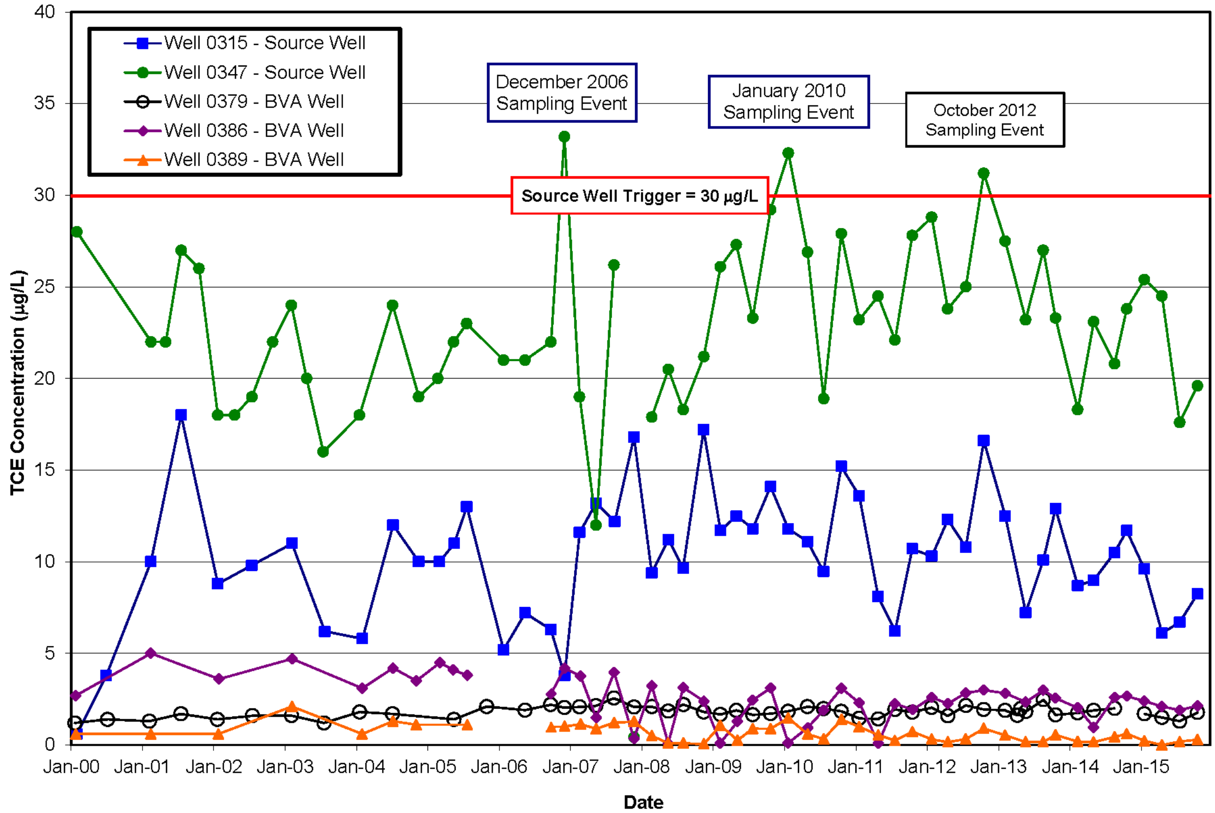

Figure 15. TCE Concentrations in Parcels 6, 7, and 8 Groundwater

Data collected over the past several years indicates variable concentrations of VOCs, primarily TCE, in the groundwater in Parcels 6, 7, and 8 as exhibited from the data from seep 0602 (Figure 13) and wells 0315 and 0347 (Figure 15). Increases in VOCs were first observed in seep 0602 starting in 2008. Increases in VOC concentrations in the wells were observed later. An investigation for the cause(s) for the increases was initiated in 2011 (DOE 2014d). The most probable cause for the changes and overall increases may be surface water infiltration that resulted in flushing residual VOCs from the vadose zone. Site improvement by others started not long after remediation activities were completed on the Main Hill and continued for several years. Several observances of surface water entering the subsurface were noted in the field. In late 2009 it was determined that grading had exposed two manholes over a large tritium capture pit, which extended into the bedrock. Another instance was surface water entering the subsurface along the foundation of the east head house of T Building. It is possible that surface water has found other access points into the subsurface via abandoned utility lines or other access ports that have been exposed by construction activities. All observed occurrences of surface water entering the subsurface were repaired.

Seep 0602 and the downgradient wells 0315 and 0347 are located in the Tributary Valley. The Tributary Valley is a narrow tongue of glacial deposits connected to the BVA that overlies the fractured bedrock at the site. Water infiltrating on the Main Hill moves through the fractured bedrock and ultimately discharges into the unconsolidated materials. Figure 16 depicts the bedrock topography beneath the Tributary Valley. Groundwater flow within the bedrock is strongly influenced by the bedrock topography (DOE 1994). TCE-impacted groundwater originated on the Main Hill may move southward and discharge to seeps or the Tributary Valley.

Seep 0602 is located along the northern side of the Tributary Valley and the wells are located along the axis of the valley.

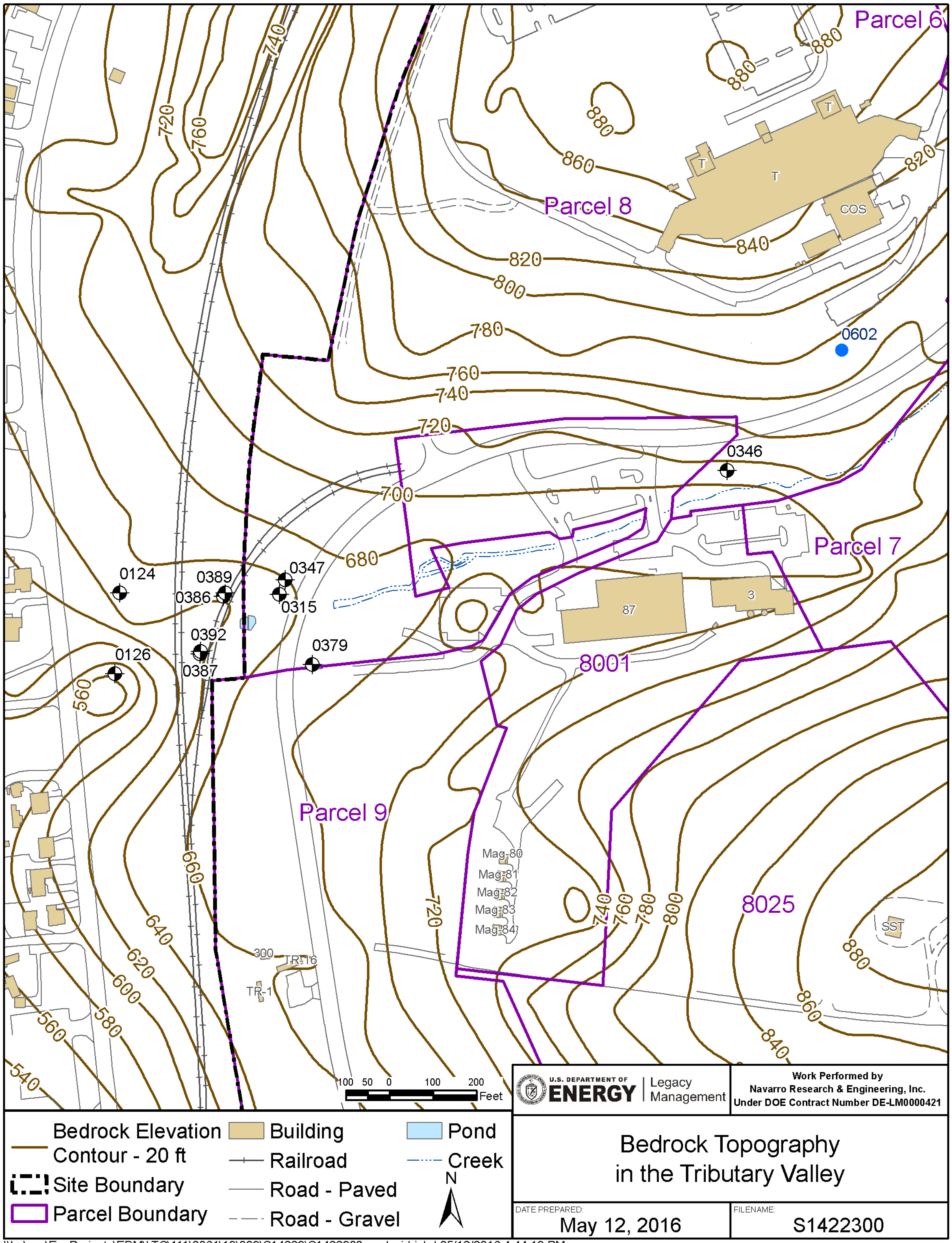

Figure 16. Bedrock Topography in the Tributary Valley

Figure 17 depicts the cross section along the transect from well pair 0315/0347 within the Tributary Valley to well 0126 in the BVA. Annual average TCE concentrations posted on the cross section show that the deep wells that are screened directly above the bedrock have the highest TCE concentrations. It is likely that these wells monitor the TCE-impacted groundwater discharging from the bedrock.

Analysis of TCE data collected since 2005 indicated increasing TCE concentrations in seep 0602 and well 0347, as implied by positive slopes (Table 23). The increases at these two locations do not constitute a statistical upward trend in the data. The concentrations at these two locations are higher than those generally measured prior to soil remediation on the Main Hill. Concentrations observed since the 2008 through 2011 timeframe in seep 0602 are declining as well as the concentration measured in the wells during the 2009 through 2012 timeframe. No exceedances of the trigger level for TCE in the source wells have occurred since 2012.

Data analysis indicated decreasing TCE concentrations in seeps 0605, 0606, 0607, and 0608 and wells 0315, 0386, and 0389. Statistical downward trends in TCE concentrations were calculated for seep 0605 and wells 0386 and 0389 (Table 23). A statistical downward trend in PCE concentrations was calculated for data from seep 0601. Concentrations of *cis*-1,2-DCE are decreasing in seeps 0602 and 0605. A statistical downward trend was calculated for seep 0605.

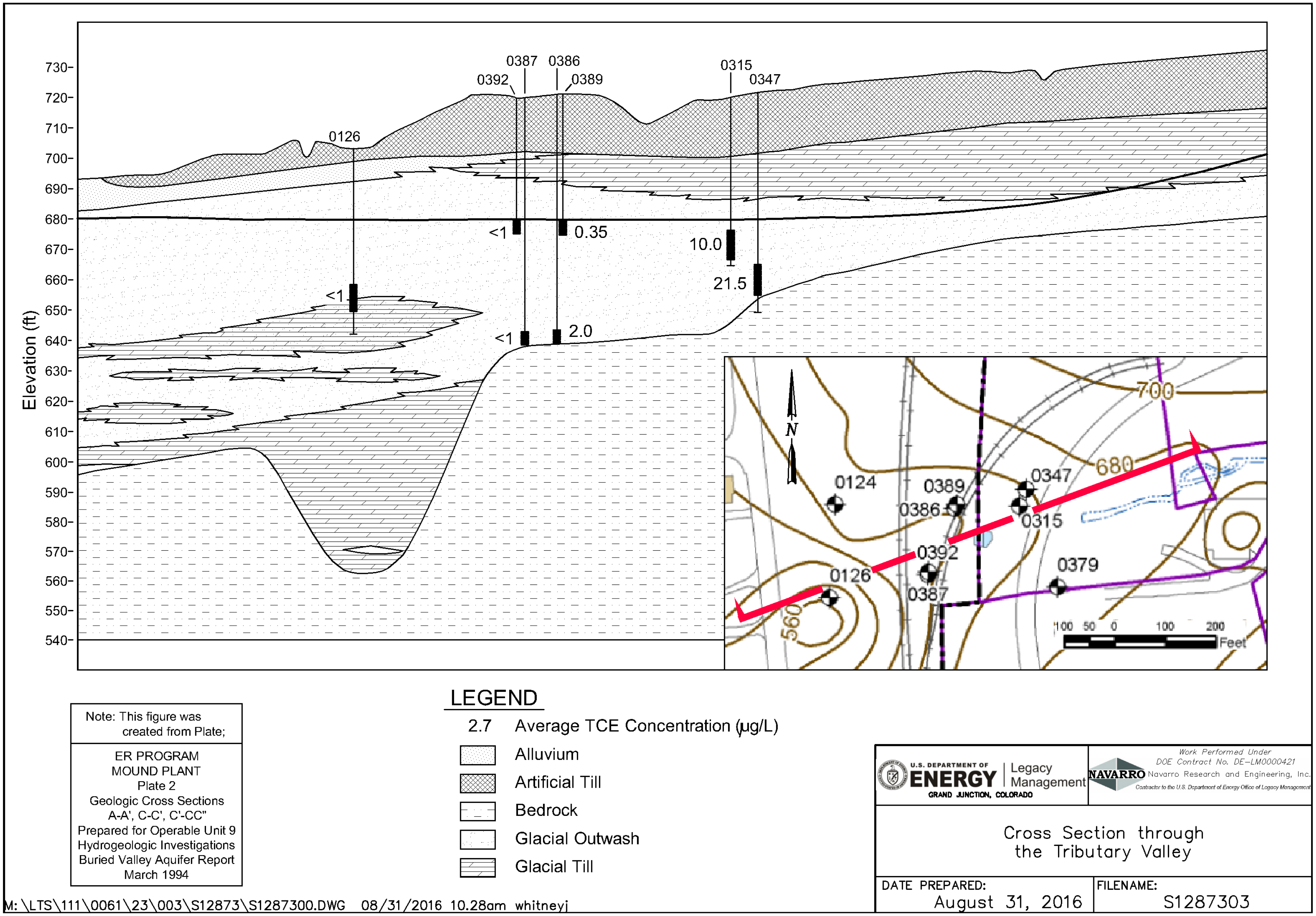

Figure 17. Cross Section Through the Tributary Valley

Table 23. Summary of Trend Analysis Results for VOCs in Parcels 6, 7, and 8 (2005–2015)

Location	Number of Samples	Trend	Trend Line Slope (µg/L/year)
TCE			
0601	44	None	0.06
0602	29	None	0.20
0605	44	**Down**	–0.64
0606	29	None	–0.20
0607	44	None	–0.20
0608	41	None	–0.03
0315	43	None	–0.14
0347	43	None	0.24
0386	41	**Down**	–0.11
0389	39	**Down**	–0.09
PCE			
0601	45	**Down**	–1.2
***cis*-1,2-DCE**			
0602	29	None	–0.44
0605	44	**Down**	–1.4

Abbreviation:
µg/L/year = micrograms per liter per year

6.7.2.4 Monitoring Results, Tritium

Tritium levels in the Main Hill seeps continued to be elevated during the review period and were higher than those in the downgradient groundwater wells (Table 24). The highest tritium activity was observed in seep 0601, which is located onsite. Seep 0601 is the only location that exceeded the MCL of 20 nanocuries per liter (nCi/L) during 2015. None of the seeps had tritium levels that exceeded the trigger level of 1,500 nCi/L.

Elevated tritium continued to be measured in well 0347. The remaining wells had tritium levels less than 1.1 nCi/L, which is similar to the background level of 0.77 nCi/L (DOE 1996). None of the groundwater wells had tritium activity levels that exceeded the MCL of 20 nCi/L.

Table 24. Summary of Tritium Results in the Main Hill Area (2011–2015)

Location	Average Tritium Activity (nCi/L)				
	2011	2012	2013	2014	2015
Seeps					
0601	**42.8**	**43.1**	**36.6**	**24.0**	**25.6**
0602	10.6	8.1	8.8	4.6	7.3
0605	13.3	9.9	10.2	7.2	8.1
0606	6.9	7.0	5.2	4.2	4.0
0607	5.4	4.9	4.8	3.2	3.3
0608	10.0	8.9	7.2	6.1	6.0
Downgradient Wells					
0118	ND (<0.22)	ND (<0.32)	ND (<0.34)	ND (<0.22)	ND (<0.36)
0138	1.2	1.1	0.74	0.74	0.74
0346	1.2	0.95	0.58	0.61	0.38
0347	4.5	4.2	2.4	2.4	2.3
0379	1.4	1.7	1.1	1.1	0.99

Notes:
Tritium trigger level at the seeps = 1,500 nCi/L.
Values in **bold** exceed the MCL of 20 nCi/L.

Abbreviation:
ND= not detected

Tritium levels in the seeps were highest during remediation activities on the Main Hill (2004−2006). Tritium data collected after building demolition and soil removal indicate decreasing levels in all of the seeps (Figure 18). The decrease in tritium levels in post-remediation data continues to support the hypothesis that the majority of the source was removed from the Main Hill area and that, with continued flushing, levels should continue to decline. Starting in 2009, the tritium levels in all of the seeps except seep 0601 were less than the MCL of 20 nCi/L. Changes in tritium levels in seep 0601 may indicate a seasonal effect, as levels are typically higher in late summer to early fall. Variation in tritium levels in seep 0602 may also follow a similar pattern, but is less pronounced. This fluctuation pattern is not observed in the groundwater wells. Comparisons of tritium levels in the seeps with those measured in downgradient monitoring wells indicate that the seeps responded more quickly than the wells because they are direct discharge points for groundwater originating beneath the Main Hill.

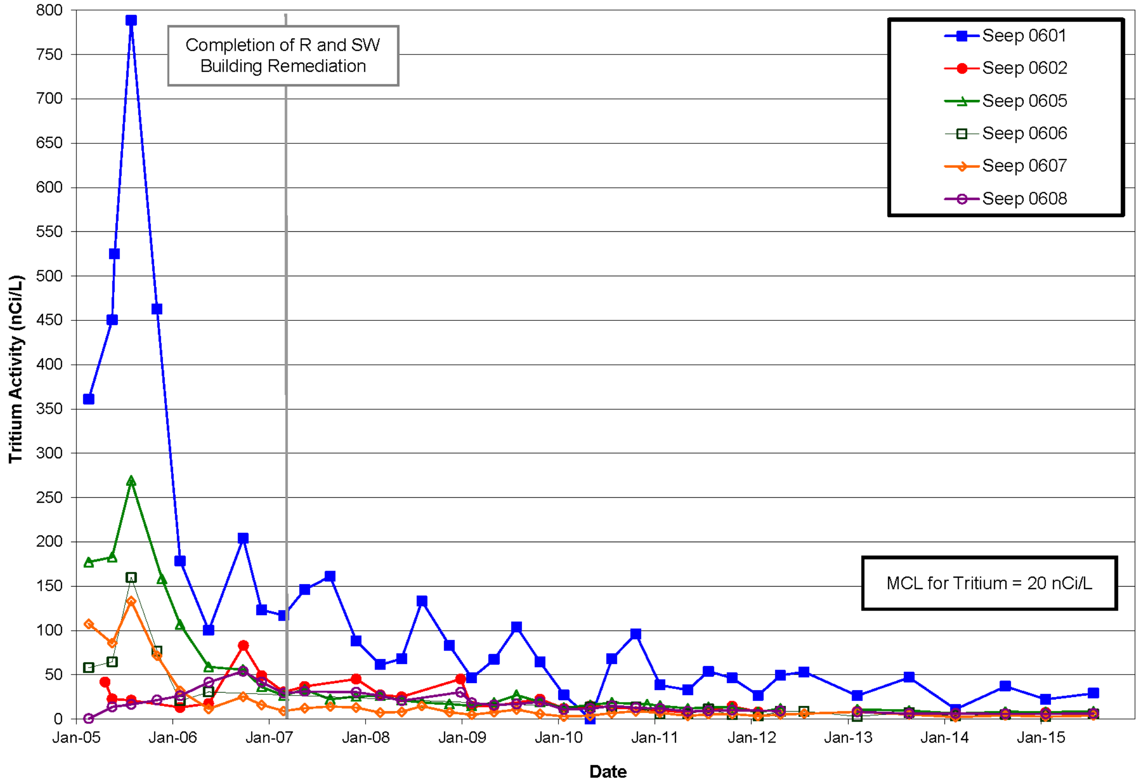

Figure 18. Tritium Activity in Parcels 6, 7, and 8 Main Hill Seeps

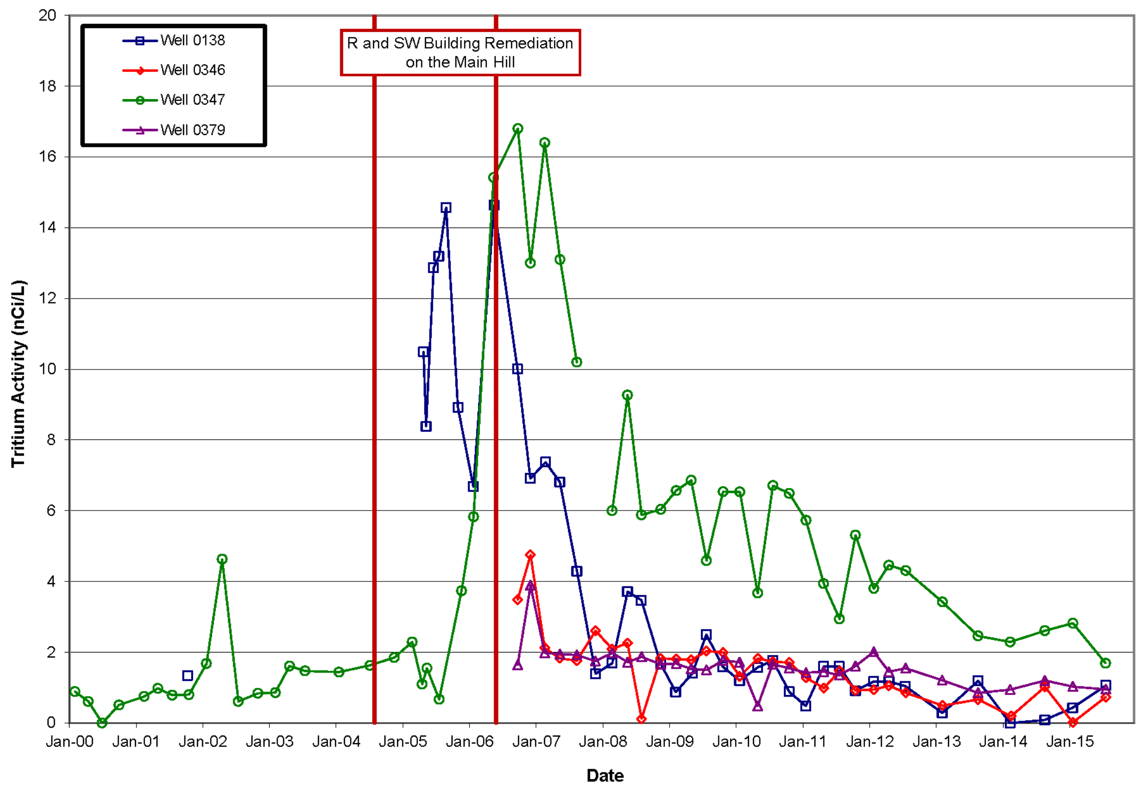

Figure 19. Tritium Activity in Parcels 6, 7, and 8 Wells 0138, 0346, 0347, and 0379

Five wells downgradient of the Main Hill area continued to show detectable levels of tritium in 2010 (Table 24). The highest levels were observed in well 0347, downgradient of seeps 0601 and 0602. The four remaining wells had tritium activity levels similar to background (1.5 nCi/L). None of the groundwater wells had tritium activity levels that exceeded the MCL of 20 nCi/L (Figure 19).

Trend analysis for tritium data collected since 2005 indicates decreasing tritium levels in all of the seeps and the four wells with detectable tritium levels, as implied by negative line slopes. Statistical downward trends in tritium were calculated in all of the seeps and wells (Table 25).

Table 25. Summary of Trend Analysis Results for Tritium in the Main Hill Seeps and Downgradient Wells (2005−2015)

Location	Number of Samples	Trend	Trend Line Slope (nCi/L/year)
0601	38	**Down**	–20.1
0602	25	**Down**	–3.1
0605	37	**Down**	–4.1
0606	22	**Down**	–3.2
0607	37	**Down**	–1.8
0608	35	**Down**	–2.4
0138	39	**Down**	–1.0
0346	41	**Down**	–0.38
0347	38	**Down**	–0.29
0379	36	**Down**	–0.08

Abbreviation:
nCi/L/year = nanocuries per liter per year

6.7.3 Operable Unit 1

Data necessary to assess the performance of the OU-1 P&T system are outlined in the O&M Plan which incorporated the requirements of the *OU-1 Pump and Treatment Operation and Maintenance Plan* (DOE 2000). The performance of the P&T system was assessed by three different metrics:

- System uptime versus downtime
- Hydraulic containment of the contaminant plume/area
- VOC mass removal and mass removal rate

When these three factors were maximized, then the system was operating in an acceptable manner. A large amount of data was collected for the OU-1 P&T system to monitor the performance of the system. This data included water-level measurements, groundwater samples, effluent samples, influent samples, and volumes treated.

Below is a chronology of recent activities that have been performed in the OU-1 area. Operation of the P&T system was modified to address the changing conditions as activities progressed. Focus was placed on maintaining hydraulic capture and assessing downgradient groundwater quality.

2007 through 2009	Phase I of the OU-1 landfill excavation
2010	Phase 2 of the OU-1 landfill excavation
2011	Second contaminant rebound test. P&T system was placed in standby from June to December.
2012	VOC investigations consisting of groundwater and soil-gas sampling.
2013	MNA evaluation consisting of groundwater sampling, pumping test, capture analysis, and soil sampling.
2014	OU-1 EA Field Demonstration was started. Injection of neat and emulsified oils was performed, and the P&T system placed in standby in September.

Monitoring programs were documented in the following plans:

- Work Plan for the Replacement of the OU-1 Extraction Wells (DOE 2007a)
- Operable Unit 1 Rebound Study Work Plan and Groundwater Exit Strategy (DOE 2011d)
- OU-1 Enhanced Attenuation Field Demonstration Sampling and Analysis Plan Mound, Ohio, Site (DOE 2014d)

6.7.3.1 System Performance

The P&T system is designed to operate continuously, or as near to as continuous as practicable, as it is the primary system that contains the contaminant plume. The P&T system has generally run more than 90 percent of the time each month. Downtime is typically for general maintenance activities. Exceptions are the result of mechanical failures or power outages, which resulted in shorter percentages of operation.

Instances where extended shutdowns occurred were:

- Contaminant rebound study, June through December 2011
- OU-1 EA Field Demonstration, September 2014, ongoing

The extraction rates of the wells were periodically adjusted to provide adequate capture without pumping more water than was necessary. The average daily extraction rates in well 0449 and 0450 from 2012 through August 2014 are shown in Figure 20.

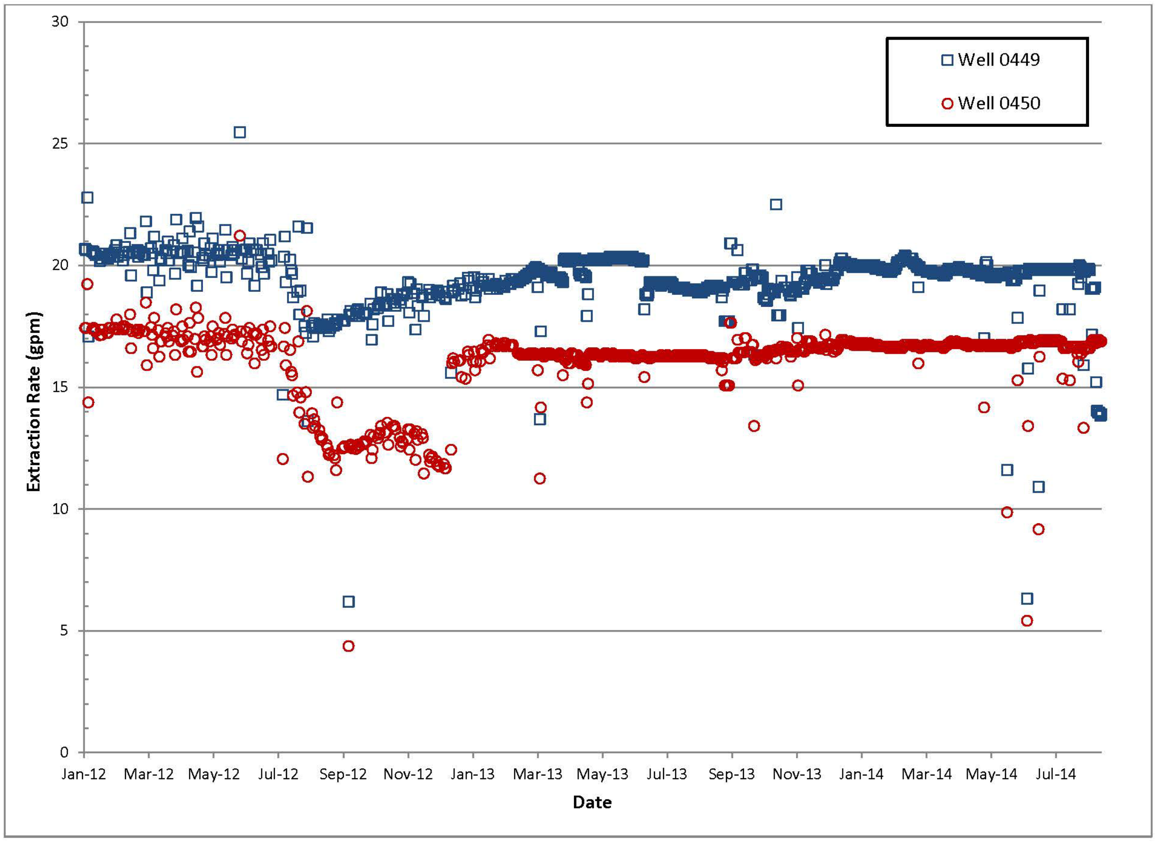

Figure 20. Extraction Rates in Wells 0449 and 0450

The VOC contaminants of concern were monitored monthly in the influent and effluent as well as the extraction wells. Historically, the influent concentrations were used to determine the mass of contaminants removed; however, in 2003 determination of the mass removed was discontinued because it was deemed minimal. A summary of the average and maximum VOC concentrations reported in the extraction wells is presented in Table 26. No data are reported for 2015 as the P&T system was in standby mode to support the ongoing EA field demonstration.

Table 26. Summary of VOC Concentrations in OU-1 Extraction Wells (μg/L)

Well	Analyte	2011		2012		2013		2014	
		average	max	average	max	average	max	average	max
0449	PCE	2.4	5.0	2.0	3.0	1.6	2.0	1.5	1.7
	TCE	4.2	9.0	3.6	5.4	1.8	2.6	1.4	1.6
	cis-DCE	<1	0.99	<1	0.47	ND	ND	<1	0.55
	trans-DCE	ND	ND	ND	ND	ND	ND	ND	ND
	VC	ND	ND	ND	ND	ND	ND	ND	ND
0450	PCE	6.4	7.7	5.2	6.7	4.1	4.8	3.7	4.3
	TCE	12.1	18.5	8.6	14.5	5.4	6.5	4.6	4.96
	cis-DCE	1.4	2.4	1.0	1.8	0.57	0.73	0.58	0.83
	trans-DCE	ND	ND	ND	ND	ND	ND	ND	ND
	VC	ND	ND	ND	ND	ND	ND	ND	ND

Abbreviation:
ND = not detected

6.7.3.2 Hydraulic Capture

Local hydraulic gradients were determined by conducting three-point evaluations using monitoring wells along the southern (downgradient) boundary of the landfill. The groundwater gradients were calculated to determine whether groundwater flow direction has been reversed and flow was coming inward across the compliance boundaries. It was assumed from a groundwater model that complete hydraulic control could be assumed if a 0.002 ft/ft average inward gradient was maintained across at least a 25 ft wide border centered on the compliance boundary. At some times, the 0.002 ft/ft gradient was not continuously maintained across the compliance boundary; however, the results did show capture of the contaminated groundwater by maintaining a positive (inward) gradient across the southern side of the landfill. Instances when the inward gradient was less than 0.002 ft/ft corresponded to times when the extraction well pumping rates were declining and the wells needed redevelopment or during transient events when the water table was significantly affected by recharge from the river (high river stage) and the groundwater flow directions were atypical.

6.7.3.3 Groundwater Monitoring

Starting in 2011, monitoring primarily focused on supporting the contaminant rebound study, which started in June 2011. Groundwater samples were collected for VOC analysis from select wells in the OU-1 area. Initially, wells were sampled biweekly to monitor the changes in VOC distribution and to ensure that unacceptable migration of VOC-impacted groundwater did not occur. Later, the frequency was reduced to monthly. Monitoring wells were divided into the following categories:

- Source Area
- Capture Zone
- Downgradient

As additional field work was performed in support of several additional studies and investigations after the completion of the rebound study in December 2011, the monitoring program remained as monthly sampling and new wells were added. Figure 21 shows the monitoring network in place as of 2014.

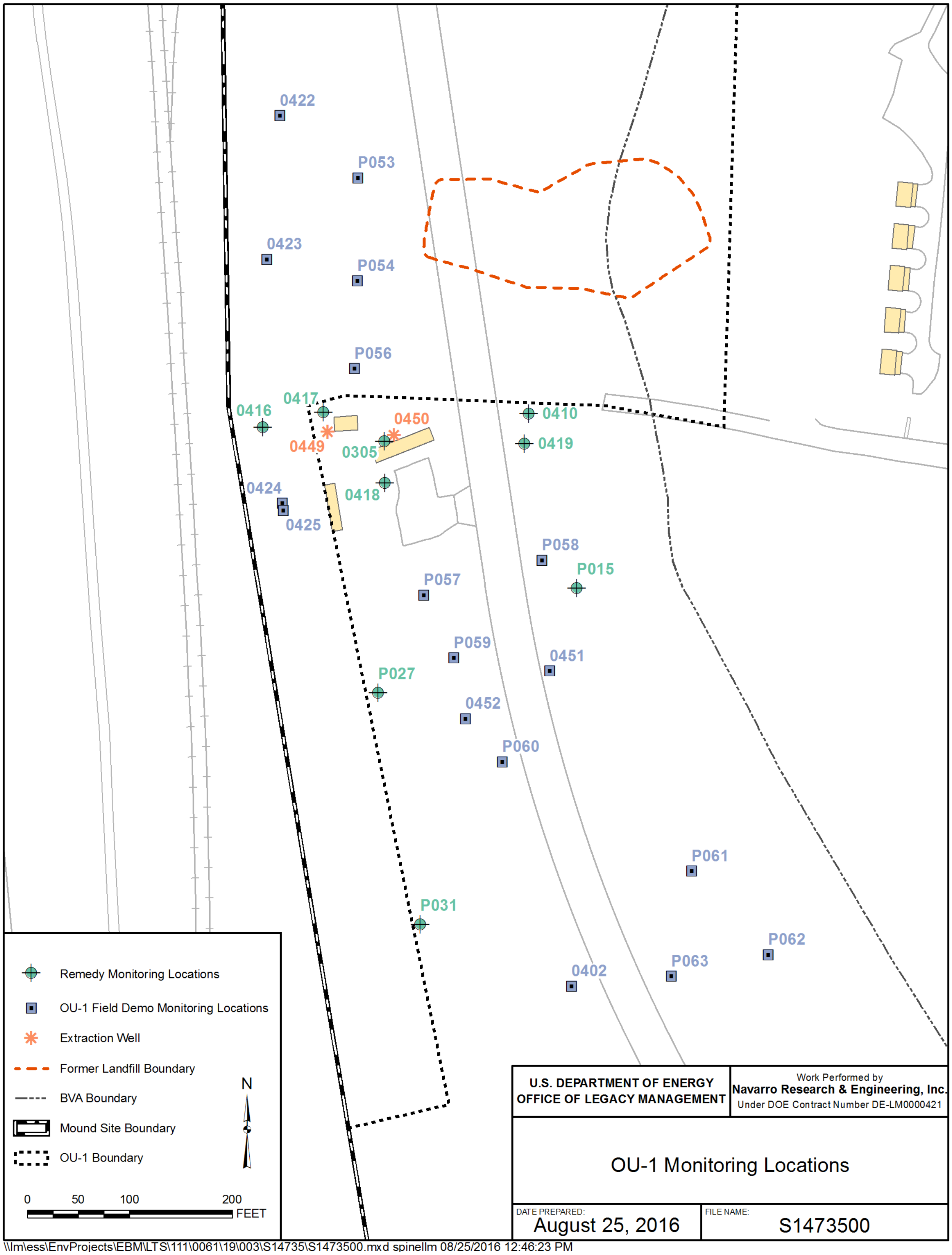

Figure 21. OU-1 Monitoring Network

Concentrations of TCE (Figure 22) and PCE (Figure 23) continued to generally decrease in the source area and capture area wells after the P&T system was restarted in December 2011. The highest concentrations of both TCE and PCE within the capture of the OU-1 P&T system were measured in well P056, which is within the southwestern corner of the former landfill. Concentrations of TCE and PCE in the majority of these wells were near or below the MCL in 2014.

An area of cVOC contamination was monitored in the groundwater downgradient of the hydraulic capture of the OU-1 P&T system. Concentrations of TCE (Figure 24) and PCE (Figure 25) greater than the MCL were consistently reported in wells 0451, 0452, P058, P059, and P060 since their installation.

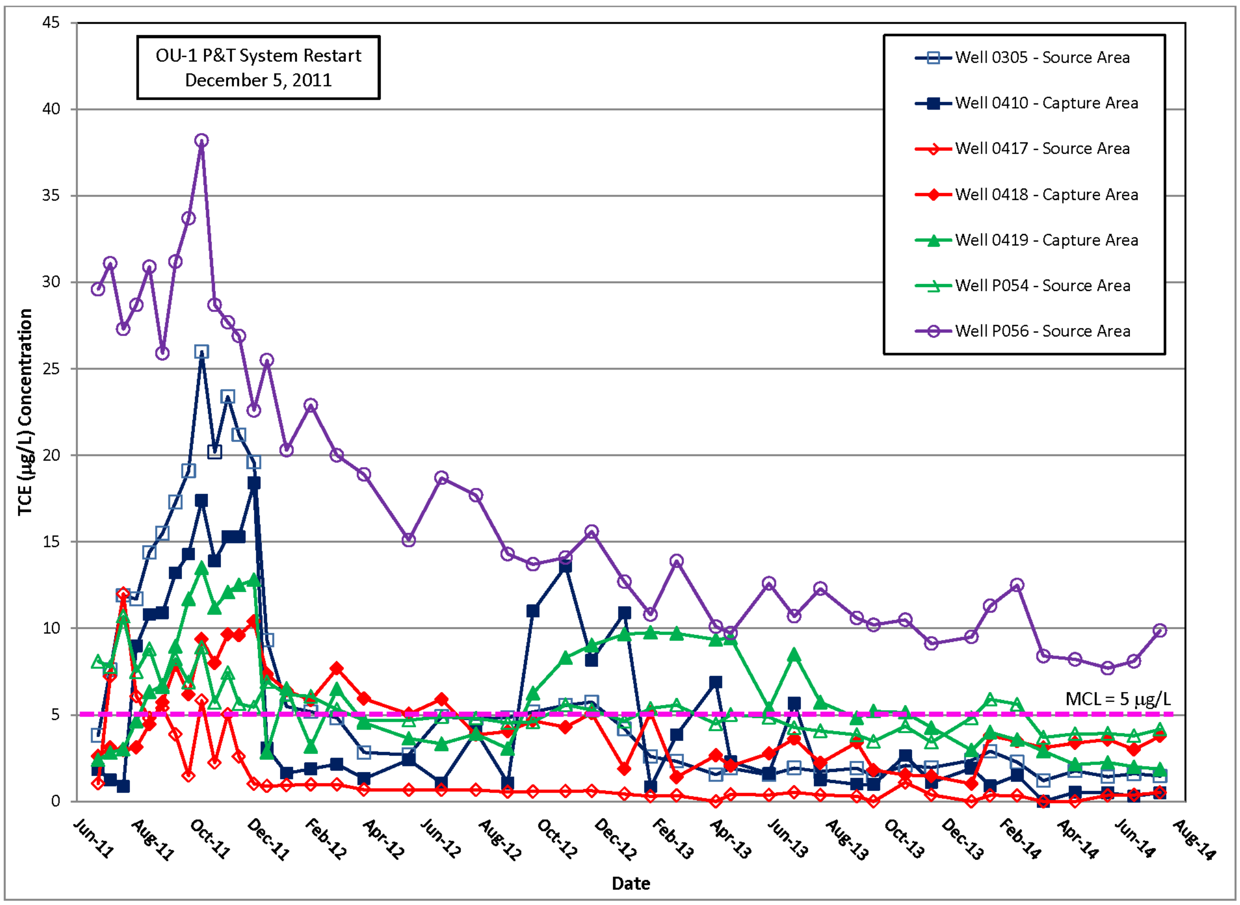

Figure 22. TCE Concentrations in OU-1 Source Area and Capture Zone Wells

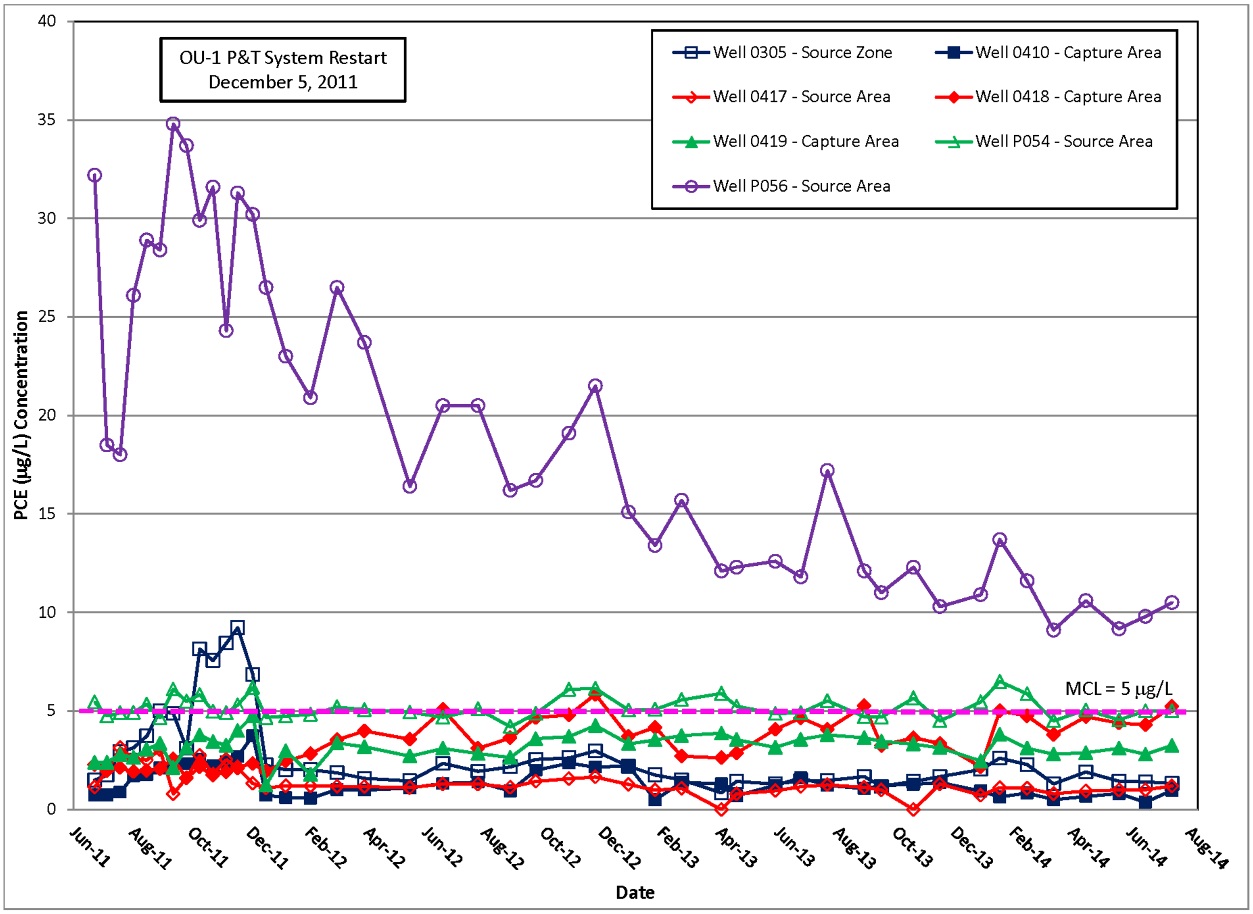

Figure 23. PCE Concentrations in OU-1 Source Area and Capture Zone Wells

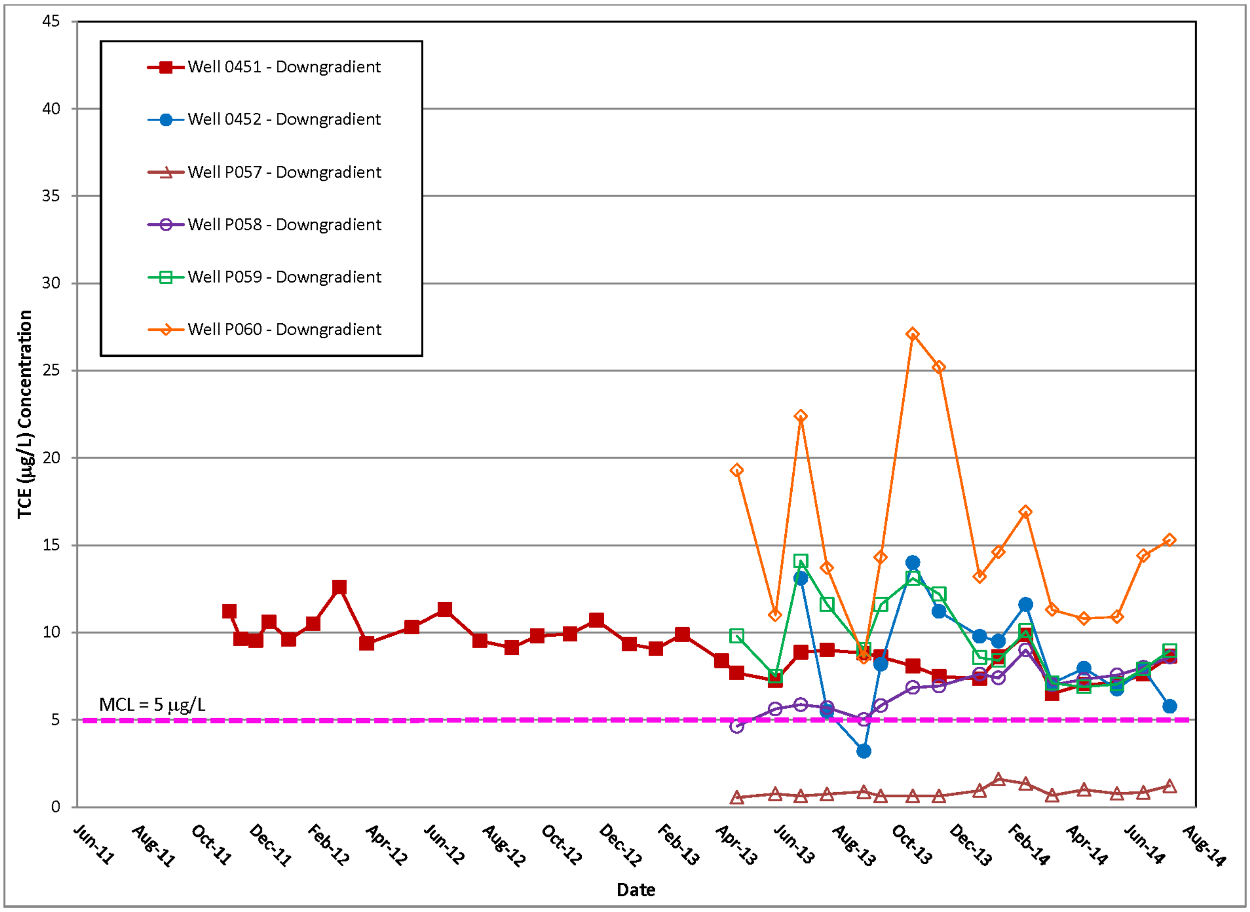

Figure 24. TCE Concentrations in OU-1 Downgradient Wells

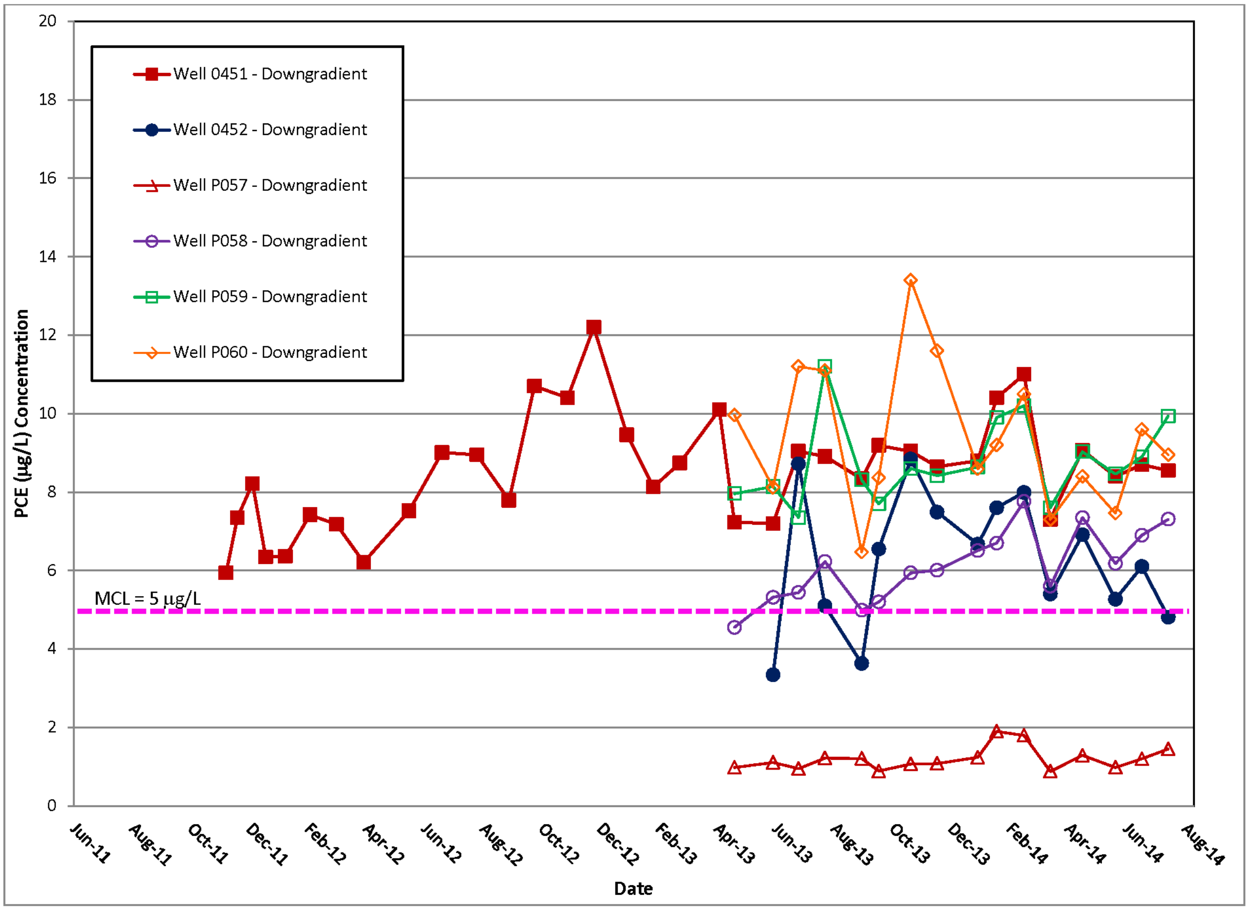

Figure 25. PCE Concentrations in OU-1 Downgradient Wells

6.7.3.4 Compliance Monitoring

The effluent from the P&T system is monitored and discharged in accordance with the CERCLA Authorization to Discharge under the National Pollutant Discharge Elimination System (Authorization Number 1IN90010*BD) (Table 27). The samples are designated as outfall 003. These data are reported monthly to OEPA. The VOC data from the effluent is typically nondetectable, indicating that system is effective at removing the organic compounds from the groundwater.

The P&T system was placed in standby mode in September 2014 to support an ongoing OU-1 field demonstration. Monthly reports indicating no discharge are being filed with Ohio EPA.

When effluent was being discharged from the P&T system, 16 constituents sampled for outfall 003 were collected daily, weekly, or monthly. There were no exceedances of these parameters at outfall 003. Typically, no detectable concentrations of PCE, TCE, *cis*-1,2-DCE, *trans*-1,2-DCE, or vinyl chloride (detection limit of 1 µg/L) were reported for the effluent from the P&T system. The discharge limit under the CERCLA Authorization to Discharge is 5 µg/L.

Table 27. Monitoring Requirements for Outfall 003

Parameter	Discharge Limits			Sample Type	Frequency
	Maximum	Minimum	Monthly		
Flow rate (MGD)	---	---	---	24-hr total	daily
pH (S.U.)	9.0	6.5	---	grab	weekly
Dissolved oxygen (mg/L)	---	---	---	grab	monthly
Copper, total recoverable (μg/L)	---	---	---	24-hr composite	monthly
Mercury, total (low level) (ng/L)	2200	---	23	grab	monthly
CBOD, 5 day (mg/L)	---	---	---	24-hr composite	monthly
Carbon tetrachloride (μg/L)	10	---	5	grab	monthly
Chloroform (μg/L)	10	---	5	grab	monthly
Methylene chloride (μg/L)	10	---	5	grab	monthly
Tetrachloroethene (μg/L)	10	---	5	grab	monthly
Trichlorofluoromethane (μg/L)	10	---	5	grab	monthly
1,1,1-Trichloroethane (μg/L)	10	---	5	grab	monthly
1,2-*trans*-Dichloroethene (μg/L)	10	---	5	grab	monthly
Vinyl chloride (μg/L)	10	---	5	grab	monthly
Trichloroethene (μg/L)	10	---	5	grab	monthly
cis-1,2-Dichloroethene (μg/L)	10	---	5	grab	monthly
Chronic toxicity	---	---	---	grab	semiannually
Acute toxicity	---	---	---	grab	semiannually

Abbreviations:
CBOD = carbonaceous biological oxygen demand
μg/L = micrograms per liter
MGD = million gallons per day
ng/L = nanograms per liter
S.U. = standard units

Twice per year (April and October) samples are collected to perform acute and chronic toxicity testing of the effluent on *Ceriodaphnia dubia*. There are no limits stated in the Authorization to Discharge; however, any values above the method detection limit (MDL) require further evaluation. From 2011 through 2014 there were several occasions when the chronic toxicity value was greater than the MDL. The Authorization to Discharge requires that toxicity be calculated using two methods, and the method that yielded the highest result must always be reported. DOE worked with OEPA to identify the cause for the positive results. It was concluded that the reported values were a statistical artifact and not cause by the effluent from the P&T.

7.0 Technical Assessments

7.1 Institutional Controls

Question A: Is the remedy functioning as intended by the decision documents?   **Answer A: Yes, the remedy is functioning as intended by the decision documents.**

7.1.1 Remedial Action Performance

The annual and FYR inspections indicate that the sitewide IC remedies are functioning as intended. The ICs include restrictions on land and groundwater use, soil removal, and penetration or removal of concrete from special IC areas of T Building.

For the property transferred to MDC, ICs were implemented in the form of deed restrictions on future land use with the CERCLA Section 120(h) environmental summary included when the parcel deed was registered with Montgomery County. Deeds for subsequent property sales or transfers include the deed restrictions or references to the original EM to MDC deed.

The ICs for leased Parcels 6, 7, 8, and 9 are implemented through a lease agreement between EM and MDC. There is also an Environmental Covenant filed as Special Instrument Deed 2012-00004722 that describes the ICs.

7.1.2 Operations and Maintenance

IC management activities are performed as outlined in the O&M Plan. DOE performed annual assessments of the effectiveness of ICs each year and found that portion of the remedy to be functioning as intended. LM meets with property owners during the annual IC assessment to review the ICs.

7.1.3 Opportunities for Optimization

None have been identified for ICs based on this FYR.

7.1.4 Early Indicators of Potential Issues

There are no early indicators of potential IC issues that could affect the protectiveness of the remedy.

Question B: Are the exposure assumption, toxicity data, cleanup levels, and remedial action objectives used at the time of the remedy selection still valid?

Answer: Yes, the exposure assumptions, toxicity data, cleanup levels, and remedial objectives used at the time of the remedy are still valid. It is recognized that toxicity values for several constituents (most notably TCE) have changed; however, these changes do not affect the cleanup levels or whether these constituent would be added as COCs (Section 6.6.3). The vapor intrusion exposure pathway is being evaluated for the Mound site. (See Section 7.5.6.)

No changes in ARARs were identified that would call into question the protectiveness of the remedy. Early risk evaluations assumed that groundwater was a current exposure pathway because production wells existed at the site; this resulted in unacceptable risk levels. Since that time production wells were decommissioned in 2005 and ICs were put in place to prohibit unauthorized access to groundwater in the near term. The near-term RAO for groundwater is to prevent groundwater use; this objective is still valid. The groundwater pathway is currently incomplete. Long-term RAOs for groundwater are drinking water standards. RAOs remain valid.

The RAO for soils is to ensure that exposures do not exceed an excess cancer risk of 10^{-4} or a hazard index of 1 through use of the site for occupational exposures (e.g., office worker and construction worker). Site use continues to be industrial/commercial, and this RAO remains protective. RBGVs used to evaluate site conditions have changed slightly over time due to changes in toxicity values for various constituents (some increases, some decreases). However, these changes have not affected contaminant identification at the site and do not significantly change estimates of site risks. A comparison of risks calculated using older and revised toxicity values for radionuclides was conducted for Parcel 3 (DOE 2001e). This comparison indicated changes in risk estimates of less than an order of magnitude. Risk evaluations conducted for some parcels did not include a dermal exposure pathway for soils and could slightly underestimate total site risks. However, exposures through the oral and external pathways make up the bulk of site risks, and these have been accounted for in all risk analyses. Results of the risk information review do not suggest that there is a need to update any of the risk calculations that have already been completed.

Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

Answer C: No other information has come to light that could call into question the protectiveness of the remedy.

7.2 OU-1 Remedy

Question A: Is the remedy functioning as intended by the decision documents?

Answer A: Yes, the remedy is functioning as intended by the decision documents.

7.2.1 Remedial Action Performance

Presently, a three-year field demonstration is being performed to assess enhanced attenuation as a viable alternative to address VOC-impacted soil and groundwater. As part of this three-year field demonstration, DOE temporarily ceased operation of the P&T system and placed it into standby mode in September 2014 with the concurrence of EPA and Ohio EPA. This action was taken to support the ongoing OU-1 Enhanced Attenuation Field Demonstration described in the following sections and to prevent edible oils from being captured by the system during the field demonstration. Ongoing monitoring in OU-1 confirms that movement of contaminants in groundwater has not resulted in concentrations of cVOCs that exceed MCLs in downgradient sentinel wells or have triggered any contingency actions.

The review of documents and environmental monitoring data during the operational period of the P&T system and the results of the five-year review inspection indicate that controlling contaminant migration through the use of a P&T system functioned as intended. Hydraulic and groundwater data indicate that the migration of the plume was controlled by the use of the extraction wells. The performance monitoring indicated that VOC contamination was extracted by the wells and treated to levels typically less than the detectable limit through the air stripper. On the basis of groundwater monitoring, potential receptors have not been exposed to VOC contamination from the landfill. ICs on land and groundwater use are functioning as intended.

Results from studies performed in 2011 and 2012 identified that an area of VOC impact, primarily PCE and TCE, was located downgradient of the hydraulic boundary maintained by the extraction wells. Historical data review indicated that groundwater impact in this area was present at the time the P&T system was put into operation. Operation of the extraction wells resulted in bisecting the original VOC plume. Additional evaluation determined that the area of impact downgradient of the hydraulic boundary has not resulted in offsite migration of cVOCs in groundwater.

7.2.2 Operations and Maintenance

O&M activities are performed as outlined in the O&M Plan*,* which incorporated the requirements of the *OU-1 Pump and Treatment Operational and Maintenance Plan*. DOE also performs annual IC inspections as required by the O&M Plan. DOE has performed groundwater, effluent, and system monitoring and has found the OU-1 remedy to be functioning as intended, thus far. The P&T system was placed in stand-by mode in 2014 to support an ongoing field demonstration; the system is inspected monthly and is available to be restarted.

Groundwater level measurements and groundwater contaminant information have been collected as prescribed in the O&M Plan. These data indicate that the groundwater originating from beneath the former landfill was being contained, and unacceptable migration did not occur while the P&T system was operating.

Influent and effluent data from the P&T system indicated that VOC-contaminated groundwater was being extracted and the mass removed over time was decreasing. Effluent data supports the assertion that the air-stripper system was effective in removing VOC contamination from the groundwater.

7.2.3 Opportunities for Optimization

A three-year field demonstration was initiated in 2014 to evaluate whether enhanced attenuation could expedite the remediation of PCE, TCE, and daughter products in groundwater and soil impacted by the former OU-1 landfill. EA uses active engineering solutions to alter the target site so that the contaminant plume will passively stabilize and shrink. For OU-1, the EA was implemented by target injection of an electron donor (soybean oil) to created "structured geochemical zones." VOCs in the altered subsurface system encounter alternating anaerobic and aerobic environments along the plume flow path. The purpose of the field demonstration is to determine whether the use of edible oils can establish and stimulate discrete treatment zones that expedite the attenuation of chlorinated volatile organic compounds in the OU-1 groundwater. The goal is that EA at OU-1 will provide a transition to natural attenuation and be an alternative to the baseline P&T system.

7.2.4 Early Indicators of Potential Issues

Starting in February 2016, the City of Miamisburg started dewatering projects at the Miamisburg Water Reclamation Facility (WRF), which is located southwest of the site and the Westover Pump Station (WPS), which is located west of the site. Groundwater was extracted at a rate of approximately 4 million gallons per day. At both projects the water table was drawn down approximately 10 ft. The aquifer in OU-1 was affected by the dewatering at these projects. Groundwater levels began to decline in May 2016 and gradients across OU-1 increased by 2 or 3 times the typical gradient of 0.0002 ft/ft. In June 2016, when two projects were underway, groundwater flow shifted to the west for a short period, but returned to typical southern flow. As of June 2016, 10 wells along the western and southern portions of OU-1 could not be sampled due to insufficient water in the well casing.

Groundwater monitoring in OU-1 during the first 18 months of the field demonstration indicated that the contaminant plume had begun to passively stabilize and shrink, concentrations were decreasing, and no downgradient movement of the plume had occurred. Sample results from May 2016 did not indicate any changes in the distribution of the cVOCs as a result of the dewatering. The distribution of TCE from the August 2016 sampling event indicates that some lateral spread occurred. Concentrations of *cis*-1,2-DCE increased and VC was detected in the southern half of the plume. Groundwater chemistry results from August 2016 suggest that the anaerobic treatment zones, created by the injection of the emulsified oil, were becoming less structured. To date, none of the concentrations in the downgradient sentinel wells exceeded MCLs or indicated offsite movement of VOC-impacted groundwater.

Sampling as prescribed in the OU-1 EA Field Demonstration Sampling and Analysis Plan continues to be performed. Groundwater sampling of the downgradient sentinel wells and sampling of the wells along the western boundary of OU-1 was done more frequently (monthly) starting in August 2016 and will continue until offsite dewatering activities are discontinued to monitor for trends in VOC concentrations or potential offsite migration. As long as dewatering continues, alternative methods may be employed (i.e., direct push groundwater sampling) to collect samples at those well locations unable to be sampled because of the water levels being too low.

The City of Miamisburg was contacted in May 2016 to discuss the impacts of the dewatering on the OU-1 groundwater. Since then the City has been evaluating options other than dewatering at their remaining projects. Close coordination with the City will continue until City construction projects are complete.

> ***Question B: Are the exposure assumption, toxicity data, cleanup levels, and remedial action objectives used at the time of the remedy selection still valid?***
>
> **Answer: Yes, the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives used at the time of the remedy are still valid. It is recognized that toxicity values for several constituents (most notably TCE) have changed; however, these changes do not affect the cleanup levels or whether these constituent would be added as COCs (Section 6.6.3).**

No changes in ARARs were identified that would call into question the protectiveness of the remedy. Early risk evaluations assumed that groundwater was a current exposure pathway because production wells existed at the site; this resulted in unacceptable risk levels. Since that time, production wells were removed and ICs were put in place to prohibit unauthorized access to groundwater in the near term. The near-term RAO for groundwater is to prevent groundwater use; this objective is still valid. The groundwater exposure pathway is currently incomplete. Long-term RAOs for groundwater are drinking water standards. RAOs remain valid.

> ***Question C: Has any other information come to light that could call into question the protectiveness of the remedy?***
>
> **Answer C: No other information has come to light that could call into question the protectiveness of the remedy.**

7.3 Phase I Groundwater (MNA) Remedy

> ***Question A: Is the remedy functioning as intended by the decision documents?***
>
> **Answer A: Yes, the remedy is functioning as intended by the decision documents.**

7.3.1 Remedial Action Performance

The review of documents and environmental monitoring data and the results of the annual and five-year review inspections indicate that the remedy for Phase I, which consists of MNA to address groundwater impact and ICs on land and groundwater use, is functioning as intended.

7.3.2 Operations and Maintenance

O&M activities are performed as outlined in the O&M Plan, which incorporated the requirements of the *Operations and Maintenance (O&M) Plan for the Implementation of Institutional Controls at the 1998 Mound Plant Property* and the *Phase I Remedy (Monitored*

Natural Attenuation) Groundwater Monitoring Plan. DOE has performed annual walkovers and records reviews with respect to ICs and has found that portion of the remedy to be functioning as intended. DOE has also performed groundwater monitoring and has found the groundwater remedy to be functioning as intended, thus far.

Results from the MNA monitoring indicate that concentrations do not exceed trigger levels. Decreasing TCE concentrations are occurring in one of the source area wells and the downgradient seep. Monitoring in the downgradient BVA wells continue to indicate no adverse impact from TCE source area. Confirmatory sampling for radium and barium was discontinued in 2013. Confirmatory sampling for chromium and nickel was discontinued in 2009.

7.3.3 Opportunities for Optimization

None have been identified based on this five-year review.

7.3.4 Early Indicators of Potential Issues

There are no early indicators of potential issues that could affect the protectiveness of the remedy.

Question B: Are the exposure assumption, toxicity data, cleanup levels, and remedial action objectives used at the time of the remedy selection still valid?

Answer B: Yes, the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives used at the time of the remedy are still valid. It is recognized that toxicity values for several constituents (most notably TCE) have changed; however, these changes do not affect the cleanup levels or whether these constituent would be added as COCs (Section 6.6.3).

No changes in ARARs were identified that would call into question the protectiveness of the remedy. Early risk evaluations assumed that groundwater was a current exposure pathway because production wells existed at the site; this resulted in unacceptable risk levels. Since that time, production wells were removed and ICs were put in place to prohibit unauthorized access to groundwater in the near term. The near-term RAO for groundwater is to prevent groundwater use; this objective is still valid. The groundwater exposure pathway is currently incomplete. Long-term RAOs for groundwater are drinking water standards. RAOs remain valid.

Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

Answer C: No other information has come to light that could call into question the protectiveness of the remedy.

7.4 Parcels 6, 7, and 8 Groundwater (MNA) Remedy

Question A: Is the remedy functioning as intended by the decision documents?
Answer A: Yes, the remedy is functioning as intended by the decision documents.

7.4.1 Remedial Action Performance

The review of documents and environmental monitoring data and the results of the annual and five-year review inspections indicate that the remedy for Parcels 6, 7, and 8, which consists of MNA to address groundwater impact and ICs on land and groundwater use, is functioning as intended.

7.4.2 Operations and Maintenance

O&M activities are performed as outlined in the O&M Plan, which incorporated the requirements of the *Operation and Maintenance (O&M) Plan for the Implementation of Institutional Controls at the 1998 Mound Plant Property* and the *Parcel 6, 7, and 8 Remedy (Monitored Natural Attenuation) Groundwater Monitoring Plan*. DOE has performed annual walkovers and records reviews with respect to ICs and has found that portion of the remedy to be functioning as intended, thus far. DOE has also performed groundwater monitoring and has found the groundwater remedy to be functioning as intended, thus far.

Results from the MNA sampling indicate that variability in the data are consistent with data collected after recent source removal. Concentrations in one onsite well have exceeded the trigger level for TCE on several occasions, and increases in TCE have been reported in one onsite well. Tritium levels show decreases in all onsite wells and seeps. Monitoring in the downgradient BVA wells continues to indicate no adverse impact from TCE or tritium from the Main Hill.

7.4.3 Opportunities for Optimization

None have been identified based on this five-year review.

7.4.4 Early Indicators of Potential Issues

There are no early indicators of potential issues that could affect the protectiveness of the remedy.

Question B: Are the exposure assumption, toxicity data, cleanup levels, and remedial action objectives used at the time of the remedy selection still valid?

Answer B: Yes, the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives used at the time of the remedy are still valid. It is recognized that toxicity values for several constituents (most notably TCE) have changed; however, these changes do not affect the cleanup levels or whether these constituent would be added as COCs (Section 6.6.3).

No changes in ARARs were identified that would call into question the protectiveness of the remedy. Early risk evaluations assumed that groundwater was a current exposure pathway because production wells existed at the site; this resulted in unacceptable risk levels. Since that time, production wells were removed and ICs were put in place to prohibit unauthorized access to groundwater in the near term. The near-term RAO for groundwater is to prevent groundwater use; this objective is still valid. The groundwater exposure pathway is currently incomplete. Long-term RAOs for groundwater are drinking water standards. RAOs remain valid.

Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

Answer C: No other information has come to light that could call into question the protectiveness of the remedy.

7.5 Facility Remedy

Question A: Is the remedy functioning as intended by the decision documents?

Answer A: Yes, the remedy is functioning as intended by the decision documents.

7.5.1 Remedial Action Performance

The overall intent of the combined remedial actions at the former DOE Mound site is to limit unacceptable exposures to areas onsite where contaminated soil, groundwater, or both are still present and limit unacceptable exposure where fixed contamination is present in T-Building. The Mound site was remediated to EPA’s risk-based standards for industrial or commercial use only. Exposure is limited through the use of ICs that allow specific land use, prevent the removal of soil, restrict the use of groundwater, and restrict the removal or penetration of concrete in specific rooms in T-Building. Groundwater remedies are in place for those contaminants that exceed MCLs.

The review of documents and environmental monitoring data and the results of the annual and five-year review inspections indicate that the remedies for groundwater and the ICs on land and groundwater use are functioning as intended.

7.5.2 Operations and Maintenance

O&M activities are performed as outlined in the O&M Plan.

7.5.3 Opportunities for Optimization

None have been identified based on this five-year review.

7.5.4 Early Indicators of Potential Issues

There are no early indicators of potential issues that could affect the protectiveness of the remedy.

Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives used at the time of the remedy selection still valid?   **Answer B: Yes, the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives used at the time of the remedy are still valid. It is recognized that toxicity values for several constituents (most notably TCE) have changed; however, these changes do not affect the cleanup levels or whether these constituent would be added as COCs (Section 6.6.3).**

No changes in ARARs were identified that would call into question the protectiveness of the remedies. Early risk evaluations assumed that groundwater was a current exposure pathway because production wells existed at the site; this resulted in unacceptable risk levels. Since that time, production wells were removed and ICs were put in place to prohibit unauthorized access to groundwater in the near term. The near-term RAO for groundwater is to prevent groundwater use; this objective is still valid. The groundwater exposure pathway is currently incomplete. Long-term RAOs for groundwater are drinking water standards. RAOs remain valid.

Question C: Has any other information come to light that could call into question the protectiveness of the remedy?   **Answer C: Two topics have come to light that could call into question the protectiveness of the remedy. The topics are discussed below.**

7.5.5 Per- and Polyfluoroalkyl Substances (PFASs)

EPA has identified per- and polyfluoroalkyl substances as emerging contaminants that need to be reviewed for use, spillage, and possible exposure to the public or workers at sites where these materials were used as fire suppressants (e.g., aqueous film-forming foam [AFFF]) or for other purposes. A part of the review program at former cleanup sites is to determine if there are any health risks associated with these contaminants that were spilled or released to the ground and that may seep into the groundwater.

A 2016 review of chemicals handled in 132 current and former buildings at the Mound site, including magazines, emergency generator structures, the Fire Fighter Housing Facility, and the Fire Fighter Training Area, was performed. There was no mention of PFASs being used at the Mound site as fire extinguisher material, fire suppressants, or for any other purpose. All building fire sprinkler systems at the Mound site utilized water. No AFFFs were used for fire suppression at the Mound site. The portable fire extinguishers used either Halon 1211 (bromochlorodifluoromethane) or 12-B (monoammonium phosphate and sodium dicarbonate). The following perfluoro compounds were used in the E/E Annex building: perfluoro heptanoic acid, perfluoro-butylamine, perfluorokerosene H and L, and perfluoro-2-butyl tetrahydrofuran. The perfluoro compounds used in the E/E Annex were external calibration standards for instrumental analysis. Although laboratory volumes of these standards listed were not given, it was best management practice as part of the waste minimization program at the Mound site to procure minimum quantities based on requesters' stated uses. The system in place at Mound for purchases of chemicals required approval from ES&H, Industrial Hygiene, and Waste Management. The approval chain was designed to ensure that industrial Hygiene could perform workplace monitoring, that personnel were prepared to treat exposures, and that waste generation would be kept to a minimum. If these calibration standards were spilled, the buildings where these calibration standards were used had sink and floor drains that were connected into the sanitary sewer system, with drainage treated at the onsite waste water treatment facility.

Over 7000 pages of building descriptions and information on all historical programs conducted in each building were reviewed for further information on materials used in research and development, production, and quality assurance and quality control analyses of weapons reserves and other associated materials. Special attention was given to the Mound Fire Fighter Training Area (PRS 18) and the Mound Fire Fighter Training Pit (PRS 19). It was determined that firefighters at the Mound site used only water or Halon 1211 or 12-B fire extinguishers as fire suppressants. No AFFFs were used at the Mound site. Water systems were the only systems installed for use as fire suppressants, and water was the only fire suppressant used at the Fire Fighter Training Facility. Practice with the Halon 1211 and 12-B fire extinguishers may have been conducted at the Fire Fighter Training Facility.

On the basis of the 2016 review of chemical inventories and site activities, it has been determined that no PFASs were used at the Mound site with the exception of small quantities used as calibration standards. The information collected will be presented to the Core Team for evaluation in order to determine if the conditions at the site are protective. If the Core Team cannot make a determination of the protectiveness, then additional information or data may be deemed necessary.

7.5.6 Vapor Intrusion Assessment

Vapor intrusion is the general term given to migration of hazardous vapors from any subsurface vapor source (i.e., contaminated soil or groundwater) through the soil and into an overlying building or structure. These vapors can enter buildings through cracks in basements and foundations, as well as through conduits and other openings in the buildings. Vapors can also enter structures that are not intended for human occupancy (e.g., sewers, drain lines, access vaults, storage sheds, pump houses) through cracks and other openings.

Vapor intrusion is a potential human exposure pathway—a way that people may come into contact with hazardous vapors while performing their day-to-day indoor activities. A vapor intrusion pathway is referred to as "complete" for a specific building or collection of buildings when the following five conditions are met under current conditions:

1. A subsurface source of vapor-forming chemicals is present (e.g., in the soil or in groundwater) underneath or near the building(s).
2. Vapors form and have a route along which to migrate (be transported) toward the building.
3. The building(s) is (are) susceptible to soil-gas entry, which means openings exist for the vapors to enter the building and driving forces (e.g., air pressure differences between the building and the subsurface environment) exist to draw the vapors from the subsurface through the openings into the building(s).
4. One or more vapor-forming chemicals comprising the subsurface vapor source(s) is (are) present in the indoor environment.
5. The building(s) is (are) occupied by one or more individuals when the vapor-forming chemical(s) is (are) present indoors.

A complete vapor intrusion pathway indicates that there is an opportunity for human exposure, which warrants further analysis to determine whether there is a basis for undertaking a response action. Depending upon building and site-specific circumstances, concentrations of chemical vapors indoors arising from a complete vapor intrusion pathway may threaten the health of building occupants, which may warrant a response action.

However, if one (or more) of the five conditions is currently absent and is reasonably expected to be absent in the future, the vapor intrusion pathway is referred to as "incomplete." Vapor migration is significantly and persistently impeded by natural geologic, hydrologic, or biochemical—that is biodegradation—processes and conditions. When the vapor intrusion pathway is determined to be incomplete, then vapor intrusion mitigation is not generally warranted.

Subsurface vapor sources that remain may have the potential to pose unacceptable human health risks due to vapor intrusion in the future, if site conditions were to change. The vapor intrusion pathway is referred to as "potentially complete" for a building when all of the following conditions apply:

- A subsurface source of vapor-forming chemicals is present underneath or near an existing building or a building that is reasonably expected to be constructed in the future.
- Vapors can form from this source(s) and have a route along which to migrate (be transported) toward the building.
- Three additional conditions are reasonably expected to all be met in the future, which may not all be met currently:
    - The building is susceptible to soil-gas entry, which means openings exist for the vapors to enter the building and driving forces exist to draw the vapors from the subsurface through the openings into the building.

— One or more vapor-forming chemicals comprising the subsurface vapor source(s) are, or will be, present in the indoor environment.

— The building is, or will be, occupied by one or more individuals when the vapor-forming chemical(s) is (are) present indoors.

Vapor intrusion was not evaluated in the RRE as a potential exposure pathway for the Mound site. Therefore, the methodology outlined in the *OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air* (OSWER Publication 9200.2-154, June 2015) (OWSER 2015) is being implemented to assess the potential for exposure in existing and future buildings and structures at the Mound site.

The following conditions should be considered during the assessment and may indicate a need for prompt action, including follow-up evaluations to determine whether urgent intervention is warranted to eliminate, avoid, reduce, or otherwise address a human health hazard. Based on the available information, conditions at the Mound site do not require response actions to be taken.

Odors reported by occupants, particularly if described as “chemical,” “solvent,” or “gasoline.”	Conditions not reported in occupied buildings.
Physiological effects reported by occupants (e.g., dizziness, nausea, vomiting, confusion).	Conditions not reported in occupied buildings.
Wet basements in areas where groundwater is known to contain vapor-forming chemicals and the associated water table is shallow enough that the basements are prone to groundwater intrusion or flooding.	Wet conditions periodically occur in the T-Building as a result of pump failure in head house sumps. Water is likely surface water infiltration entering the T-Building foundation drainage system. The T-Building is presently unoccupied.

At the preliminary assessment stage, the available information may not be sufficient to evaluate whether all five conditions of vapor intrusion are present under current or reasonably expected future conditions. Readily ascertainable information should be reviewed for the purposes of assessing whether the first and fifth conditions (listed above) are present.

Subsurface sources of vapor-forming chemicals are present (e.g., soil or groundwater).	A preliminary assessment of available data for the Mound site indicates that VOCs, semi-VOCs, and pesticides with known or potential toxicity or volatility are or were present in soil or groundwater.
At least one building is present or is reasonably expected to be constructed in the future above or “near” the subsurface vapor source(s), which is or could be occupied by humans.	Existing buildings and potential future buildings are near areas where subsurface sources are located. Also, nonoccupied structures (i.e., sewers, utilities, and subsurface drains) that connect to buildings are present.

Reliable evidence indicates the presence of vapor-forming chemicals in the subsurface at the Mound site. It is recommended that further vapor intrusion assessment be performed in areas where buildings are present or future buildings could be constructed to determine whether complete exposure pathways are present or could be present in the future.

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8.0 Issues

It has been determined that all remedies are functioning as designed. Adequate oversight mechanisms appear to be in place to identify possible deficiencies, and adequate resources are available to correct or mitigate any problems, if they were to occur.

Two issues identified as a result of this five-year review are shown in Table 28.

Table 28. Issues Identified

Issue	Affects Protectiveness (Y/N)	
	Current	Future
1. Vapor Intrusion: Evidence indicates the presence of vapor-forming chemicals in the subsurface at the Mound site. Information reviewed to date is not sufficient to evaluate whether complete exposure pathways are present under current or reasonably expected future conditions. However, the information reviewed does not prompt immediate response action.	N	Y
2. Per- and Polyfluoroalkyl Substances: A significant body of historical documentation and chemical inventories has been compiled regarding the use of PFASs or AFFF at the Mound site. Results of this review indicate that these chemicals or materials were not used at the Mound site as fire suppressants, although small quantities were used as calibration standards. An evaluation of this information needs to be completed by the Mound Core Team (DOE, EPA, and Ohio EPA) and a determination regarding the protectiveness of the site conditions needs to be established.	N	Y

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9.0 Recommendations and Follow-Up Actions

Table 29 identifies the recommendations that were identified as the result of this FYR and the associated actions.

Table 29. Recommendations and Follow-up Actions

Issue	Recommendations and Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness (Y/N)	
					Current	Future
1	It is recommended that an assessment of current site data be performed to evaluate if possible exposure pathways are or could be present that would result in potential exposure in existing and future buildings and structures at the Mound site as outlined in the OSWER Technical Guide. The assessment will prioritize areas with existing buildings and may include indoor air quality testing as well as sampling of subsurface vapors in or near existing buildings. If additional work is warranted, this assessment will include a proposal for additional work and associated schedule. If it is determined during this assessment that conditions exist that may pose a health risk to building occupants, the Mound Core Team will be contacted immediately, and a course of action will be developed.	DOE LM	EPA	May 30, 2017	N	Y
2	It is recommended that the results of the PFAS research be presented, along with a written summary, to the Mound Core Team.	DOE LM	EPA	January 30, 2017	N	Y

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10.0 Protectiveness Statements

10.1 Institutional Controls Remedy

The IC remedies for Parcels D, H, 3, and 4 and the IC portion of the remedies for Phase I (A, B, C); Parcels 6, 7, and 8; and OU-1 are protective of human health and the environment because ICs are in place and functioning as intended.

10.2 Operable Unit 1 (Parcel 9) Remedy

The remedy for OU-1 (Parcel 9) is currently protective of human health and the environment because exposure pathways that could result in unacceptable risks are being controlled through containment of the plume and ICs that prevent usage of the groundwater in the restricted area. However, in order for the remedy to be protective in the long term, attainment of the cleanup standards in OU-1 groundwater will be required to ensure protectiveness.

A field demonstration was initiated in 2014 to evaluate whether enhanced attenuation could expedite the remediation of PCE, TCE, and daughter products in groundwater impacted by the former OU-1 landfill. DOE temporarily ceased operation of the P&T system and placed it into standby mode in September 2014 with the concurrence of EPA and Ohio EPA.

Groundwater monitoring in OU-1 during the first 18 months of the field demonstration indicated that the contaminant plume had begun to passively stabilize and shrink, concentrations were decreasing, and no downgradient movement of the plume had occurred.

Starting in February 2016, as part of several offsite City projects, groundwater began to be extracted to lower the water table and allow for deep excavations and below-grade construction. The aquifer in OU-1 was affected by the dewatering at these projects. Groundwater sampling of the downgradient sentinel wells and wells along the western boundary of OU-1 are presently sampled more frequently (monthly) until offsite dewatering activities are discontinued to monitor for trends in VOC concentrations or potential offsite migration. To date, none of the concentrations in the downgradient sentinel wells have exceeded MCLs or indicated offsite movement of VOC-impacted groundwater. The goal is that EA at OU-1 will provide a transition to natural attenuation and is an alternative to the baseline P&T system. The P&T system remains in standby mode.

10.3 Phase I Groundwater (MNA) Remedy

The remedy for Phase I is currently protective of human health and the environment because exposure pathways that could result in unacceptable risks are being controlled through ICs that prevent use of the groundwater in the restricted area. However, in order for the remedy to be protective in the long term, attainment of the cleanup standards in Phase I groundwater will be required to ensure protectiveness. Monitoring of bedrock groundwater will continue to demonstrate that MNA is effectively reducing TCE to concentrations below the MCL. Monitoring of the BVA will continue to demonstrate the aquifer is not affected by TCE-impacted groundwater originating from Phase I.

10.4 Parcels 6, 7, and 8 Groundwater (MNA) Remedy

The remedy for Parcels 6, 7, and 8 is currently protective of human health and the environment because exposure pathways that could result in unacceptable risks are being controlled through ICs that prevent use of the groundwater in the restricted area. However, in order for the remedy to be protective in the long term, attainment of the cleanup standards in Parcels 6, 7, and 8 groundwater will be required to ensure protectiveness. Monitoring of seeps and onsite wells will continue to demonstrate that with the removal of PCE, TCE, and tritium sources, natural degradation will result in these constituents reducing to concentrations below the MCLs. Monitoring of the BVA will continue to demonstrate the aquifer is not affected by impacted groundwater originating from Parcels 6, 7, and 8.

10.5 Sitewide Remedy

The remedies in place at the Mound site currently protect human health and the environment through ICs that are in place to reduce exposure to contaminated soil and groundwater. However, in order for the remedies to be protective in the long term, the determination on complete exposure pathways for vapor intrusion and a determination regarding the use of PFASs at the Mound site need to be completed by the Mound Core Team.

11.0 Next Review

This is the fourth statutory FYR for this site. The next FYR will be conducted in 2021.

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12.0 References

DOE (U.S. Department of Energy), 1994. *Operable Unit 9 Hydrogeological Investigation - Buried Valley Report*, Final, September.

DOE (U.S. Department of Energy), 1995. *Operable Unit 1 Record of Decision*, Final, June.

DOE (U.S. Department of Energy), 1996. *OU9 Hydrogeologic Investigation—Groundwater Sweeps Report, Mound Plant* (Revision 1).

DOE (U.S. Department of Energy), 1997a. *Mound 2000 Residual Risk Evaluation Methodology, Mound Plant*, Final, January.

DOE (U.S. Department of Energy), 1997b. *Risk-Based Guideline Values, Mound Plant, Miamisburg, Ohio*, March.

DOE (U.S. Department of Energy), 1999a. *CERCLA 120(h) Summary Notice of Hazardous Substances, Release Block D, Mound Plant, Miamisburg, Ohio*, February.

DOE (U.S. Department of Energy), 1999b. *Record of Decision for Release Block D, Mound Plant, Miamisburg, Ohio,* Final, February.

DOE (U.S. Department of Energy), 1999c. *Work Plan for Environmental Restoration of the DOE Mound Site, the Mound 2000 Approach*, Revision 0 – Final, February.

DOE (U.S. Department of Energy), 1999d. *Record of Decision for Release Block H, Mound Plant, Miamisburg, Ohio,* Final, June.

DOE (U.S. Department of Energy), 1999e. *CERCLA 120(h) Summary Notice of Hazardous Substances, Release Block H, Mound Plant, Miamisburg, Ohio*, Final, July.

DOE (U.S. Department of Energy), 2000. *OU-1 Pump and Treatment Operation and Maintenance Plan*, Final, Revision 3, March.

DOE (U.S. Department of Energy), 2001a. *Parcel 4 Record of Decision, Mound Plant, Miamisburg, Ohio*, Final, February.

DOE (U.S. Department of Energy), 2001b. *Parcel 4 Environmental Summary, CERCLA 120(h) Summary Notice of Hazardous Substances, Mound Plant, Miamisburg, Ohio,* Final, March.

DOE (U.S. Department of Energy), 2001c. *Parcel 3 Environmental Summary, CERCLA 120(h) Summary Notice of Hazardous Substances, Mound Plant, Miamisburg, Ohio*, Final, September.

DOE (U.S. Department of Energy), 2001d. *Parcel 3 Record of Decision, Mound Plant, Miamisburg, Ohio*, Final, September.

DOE (U.S. Department of Energy), 2001e. *Residual Risk Evaluation, Parcel 3, Mound Plant, Miamisburg, Ohio*, Final, September.

DOE (U.S. Department of Energy), 2001f. *CERCLA Five-Year Review Report for the Operable Unit 1 Remedy at the U.S. Department of Energy Miamisburg Environmental Management Project*, September.

DOE (U.S. Department of Energy), 2003a. *Phase I Residual Risk Evaluation, Miamisburg Closure Project*, Final, March.

DOE (U.S. Department of Energy), 2003b. *Phase I Record of Decision*, *Miamisburg Closure Project,* Final, July.

DOE (U.S. Department of Energy), 2003c. *Phase I Environmental Summary, CERCLA 120(h) Summary Notice of Hazardous Substances, Miamisburg Closure Project*, Final, December.

DOE (U.S. Department of Energy), 2004a. *Operation and Maintenance (O&M) Plan for the Implementation of Institutional Controls at the 1998 Mound Plant Property, Phase I Parcel*, update, Rev. 1, February.

DOE (U.S. Department of Energy), 2004b. *Miami-Erie Canal Record of Decision, Miamisburg Closure Project,* Final, Revision 0, September.

DOE (U.S. Department of Energy), 2004c. *Phase I Remedy (Monitored Natural Attenuation) Groundwater Monitoring Plan*, Final, September.

DOE (U.S. Department of Energy), 2005. *Long-Term Surveillance and Maintenance Plan for the U.S. Department of Energy Miamisburg Closure Project, Mound Site, Miamisburg, Ohio*, (Vol. 1), DOE-LM/GJ877-2005, Draft, September.

DOE (U.S. Department of Energy), 2006a, *Risk-Based Guideline Value Document, Revision 9*, June.

DOE (U.S. Department of Energy), 2006b. *Second Five-Year Review for the Mound, Ohio, Site, Miamisburg, Ohio*, DOE-LM/1308-2006, September.

DOE (U.S. Department of Energy), 2006c. *Parcel 6, 7, and 8 Remedy (Monitored Natural Attenuation) Groundwater Monitoring Plan*, December

DOE (U.S. Department of Energy), 2007a. *Work Plan for the Replacement of the OU-1 Extraction Wells.*

DOE (U.S. Department of Energy), 2007b. *Miamisburg Closure Project; Parcel 6, 7, and 8 Residual Risk Evaluation*, Mound Plant, Miamisburg, Ohio, Public Review Draft, September.

DOE (U.S. Department of Energy), 2008a. *Miamisburg Closure Project, Parcel 6, 7 & 8, Residual Risk Evaluation (RRE), September 2007, Response to Comments*, February.

DOE (U.S. Department of Energy), 2008b. *Sales Contract by and between the United States Department of Energy and the Miamisburg Mound Community Improvement Corporation, August 28, 2008*, August.

DOE (U.S. Department of Energy), 2009. *Parcels 6, 7, and 8 Record of Decision*, *Miamisburg Closure Project, Miamisburg, Ohio,* Final, August.

DOE (U.S. Department of Energy), 2010. *Parcels 6, 7, and 8 Environmental Summary, CERCLA 120(h) Summary Notice of Hazardous Substances*, Final, August.

DOE (U.S. Department of Energy), 2011a. *Parcel 9 Environmental Summary, CERCLA 120(h) Summary Notice of Hazardous Substances*, Final, July.

DOE (U.S. Department of Energy), 2011b. *Amendment of the Operable Unit 1 Record of Decision, U.S. Department of Energy, Mound Closure Project,* Final, August.

DOE (U.S. Department of Energy), 2011c. *Third Five-Year Review for the Mound, Ohio, Site, Miamisburg, Ohio*, LMS/MND/S07963, Office of Legacy Management, September.

DOE (U.S. Department of Energy), 2011d. *Operable Unit 1 Rebound Study Work Plan and Groundwater Exit Strategy,* LMS/MND/S08242, Office of Legacy Management, September .

DOE (U.S. Department of Energy), 2012a. *Environmental Covenant, Parcel 9, Special Instrument Deed 2012-00004722 recorded with Montgomery County Ohio*, January.

DOE (U.S. Department of Energy), 2012b. *Annual Assessment of the Effectiveness of Sitewide Institutional Controls Applied to the Former DOE Mound Site Property*, *Miamisburg, Ohio,* LMS/MND/S08846, Office of Legacy Management, June.

DOE (U.S. Department of Energy), 2012c. *Amendment to Sales Contract dated August 28, 2008, between the U.S. Department of Energy and Mound Development Corporation (Previously The Miamisburg Mound Community Corporation)*, November.

DOE (U.S. Department of Energy), 2012d. *U.S. Department of Energy Amendment Number 24 to the General Purpose Lease*, December.

DOE (U.S. Department of Energy), 2013a. *Annual Assessment of the Effectiveness of Institutional Controls at the Mound Site, Miamisburg, Ohio*, LMS/MND/S10173, Office of Legacy Management, June.

DOE (U.S. Department of Energy), 2013b. *Appendix #1 to the General Purpose Lease,* between EMCBC and MDC, December.

DOE (U.S. Department of Energy), 2014a. *Sitewide Groundwater Monitoring Report Calendar Year 2012, Mound, Ohio, Site*, LMS/MND/S10184, Office of Legacy Management, February.

DOE (U.S. Department of Energy), 2014b. *Annual Assessment of the Effectiveness of Institutional Controls at the Mound Site, Miamisburg, Ohio*, LMS/MND/S11616, Office of Legacy Management, June.

DOE (U.S. Department of Energy), 2014c. *OU-1 Enhanced Attenuation Field Demonstration Edible Oil Deployment Design, Mound, Ohio, Site,* LMS/MND/S11608, Office of Legacy Management, June.

DOE (U.S. Department of Energy), 2014d*. OU-1 Enhanced Attenuation Field Demonstration Sampling and Analysis Plan Mound, Ohio, Site* LMS/MND/S11745, Office of Legacy Management, June.

DOE (U.S. Department of Energy), 2014e. *Field Demonstration Work Plan for Using Edible Oils to Achieve Enhanced Attenuation of cVOCs and a Groundwater Exit Strategy for the OU-1 Area, Mound, Ohio*, LMS/MND/S11039, Office of Legacy Management, July.

DOE (U.S. Department of Energy), 2014f. *Evaluation of Volatile Organic Compounds in Operable Unit 1 of the Mound, Ohio, Site,* LMS/MND/S10323, Office of Legacy Management, July.

DOE (U.S. Department of Energy), 2015a. *Community Involvement Plan for the U.S. Department of Energy Mound, Ohio, Site,* LMS/MND/S02885, Office of Legacy Management, January.

DOE (U.S. Department of Energy), 2015b. *Long-Term Surveillance and Maintenance Plan for the U.S. Department of Energy Mound, Ohio, Site,* LMS/MND/S01369, Office of Legacy Management, January.

DOE (U.S. Department of Energy), 2015c. *Operations and Maintenance Plan for the U.S. Department of Energy Mound, Ohio, Site,* LMS/MND/S08406, Office of Legacy Management, January.

DOE (U.S. Department of Energy), 2015d. *Annual Assessment of the Effectiveness of Institutional Controls at the Mound Site, Miamisburg, Ohio*, LMS/MND/S12917, Office of Legacy Management, June.

DOE (U.S. Department of Energy), 2016a. *Annual Assessment of the Effectiveness of Institutional Controls at the Mound Site, Miamisburg, Ohio*, LMS/MND/S14084, Office of Legacy Management, June.

DOE (U.S. Department of Energy), 2016b. *OU-1 Pump-and-Treat System Operation and Maintenance Procedure*, LMS/MND/S08755, Office of Legacy Management, current version.

EPA (U.S. Environmental Protection Agency), Integrated Risk Information System (IRIS), http://www.epa.gov/iris/.

EPA (U.S. Environmental Protection Agency), 1993. *Federal Facility Agreement Under CERCLA Section 120; In the Matter of the United States Department of Energy's Mound (Ohio) Plant*, *Miamisburg, Ohio,* July.

EPA (U.S. Environmental Protection Agency), 1999. Cancer Risk Coefficients for Environmental Exposure to Radionuclides, Federal Guidance Report No. 13, EPA 402-R-99-001, September.

EPA (U.S. Environmental Protection Agency), 2001. Health Effects Assessment Summary Tables (HEAST), https://cfpub.epa.gov/ncea/risk/recordisplay.cfm;jsessionid=BED190E1A3D0F3A9392C0994C3AD54CC.cfpub?deid=2877&CFID=74278640&CFTOKEN=38578328.

EPA (U.S. Environmental Protection Agency), 2001. *Comprehensive Five-Year Review Guidance*, OSWER 9355.7-03B-P, June.

EPA (U.S. Environmental Protection Agency), 2005. *Institutional Controls: A Citizen's Guide to Understanding Institutional Controls at Superfund, Brownfields, Federal Facilities, Underground Storage Tank, and Resource Conservation and Recovery Act Cleanups*, OSWER 9255.0-98, EPA-540-R-04-004, February, available online at https://www.epa.gov/sites/production/files/documents/ic_ctzns_guide.pdf, accessed April 29, 2016.

EPA (U.S. Environmental Protection Agency), 2008. *A Systematic Approach for Evaluation of Capture Zones at Pump and Treat Systems*.

OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air (OSWER Publication 9200.2-154, June 2015.

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