LMS/MND/46374

Remedial Design and Remedial Action Work Plan for Operable Unit 1 and Parcel 9 of the Mound, Ohio, Site

February 2025

U.S. DEPARTMENT OF ENERGY | Legacy Management

This document is designed for online viewing.

Contents

Figures

Tables

Abbreviations

ARAR	applicable or relevant and appropriate requirement
BVA	Buried Valley Aquifer
cDCE	*cis*-1,2-dichloroethene
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
DCA	dichloroethane
DCE	dichloroethene
DOE	U.S. Department of Energy
EA	enhanced attenuation
ELCR	excess lifetime cancer risk
EPA	U.S. Environmental Protection Agency
FFA	Federal Facility Agreement
ft	feet
HI	Hazard Index
HQ	Hazard Quotient
IC	institutional control
ICIAP	Institutional Control Implementation and Assurance Plan
LLRW	low-level radioactive waste
LM	Office of Legacy Management
MCL	maximum contaminant level
µg/L	micrograms per liter
NPL	National Priorities List
Ohio EPA	Ohio Environmental Protection Agency
ORC	Ohio Revised Code
ORP	oxidation-reduction potential
OU-1	Operable Unit 1
PCE	tetrachloroethene
P&T	pump-and-treatment
RAO	Remedial Action Objective
ROD	Record of Decision
TCE	trichloroethene
USC	*United States Code*

VC	vinyl chloride
VI	vapor intrusion
VISL	vapor intrusion screening level
VOC	volatile organic compound
yd^3	cubic yard

1.0 Introduction

The Remedial Design and Remedial Action Work Plan, hereafter referred to as the Work Plan, has been prepared for the U.S. Department of Energy (DOE) Office of Legacy Management (LM) by the Legacy Management Support contractor, RSI EnTech, LLC. The Work Plan provides details of Operable Unit 1 (OU-1) and Parcel 9 and associated contaminants, design and regulatory requirements, tasks, and submittals for the remedies for groundwater and vapor intrusion (VI). The work is being performed to implement the decisions established in the *Amendment to the Record of Decision for Operable Unit 1 of the Mound Site, Miamisburg, Ohio* (DOE 2023), hereafter referred to as the 2023 OU-1 Record of Decision (ROD) Amendment, which was issued on September 26, 2023.

The Mound, Ohio, Site[1] is in Miamisburg, Ohio, in southern Montgomery County, approximately 10 miles southwest of Dayton and 45 miles north of Cincinnati (Figure 1). The Mound Plant, named after the Miamisburg Mound that was a Native American burial mound adjacent to the site, was operated to support the nation's weapons and energy programs and included 120 buildings on 306 acres. The site was separated into 11 operable units, parcels, or phases over the years (Figure 2) as part of the remediation approach, and the site was remediated to an industrial and commercial use standard. DOE has transferred all but an 18.5-acre portion of Parcel 9 (shaded green in Figure 2), which includes the OU-1 area, hereafter referred to as the OU-1 and Parcel 9 area, where the groundwater and VI remedies outlined in the 2023 OU-1 ROD Amendment are applied.

Figure 1. Location of the Mound, Ohio, Site

[1] The Mound, Ohio, Site (EPA ID: OH6890008984) (Comprehensive Environmental Response, Compensation, and Liability Information System [CERCLIS] ID 04935) has also been known as the Mound Laboratory, the Mound Laboratories, the Mound Plant, the USDOE Mound Plant, the USDOE Mound Facility, the Miamisburg Environmental Management Project (MEMP), and the Miamisburg Closure Project (MCP).

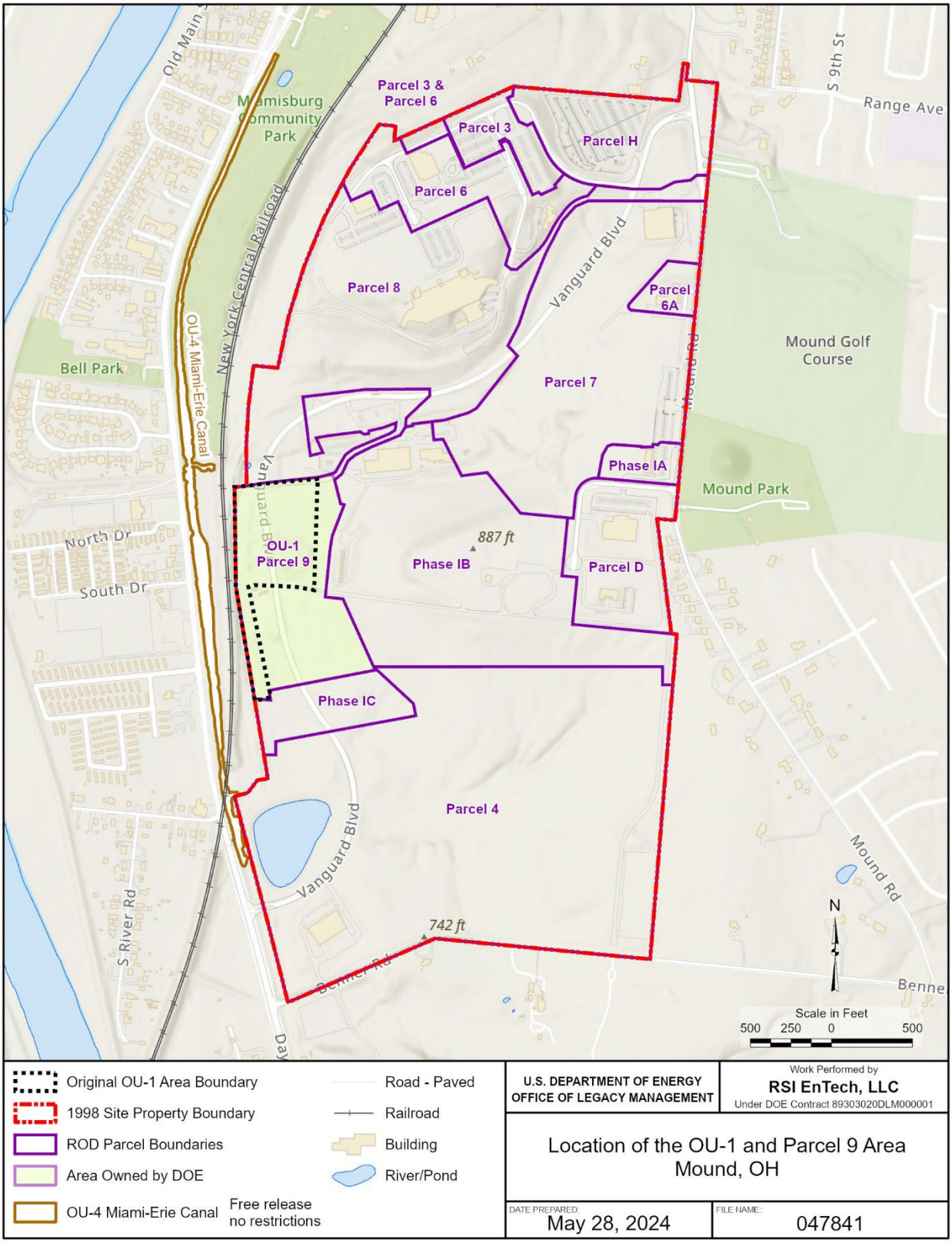


Figure 2. Location of the OU-1 and Parcel 9 Area at the Mound Site

The Work Plan was completed in accordance with the requirements of the Federal Facility Agreement (DOE et al. 1993) (FFA) and the 2023 OU-1 ROD Amendment (DOE 2023). The Work Plan provides an overview of the selected remedy, Remedial Design process, and strategy used to implement the remedial action for the OU-1 and Parcel 9 area. This Work Plan includes all the content required in the 2023 OU-1 ROD Amendment, including the activities and deliverables that will be completed during the Remedial Design and implementation of the enhanced attenuation (EA) remedy for groundwater and the mitigation of the VI pathway in the OU-1 and Parcel 9 area.

1.1 Purpose of the Work Plan

The purpose of this Work Plan is to outline how the selected remedy will be designed and implemented to meet the Remedial Action Objectives (RAOs) identified in the 2023 OU-1 ROD Amendment. The 2023 OU-1 ROD Amendment specifies and explains the modification of the selected remedial action of pump-and-treatment (P&T) for groundwater in OU-1 set forth in the *Operable Unit 1 Record of Decision, Mound Plant, Miamisburg, Ohio* (DOE 1995), hereafter referred to as the 1995 OU-1 ROD, to EA and specifies and explains the activity and use restrictions to address VI in OU-1 and Parcel 9. The 2023 OU-1 ROD Amendment does not modify any other remedies (i.e., institutional controls [ICs]) for Parcel 9 that were documented in the *Amendment of the Operable Unit 1 Record of Decision, U.S. Department of Energy, Mound Closure Project* (DOE 2011a), hereafter called the 2011 OU-1 ROD Amendment.

The selected remedies are:

- **Groundwater:** EA with monitoring and ICs (Alternative GW-4).
- **Vapor Intrusion:** Preemptive measures or actions to mitigate VI exposure with ICs (Alternative VI-3).

1.2 Objectives of the Work Plan

The primary objectives of the Work Plan are to (1) lay out the objectives and technical approach for the Remedial Design activities for both the groundwater and VI components of the selected remedy to meet RAOs and (2) outline the strategy and activities needed to implement the selected remedies.

1.3 Scope of the Work Plan

The Work Plan addresses the remedial actions to be implemented to address residual volatile organic compounds (VOCs) remaining in groundwater and soil vapors in the OU-1 and Parcel 9 area of the Mound site. The 2023 OU-1 ROD Amendment modifies the groundwater remedy component of the 1995 OU-1 ROD from P&T to EA and adds a component to address VI. The remaining remedy components (ICs) outlined in the 2011 OU-1 ROD Amendment will continue to be maintained and remain unchanged.

1.3.1 Groundwater

The major components of the groundwater remedy (Alternative GW-4) are:

- Use of EA to address VOC contamination in OU-1.
- Routine groundwater monitoring of VOCs, geochemical parameters, and microbial counts.
- Enhancement of attenuation processes through the injection of amendments or microbes (if deemed necessary).
- Reliance on ICs that limit the land use to industrial and commercial (prohibit residential use) in the OU-1 and Parcel 9 and prohibit the use, including extraction or consumption, of groundwater.

1.3.2 Vapor Intrusion

The major components of the VI remedy (Alternative VI-3) are:

- Placement of ICs that require future property owners to perform one of the following:
  - Incorporate adequate engineering controls to mitigate potential VI exposures at the time of construction and confirm the continued operation, maintenance, and testing to ensure that the controls are in use and effective in the long term
  - Provide sufficient information that indicates that conditions are such that the VI pathway is incomplete and engineering controls are not necessary
- Reliance on existing ICs that limit the land use to industrial and commercial (prohibit residential use) in Parcel 9.

An additional task associated with the addition of the VI remedy is incorporating the VI ICs into the current project IC inspection and assessment program.

1.3.3 Maintenance of New and Existing ICs

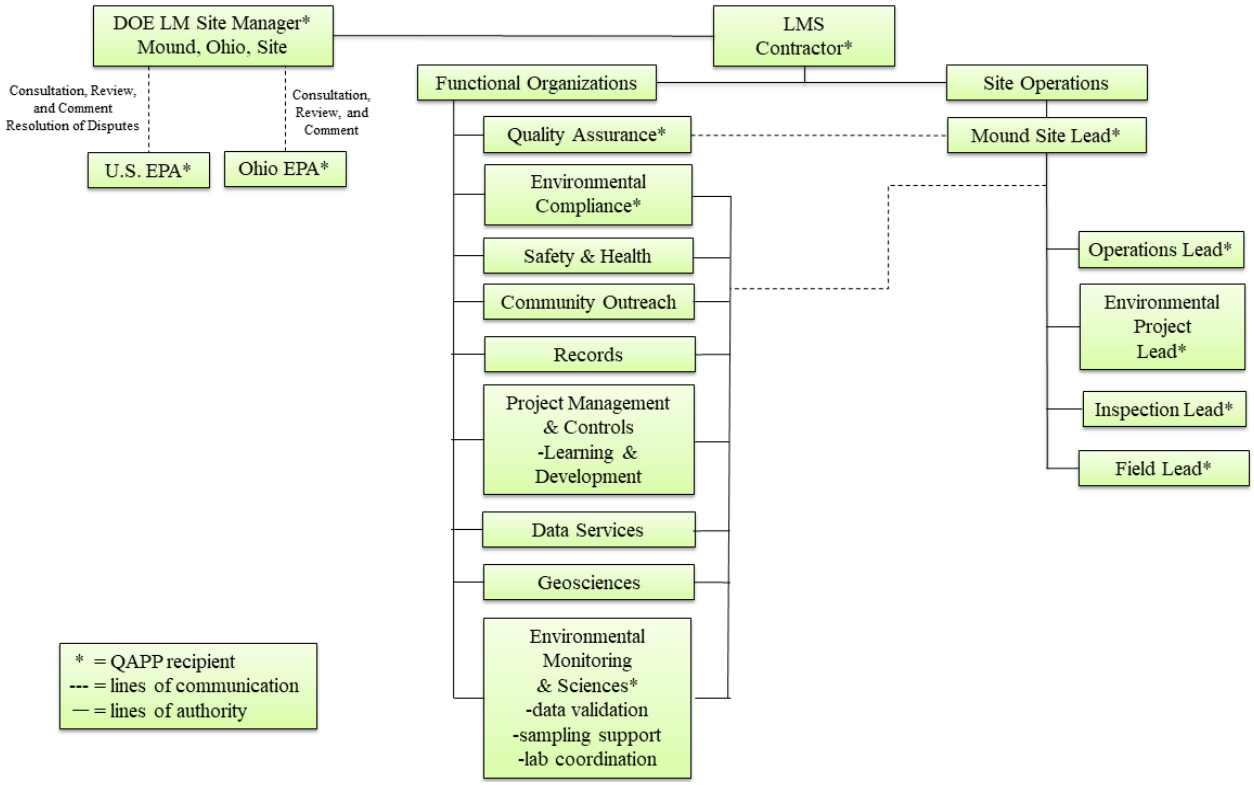
The remedies for both groundwater and VI in the OU-1 and Parcel 9 area rely on the maintenance of existing ICs established by the 2011 OU-1 ROD Amendment (DOE 2011a). The remedies must incorporate mechanisms that ensure that future property owners shall also be required to adhere to any new ICs and the following existing ICs:

- Prohibit the extraction or consumption of, exposure to, or any use of the groundwater underlying the Mound site
- Prohibit the removal of soil from the Mound site
- Limit land use to industrial or commercial activities
- Allow federal and state agencies site access for sampling and monitoring

1.4 Project Management of the Work Plan

Activities at the Mound site are conducted by LM and regulated by the U.S Environmental Protection Agency (EPA) and Ohio Environmental Protection Agency (Ohio EPA). The responsibilities of each group are defined in the FFA (DOE et al. 1993). Organizational and

management structure showing the relationships among regulatory agencies and the Mound site are provided in Figure 3.



Abbreviation: QAPP = Quality Assurance Program Plan

Figure 3. Mound, Ohio, Site Project Organization

1.5 Organization of the Work Plan

The content of this document is specified in Section XI, "Remedial Design/Remedial Action," and Attachment II, "Deliverables of the FFA," of the FFA (DOE et al. 1993). The principal content of the Work Plan is as follows:

- Section 2.0 – Background
- Section 3.0 – Basis for Remedial Action
- Section 4.0 – Remedial Design
- Section 5.0 – Remedial Design Approach
- Section 6.0 – Remedial Design Submittals and Schedule
- Section 7.0 – Remedial Action Implementation
- Section 8.0 – Completion of Remedial Action Work
- Section 9.0 – References

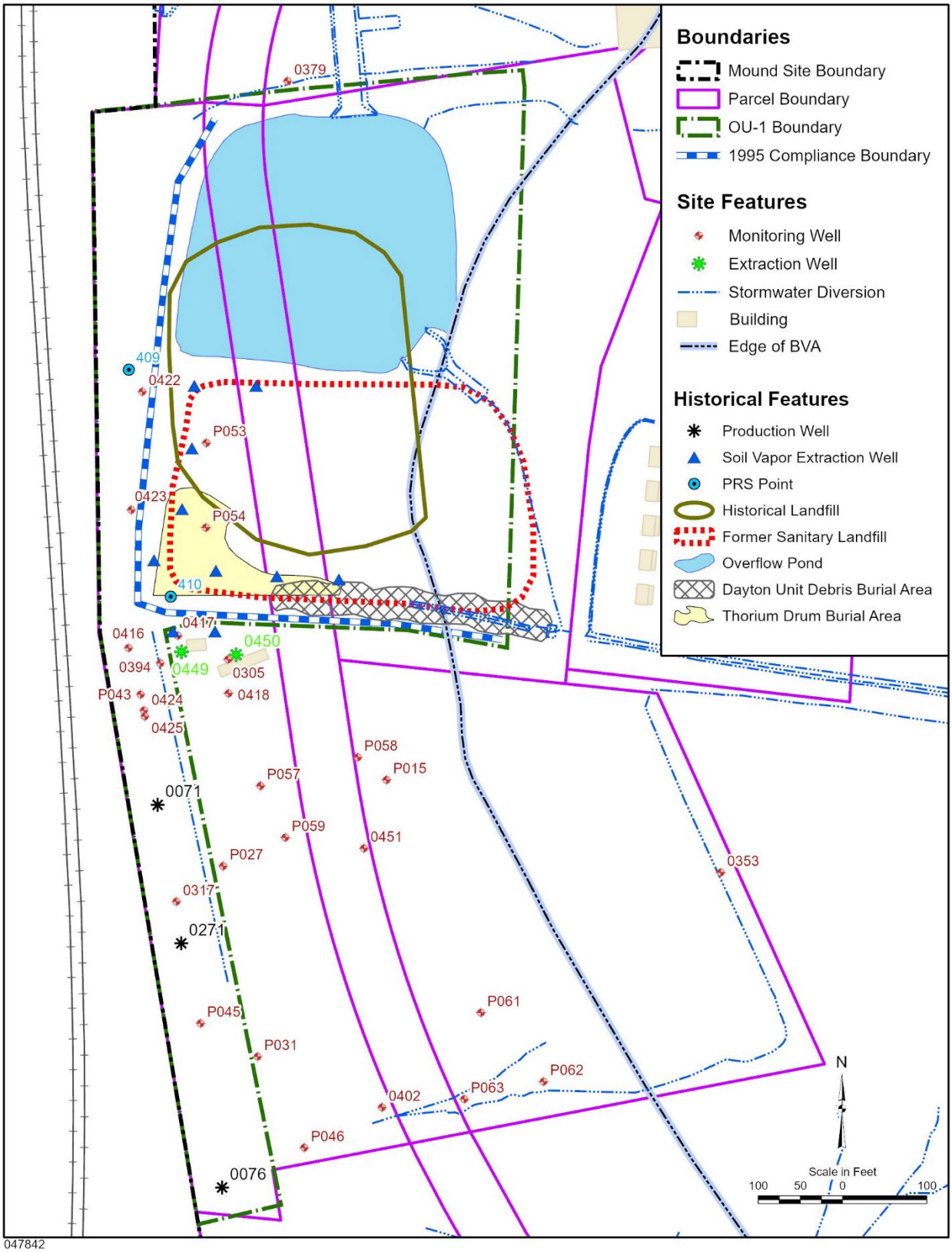
2.0 Background

The U.S. Atomic Energy Commission, a predecessor to DOE, established the Mound Plant to support the nation's weapons and energy programs. The plant operated from 1948 to 1995 to support early atomic weapons programs and later research, development, and production work to support nuclear and explosive weapons and energy technology (also referred to as the general-purpose heat source program). The general-purpose heat source program continued until 2003. DOE established the Environmental Restoration Program at the site in 1984, and the site was placed on the EPA National Priorities List (NPL) in 1989. Remedial actions were planned, developed, and implemented to facilitate future economic development of the plant property into an industrial and commercial site.

2.1 Operable Unit 1 and Parcel 9 History

During operation of the Mound site, an onsite landfill was created on the western side of the site on the edge of the Great Miami Buried Valley Aquifer (BVA). The BVA is designated as a sole source aquifer that provides drinking water to much of the Miami River Valley. In 1989, the Mound site was placed on the NPL as a result of the VOCs in groundwater beneath the OU-1 landfill area (Figure 4). Pursuant to this NPL designation, an FFA was executed between DOE and EPA in October 1990. Ohio EPA became a party to the FFA in 1993 (DOE et al. 1993).

The original area designated as OU-1 occupies approximately 4 acres in the southwestern portion of the Mound site. OU-1 includes the historical landfill site, former sanitary landfill site, and former OU-1 overflow pond. During later investigations, the former production well area was incorporated into OU-1 (Figure 4).



Abbreviation: PRS = potential release site

Figure 4. OU-1 Site Map

2.1.1 1995 OU-1 Groundwater Remedy

The 1995 OU-1 ROD (DOE 1995) was approved by EPA and Ohio EPA in 1995 and was the first of several actions planned as part of the overall remedial action for the Mound site. The 1995 OU-1 ROD remedy addressed the principal threats posed by contaminants within OU-1 by controlling groundwater contamination (dilute VOCs), preventing the migration of contamination toward the Mound Plant production wells, and minimizing exposure to potential receptors. The pathways of concern consist of leaching of contaminants from OU-1 soils or disposed waste into groundwater, migration in the groundwater flow, and withdrawal by the Mound Plant production wells or by other, future wells. It was determined that the soils within the OU-1 area would not pose an unacceptable risk to a future outdoor industrial worker with appropriate ICs in place. The 1995 OU-1 ROD documented the collection and treatment of contaminated groundwater (i.e., P&T system) and disposal of treated water to control groundwater contamination and prevent migration of the contamination. Contents of the 1995 OU-1 ROD included the following actions:

- Controlling groundwater contamination (primarily low VOC concentrations) and preventing migration of contamination toward the Mound Plant production well through the collection and treatment of contaminated groundwater (i.e., P&T system) and disposal of treated water
- Establishing controls to manage surface water and reduce infiltration through the landfill
- Establishing controls (e.g., fencing) to minimize contact with contaminated soil
- Establishing controls, such as deed restrictions, to maintain specific land use and prevent groundwater use

The P&T system was installed in 1996 and began operation in February 1997. The groundwater treatment process consisted of capturing groundwater using two extraction wells (0449 and 0450) and treating the groundwater using an air stripper. The air stripper removed VOCs, primarily tetrachloroethene (PCE) and trichloroethene (TCE), through aeration. As groundwater discharged at the top of the air stripper tower, it would cascade over slotted trays while a blower at the bottom of the tower pushed air up through the tower to volatilize VOCs. The air stripper was vented to the atmosphere. Treated water that was collected from the bottom of the air stripper was released through an effluent discharge pipe to a drainage system that ultimately discharged to the Great Miami River. Discharged water was sampled and analyzed in accordance with a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Authorization to Discharge, and the results were reported to Ohio EPA.

The P&T system was housed in Building 300, which is on the southwestern corner of the former OU-1 landfill. The stainless-steel air stripper and all ancillary equipment are inside the 12 × 24-foot (ft) metal-frame building that was constructed on a concrete slab with footers. The air stripper is 5 × 8 × 5 ft and constructed from stainless-steel materials.

Approximately 12 kilograms of TCE were removed between startup and April 2003. After April 2003, the mass removed by the P&T system was no longer calculated, as it was negligible (DOE 2006). The operation of the P&T system continued until 2014 when regulators allowed the system to be placed in standby mode while a multiyear field demonstration was being performed to assess the feasibility of attenuation remedies.

2.1.2 Other Removal Actions to Support the 1995 Groundwater Remedy

In addition to the operation of the P&T system to control contaminated groundwater, several removal actions were completed in the former OU-1 landfill area to support project activities and expedite remediation time frames by addressing VOC contamination in the vadose zone. These actions included the following:

- Removing suspected VOC-contaminated soil encountered during the installation of a stormwater pipe in 1996
- Reducing the mass of VOCs in the vadose zone by operating a soil vapor extraction system from 1996 until 2003
- Removing radiologically contaminated soil from the southwestern corner of the former landfill in 2005

2.1.3 OU-1 Landfill Excavation

Two additional removal actions were performed to facilitate future economic development of the landfill area. In 2007, DOE received funding from Congress to perform non-CERCLA removal actions at OU-1 to excavate the landfill. In 2009, DOE received funding through the American Recovery and Reinvestment Act to complete final excavation and site restoration activities. Excavation of the landfill occurred intermittently from 2007 through 2010, which resulted in removal of most of the VOC source.

As a result of the two non-CERCLA removal activities, most of the source material was removed from the former landfill. During the first phase (2007 and 2008), 60,494 cubic yards (yd^3) of low-level radioactive waste (LLRW) and 4409 bulk tons of VOC hazardous waste were removed (DOE 2009). During the second phase (2009 and 2010), 33,450 yd^3 of LLRW and 37 yd^3 of mixed waste (polychlorinated biphenyls and LLRW) were removed (DOE 2010). Parcel 9 was remediated in accordance with the *Work Plan for Environmental Restoration of the DOE Mound Site, The Mound 2000 Approach* (DOE 1999), and the results of that action are documented in the *Miamisburg Closure Project Parcel 9 Residual Risk Evaluation, Mound Plant, Miamisburg, Ohio* (DOE 2011c). The remaining soil in the OU-1 area meets the site cleanup objective for future industrial and commercial land use. Soil cleanup levels were risk-based in consideration of the industrial and commercial user. The results of the two excavation actions, including cleanup levels, are reported in the *Operable Unit 1 Closeout Report* (DOE 2009) and *Operable Unit 1 Landfill Area Closeout Report* (DOE 2010). The remaining soil meets site cleanup objectives that were risk-based values developed in consideration of industrial and commercial land use. However, the VI pathway was not a recognized pathway for exposure at that time; therefore, VI was not considered when cleanup levels were calculated.

2.1.4 2011 OU-1 ROD Amendment

The 2011 OU-1 ROD Amendment (DOE 2011a) was approved by both EPA and Ohio EPA in 2011. The contents of this amendment included the following actions:

- Documenting the geographic expansion of the land area included in the 2011 OU-1 ROD Amendment
- Identifying ICs to be implemented for the OU-1 area in the Parcel 9 *Environmental Covenant* (DOE 2011b)

When the 1995 OU-1 ROD (DOE 1995) was written, there was little guidance on which specific restrictions should be required or how deed restrictions should be implemented at CERCLA sites. The 2011 OU-1 ROD Amendment contains language from the Parcel 9 *Environmental Covenant* (DOE 2011b) in accordance with Title 53 Ohio Revised Code Section 5301.80–5301.92 (53 ORC 5301.80–5301.92), "Conveyances; Encumbrances." The 2011 OU-1 ROD Amendment ensured that the ICs for Parcel 9 are consistent with sitewide ICs previously identified for other portions of the Mound site and include the following:

- Prohibit the removal of soil from the original 306 acres of the DOE Mound site property boundaries
- Prohibit the extraction or consumption of, exposure to, or any use of the groundwater underlying the Mound site
- Limit land use to industrial and commercial activities
- Allow site access for federal and state agencies for sampling and monitoring

2.1.5 2023 OU-1 ROD Amendment

Based on the effectiveness of an OU-1 Enhanced Attenuation Field Demonstration, modifying the groundwater remedy to an attenuation-based approach to address VOCs in OU-1 groundwater was proposed as a viable alternative to the ineffective P&T remedy. Also, as part of the sitewide VI assessment occurring at that time, it was determined that several VOCs were present at sufficient levels in the vadose zone in OU-1 to result in an unacceptable risk to building occupants if these vapors were to enter a building. An amendment to the 1995 OU-1 ROD was proposed to modify the remedy addressing VOCs in groundwater and to add a remedy to address potential VI exposure.

The 2023 OU-1 ROD Amendment (DOE 2023) was issued in accordance with Section 117(c) of CERCLA, as amended by the Superfund Amendments and Reauthorization Act of 1986 (hereafter jointly referred to as CERCLA), Title 42 *United States Code* Section 9617(c) (42 USC 9617[c]), and Title 40 *Code of Federal Regulations* Section 300.435(c)(2)(ii) (40 CFR 300.435[c][2][ii]), "Community Relations." The 2023 OU-1 ROD Amendment was prepared to document changes to the selected remedy identified in the 1995 OU-1 ROD, to summarize the information that led to the 2023 OU-1 ROD Amendment, and to affirm that the 2023 OU-1 ROD Amendment complies with the statutory requirements of Section 121 of CERCLA (42 USC 9621) and the National Oil and Hazardous Substances Pollution Contingency Plan, also called the National Contingency Plan. The 2023 OU-1 ROD Amendment was signed on September 26, 2023.

The 2023 OU-1 ROD Amendment (DOE 2023) modifies the groundwater remedy component of the 1995 OU-1 ROD (DOE 1995) and adds a VI component; the remaining components outlined in the 2011 OU-1 ROD Amendment (DOE 2011a) remain unchanged. The selected remedies were developed to address residual VOCs remaining in groundwater and soil vapors in the OU-1 and Parcel 9 area of the Mound site. These remedies are referred to as:

- **Groundwater:** EA with monitoring and ICs.
- **Vapor Intrusion:** Preemptive measures or actions to mitigate VI exposure with ICs.

2.2 Field Studies and Investigations

In addition to the operation of the P&T system, a significant number of investigations were performed to evaluate changes as the groundwater remedy progressed or removal actions were completed. These investigations included the following:

- Evaluation of the changes in contaminant concentrations as groundwater levels rebounded after shutting off the extraction wells for a limited time (2004 and 2011)
- Additional delineation of the areal extent of the VOC impact in groundwater (2011–2013)
- Evaluation of possible additional sources of VOCs (2011–2013)
- Evaluation of attenuation mechanisms (geochemistry and microbial populations) (2011–2012)
- Assessment of the feasibility of reducing VOC mass and concentrations using attenuation-based methods through a multiyear field demonstration, which resulted in a reduction in the mass and concentrations of VOCs in groundwater (2012–2018)

2.2.1 Operable Unit 1 Enhanced Attenuation Field Demonstration

Information from studies performed after the 2011 rebound test led to the recommendation that passive methods should be considered to address the current VOC impact in OU-1 groundwater. The recommendation also suggested that the methods could include limited treatment of hot spots to reduce VOC concentrations in portions of the saturated soil or groundwater and create an environment more conducive to the destruction of VOCs. Information to support this recommendation was compiled in the *Evaluation of Volatile Organic Compounds in Groundwater in Operable Unit 1 of the Mound, Ohio, Site* (DOE 2014a).

As determined from these previous investigations and studies, the impact downgradient of the hydraulic boundary of the P&T system is residual dissolved-phase VOC in groundwater with no additional VOC sources. It was also determined that the migration rate of the plume is slow due to small hydraulic gradients. Within the areas of impact, characterization data indicate that reductive dechlorination of PCE to TCE occurs; however, subsequent reductive dechlorination of TCE to *cis*-1,2-dichloroethene (cDCE) is limited. Overall, aerobic conditions dominate the OU-1 groundwater system, indicating that cometabolic aerobic oxidation of TCE and cDCE is feasible based on organic carbon and dissolved oxygen results.

The combination of technologies that emerged for OU-1 included (1) neat (or pure) vegetable oil deployment in the deep vadose zone in the former source area, (2) emulsified vegetable oil deployment within the footprint of the groundwater plume, and (3) monitoring of concentration trends, attenuation mechanisms, and attenuation rates in the plume. The goal of the edible oil deployment was to develop structured geochemical zones that decrease chlorinated compound concentrations in two ways: (1) physical sequestration, which reduces effective aqueous concentration and mobility, and (2) stimulation of anaerobic degradation, abiotic degradation, and aerobic cometabolic processes.

The OU-1 Enhanced Attenuation Field Demonstration was designed based on structured geochemical zones and relies on groundwater flow through a succession of anaerobic and aerobic zones (DOE 2014c). The anaerobic zones stimulate relatively rapid degradation of the

original solvent source compounds (e.g., chlorinated VOCs, such as PCE and TCE). The surrounding aerobic areas encourage relatively rapid degradation of daughter products (dichloroethene [DCE] and vinyl chloride [VC]), as well as enhanced cometabolism of TCE resulting from the utilization of methane and other reduced hydrocarbons that are formed and released from the anaerobic zones. The hybrid structured geochemical zone approach supports reasonable progress toward remedial goals based on the complementary strengths of the different attenuation and degradation processes that occur in the two redox conditions. The strategy also minimizes adverse collateral impacts that may ensue when converting an aerially extensive region of an aquifer from baseline aerobic conditions to strongly anaerobic conditions. Finally, structured geochemical zones allow the microbial communities to work in sequence in environments to allow the overall degradation to be relatively rapid and robust.

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 (DOE 2014c). The injection points were designed to be temporary and were removed after completion of the injection program. The key factors considered in the site-specific implementation for the field demonstration were:

- **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.
- **Former Source Area—Groundwater:** Strategic emulsified oil injection into the groundwater to form treatment zones that address key flow lines in the aquifer beneath the former landfill area.
- **Downgradient of Former OU-1 Landfill—Groundwater:** Intensive emulsified oil injection in multiple locations to address the chlorinated VOC-impacted groundwater downgradient of the former landfill.

The overall goal of the OU-1 Enhanced Attenuation Field Demonstration was to show that structured geochemical zones could be established and effectively maintained so that chlorinated VOC concentrations in groundwater could decrease to maximum contaminant levels (MCLs) in a reasonable time frame. Based on the data generated from the field demonstration and discussed in the *Operable Unit 1 Field Demonstration Project Completion Report, Mound, Ohio, Site* (DOE 2020), it was concluded that a passive attenuation-based remedy is a viable alternative to address VOCs in OU-1 groundwater. Based on the overall performance and maintenance of the structured geochemical zones throughout the 4-year demonstration period, it was concluded that the field demonstration objectives were met. The factors for evaluating whether the field demonstration objectives were met were modeled after the *Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites* document (EPA 1999).

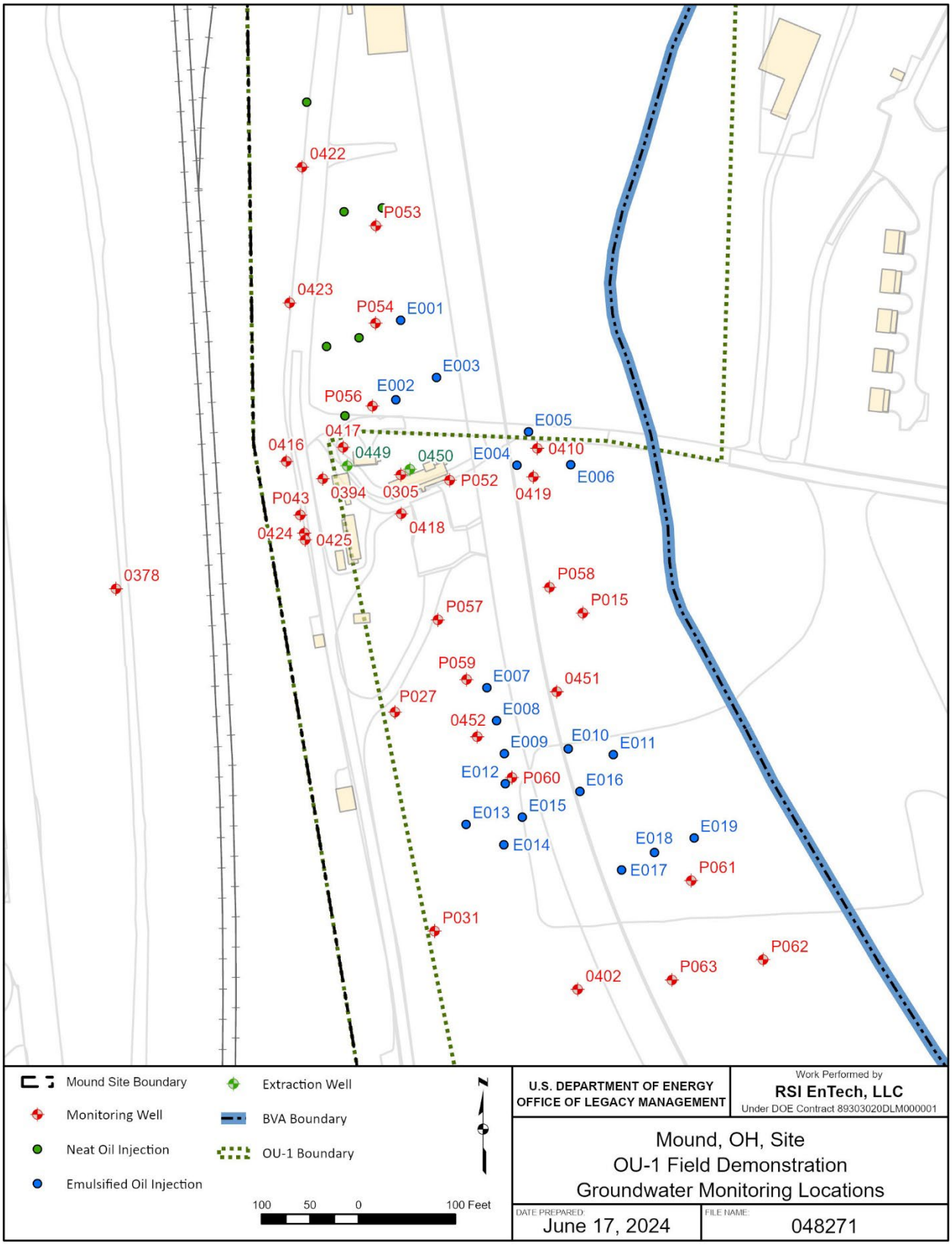


Figure 5. OU-1 Enhanced Attenuation Field Demonstration Monitoring Well and Injection Point Locations

2.2.2 Sitewide Vapor Intrusion Assessment

A sitewide VI assessment is underway at the Mound site. Based on the results of the *Vapor Intrusion Assessment: Phase I Preliminary Screening and Conceptual Model for the Mound, Ohio, Site* (DOE 2019b), the majority of Parcel 9, including all of OU-1, was identified as an area requiring additional characterization sampling. The datasets that supported the determination that this area required additional characterization are listed below:

- **Soil:** Locations with detectable concentrations of several VOCs and polycyclic aromatic hydrocarbons identified as vapor-forming chemicals
- **Groundwater:** Concentrations of TCE, VC, chloroform, and carbon tetrachloride greater than vapor intrusion screening levels (VISLs) for groundwater that indicate potential unacceptable risk
- **Soil Gas:** Concentrations of TCE and VC greater than VISL for soil gas that indicate potential unacceptable risk

Based on results from an extensive field investigation, it was concluded that no additional areas exhibited significant levels of VOCs in soil outside the boundary of the former landfill area (DOE 2014a). However, because of the historical migration of impacted groundwater before the OU-1 groundwater remedy was implemented, low levels of VOCs may be present in the till and outwash materials near the water table near and downgradient from the former landfill. These materials are a mixture of sand, silt, and clay; therefore, VOCs may have sorbed onto the clayey materials and are contributing very low levels of VOCs in soil vapors.

Data from soil-gas samples collected in 2011 indicate that concentrations of TCE in several locations near the former landfill exceed the risk-based (industrial or commercial) concentration levels for vapors measured beneath a building that were established using the EPA VISL calculator. The VISL calculator permits inputs of site-specific exposure scenarios, target excess lifetime cancer risk (ELCR) levels for carcinogens, target Hazard Quotients (HQs) for noncarcinogens, and average in situ groundwater temperature. The present and expected future onsite land use is industrial and commercial. The average in situ groundwater temperature is 15 °C. For this assessment, the following two target risk-based values were developed for evaluating data:

- Screening level: ELCR = 1.0×10^{-6} and HQ = 0.1
- Threshold level: ELCR = 1.0×10^{-5} and HQ = 1

Additional data from a soil-gas investigation that was conducted by Ohio EPA at the Mound site in early 2020 are documented in the *Vapor Intrusion Comparative Soil Gas Sampling Event at Former DOE Mound Facility Field and Data Analysis Report* (Ohio EPA 2020b). This investigation was performed to examine active and passive sample collection methods and focused on areas in or near the former landfill. The results of this sampling indicated that concentrations of benzene, chloroform, 1,2-dichloroethane (DCA), PCE, TCE, and VC in soil gas exceed risk-based screening levels.

3.0 Basis for Remedial Action

This section describes the remedies for groundwater and VI that are being implemented in accordance with the 2023 OU-1 ROD Amendment (DOE 2023) and discusses the RAOs, remediation goals, and applicable or relevant and appropriate requirements (ARARs) that address residual VOCs in groundwater and soil vapors.

3.1 Remedy Description

The 2023 OU-1 ROD Amendment selects and explains modifications to the selected remedy for groundwater set forth in the 1995 OU-1 ROD (DOE 1995) and the remedy for VI in OU-1 and Parcel 9. This 2023 OU-1 ROD Amendment does not modify the remedies (i.e., ICs) for OU-1 and Parcel 9 that are documented in the 2011 OU-1 ROD Amendment (DOE 2011a).

The following remedial actions were presented in the 2023 OU-1 ROD Amendment to address residual VOC contamination:

- **Groundwater:** EA with monitoring and ICs
- **Vapor Intrusion:** Preemptive measures or actions to mitigate VI exposure with ICs

3.1.1 Enhanced Attenuation Groundwater Remedy

"Enhanced Attenuation with Monitoring and ICs" (designated as Alternative GW-4 in the 2023 OU-1 ROD Amendment) was selected as the remedial action to address VOC-contaminated groundwater in OU-1 and Parcel 9. This remedy was initiated with the injection of both neat and emulsified oil to enhance biodegradation by reductive dechlorination in 2014 and is currently operating as intended, as reflected in decreasing contaminant concentrations and stability (no expansion) of the plume. This remedy is designed to achieve all RAOs and remediate groundwater throughout the plume within a reasonable time frame (i.e., approximately 10 years). This alternative complies with ARARs, addresses all VOC-impacted groundwater originating from the former OU-1 landfill within Parcel 9, acknowledges uncertainties associated with long-term treatment of VOCs by allowing injection of amendments or microbes (if deemed necessary), and can be performed cost-effectively. The results of the OU-1 Enhanced Attenuation Field Demonstration completed in 2018 indicate that sustainable geochemical and biological processes will degrade contaminants to MCLs within a reasonable time frame (i.e., approximately 10 years). The structured geochemical zone approach supports reasonable progress toward remedial goals based on the complementary strengths of the different attenuation and degradation processes that occur in the two redox conditions. The operation of the EA remedy relies on groundwater flow through a succession of anaerobic and aerobic structured geochemical zones to produce the following:

- Anaerobic zones that stimulate relatively rapid degradation of the parent compounds (PCE and TCE)
- Surrounding aerobic areas that encourage relatively rapid degradation of daughter products (DCE and VC), as well as enhanced cometabolism of TCE resulting from the utilization of methane and other reduced hydrocarbons that are formed and released for the anaerobic zones

Modifying the groundwater remedy outlined in the 1995 OU-1 ROD (DOE 1995) to an attenuation-based remedy is considered a superior change for the following reasons:

- The majority of the VOC source has been removed from the former landfill area
- Concentrations of VOCs in groundwater have decreased since the removal of source materials
- Attenuation mechanisms, such as reductive dechlorination and aerobic cometabolism, have been determined to be effective in reducing the concentrations of VOCs in OU-1 groundwater

The EA remedy will achieve the RAOs and will remediate groundwater throughout the plume within a reasonable time frame (i.e., approximately 10 years). The results of the OU-1 Enhanced Attenuation Field Demonstration indicate that geochemical and biological processes are present, sustainable, and will degrade contaminants to remediation goals within a reasonable time frame (approximately 10 years). The primary components of the EA remedy are:

- Attenuation of VOCs via biodegradation, including reductive dechlorination and aerobic cometabolism, and abiotic processes.
- Enhancement of attenuation processes through the injection of amendments or microbes to stimulate the attenuation process (if deemed necessary).
- Monitoring of VOCs, other geochemical constituents (sampling twice per year), and microbial counts in groundwater.
- Evaluation of data to ensure that biogeochemical conditions remain favorable for attenuation processes.
- Identification of conditions that may warrant the necessity to inject additional amendments or microbes to maintain the biogeochemical conditions.
- Maintenance of the following ICs existing under the 2011 OU-1 ROD Amendment (DOE 2011a):
  - Prohibit the extraction or consumption, exposure to, or any use of the groundwater underlying the Mound site
  - Prohibit the removal of soil from the Mound site
  - Limit land use to industrial and commercial
  - Allow federal and state agencies site access for sampling and monitoring

3.1.2 Vapor Intrusion Remedy

"Preemptive Measures or Actions to Mitigate VI Exposure with ICs" (designated as Alternative VI-3 in the 2023 OU-1 ROD Amendment [DOE 2023]) is selected as the remedy to address vapor-forming chemicals in the vadose zone in OU-1 and Parcel 9. This remedy will achieve all RAOs by eliminating the VI pathway and preventing exposure to future building occupants. Although the implementation of ICs does not reduce the toxicity or volume of contaminants, it does recognize that the major VOC source areas have been removed and residual sources are currently being addressed by other remediation actions. In addition, the remedy will include requirements for subsequent activities to be performed by future property owners that will

reduce the mobility of vapors into buildings by employing preemptive measures (engineering controls) or actions to mitigate the VI pathway. While there are currently no ARARs for VI, the concepts in EPA and Ohio EPA guidance documents are used by employing preemptive measures or actions to mitigate the VI pathway and provide data that support the effectiveness of any preemptive measures or actions.

The primary component of the VI remedy is recording an environmental covenant with Montgomery County to document and impose activity and use limitations. The environmental covenant will be prepared in accordance with 53 ORC 5301.80–5301.92. This environmental covenant shall require a future property owner to choose to perform one of the alternatives presented below prior to initiating new building construction in the OU-1 and Parcel 9 area:

1. Incorporate engineering controls (i.e., vapor mitigation system) at the property or a portion thereof at the time of construction and confirm continued operation, maintenance, and monitoring to ensure that the controls are effective in the long term to protect human health and the environment. Such plans shall be provided to DOE, EPA, and Ohio EPA for review and approval before construction. Information and evidence regarding the final and as-built engineering controls shall be provided in writing to the parties identified in the environmental covenant.
2. Provide information and evidence that demonstrate the conditions at the property or portion thereof are such that the VI exposure pathway is incomplete and engineering controls (i.e., vapor mitigation system) are not necessary to protect human health and the environment. Such information shall be provided to DOE, EPA, and Ohio EPA for review and approval prior to construction. Information and evidence that demonstrate there is no unacceptable risk from VI should be obtained through samples collected from the property. A final determination of the risk that concentrations of subsurface vapors could pose to building occupants shall be provided in writing to the parties identified in the environmental covenant.

3.1.3 Maintenance of New and Existing ICs

The remedies for both groundwater and VI in the OU-1 and Parcel 9 area rely on the maintenance of new and existing ICs. The environmental covenant will include that future property owners shall be required to adhere to the new ICs to address VI (Section 3.1.2) and all existing ICs established under the 2011 OU-1 ROD Amendment (DOE 2011a) as follows:

- Prohibit the extraction or consumption of, exposure to, or any use of the groundwater underlying the Mound site
- Prohibit the removal of soil from the Mound site
- Limit land use to industrial or commercial activities
- Allow federal and state agencies site access for sampling and monitoring

3.2 Regulatory Framework

The following subsections discuss the RAOs, remediation goals, and ARARs to address VOC-contaminated groundwater and VI that were identified for Parcel 9 based on the summary of risks for current and future exposure scenarios. RAOs are site-specific statements that convey the goals for minimizing or eliminating risk to the public or environment. Typically, remediation

goals are selected using either risk-based, conservative screening values that provide risk-reduction targets or regulatory established values that have been determined to be ARARs. Applicable requirements mean those cleanup standards, standards of control, and other environmental protection requirements promulgated under federal or state law that specifically address a chemical, action, or location. Relevant and appropriate requirements mean those cleanup standards that address problems or situations sufficiently similar to those at a site and that their use is well suited to the site. ARARS are classified as chemical, action, or location specific. Chemical-specific ARARs are usually health- or risk-based concentrations in environmental media, such as groundwater or air. Location-specific ARARs generally are restrictions imposed when remedial activities are performed in an environmentally sensitive area or special location. Action-specific ARARs are restrictions placed on treatment or disposal technologies.

3.2.1 Remedial Action Objectives

3.2.1.1 Groundwater

RAOs are site-specific statements that convey the goals for minimizing or eliminating risk to the public or environment. The RAO for the modified groundwater remedy is to reduce (to remedial goals) the contaminant concentrations throughout the VOC plume (both former landfill and downgradient), thereby restoring the groundwater to beneficial reuse and prohibit groundwater with contaminant concentrations greater than the remediation goals from moving outside the boundary of Parcel 9.

3.2.1.2 Vapor Intrusion

The RAO for the VI remedy in OU-1 is to mitigate potential health risks from contaminated vapors to future building occupants within OU-1 and Parcel 9 by addressing the VI pathway. There currently are no permanent buildings within the area of interest in OU-1 and Parcel 9; therefore, there are no current onsite receptors to vapors. However, if buildings were constructed in this area, future occupants may have the potential to be exposed to vapors that equate to concentrations calculated using the EPA VISL calculator that are greater than risk-based target levels of 1.0×10^{-6} total ELCR or 0.1 total HQ concentrations for vapors measured beneath a building.

3.2.2 Remediation Goals and ARARs

3.2.2.1 Groundwater

The selected remedy for groundwater is intended to reduce contaminant concentrations and maintain control of plume expansion until remediation goals are reached. Figure 6 depicts the geographic area where remediation goals would apply. This expanded area includes the OU-1 area, as well as the majority of Parcel 9 that encompasses the area of downgradient groundwater impact.

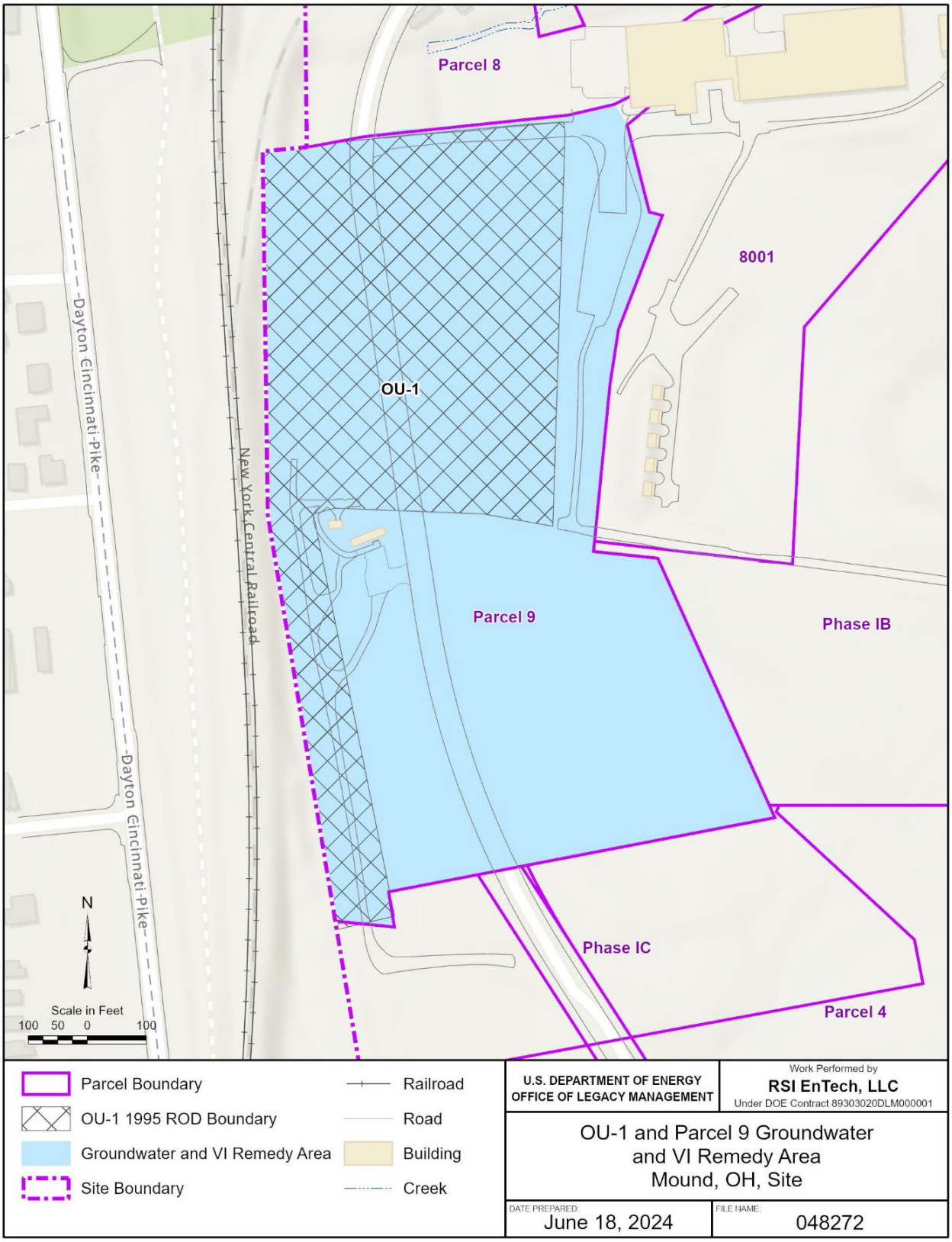


Figure 6. OU-1 Groundwater and VI Remedy Area

The selected remedy will reduce the ELCR associated with potential exposure to contaminated groundwater to a risk range of 1.0×10^{-4} to 1.0×10^{-6} by reducing the concentration of the contaminants in groundwater to the remediation goals. The specific remediation goals of each contaminant are based on either risk-based values for residential use of groundwater or MCLs from the Safe Drinking Water Act (40 CFR 141) and Ohio's "Primary Drinking Water Rules" in *Ohio Administrative Code* 3745:81 (OAC 3745:81). Based on the ARARs and risk-based screening levels, the remediation goals are provided in Table 1.

These values are similar to those presented in the 1995 OU-1 ROD (DOE 1995), and changes are due to updated risk characterization parameters. It is assumed that all carcinogens are additive, and for the purposes of establishing the remediation goals, the combined carcinogenic risk cannot exceed 1×10^{-4}, but conservative remediation goals have been set to maintain the ELCR closer to 1×10^{-5}, which is consistent with the Ohio EPA target risk. PCE has a remediation goal set at the MCL of 5 micrograms per liter (µg/L), equating to an ELCR less than 1×10^{-6}. TCE has a remediation goal set at the MCL of 5 µg/L, equating to an ELCR of 1×10^{-5}. The remediation goal for cDCE is set at a risk-based value assuming a Hazard Index (HI) of 1, which is consistent with the value established in the 1995 OU-1 ROD. As this is the only contaminant with a remediation goal based on noncancer adverse effects, it can be considered protective assuming an HI of 1. The remediation goal for VC is set at its quantification reporting limit of 1 µg/L and equates to a risk of 5×10^{-5}. The aggregate carcinogenic risk at the remediation goals is 6.3×10^{-5}.

Table 1. Remediation Goals for Groundwater in OU-1

COCs (µg/L)	Risk-Based Comparison Value[a]	Regulatory Limits[b]	Maximum Concentration[c]	Remediation Goal	Lifetime Risk at Remediation Goal
PCE	11.3	5.0	5.82	5.0	4.4×10^{-7}
TCE	0.49	5.0	7.37	5.0	1.0×10^{-5}
cDCE	36.1	70.0	32.2	50.0	HI = 1.0
VC	0.019	2.0	14.2	1.0	5.3×10^{-5}
TOTAL					**6.3×10^{-5}**

Notes:
[a] Risk-based comparison values equate to a 1.0×10^{-6} ELCR or an HI of 1.0 and were estimated using the EPA Regional Screening Level calculator in June 2021.
[b] Regulatory limits equate to MCLs or Ohio's Primary Drinking Water Rules.
[c] Maximum concentrations were obtained from 2019–2021 groundwater data.

Abbreviations:
COC = contaminant of concern
HI = Hazard Index
µg/L = micrograms per liter

3.2.2.2 Vapor Intrusion

The other goal is to address the potential for VI risk within OU-1 and Parcel 9 in newly constructed buildings. The primary receptors to vapor sources in the future are occupants of buildings that may be constructed within the boundaries of OU-1 and Parcel 9. Because there are sources that could generate vapors of sufficient concentrations to result in a human health risk, there is the potential for vapors to enter structures either through diffusion from sources or preferential migration through existing or future utility conduits.

The remediation goal for the VI remedy is to demonstrate that either:

1. A mitigation system installed in a newly constructed building is functioning, and each contaminant does not exceed risk-based values based on industrial and commercial use risk scenarios for indoor air based on an ELCR of 1.0×10^{-5} and HQ of 1.0.
2. The VI pathway is incomplete because there are no concentrations of vapors in the subsurface that could result in an unacceptable risk to building occupants if vapors were to enter a building.

There are no federal or state ARARs for VI. However, guidance documents provided by both EPA and Ohio EPA contain elements that should be considered for selecting an approach to meet remedial objectives. These three guidance documents are as follows:

1. *OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air* (EPA 2015)
2. *Sample Collection and Evaluation of Vapor Intrusion to Indoor Air for Remedial Response, Resource Conservation and Recovery Act and Voluntary Action Programs* (Ohio EPA 2020a)
3. *Vapor Intrusion Handbook* (EPA 2020)

Table 2 outlines risk-based concentration limits that will be used to confirm the effectiveness of preemptive measures (engineering controls). These values could change in the future based on updated information from regulatory agencies and should be reevaluated when a building is considered for construction on Parcel 9. Figure 6 depicts the geographic area (shaded blue) within Parcel 9 where this remedy would apply. This area includes only the southern portion of Parcel 9. This remedy does not include the remainder of Parcel 9 because that portion is being evaluated under the ongoing sitewide VI assessment.

Table 2. Indoor Air Limits for VI in Parcel 9

COC	Indoor Air Goal (µg/m^3)	COC	Indoor Air Goal (µg/m^3)
Benz[a]antracene	2.0	Toluene	21,900
Benzene	16	Total xylenes	438
Carbon tetrachloride	20	VC	28
Chloroform	5.3	1,2-DCA	4.7
Ethylbenzene	49	1,1,1-Trichloroethane	21,900
Naphthalene	3.6	2-Butanone	21,900
PCE	175	2-Hexanone	131
TCE	8.8		

Notes:
Levels are risk-based concentrations developed using the EPA VISL calculator; each is based on the specific ELCR and noncancer HQ of 1.0×10^{-5} and 1.0, respectively.
Data were calculated using the EPA VISL calculator on June 30, 2021.

Abbreviations:
COC = contaminant of concern
µg/m^3 = micrograms per cubic meter

As an alternative, a future property owner can provide information and evidence that supports there is no unacceptable risk from VI. If the property owner can demonstrate that the VI pathway is incomplete through sampling and evaluation of data or that there is no unacceptable risk to building occupants from VI, then mitigation would not be required. A property owner would be required to identify which contaminants are present beneath the property and determine whether the contaminant concentrations can be considered within an acceptable risk range by comparison to risk-based values of 1.0×10^{-5} ELCR or 1.0 HQ for noncancer risk reference for vapors measured beneath a building. Contaminants that exceed these values are considered elevated and would require additional evaluation as recommended by Ohio EPA (Ohio EPA 2020a). A final determination of the risk that the concentrations of subsurface vapors could have on building occupants shall be provided in writing to EPA, Ohio EPA, and DOE for review and approval prior to building construction.

4.0 Remedial Design

The following sections describe the changes to the 1995 OU-1 ROD (DOE 1995) remedy and describe the design objectives for those components that need to be developed to implement the groundwater and VI remedies.

The 2023 OU-1 ROD Amendment (DOE 2023) modifies the groundwater remedy component of the 1995 OU-1 ROD and adds a VI component; the remaining components (ICs) outlined in the 2011 OU-1 ROD Amendment (DOE 2011a) remain unchanged. The selected remedies were developed to address residual VOCs remaining in groundwater and soil vapors in the OU-1 and Parcel 9 area of the Mound site. These remedies are referred to as:

- **Groundwater:** EA with monitoring and ICs.
- **Vapor Intrusion:** Preemptive measures or actions to mitigate VI exposure with ICs.

Both remedies were selected recognizing that the distribution and concentrations of VOCs have been modified, altered, or reduced by previous activities performed in the OU-1 area. These are as follows:

- The EA remedy recognizes that the present distribution of VOCs and biogeochemical conditions are the result of the injection of neat and emulsified oils in 2014 as part of the OU-1 Enhanced Attenuation Field Demonstration that concluded in 2018. The injection of oils resulted in the enhancement of the existing redox conditions (i.e., reduction in oxidation-reduction potential [ORP]) in the aquifer and an increase in the population of microbial communities in the VOC plume. The goal is to maintain and verify through monitoring the series of structured geochemical zones that were established and allow for attenuation of VOCs in groundwater. To assess the geochemistry of the aquifer, groundwater samples will be collected and analyzed for indicator parameters (i.e., pH, ORP, dissolved oxygen, specific conductance, and alkalinity), competing ion acceptors (i.e., sulfate and nitrate), and other indicators of aquifer geochemistry (i.e., dissolved iron). Samples will also be collected to assess the presence of both dechlorinating and cometabolic bacterial communities in structured treatment zones. The results from routine sampling will also demonstrate that contaminant concentrations have been trending downward, the plume has remained stable, and the microbial communities have remained robust. The monitoring

program, which will include sampling locations, analytes, and frequencies, will be finalized and provided to the regulators for approval.

- The VI remedy recognize that the distribution and concentrations of VOCs in the vadose zone are the result of residually contaminated soil that remained after the landfill excavation that was completed in 2010. Prior to excavation of the landfill, a significant amount of VOCs were removed using the soil vapor extraction system in conjunction with the P&T system that addresses groundwater contamination originating from the former OU-1 landfill. Residually contaminated groundwater is currently present, but concentrations are low and do not provide a significant contribution to the vapors in the OU-1 and Parcel 9 area.

Both remedies also rely on the maintenance of existing ICs established by the 2011 OU-1 ROD Amendment (DOE 2011a). The remedies require that future property owners shall adhere to the following existing ICs to remain protective:

- Prohibit the extraction or consumption of, exposure to, or any use of the groundwater underlying the Mound site
- Prohibit the removal of soil from the Mound site
- Limit land use to industrial or commercial activities
- Allow federal and state agencies site access for sampling and monitoring

4.1 Changes to the 1995 OU-1 ROD Remedy

The 2023 ROD Amendment (DOE 2023) specifies and explains the modification of the selected remedial action of P&T for groundwater in OU-1 set forth in the 1995 OU-1 ROD (DOE 1995) to EA and specifies and explains the activity and use restrictions to address VI in OU-1 and Parcel 9. The 2023 ROD Amendment does not modify any other the remedies (i.e., ICs) for Parcel 9 that are documented in the 2011 OU-1 ROD Amendment.

The EA remedy no longer includes the operation of the P&T system, which allows for the decommissioning and dismantlement of the system, including the air stripper, influent and effluent lines, extraction wells, and Building 300. The EA remedy recognizes that the distribution of VOCs and biogeochemical conditions present are the result of the injection of neat and emulsified oils performed as part of the OU-1 Enhanced Attenuation Field Demonstration that was completed in 2018. However, it was acknowledged at the end of the field demonstration that a few existing conditions could impact maintenance of the structured geochemical zones. If it is determined that the structured zones, which support both reductive dechlorination and aerobic cometabolism of VOCs, cannot be maintained throughout the remediation time frame (DOE 2020), then additional enhancement may be necessary. Sampling of groundwater to monitor the contaminant concentrations and the types and number of microbial communities will continue. Based on the reduction in the plume due to the field demonstration and transition to a revised groundwater remedy, a more focused set of analytes may be recommended in the revised groundwater monitoring plan that will continue to demonstrate that the performance objectives are being met. A smaller network of 12 to 15 wells selected from the existing 35 monitoring wells in the OU-1 area is anticipated to achieve adequate coverage of the structured geochemical zones. The selection of the final monitoring program (locations and analytes) will be made through the assessment of the results of samples collected since the completion of the OU-1

Enhanced Attenuation Field Demonstration. A program will be established that will provide data to best verify the attenuation of VOCs and fulfill the RAOs, as well as define reporting and notification requirements and conditions that could warrant contingency actions outlined in the 2023 OU-1 ROD Amendment (DOE 2023).

The VI remedy requires that provisions are made that require future property owners to design and employ measures in the building to mitigate the VI exposure pathway prior to vapors potentially entering a building. This remedy allows for new construction in the Parcel 9 area, but preemptive measures or actions that would prohibit exposure of building occupants to vapors must be designed on a case-by-case basis and installed, maintained, and monitored by the future building owner. This remedy recognizes that the distribution of VOCs in the vadose zone has not been fully characterized, although sufficient data are currently available to indicate that concentrations of TCE and VC in soil gas exceed industrial and commercial use risk-scenario concentrations calculated using the EPA VISL calculator for vapors beneath a building (subslab). It is possible that additional data could be provided by a future property owner to DOE and the regulators for approval that would indicate there is insufficient vapor source to result in an unacceptable exposure to building occupants or incomplete exposure pathways.

4.2 Design Objectives

This section presents the objectives for the design of the 2023 OU-1 ROD Amendment (DOE 2023) remedy to address residual VOC contamination in groundwater and soil vapors in the OU-1 area. Design objectives are summarized in the following subsections. The components of the groundwater and VI remedies, as well as other tasks associated with the remedies are as follows:

- EA of VOC in groundwater
- ICs for preemptive mitigation of VI
- Maintenance of new and existing ICs

4.2.1 Enhanced Attenuation Groundwater Remedy

The goal of the groundwater remedy is to reduce concentrations of VOCs throughout the plume (both beneath the former landfill and downgradient) to remediation goals, thereby restoring the groundwater to beneficial reuse and continuing to provide containment of the VOC plume within the boundary of Parcel 9. The following EA remedy components will be implemented to achieve the RAOs:

- Enhanced attenuation of VOCs in groundwater
- Routine groundwater monitoring of VOCs, geochemical parameters, and microbial counts
- Enhancement of attenuation processes through the injection of amendments or microbes, if deemed necessary

The implementation of the EA remedy selected in the 2023 OU-1 ROD Amendment involves assessment and optimization of the current EA program outlined in Addendum 2, “Interim Monitoring Program,” to the *OU-1 Enhanced Attenuation Field Demonstration Sampling and Analysis Plan, Mound, Ohio, Site* (DOE 2014d), as determined necessary, to ensure that

remediation goals are met within the estimated 10-year time frame. The following remedy elements are part of the implementation:

- Attenuation of VOCs via reductive dechlorination, aerobic cometabolism, and abiotic processes
- Enhancement of attenuation processes through the injection of amendments or microbes, if deemed necessary
- Monitoring of VOCs, other geochemical constituents (sampling twice per year), and microbial counts in groundwater
- Evaluation of data to ensure that biogeochemical conditions remain favorable for attenuation processes
- Identification of conditions that may warrant the necessity to inject additional amendments or microbes to maintain the biogeochemical conditions

The attenuation of PCE and TCE is supported by several lines of evidence, including:

- Decreasing concentrations of PCE and TCE.
- Geochemical data that indicate the presence of both reducing and oxidizing zones.
- Microbial data that reflect the presence of a robust microbial community that supports degradation of VOCs.
- Presence of the degradation products cDCE and VC.

The assessment and optimization program that will be used to track remediation progress and determine the potential need for enhancement, will be designed to:

- Confirm that EA continues to reduce (to remediation goals) the contaminant concentrations throughout the VOC plume (i.e., verification of attainment of remediation goals).
- Confirm that groundwater with contaminant concentrations greater than the remediation goals does not move outside the boundary of Parcel 9 (i.e., verification that the plume is not expanding).
- Identify any potentially toxic or mobile transformation products that could impact the effectiveness of the attenuation remedy.
- Detect changes in the environmental conditions that may reduce the efficacy of the attenuation processes.
- Identify conditions that would indicate that the attenuation conditions may not be functioning as expected and further investigation or the addition of amendments or microbes may be necessary.

4.2.2 Vapor Intrusion Remedy

The goal of the VI remedy is to provide a permanent and cost-effective solution to mitigate potential risk to future building occupants from vapor-forming chemicals present in the vadose zone in OU-1 and Parcel 9. Currently, the property is owned by DOE, and no permanent buildings are designed for occupancy in the OU-1 area. Although it will not reduce the toxicity or volume of the contaminants, the VI remedy will reduce the mobility and mitigate the intrusion

of subsurface vapors into buildings. Land use and activity restrictions were stipulated in the 2023 OU-1 ROD Amendment (DOE 2023) acknowledging that existing conditions may result in unacceptable VI exposure to an occupant if a building were to be constructed in the OU-1 area.

The design objective for the VI remedy is to establish activity or use limitations to fulfill the following RAOs:

- Mitigate potential health risks from contaminated vapor to future building occupants within OU-1 and Parcel 9 by eliminating the VI pathway
- Preemptively address the potential for VI within OU-1 and Parcel 9 in newly constructed buildings as documented in the 2023 OU-1 ROD Amendment (DOE 2023)
- Confirm that activity and use restrictions are durable and followed

4.2.3 Maintenance of New and Existing ICs

The goal for ICs is to impose activity and use restrictions on a property to minimize or eliminate exposure to contamination and to protect the integrity of a remedy. The Mound site ICs run with the land in the form of: (1) restrictions and covenants in the quitclaim deeds or (2) activity and use limitations in the Parcel 9 Environmental Covenant (DOE 2011b) filed with Montgomery County, Ohio, so that all future property owners will know about the deed restrictions. DOE is responsible for long-term surveillance of the ICs. An IC assessment process is performed annually, and this IC assessment process follows the requirements in the following three documents that make up the Long-Term Surveillance Plan for the Mound site:

- *Operations and Maintenance Plan for the U.S. Department of Energy Mound, Ohio, Site* (DOE 2015), hereafter referred to as the O&M Plan
- *Long-Term Surveillance and Maintenance Plan for the U.S. Department of Energy Mound, Ohio, Site* (DOE 2021b)
- *Community Involvement Plan for the U.S. Department of Energy Mound, Ohio, Site* (DOE 2021a)

Currently, the existing ICs are monitored in accordance with the O&M Plan, and the IC assessment program fulfills the requirements of *Institutional Controls: A Guide to Preparing Institutional Control Implementation and Assurance Plans at Contaminated Sites* (EPA 2012), which provides guidance for Institutional Control Implementation and Assurance Plans (ICIAPs).

The design objective for the maintenance of new and existing ICs is to update the current IC assessment process to meet the EPA ICIAP guidance and to incorporate assessment steps to ensure that the VI remedy remains protective. The IC assessment process will address that the following criteria are met:

- Mitigate potential health risks from contaminated vapor to future building occupants within OU-1 and Parcel 9 by eliminating the VI pathway through the enforcement of activity and land use restrictions in the form of an environmental covenant

- Preemptively address the potential for VI within OU-1 and Parcel 9 in newly constructed buildings as documented in the 2023 OU-1 ROD Amendment by requiring future property owners to perform one of the following:
  - Incorporate adequate engineering controls to mitigate potential VI exposures at the time of construction and ensure the continued operation, maintenance, and testing to verify that the controls are effective in the long term
  - Provide sufficient information that indicates that conditions are such that the VI pathway is incomplete and engineering controls are not necessary
- Confirm that activity and use restrictions are durable and followed
- Identify possible violations of ICs

5.0 Remedial Design Approach

This section presents the overall technical approach for completing the design (or plan) for each remedy component. This will include the following, which are discussed below:

- Implementation of the EA remedy to address VOCs in groundwater, including assessment and optimization of the current program
- Documentation of the activity and use restrictions (ICs) for preemptive mitigation of VI exposure
- Maintenance of new and existing ICs

5.1 Enhanced Attenuation of VOCs in Groundwater

The remedy outlined in the 2023 OU-1 ROD Amendment (DOE 2023) recognizes that the present distribution of VOCs and the biogeochemical conditions (treatment zones) are the result of the injection of neat and emulsified oils in 2014 as part of the OU-1 Enhanced Attenuation Field Demonstration that concluded in 2018. Based on the routine monitoring data collected under this program to date, data continue to support the lines of evidence that the attenuation of PCE and TCE is ongoing and that the plume has remained stable, and it can be concluded that the EA remedy is in place and currently operating properly and successfully.

The operation of the EA remedy relies on groundwater flow through a succession of anaerobic and aerobic structured geochemical zones to produce the following:

- Anaerobic zones that stimulate relatively rapid degradation of the parent compounds (PCE and TCE)
- Surrounding aerobic areas that encourage relatively rapid degradation of daughter products (DCE and VC), as well as enhanced cometabolism of TCE resulting from the utilization of methane and other reduced hydrocarbons that are formed and released for the anaerobic zones

Since the completion of the OU-1 Enhanced Attenuation Field Demonstration, data continue to be evaluated for the lines of evidence of EA as outlined in the Field Demonstration Work Plan (DOE 2014b). Addendum 2, “Interim Monitoring Program,” to the *OU-1 Enhanced Attenuation*

Field Demonstration Sampling and Analysis Plan, Mound, Ohio, Site (DOE 2014d) was prepared in 2018 and outlined the monitoring program to follow until the groundwater remedy was changed to EA and a subsequent monitoring program was approved. This interim program was approved by the regulators in the *Mound Core Team Agreement for Operable Unit 1 Monitoring for Interim Period After Enhanced Attenuation Demonstration* (DOE 2019a). Under this current program, 35 monitoring wells are sampled quarterly for VOCs and geochemical indicator parameters with a subset sampled to monitor the state of the microbial communities in the different geochemical zones. It is anticipated that a smaller network of monitoring wells (estimated 12 to 15) from the current network of wells will achieve adequate coverage.

The implementation of the EA remedy involves assessment and optimization of the current EA program, as determined necessary, to ensure that remediation goals are met within the estimated 10-year time frame. The assessment and optimization of the current program will focus on establishing monitoring locations and analytes that will provide data to best verify the attenuation of VOCs and fulfill the RAOs. Also, this assessment will be used to better define reporting and notification requirements and conditions that could warrant contingency actions outlined in the 2023 OU-1 ROD Amendment (DOE 2023).

It is anticipated that this assessment and optimization will be performed in two parts:

- A technical evaluation of current contaminant distributions and attenuation conditions to establish a baseline for development of a long-term monitoring program for the EA remedy
- A proposal for an optimized long-term monitoring program that will include recommendations for monitoring locations, sampling frequencies, and analytes as supported by the results of the technical evaluation

5.1.1 Evaluation of Baseline Contaminant and Attenuation Conditions

A technical evaluation of the groundwater contaminant, geochemical, and microbial data collected in OU-1 from 2018 through 2023 will be conducted to assess the current performance of the attenuation program using geochemical zones as a remediation strategy for OU-1 groundwater. The technical evaluation will include similar data evaluations as those performed throughout the OU-1 Enhanced Attenuation Field Demonstration from 2014 through 2018 that provided information on contaminant trends, plume behavior, microbial community strength, and attenuation mechanisms in OU-1 groundwater. The evaluation will include the following activities:

- Determine trends in chlorinated VOC concentrations and mass using the Monitoring and Remediation Optimization System (MAROS)
- Evaluate geochemical data that can be used to demonstrate indirectly the types of attenuation processes in different areas of the structured geochemical zones
- Assess the microbial community to document that one or more recognized attenuation mechanisms are occurring within the geochemical zones
- Provide updated estimations of the attenuation and degradation rates to aid in estimating remediation time frames for OU-1 groundwater

The results from this technical evaluation will be documented in the *Evaluation of Enhanced Attenuation Mechanisms and Baseline Conditions in Operable Unit 1 Groundwater at the*

Mound, Ohio, Site (Submittal 4). Information from this technical data evaluation will be used as predesign information to support development of an optimized long-term monitoring program, primarily determination of monitoring locations, sampling frequencies, and analytes. It is anticipated that a smaller network of monitoring wells (estimated 12 to 15) from the current network of 35 wells in OU-1 will achieve adequate coverage. A more focused set of analytes will be recommended that will demonstrate that the performance objectives are being met.

5.1.2 Optimized Long-Term Monitoring Program

The EA remedy will continue to operate while activities to assess and optimize the remedy are performed to support the development of a long-term monitoring program that will be used to determine if remediation goals are met within the estimated 10-year time frame or if further enhancement of the remedy should be implemented. The design of the revised monitoring program will be presented in an Optimized Groundwater Monitoring Program, and, upon approval by the regulators, the long-term program will be provided in a subsequent plan.

The optimized program is intended to: (1) address the use of EA to remediate VOC-contaminated groundwater in OU-1; (2) monitor VOC concentration trends, verify degradation processes, and assess the types and number of microbial communities present within the VOC plume; and (3) identify conditions that may warrant additional enhancement of the attenuation processes through the injection of amendments or microbes, if deemed necessary.

5.1.2.1 Use of EA to Address VOCs in OU-1 Groundwater

The EA remedy was initiated with the injection of both neat and emulsified oil in 2014 to enhance biodegradation of VOCs by reductive dechlorination and cometabolism and is currently operating as intended. This remedy is designed to achieve all RAOs and remediate groundwater throughout the plume within a reasonable time frame (i.e., approximately 10 years). This alternative complies with ARARs, addresses all VOC-impacted groundwater originating from the former OU-1 landfill within Parcel 9, and acknowledges uncertainties associated with long-term treatment of VOCs by allowing injection of amendments or microbes (if deemed necessary). The results of the OU-1 Enhanced Attenuation Field Demonstration, which was completed in 2018, and routine sampling results collected since the completion of the field demonstration indicate that sustainable geochemical and biological processes degrade contaminants to MCLs within a reasonable time frame (i.e., approximately 10 years).

The primary objectives of the EA groundwater remedy are to reduce (to remediation goals) the contaminant concentrations throughout the VOC plume, thereby restoring the groundwater to beneficial reuse, and to prohibit groundwater with contaminant concentrations greater than the preliminary remediation goals from moving outside the boundary of Parcel 9. The remedy is designed to reduce contaminant concentrations and maintain control of plume expansion until remedial goals are reached, thereby preventing unacceptable risk in the event of exposure to groundwater.

The EA remedy recognizes that the present distribution of VOCs and biogeochemical conditions are the result of the injection of neat and emulsified oils during the 2014 OU-1 Enhanced Attenuation Field Demonstration. The injection of oils resulted in the enhancement of the existing redox conditions in the aquifer and an increase in the population of microbial

communities in the VOC plume. Remediation progress will be tracked through a routine monitoring program. Table 3 outlines the information that will be provided through the monitoring program to meet the primary objectives of the EA remedy.

Table 3. Summary of the Long-Term Monitoring Program Goals and Metrics

Information	Goal	Metric
Confirmation that EA continues to reduce (to remediation goals) the contaminant concentrations throughout the VOC plume (i.e., verification of attainment of remediation goals) within the estimated time frame of 10 years	Assess the degradation of parent compounds (i.e., PCE and TCE)	Measure PCE, TCE, cDCE, and VC concentrations over time within the treatment and interior zones
	Assess the degradation rates of PCE and TCE	
	Assess the degradation of daughter products (i.e., cDCE and VC)	
Confirmation that the series of structured geochemical zones that were established during the OU-1 Enhanced Attenuation Field Demonstration and allow for attenuation of VOCs in groundwater are maintained	Assess the geochemistry within the redox zones	Measure geochemistry and chemistry parameters (i.e., pH, ORP, dissolved oxygen, specific conductance, and alkalinity) and other indicators (i.e., dissolved iron) within the treatment and interior zones
	Assess the presence of appropriate electron donors to support cometabolism of TCE	Measure cometabolites (i.e., methane, ethene, and ammonia) in interior zone and downgradient wells
	Assess the presence of appropriate bacteria and a sufficient amount of biomass	Measure temporal type and abundance of microbial communities (fermentative, dechlorinating, and cometabolic)
Confirmation that groundwater with contaminant concentrations greater than the remediation goals does not move outside the boundary of Parcel 9 (i.e., verification that the plume is not expanding)	Assess the presence and changes in PCE, TCE, cDCE, and VC concentrations along the boundary of the VOC plume	Measure PCE, TCE, cDCE, and VC concentrations in lateral and downgradient wells
Identification of any potentially toxic or mobile transformation products that could impact the effectiveness of the attenuation remedy	Assess the accumulation of daughter products (i.e., cDCE and VC)	Measure PCE, TCE, cDCE, and VC concentrations over time within the plume
	Assess the presence of competing ion acceptors	Measure for competing ion acceptors (i.e., sulfate and nitrate) in treatment zone wells
Detection of changes in the environmental conditions that may reduce the efficacy of the attenuation processes	Assess the geochemistry within the redox zones	Measure geochemistry and chemistry parameters for maintenance of appropriate attenuation conditions (i.e., pH, ORP, dissolved oxygen, specific conductance, and alkalinity
	Assess the presence of competing ion acceptors within the redox zones	Measure for competing ion acceptors (i.e., sulfate and nitrate) in treatment zone wells
	Assess the presence of appropriate electron donors to support cometabolism of TCE	Measure cometabolites (i.e., methane, ethene, and ammonia)

Table 3. Summary of the Long-Term Monitoring Program Goals and Metrics (continued)

Information	Goal	Metric
Identification of conditions that would indicate that the attenuation conditions may not be functioning as expected and further investigation or the addition of amendments or microbes may be necessary	Assess temporal changes in PCE, TCE, cDCE, and VC	Measure PCE, TCE, cDCE, and VC concentrations over time within the treatment and interior zones
	Assess the accumulation of daughter products (i.e. cDCE and VC)	
	Assess the presence of appropriate bacteria and a sufficient amount of biomass	Measure temporal type and abundance of microbial communities (fermentative, dechlorinating, and cometabolic)
	Assess the presence of appropriate electron donors to support cometabolism of TCE	Measure cometabolites (i.e., methane, ethene, and ammonia) in interior zone and downgradient wells
	Assess the presence of appropriate bacteria and a sufficient amount of biomass	Measure temporal type and abundance of microbial communities (fermentative, dechlorinating, and cometabolic)

5.1.2.2 Routine Monitoring of EA Progress

A long-term monitoring program (Submittal 5) will be developed that will continue to provide data to demonstrate monitoring of VOCs in groundwater, the behavior of the plume, and that biogeochemical conditions remain favorable for attenuation of VOCs within a reasonable time frame (i.e., approximately 10 years). The evaluation to assess the performance of the EA remedy has been modeled after the *Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites* document (EPA 1999). The monitoring program will be designed to provide information and data that support the objectives and goals outlined in Table 3.

Information from a technical evaluation of the data collected after the completion of the OU-1 Enhanced Attenuation Field Demonstration in 2018 will be used as predesign information to support determination for an optimized long-term monitoring program, primarily determination of monitoring locations, sampling frequencies, and analytes. It is anticipated that a smaller network of monitoring wells (estimated 12 to 15) from the current network of 35 wells in OU-1 will achieve adequate coverage. A more focused set of analytes will be identified that will demonstrate that the performance objectives are being met.

Components of this monitoring program will be as follows:

- Data quality objectives
- Monitoring locations
- Monitoring analytes
- Monitoring frequencies
- Data evaluation
- Contingencies for deployment of additional amendments
- Notifications and reporting

5.1.2.3 Enhanced Attenuation Processes

It was acknowledged at the end of the field demonstration and during the development of the EA groundwater remedy that some existing conditions could have an impact on the structured geochemical zones (DOE 2020). If it is determined from monitoring data that the structured zones cannot be maintained throughout the remediation time frame, then additional enhancement (injection of amendments or microbes) may be necessary. Table 3 outlines data that can be used to evaluate the performance of the EA remedy long term.

Information from the technical evaluation of baseline contamination and attenuation conditions will be used to develop evaluation steps to continue to verify that the remedy is functioning as intended and the RAOs are being met or whether additional investigation or contingency actions are warranted. The contingency action stipulated in the 2023 OU-1 ROD Amendment (DOE 2023) is enhancement of attenuation processes through the injections of amendments or microbes. The design of the revised monitoring program will be presented in an Optimized Groundwater Monitoring Program and, upon approval by the regulators, the long-term program will be provided in a subsequent plan. If it is deemed necessary, the injections will be designed and will include the injection infrastructure, injection solution, volumes, and delivery methods. The design approach used during the OU-1 Enhanced Attenuation Field Demonstration (DOE 2014c) will be reviewed and could be used as a basis for any future injection design. Any injection systems designed as a contingency action will be submitted and reviewed by EPA and Ohio EPA.

5.2 Preemptive Mitigation to Vapor Intrusion Exposure

The 2023 OU-1 ROD Amendment selected preemptive mitigation of potential risk to future building occupants from vapor-forming chemicals present in the vadose zone in OU-1 and Parcel 9 through the enforcement of activity and land use restrictions in the form of an Environmental Covenant. The Environmental Covenant requires future property owners to coordinate with EPA, Ohio EPA, and DOE prior to construction and submit for approval either a design of engineering controls to mitigate potential VI exposure or information that demonstrates that the VI pathway is incomplete.

The tasks necessary to implement the VI remedy will include the following:

- Documenting the activity and use restrictions (ICs) listed in the 2023 OU-1 ROD Amendment in an environmental covenant in accordance with 53 ORC 5301.80–5301.92, “Conveyances; Encumbrances”
- Filing the IC in the form of an environmental covenant with Montgomery County, Ohio, upon property transfer
- Coordinating future property owners with EPA, Ohio EPA, and DOE, as stipulated in the Environmental Covenant, to perform one of the following actions to preemptively address potential VI exposure:
  - Incorporate adequate engineering controls to mitigate potential VI exposures at the time of construction and ensure the continued operation, maintenance, and testing to verify that the controls are effective in the long term
  - Provide sufficient information that indicates that conditions are such that the VI pathway is incomplete and engineering controls are not necessary

- Incorporating compliance inspections or assessments relating to the VI remedy into the existing monitoring and assessment program to ensure that ICs remain protective (see Section 5.3)

5.3 Maintenance of New and Existing ICs

Activity and use restrictions that were stipulated in the 2023 OU-1 ROD Amendment and focus on the mitigation of VI will be established for the OU-1 and Parcel 9 area in an environmental covenant. The groundwater and VI remedies also rely on existing ICs that were established for this area in the 2011 OU-1 ROD Amendment (DOE 2011a) that prohibit residential land use and prevent exposure to contaminants in groundwater. The ICs for Parcel 9 are consistent with sitewide ICs previously identified for other portions of the Mound site and include the following:

- Prohibit the removal of soil from the original 306 acres of the DOE Mound site property boundaries
- Prohibit the extraction or consumption of, exposure to, or any use of the groundwater underlying the Mound site
- Limit land use to industrial and commercial activities only (prohibit residential land use)
- Allow site access for federal and state agencies for sampling and monitoring

Currently, the existing ICs are monitored in accordance with the O&M Plan, and the IC assessment program fulfills the requirements of the EPA ICIAP guidance (EPA 2012). An ICIAP will be prepared to support not only the ICs associated with the VI remedy established in the 2023 OU-1 ROD Amendment (DOE 2023) but also to include the ICs for the remainder of the Mound site. The IC assessment program currently documented in the O&M Plan will be replaced with this new ICIAP. The objective of the ICIAP is to describe plans to implement, maintain, and enforce the ICs at the Mound site. The ICIAP explains how LM will continue to fulfill its surveillance and maintenance obligations of ICs to ensure that the selected IC remedies remain functional and effective so that conditions at the site remain protective.

Components of the IC assessment program for the VI remedy will include the following:

- Preparation of a separate document that describes plans to implement, maintain, and enforce the ICs at the Mound site in accordance with the EPA ICIAP guidance
- Compliance inspections or assessments, which are performed annually for the Mound site, to ensure that new and existing ICs are effective
- Contingency actions for the violation of any ICs at the Mound site
- Reporting and notification

6.0 Remedial Design Submittals and Schedule

Table 4 outlines reports or plans that will be submitted as part of the Remedial Design. All submittals will be provided to EPA and Ohio EPA for review and comment in accordance with the FFA (DOE et al. 1993). These documents will be prepared as outlined in Section XII, "Consultation with U.S. EPA and OEPA." The submittal and review process for documents is

outlined in Section B, "General Process for RI/FS and RD/RA Documents." Documents will be submitted as drafts and are subject to review and comment by EPA and Ohio EPA. The dates in Table 4 reflect the submittal of draft versions of the document provided for regulator review and comment.

Table 4. Remedial Design Submittals and Schedule

Remedial Design Submittal		Date for Draft Submission	Notes
1	*Remedial Design and Remedial Action Work Plan for Operable Unit 1 and Parcel 9 of the Mound, Ohio, Site*	November 26, 2023 (Actual)	Draft submitted to the Core Team. Required 60 days after approval of the 2023 OU-1 ROD Amendment (DOE 2023) in accordance with the FFA (DOE et al. 1993).
2	*Environmental Covenant for OU-1 and Parcel 9*	February 9, 2024 (Actual)	Draft submitted to the Core Team. To be filed with Montgomery County, Ohio, when property transfer occurs).
3	*Institutional Controls Implementation and Assurance Plan*	February 28, 2025 (Forecast)	Draft submitted to the Core Team. Proposed text outlines the inspection and assessment program for the ICs for VI mitigation.
4	*Evaluation of Enhanced Attenuation Mechanisms and Baseline Conditions in Operable Unit 1 Groundwater at the Mound, Ohio, Site*	June 30, 2025 (Forecast)	Summary of post-OU-1 Enhanced Attenuation Field Demonstration data that will document current (baseline) conditions in OU-1 groundwater and will be used to support Submittal 5.
5	*Optimized Groundwater Monitoring Program for the Operable Unit 1 Enhanced Attenuation Remedy at the Mound, Ohio, Site*	September 30, 2025 (Forecast)	Information from Submittal 4 will be used to optimize the long-term monitoring program.

7.0 Remedial Action Implementation

This section describes the implementation of the OU-1 EA remedy and the activity and use restrictions for preemptive mitigation measures for VI exposure. Also, decommissioning of the OU-1 P&T system, the extraction wells, and monitoring wells that are not included as part of the optimized long-term monitoring network will be performed due to the change in the groundwater remedy from P&T to EA.

7.1 Enhanced Attenuation of VOCs in Groundwater

Based on the routine monitoring data, it can be concluded that the EA remedy is in place and operating properly and successfully. The implementation of the EA remedy involves assessment and optimization of the current EA program, as determined necessary, to ensure that remediation goals are met within the estimated 10-year time frame. The current monitoring program provides data to support that the remedy is operating properly until a more optimized and focused program is designed. This EA program will be used to track remedy progress toward the estimated remediation time frame of 10 years and to determine whether injection of enhancement to increase the effectiveness of the biodegradation processes is necessary to achieve this goal.

The optimized program is intended to: (1) monitor concentration trends, verify degradation processes, and assess the types and number of microbial communities present within the VOC

plume and (2) monitor VOC concentrations in the downgradient portion of the plume to ensure that plume expansion is not occurring. The monitoring program, which will be used to track remediation progress and determine the potential need for enhancement, will be designed to provide information and data that support the objectives and goals outlined in Table 3. The design of the revised monitoring program will be presented in an Optimized Groundwater Monitoring Program, and, upon approval by the regulators, the long-term program will be provided in a subsequent plan.

7.2 Preemptive Measures or Actions to Mitigate Vapor Intrusion Exposure

The activity or use restrictions (ICs) to preemptively mitigate VI exposure will be enforced by recording an environmental covenant with Montgomery County, Ohio. Currently, the OU-1 and Parcel 9 area is owned by DOE and there are no buildings where VI mitigation is required. It is anticipated that the OU-1 and Parcel 9 area will be transferred to the Mound Development Corporation. An environmental covenant has been prepared (Remedial Design Submittal 2) and will be filed in accordance with 53 ORC 5301.80–5301.92, "Conveyances; Encumbrances" when the property transfer occurs. This environmental covenant shall require a future property owner to address VI prior to initiating new building construction in the OU-1 and Parcel 9 area.

7.3 Maintenance of New and Existing ICs

Currently, the IC assessment program for the Mound site is carried out through the regulator-approved O&M Plan. The goal of maintaining new and existing ICs in the OU-1 and Parcel 9 area will be considered implemented upon approval of the ICIAP that is currently under development (Remedial Design Submittal 3). The ICIAP will include the required inspections, assessments, and contingency actions associated with the VI remedy and use restriction imposed through ICs.

8.0 Completion of Remedial Action Work

The implementation of the EA and VI remedies will be considered complete when each remedy is determined to be operating as designed (i.e., operational and functional).

Components that will require the determination of operational and functional are as follows:

- Enhanced attenuation of VOCs in groundwater and maintenance of existing ICs that prohibit future use of groundwater.
- Preemptive mitigation to VI exposure through the maintenance of new and existing ICs that restrict land use to commercial or industrial (prohibit residential land use).

8.1 Certification of Completion of Work

The EA remedy was initiated with the injection of both neat and emulsified oil to enhance biodegradation by reductive dechlorination as part of the OU-1 Enhanced Attenuation Field Demonstration in 2014 and is currently operating as intended. The results of the field demonstration showed design objectives have been met and that the current monitoring results support that the groundwater remedy is in place and operating properly and successfully. The

implementation of the EA remedy involves assessment and optimization of the current EA program outlined in Addendum 2, "Interim Monitoring Program," to the *OU-1 Enhanced Attenuation Field Demonstration Sampling and Analysis Plan, Mound, Ohio, Site* (DOE 2014d), as determined necessary, to ensure that remediation goals are met within the estimated 10-year time frame.

The VI remedy will be implemented through ICs specified in an environmental covenant that will require future property owners to coordinate with EPA, Ohio EPA, and DOE prior to construction for approval of engineering controls to mitigate potential VI exposure or to provide information that supports that the VI pathway is incomplete. Items that will be considered in the determination of operational and functional for the VI remedy are the filing of the *Environmental Covenant for OU-1 and Parcel 9* (Submittal 2) with Montgomery County, Ohio, and the approval of the ICIAP (Submittal 3) by the regulators.

8.2 Remedial Action Reports

A Remedial Action Report will not be prepared to document the completion of the remedial actions. Completion of the work scope included in this Work Plan will be included in the following regulator-approved plans:

- **Enhanced attenuation of VOCs in groundwater:** Documentation of the long-term EA program
- **Preemptive mitigation to VI exposure:** Environmental covenant filed with Montgomery County at the time of property transfer
- **Maintenance of new and existing ICs:** Documentation of the monitoring and assessment of the new VI ICs and existing ICs in an ICIAP

9.0 References

40 CFR 141. "National Primary Drinking Water Regulations," *Code of Federal Regulations*.

40 CFR 300.435(c)(2)(ii). "Community Relations," *Code of Federal Regulations*.

53 ORC 5301. "Conveyances; Encumbrances," Ohio Revised Code.

42 USC 9617(c). "Explanation of Differences," *United States Code*.

42 USC 9621. "Cleanup Standards," *United States Code*.

DOE (U.S. Department of Energy), 1995. *Operable Unit 1 Record of Decision, Mound Plant, Miamisburg, Ohio*, Ohio Field Office, Final, June.

DOE (U.S. Department of Energy), 1999. *Work Plan for Environmental Restoration of the DOE Mound Site, The Mound 2000 Approach*, prepared by Babcock & Wilcox of Ohio for the U.S. Department of Energy Office of Environmental Management, Final (Revision 0), February.

DOE (U.S. Department of Energy), 2006. *Second Five-Year Review for the Mound, Ohio, Site, Miamisburg, Ohio*, DOE-LM/1308–2006, prepared by S.M. Stoller Corporation for the U.S. Department of Energy Office of Legacy Management, September.

DOE (U.S. Department of Energy), 2009. *Operable Unit 1 Closeout Report*, prepared by Accelerated Remediation Company for the U.S. Department of Energy Environmental Management Consolidated Business Center, Revision 1, Final, April.

DOE (U.S. Department of Energy), 2010. *Operable Unit 1 Landfill Area Closeout Report*, prepared by Accelerated Remediation Company for the U.S. Department of Energy Environmental Management Consolidated Business Center, Final, October.

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

DOE (U.S. Department of Energy), 2011b. *Environmental Covenant*, approved December 22, 2011, and recorded with Montgomery County, Ohio, as Special Instrument Deed 2012-00004722 on January 24, 2012.

DOE (U.S. Department of Energy), 2011c. *Miamisburg Closure Project Parcel 9 Residual Risk Evaluation*, *Mound Plant, Miamisburg, Ohio,* RPT-2185.00-001, prepared by Portage, Inc. for the U.S. Department of Energy, Ohio Field Office, Final, June.

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

DOE (U.S. Department of Energy), 2014b. *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), 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), 2015. *Operations and Maintenance Plan for the U.S. Department of Energy Mound, Ohio, Site*, LMS/MND/S08406-1.0, Office of Legacy Management, May.

DOE (U.S. Department of Energy), 2019a. *Mound Core Team Agreement for Operable Unit 1 Monitoring for Interim Period After Enhanced Attenuation Demonstration*, memorandum by Mound Core Team, February 13.

DOE (U.S. Department of Energy), 2019b. *Vapor Intrusion Assessment: Phase I Preliminary Screening and Conceptual Model for the Mound, Ohio, Site*, LMS/MND/S15736, Office of Legacy Management, March.

DOE (U.S. Department of Energy), 2020. *Operable Unit 1 Field Demonstration Project Completion Report, Mound, Ohio, Site*, LMS/MND/S25064, Office of Legacy Management, April.

DOE (U.S. Department of Energy), 2021a. *Community Involvement Plan for the U.S. Department of Energy Mound, Ohio, Site*, LMS/MND/S02885-1.0, Office of Legacy Management, December.

DOE (U.S. Department of Energy), 2021b. *Long-Term Surveillance and Maintenance Plan for the U.S. Department of Energy Mound, Ohio, Site*, LMS/MND/S01369-2.0, Office of Legacy Management, December.

DOE (U.S. Department of Energy), 2023. *Amendment to the Record of Decision for Operable Unit 1 of the Mound Site*, *Miamisburg, Ohio*, LMS/MND/S29546, Office of Legacy Management, September.

DOE (U.S. Department of Energy), EPA (U.S. Environmental Protection Agency), and Ohio EPA (Ohio Environmental Protection Agency), 1993. *Federal Facility Agreement Under CERCLA Section 120,* July 15.

EPA (U.S. Environmental Protection Agency), 1999. *Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites*, OSWER Publication 9200.4-17P, Office of Solid Waste and Emergency Response, April.

EPA (U.S. Environmental Protection Agency), 2012. *Institutional Controls: A Guide to Preparing Institutional Control Implementation and Assurance Plans at Contaminated Sites,* OSWER 9200.0-77, EPA-540-R-09-002, December.

EPA (U.S. Environmental Protection Agency), 2015. *OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air*, OSWER Publication 9200.2-154, Office of Solid Waste and Emergency Response, June.

EPA (U.S. Environmental Protection Agency), 2020. *Vapor Intrusion Handbook*, Region 5 Superfund and Emergency Management Division, March.

OAC 3745:81. "Primary Drinking Water Rules," *Ohio Administrative Code*.

Ohio EPA (Ohio Environmental Protection Agency), 2020a. *Sample Collection and Evaluation of Vapor Intrusion to Indoor Air for Remedial Response, Resource Conservation and Recovery Act and Voluntary Action Programs*, Division of Environmental Response and Revitalization, March.

Ohio EPA (Ohio Environmental Protection Agency), 2020b. *Vapor Intrusion Comparative Soil Gas Sampling Event at Former DOE Mound Facility Field and Data Analysis Report*, prepared by the Division of Environmental Response and Revitalization, July.