LMS/MND/S29546

Amendment to the Record of Decision for Operable Unit 1 of the Mound Site

Miamisburg, Ohio

September 2023

U.S. DEPARTMENT OF ENERGY | Legacy Management

This document is designed for online viewing.

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Abbreviations

ARAR	applicable or relevant and appropriate requirement
ATD	Authorization to Discharge
bgs	below ground surface
BVA	Buried Valley Aquifer
cDCE	*cis*-1,2-dichloroethene
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
COC	contaminant of concern
COPC	contaminant of potential concern
CSM	conceptual site model
cVOC	chlorinated volatile organic compound
DCA	1,2-dichloroethane
DOE	U.S. Department of Energy
ELCR	excess lifetime cancer risk
EPA	U.S. Environmental Protection Agency
ft	feet
HI	Hazard Index
HQ	Hazard Quotient
IC	institutional control
LM	Office of Legacy Management
MCL	maximum contaminant level
MDC	Mound Development Corporation
MNA	monitored natural attenuation
NCP	National Contingency Plan
NPL	National Priorities List
Ohio EPA	Ohio Environmental Protection Agency
O&M	operations and maintenance
OU-1	Operable Unit 1
PAH	polycyclic aromatic hydrocarbon
PCE	tetrachloroethene
PRG	preliminary remediation goal
P&T	pump-and-treatment

RAO	Remedial Action Objective
ROD	Record of Decision
RRE	residual risk evaluation
SVE	soil vapor extraction
TCE	trichloroethene
USC	*United States Code*
VC	vinyl chloride
VI	vapor intrusion
VISL	vapor intrusion screening level
VOC	volatile organic compound

1.0 Declaration

1.1 Site Name and Location

- **Site Name:** Mound Plant (also known as the Miamisburg Closure Project and the Mound, Ohio, Site), Operable Unit 1
- **Site Location:** Montgomery County, Ohio
- **Lead Regulatory Oversight Agency:** U.S. Environmental Protection Agency, Region 5
- **Support Regulatory Oversight Agency:** Ohio Environmental Protection Agency
- **Remedial Action Agency:** U.S. Department of Energy

The U.S. Department of Energy (DOE) Mound, Ohio, Site (CERCLIS ID-04935), originally known as the Mound Plant, lies within the city limits of Miamisburg, in southern Montgomery County, Ohio, approximately 10 miles southwest of Dayton and 45 miles north of Cincinnati.

1.2 Statement of Basis and Purpose

The *Operable Unit 1, Record of Decision* (DOE 1995), hereafter called the 1995 OU-1 ROD, was approved by the U.S. Environmental Protection Agency (EPA) and the Ohio Environmental Protection Agency (Ohio EPA) in 1995. The 1995 OU-1 ROD (DOE 1995) documented controlling groundwater contamination and preventing migration of contamination through the collection and treatment of contaminated groundwater (i.e., pump-and-treatment [P&T] system) and disposal of treated water. In 2011, 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, was approved by both EPA and Ohio EPA and documented the geographic area expansion of OU-1 within Parcel 9 and the institutional controls (ICs) to be implemented at OU-1 in an environmental covenant in accordance with Title 53 *Ohio Revised Code* Section 5301.80 to 5301.92 (53 ORC 5301.80–5301.92). All other components of the 1995 OU-1 ROD (DOE 1995) remained unchanged and in effect.

This decision document sets forth the basis for the decision to issue an amendment to the 1995 OU-1 ROD (DOE 1995). This ROD Amendment selects and explains modification to the selected remedial action for groundwater in OU-1 set forth in the 1995 OU-1 ROD (DOE 1995) and selects and explains the remedial action for vapor intrusion (VI) in OU-1/Parcel 9. This Amendment does not modify the remedies for OU-1/Parcel 9 documented in the 2011 OU-1 ROD Amendment (DOE 2011a).

This Amendment is being issued in accordance with Section 117(c) of the Comprehensive Environmental Response, Compensation, and Liability Act (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]). This Amendment has been prepared to document changes to the selected remedy identified in the 1995 OU-1 ROD (DOE 1995), to summarize the information that leads to the Amendment, and to affirm that the 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 (NCP).

The amended remedy is being adopted in response to information that has been collected and analyzed since the 1995 OU-1 ROD (DOE 1995). Subsequent investigations determined that the volatile organic compound (VOC) concentrations in groundwater outside the OU-1 compliance boundary were higher than expected and several locations exceeded the maximum contaminant level (MCL) for trichloroethene (TCE) and vinyl chloride (VC), and this portion of the plume is not within the hydraulic capture of the existing extraction wells. The current remedy cannot address the complete area of VOC impact in OU-1. The current configuration of the P&T system was not considered in the Focused Feasibility Study (DOE 2022a) for this reason.

After the Focused Feasibility Study (DOE 2022a) was initiated, it was determined that vapor-forming chemicals were present at sufficient levels in the vadose zone within the former OU-1 landfill area to warrant the evaluation of health risks from VI and potential remedial alternatives. An addendum to the Focused Feasibility Study (DOE 2022a) was prepared and presents information pertaining to VI in OU-1 and Parcel 9. The results of historical data evaluation and several investigations conducted in the former landfill area indicate the presence of vapor-forming chemicals, namely TCE and VC, at levels that could result in an unacceptable risk to future building occupants if a complete exposure pathway were present.

1.3 Assessment of the Site

The response actions selected in this ROD Amendment are necessary to protect public health or welfare of the environment from actual or threatened releases of pollutants or contaminants from this site, which may present an imminent and substantial endangerment to public health and welfare.

1.4 Description of the Amendment to the Selected Remedy

This amendment 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/Parcel 9 area of the Mound site. These remedies are referred to as:

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

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

- The use of enhanced attenuation to address VOC contamination in OU-1.
- Routine groundwater monitoring of VOCs, geochemical parameters, and microbial counts.
- ICs that limit the land use to industrial and commercial (restrict residential use) in OU-1/Parcel 9 and prohibit the use, including extraction or consumption, of groundwater.

- Decommissioning of the P&T system, including the two extraction wells, and removing monitoring wells not retained as part of the long-term network.
- Enhancement of attenuation processes through the injection of amendments or microbes (if deemed necessary).

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 ensure the continued operation, maintenance, and testing to ensure 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
- Placement of ICs that limit the land use to industrial and commercial (restrict residential use) in OU-1/Parcel 9 and prohibit the use, including extraction or consumption, of groundwater or the removal of soil from within the original Mound site boundary to offsite locations.

1.5 Statutory Determinations

In accordance with Section 121 of CERCLA (42 USC 9621), the modification to the 1995 OU-1 ROD (DOE 1995) will satisfy statutory requirements as follows:

- Protection of human health and the environment
- Compliance with applicable or relevant and appropriate requirements (ARARs)
- Cost-effectiveness
- Utilization of permanent solutions to the maximum extent as practicable

In accordance with Section 121(c) of CERCLA (USC 42 9621[c]) and the Federal Facility Agreement among EPA, DOE, and Ohio EPA, EPA will review this remedial action from a sitewide perspective no less than every 5 years after the implementation of final remedial actions to ensure that human health and the environment are being protected by the remedial actions.

The alternative selected to address the residual VOC contamination in groundwater in OU-1 is Alternative GW—4, "Enhanced Attenuation with Monitoring and ICs." Alternative GW—4 will achieve all Remedial Action Objectives (RAOs) and remediate groundwater throughout the plume within a reasonable time frame (i.e., approximately 10 years). Based upon an evaluation using the CERCLA evaluation criteria, Alternative GW—4 presents the best balance in addressing risks from OU-1 groundwater. This alternative complies with ARARs, addresses all VOC-impacted groundwater originating from the former OU-1 landfill within Parcel 9, acknowledges uncertainties associated with the long-term treatment of VOCs by allowing for injection of amendments or microbes (if deemed necessary), and can be performed cost-effectively. The results of the OU-1 Enhanced Attenuation Field Demonstration indicate that sustainable geochemical and biological processes will degrade contaminants to MCLs within a reasonable time frame.

The alternative selected to address potential VI exposure from vapor-forming chemicals in the vadose zone in OU-1 is Alternative VI—3, "Preemptive Measures or Actions to Mitigate VI Exposure with ICs." Alternative VI—3 will achieve all RAOs by eliminating the VI pathway and preventing exposure to future building occupants. Although Alternative VI—3 does not reduce the toxicity or volume of contaminants, it does recognize that the major VOC source areas have been removed, the original VOC groundwater plume has been reduced, and residual sources are currently being addressed by other remedial actions (Alternative GW—4). There are no federal or state ARARs for VI; guidance documents provided by both EPA (EPA 2015) and Ohio EPA (Ohio EPA 2020a) contain elements that are "to be considered" for addressing potential migration of vapors into future buildings and meeting the RAOs. Alternative VI—3 will reduce the mobility of vapors into future buildings by employing preemptive measures (engineering controls) to address the VI pathway; however, the prevention of potential exposure through the VI pathway is not mitigated by treatment, but rather through engineering controls. Achievement of RAOs may be demonstrated by confirming that the VI pathway has been mitigated through engineering controls installed in a newly constructed building or by providing data or additional information that supports that there would not be an unacceptable risk to building occupants from subsurface vapors. Future building owners shall ensure that engineering controls are functioning and that contaminant concentrations within the building do not exceed risk-based values for industrial and commercial use scenarios for indoor air. These values could change in the future based on updated information and should be reevaluated when a building is considered for construction within Parcel 9. It is anticipated that any costs associated with the installation and operation of vapor mitigation systems, including design, construction, monitoring, and maintenance or sampling and characterization of subsurface vapors will be the responsibility of future building owners.

1.6 ROD Data Certification Checklist

The following information is included in Section 2.0, "Decision Summary," of this ROD Amendment. Each item presented here references a section of this document. Additional information can be found in the Administrative Record file for the site.

- Contaminants of concern (COCs) and their respective concentrations (Section 2.5.3).
- Baseline risk represented by the COCs (Section 2.7).
- Remediation goals established for COCs and the basis for these cleanup levels (Section 2.8).
- Handling of source materials constituting the principal threats (Section 2.2).
- Current and reasonable anticipated future land use assumptions and current and potential future beneficial uses of groundwater used in the risk assessment and this ROD Amendment (Section 2.6).
- Potential land and groundwater use that will be available at the site as a result of the amended remedy (Section 2.6).
- Estimated capital, lifetime operations and maintenance (O&M), and total present worth costs; discount rate; and the number of years over which the remedy costs estimates are projected (Section 2.10).
- Key factors that led to amending the remedy (Section 2.4).

1.7 Authorizing Signatures and Support Agency Acceptance

This Amendment to the Record of Decision for Operable Unit 1 of the Mound, Ohio, Site has been prepared by DOE. The approval of DOE and EPA is required and has been secured as documented here. The Director of Site Operations, Jay Glascock, of the DOE Office of Legacy Management (LM) and the Director of the Superfund and Emergency Management Division, Douglas Ballotti, of EPA Region 5 have been delegated the authority to approve this decision document.

Jay D. Glascock Digitally signed by Jay D. Glascock Date: 2023.09.14 12:32:41 -06'00'

Jay Glascock
U.S. Department of Energy

Date

DOUGLAS BALLOTTI Digitally signed by DOUGLAS BALLOTTI Date: 2023.09.26 08:36:08 -05'00'

September 26, 2023

Douglas Ballotti
U.S. Environmental Protection Agency

Date

Ohio EPA concurs with this ROD Amendment. DOE has added the Ohio EPA concurrence letter to the Administrative Record and includes this letter as Appendix A to this ROD Amendment.

2.0 Decision Summary

2.1 Site Name, Location, and Description

- **Site Name:** Mound Plant (also known as the Miamisburg Closure Project and the Mound, Ohio, Site), Operable Unit 1 and Parcel 9
- **Site Location:** Montgomery County, Ohio
- **Lead Regulatory Oversight Agency:** U.S. Environmental Protection Agency, Region 5
- **Support Regulatory Oversight Agency:** Ohio Environmental Protection Agency
- **Remedial Action Agency:** U.S. Department of Energy

The Mound site (CERCLIS ID-04935) lies within the city limits of Miamisburg, in southern Montgomery County, Ohio, approximately 10 miles southwest of Dayton and 45 miles north of Cincinnati (Figure 1). 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. 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 and developed to facilitate future economic development of the plant property into an industrial and commercial site.

The plant was originally situated on 182 acres. In 1981, DOE purchased an additional 124 acres south of the original property; however, the additional property remained undeveloped. During operation of the Mound site, an onsite landfill was created, which was located 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.

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 2). As part of the 2011 OU-1 ROD Amendment (DOE 2011a), the original 4-acre OU-1 (also referred to as the OU-1 landfill area) is now synonymous with Parcel 9. The OU-1 landfill area that was the basis for the original 1995 OU-1 ROD (DOE 1995) covered only part of the land now comprising Parcel 9.

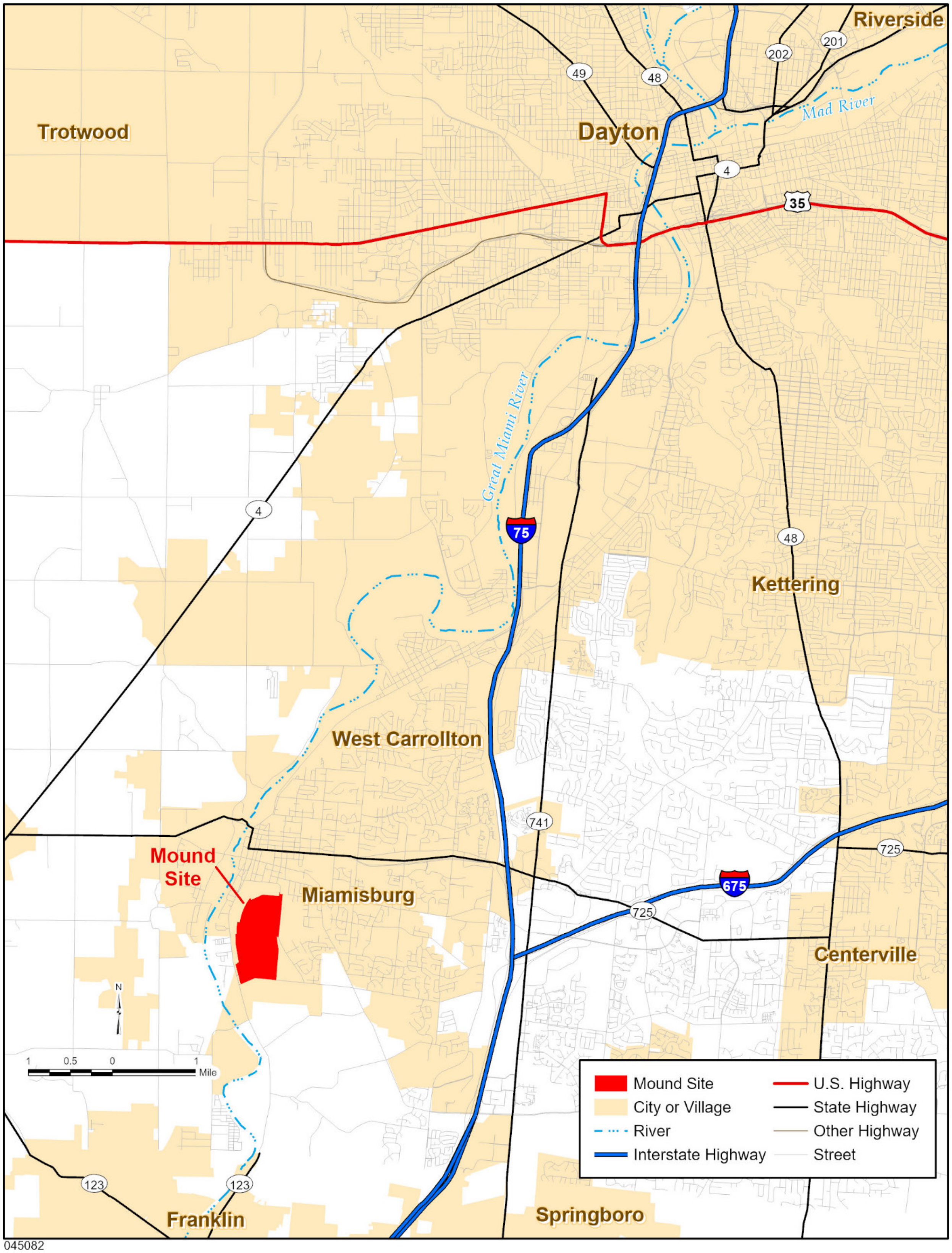


Figure 1. Location of Mound, Ohio, Site

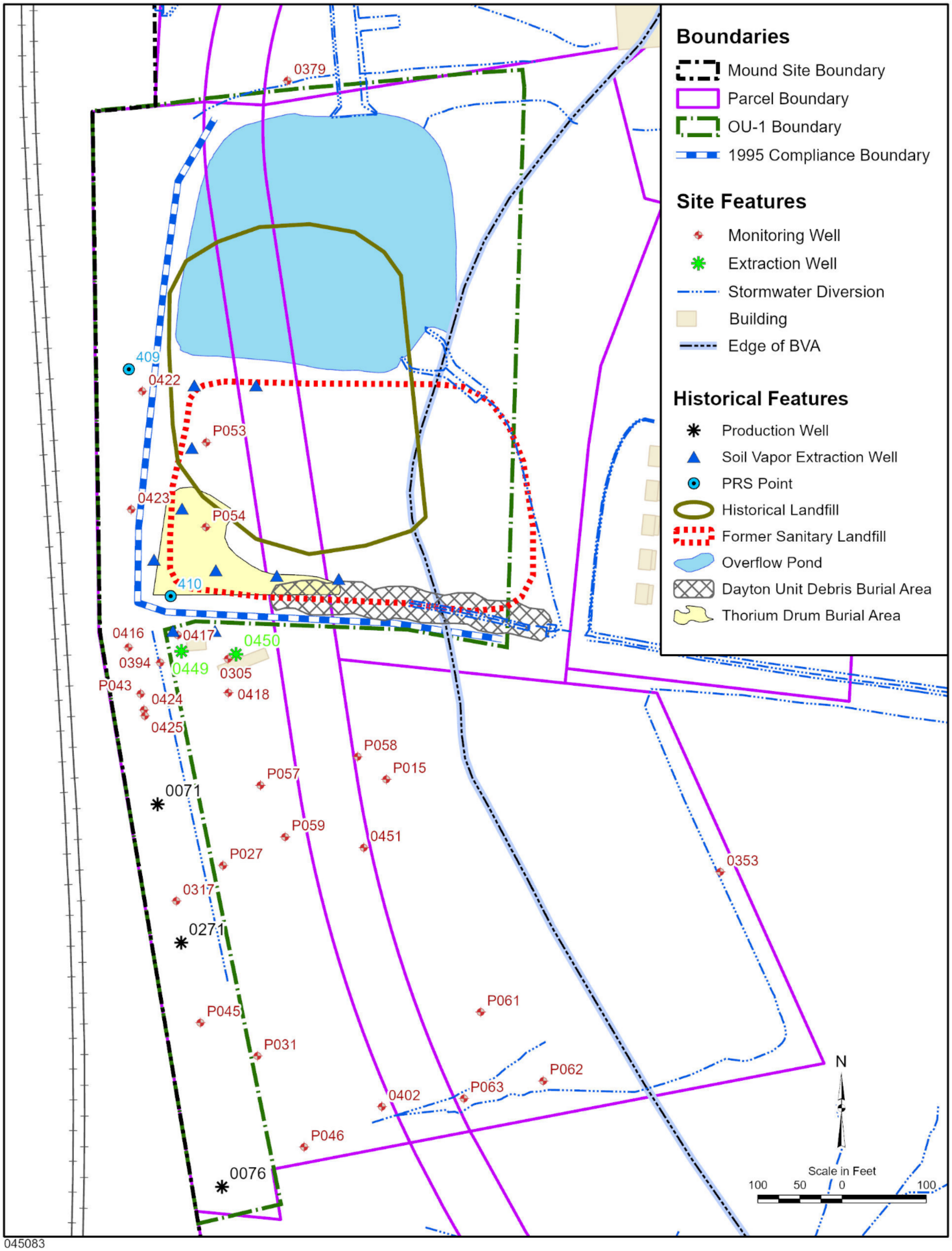


Figure 2. Operable Unit 1 Site Map

2.2 OU-1/Parcel 9 History and Enforcement Activities

In 1989, the Mound site was placed on the NPL as a result of the VOCs in groundwater beneath the OU-1 landfill area. Pursuant to this NPL designation, a Federal Facility Agreement was executed between DOE and EPA in October 1990. Ohio EPA became a party to this agreement in 1993. Subsequent to the signing of this agreement, the 1995 OU-1 ROD (DOE 1995) was signed in June 1995. The 1995 OU-1 ROD selected a groundwater P&T remedy to collect, treat, and dispose of groundwater contaminated with VOCs, which represented the principal risk concern. The 1995 OU-1 ROD required CERCLA Five-Year Reviews of the remedy as long as contaminants above health-based levels remained within the OU-1 area.

This ROD Amendment includes information regarding significant activities conducted at OU-1 since the signing of the ROD in 1995. In addition to the operation of the P&T system, numerous contaminant and hydrogeologic investigations and additional source removal activities were performed since the remedy was implemented in 1996. The information in this section can be further reviewed in documents contained within the Administrative Record, which is available at https://www.energy.gov/lm/mound-ohio-site/ or currently can be accessed electronically at the Mound Cold War Discovery Center at 1075 Mound Road, Miamisburg, Ohio.

2.2.1 OU-1/Parcel 9 History

The 1995 OU-1 ROD (DOE 1995) was the first of several actions planned as part of the overall remedial action for the Mound site. The 1995 OU-1 ROD was signed by DOE on June 2, 1995, and by EPA on June 12, 1995. Ohio EPA concurred with the remedy described in the 1995 OU-1 ROD on May 22, 1995. Contents of the 1995 OU-1 ROD included the following actions:

- Controlling groundwater contamination (primarily dilute VOCs) 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 1995 OU-1 ROD (DOE 1995) 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 of 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 remedy included surface water controls, ICs to limit site access, and long-term groundwater monitoring.

The P&T system was installed in 1996 and began operation in February 1997. 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). Starting in 1997, sampling of selected groundwater monitoring wells for VOCs was performed quarterly to look for sustained downward trends as proof of successful capture of the plume. Hydrologic data were also collected to verify that hydraulic containment of the impacted groundwater was maintained.

In 2005, the Mound Plant production wells, which were also used to supply drinking water to the facility, were removed from service and decommissioned. At that time, the facility was connected to the City of Miamisburg water supply.

The OU-1 ROD Amendment (DOE 2011a) was approved in 2011. It was signed by DOE on September 9, 2011; by EPA on September 16, 2011; and by Ohio EPA on September 19, 2011. The contents of that ROD Amendment included the following actions:

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

At the time the 1995 OU-1 ROD (DOE 1995) was written, there was little guidance on what specific restrictions should be required or how deed restrictions should be implemented at CERCLA sites. The 2011 OU-1 ROD Amendment (DOE 2011a) contains language from the Parcel 9 *Environmental Covenant* (DOE 2011b) in accordance with 53 ORC 5301.80–5301.92 and recorded with Montgomery County, Ohio. 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-acre DOE Mound site property boundaries
- Prohibit the extraction or consumption, exposure, or use in any way of the groundwater underlying the former DOE Mound site
- Limit land use to industrial and commercial only
- Allow site access for federal and state agencies for sampling and monitoring

With the approval of the Mound Core Team, the P&T system was placed on standby during the OU-1 Enhanced Attenuation Field Demonstration period that commenced in August 2014 and ended in August 2018. The study was performed to evaluate the feasibility of transitioning from the P&T remedy to an attenuation-based remedy to address VOCs in OU-1 groundwater. Given the favorable results of the field demonstration, the system has remained in standby to avoid disturbing the structured geochemical treatment zones, which were created as part of the field demonstration until it is determined whether modifying the groundwater remedy to enhanced attenuation is approved in this second amendment to the 1995 OU-1 ROD (DOE 1995).

2.2.2 Additional Removal Actions

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, expedite remediation times by addressing VOC contamination in the vadose zone, and facilitate future economic development of the landfill area. 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 (SVE) system from 1996 until 2003
- Removing radiologically contaminated soil from the southwestern corner of the former landfill in 2005
- Removing the bulk of the contaminated soil and waste materials from the former landfill from 2007 through 2010

2.2.3 Additional Groundwater Investigations and Field Studies

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 duration
- Additional delineation of the areal extent of the VOC impact in groundwater
- Evaluation of possible additional sources of VOC
- Evaluation of attenuation mechanisms (geochemistry and microbial populations)
- 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

2.2.4 Identification of Subsurface Vapors in OU-1

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 2019), 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 here and further discussed in Section 2.4.2:

- **Soil:** Locations with detectable concentrations of several VOCs and polycyclic aromatic hydrocarbons (PAHs) identified as vapor-forming chemicals
- **Groundwater:** Concentrations of TCE, VC, chloroform, and carbon tetrachloride greater than VI screening levels (VISL) 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

2.3 Community Participation

Public participation requirements under CERCLA Sections 113(k)(2)(B)(i–v) and 117 were satisfied during the remedial investigation and Feasibility Study process. LM has been primarily responsible for conducting the community involvement program for this site, with the assistance of EPA and Ohio EPA. The following public participation activities were conducted to comply with CERCLA:

- A community involvement plan was developed for the Mound site to assess the community's informational needs related to the site and to outline community involvement activities to meet these needs.
- A public information repository was established at the Mound site and the Administrative Record and other informational documents are currently available electronically at the Mound Cold War Discovery Center, 1075 Mound Road, Miamisburg, Ohio. The public information repository can also be accessed on the LM Mound, Ohio, Site webpage at https://www.energy.gov/lm/mound-ohio-site/.
- An initial mailing list of interested citizens, organizations, news media, and elected officials in local, county, state, and federal government was developed. This mailing list has been updated periodically as interested individuals have approached LM for information.

LM has met the public participation requirements defined in Section 300.435(c)(2)(ii) of the NCP. LM published a notice of availability of the *Proposed Plan for Amendment of Operable Unit 1 Record of Decision, Mound, Ohio, Site* (DOE 2022b) in the *Dayton Daily News* on November 20, November 21, and November 25, 2022. LM held a public meeting on December 7, 2022, and also provided the opportunity for members of the public to attend virtually due to coronavirus disease 2019 concerns. A 30-day public comment period was held from November 23 through December 23, 2022, to give members of the public time to review the Proposed Plan and other documents contained in the Administrative Record for the site. Following the close of the public review period, LM placed a copy of the Proposed Plan in the Administrative Record file, which was and is available on the LM Mound, Ohio, Site webpage and at the public information repository maintained electronically at the Mound Cold War Discovery Center. No comments were received during the public comment period.

2.4 Scope and Role of the Response Action

This Amendment fundamentally modifies the remedy selected in the 1995 OU-1 ROD with respect to scope, performance, and cost. Section 117(c) of CERCLA states that an amendment to a ROD shall be proposed if the differences in the remedial action being undertaken at a site is fundamentally altered from the overall remedy set forth in the ROD with respect to scope, performance, or cost. It also requires that the reasons for the amendment be published; therefore, this ROD Amendment will be incorporated into the Administrative Record in accordance with Section 300.825(a)(2) of the NCP [40 CFR 300.825(a)(2)] and can be accessed at the LM Mound, Ohio, Site webpage (https://www.energy.gov/lm/mound-ohio-site) or reviewed electronically at the Mound Cold War Discovery Center, 1075 Mound Road, Miamisburg, Ohio.

This ROD Amendment presents remedial alternatives that address:

- VOC-impacted groundwater that originated from the former OU-1 landfill and extends downgradient into Parcel 9 of the Mound site.
- Potential VI exposure to future building occupants in Parcel 9.

The role of the selected groundwater alternative is to replace the current P&T system, which provides hydraulic containment of the VOC plume beneath the former OU-1 landfill, as described in the 1995 OU-1 ROD (DOE 1995). The alternative will provide a cost-effective and permanent solution for VOCs in groundwater beneath the former landfill and downgradient in Parcel 9 and is expected to result in the attainment of MCLs and a reduction in the toxicity, mobility, and volume of contaminants in groundwater. The alternative acknowledges that the existing distribution of VOCs and the biogeochemical conditions result from the injection of neat and emulsified oils performed as part of the OU-1 Enhanced Attenuation Field Demonstration completed in 2018.

The role of the selected VI alternative is to provide a cost-effective and permanent solution to mitigate potential risk to future building occupants from vapor-forming chemicals present in the vadose zone in OU-1/Parcel 9. Currently, 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 alternative will reduce the mobility and mitigate the intrusion of subsurface vapors into buildings. Recently, vapor-forming chemicals were discovered at sufficient levels in the vadose zone within the former OU-1 landfill area to warrant the evaluation of health risks and potential remedial alternatives. This alternative acknowledges that existing conditions may result in unacceptable exposure to a potential occupant if a building were to be constructed in the OU-1 area.

2.4.1 Basis for Groundwater Remedy Change

Starting in 2014, a multiyear field demonstration was performed to evaluate the feasibility of employing an attenuation-based remedy to remediate VOCs in groundwater in the OU-1 area. A combination of technologies that emerged for OU-1 included the injection of neat (pure) vegetable oil in the deep vadose zone in the former source area and emulsified edible oil (i.e., vegetable oil) within the footprint of the groundwater plume. The goal of the edible oil deployment was to enhance the reducing environment within the VOC plume and stimulate the naturally occurring microbes, as well as develop a series of structured geochemical zones for the VOC plume to flow though. These structured zones serve to decrease chlorinated compound concentrations in two ways: (1) physical sequestration, which reduces effective aqueous concentration and mobility of residual VOCs remaining within the base of the landfill excavation footprint and (2) stimulation of anaerobic, abiotic, and cometabolic degradation processes within the aquifer. In the subsurface, the oil ferments to produce hydrogen, which is used as an electron donor for anaerobic dechlorination by organisms, such as *Dehalococcoides*. Degradation (daughter) products leaving the treatment zone are amenable to aerobic oxidation and abiotic degradation. Furthermore, the organic compounds leaving the deployment zone (e.g., methane) stimulate and enhance downgradient aerobic cometabolism, which degrades both daughter compounds and several parent VOCs.

The OU-1 area is uniquely suited for this type of remedial approach because the aquifer chemistry supports the presence of structured geochemical zones, the low average linear velocity of groundwater (less than 100 feet [ft] per year), and there are no nearby receptors. The low groundwater velocity allows for longer residence time for attenuation mechanisms within the treatment zones to reduce VOC concentrations in groundwater and adequate time to react to changed conditions before groundwater could migrate offsite. Also, ICs restricting groundwater use eliminate the possibility of future onsite receptors until the groundwater quality is returned to beneficial use (i.e., meeting the remediation goals set at or below drinking water standards).

The OU-1 Enhanced Attenuation Field Demonstration was completed in 2018 (DOE 2020). Edible oil was injected in a pattern that resulted in the formation of two treatment zones—beneath the southwestern corner of the former OU-1 landfill area (northern zone) and approximately 350 ft downgradient of the landfill where elevated VOCs were measured (southern zone). The creation of these two treatment zones allowed for the attenuation of VOCs in groundwater through a series of differing geochemical zones that allowed for reductive dechlorination and subsequent aerobic cometabolism of VOCs. Throughout the 4-year field demonstration, contaminant concentrations were trending downward while the microbial communities remained robust; these conditions have continued to be sustained. By the end of the field demonstration in 2018, tetrachloroethene (PCE), TCE, and VC had concentrations in groundwater that exceeded their respective MCLs. Concentrations of *cis*-1,2-dichloroethene (cDCE) were elevated but never exceeded the MCL.

The consideration of an attenuation-based remedy to address VOCs in OU-1 groundwater was based on the effectiveness of the emulsified oil treatment to stimulate (enhance) the natural attenuation processes in the treatment zones and reduce PCE and TCE, as well as daughter products (cDCE and VC) in groundwater. The following factors were outlined in the Field Demonstration Work Plan (DOE 2014b) and were modeled after EPA's *Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites* (EPA 1999). The following factors are typically used when considering natural attenuation as a remedy:

- The VOCs in groundwater can be effectively remediated by natural attenuation processes
- The contaminant plume is stable, and the potential for the environmental conditions that influence plume stability will not change over time
- The downgradient groundwater will not be adversely impacted as a consequence of selecting monitored natural attenuation (MNA) as a remedy
- The estimated time frame of remediation is reasonable compared to time frames of other, more active methods, such as P&T
- The nature and distribution of sources can be controlled
- The resulting transformation (daughter) products do not pose a greater risk than the parent contaminants

Of these factors, the most important considerations regarding the suitability of an attenuation-based remedy include whether the contaminants are likely to be remediated by natural attenuation processes, the stability of the contaminant plume and its potential for migration, and the potential for unacceptable risk from contamination.

Table 1 provides a summary of the conclusions reached from the OU-1 Enhanced Attenuation Field Demonstration for each line of evidence as discussed in the *Fifth Five-Year Review for the Mound, Ohio, Site* (DOE 2021).

Besides decreasing the concentrations and mass of PCE and TCE in OU-1 groundwater and developing and sustaining the treatment zones, demonstrating that the plume could be stabilized was another objective of the field study, as discussed in the Enhanced Attenuation Field Demonstration Completion Report (DOE 2020). By the end of the field demonstration, data analysis indicated that plume strength of the parent constituents was decreasing, and the plumes could generally be classified as stable or shrinking. Also, the concentrations and concentration trends in the downgradient sentinel wells were used as a metric related to potential plume expansion. The concentrations and trends in these wells demonstrated that the plume was not expanding.

Table 1. Conclusions Supporting Lines of Evidence of Enhanced Attenuation

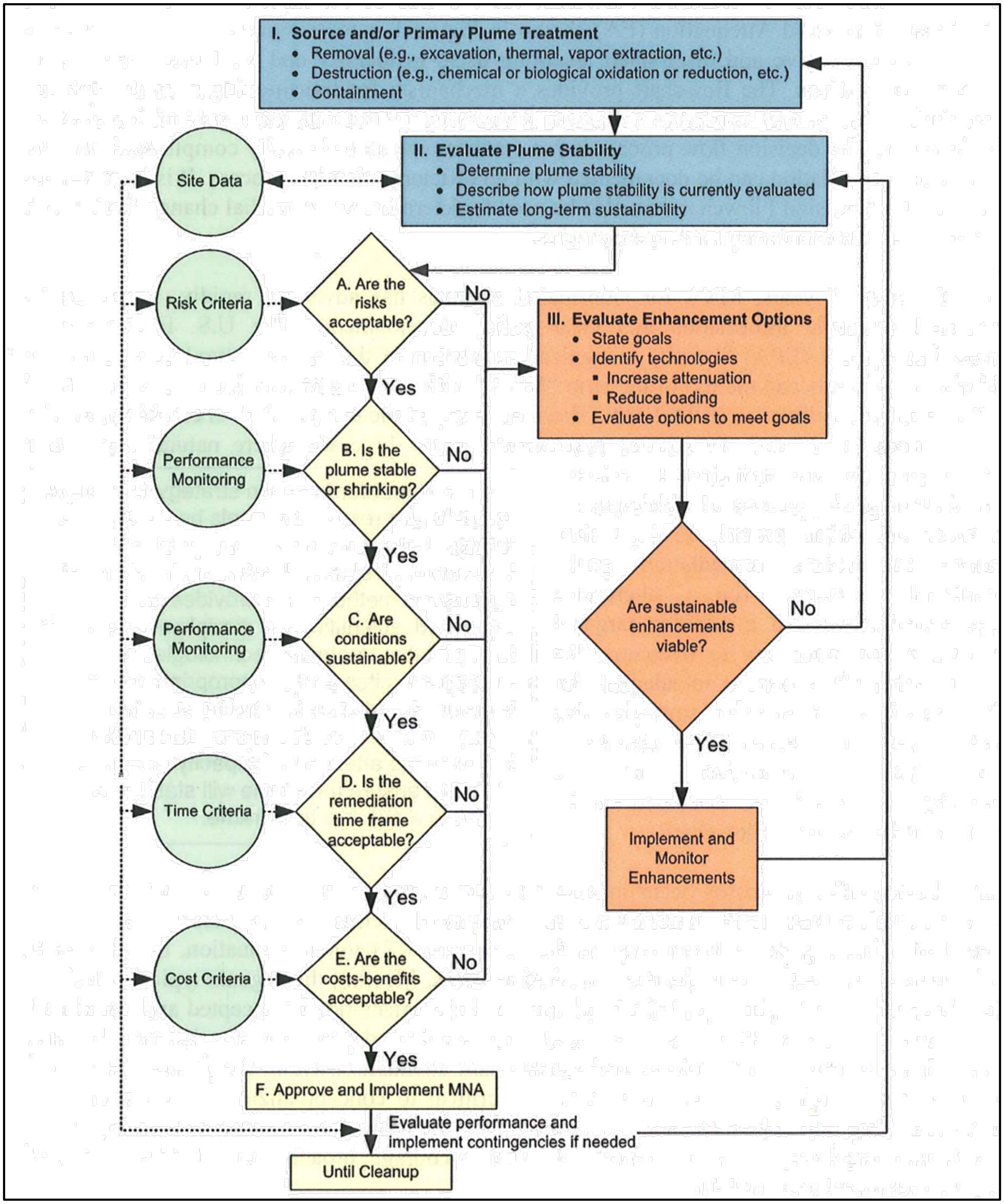
Line of Evidence	Conclusions from OU-1 Enhanced Attenuation Field Demonstration
Historical groundwater data that demonstrate a clear and meaningful trend of decreasing contaminant mass or concentration over time and the presence of degradation (daughter) products at appropriate monitoring points.	PCE and TCE masses decreased significantly over the 4-year period. Trends in individual well concentrations for the parent products (PCE and TCE) were decreasing in most of the OU-1. Moment analysis indicates that PCE and TCE mass can be classified as stable or shrinking. The increase in the mass of cDCE and VC demonstrates that significant reductive attenuation processes have developed and are continuing. Daughter products, cDCE and VC have increasing trends in the OU-1 plume, particularly in and near the treatment zones, indicating reductive dechlorination of the parent products. Moment analysis indicates that the cDCE mass can be classified as expanding; however, the generation of daughter products was anticipated. Moment analysis indicated that the VC mass can be classified as stable.
Hydrogeologic and geochemical data that can be used to demonstrate indirectly the types of natural attenuation processes at the site.	Prior to the enhanced attenuation deployment, the entire site was predominantly aerobic. Following deployment, predominantly anaerobic zones developed near and downgradient of electron donor injection. Development of distinct zones within the aquifer with reduced conditions that are variable for reductive dechlorination. Shifts of geochemistry toward cometabolic (oxidation) conditions in the plume interior and sentinel well areas. Postdeployment, the patterns of anaerobic and aerobic conditions are consistent with the structured geochemical zone design basis. The sequence of anaerobic and aerobic conditions along the flow path of OU-1 groundwater provides conditions that maximize the degradation opportunities of parent (PCE and TCE) and daughter (cDCE and VC) chlorinated ethenes and mitigates the potential for excessive buildup of VC.

Table 1. Conclusions Supporting Lines of Evidence of Enhanced Attenuation (continued)

Line of Evidence	Conclusions from OU-1 Enhanced Attenuation Field Demonstration
Data from field or microcosm studies, which directly demonstrate or quantify the occurrence of a particular natural attenuation process and ability to degrade COCs.	All the microbial counts (total bacteria, chlorinated-solvent-reducing bacteria, aerobic cometabolic bacteria, methanogens, and sulfate reducers) increased following the enhanced attenuation deployment and were generally sustained during the field demonstration period. At the end of the 4-year field demonstration period, the microbial community had adjusted to the decrease in the mass of VOCs, the decrease in PCE and TCE concentrations, and the generation of daughter products (cDCE and VC). A general decline in the total eubacteria counts has occurred over the 4-year period; however, at the end of the field demonstration, the counts are higher than baseline counts and within acceptable levels to maintain the structured zones. The wells in the treatment zones showed significant increases in chlorinated-solvent-reducing bacteria that are capable of degrading TCE and PCE. Side-gradient, intermediate, and downgradient wells have also shown increases in chlorinated-solvent-reducing bacteria counts. Total eubacteria, sulfate reducers, and methanogens increased in the mid-plume and distal areas and are at levels that indicate aerobic and transitional conditions, consistent with the objectives of structured geochemical zones. The microbial species and enzymes associated with biodegradation generally require the presence of the target contaminants; the decrease in microbial counts can be attributed to the low concentrations of VOCs present in the groundwater (i.e., the decrease in the mass of chlorinated VOCs has resulted in a decrease in the microbial community). The makeup of the microbial species and enzymes in some wells have adapted to account for the decrease in PCE and TCE and presence of cDCE and VC.

A decision flowchart (Figure 3) was developed by the Interstate Technology and Regulatory Council (ITRC 2007), which incorporates the factors identified in guidance documents and provides a systematic mechanism for evaluating site data and information. This flowchart evaluates natural attenuation according to established protocols but places additional emphasis on plume stability and sustainability. If data suggest that a site is approaching MNA but does not meet the requirements of MNA, the flowchart provides an additional potential option of enhanced attenuation. Evaluating the potential option for enhanced attenuation allows for implementation of suitable activities that will modify those factors (risk, plume stability, sustainability, or time frame) that did not allow the site to directly implement MNA.

The decision to implement MNA as part of a remedy relies on a demonstration that, under current conditions, the overall VOC plume is stable and the areal extent of several contaminants (PCE and TCE) are decreasing, and that plume stability can be maintained in the future. Table 2 summarizes the decision factors that were evaluated in the Enhanced Attenuation Field Demonstration Completion Report (DOE 2020) using the flowchart in Figure 3 and indicates whether these factors were met at the completion of the demonstration. The results of the evaluation from the Enhanced Attenuation Field Demonstration indicated that additional information may be necessary to address the long-term sustainability of the treatment zones and the remediation time frame for VC in groundwater.



Source: ITRC 2007.

Figure 3. Data Evaluation Flowchart for MNA and Enhanced Attenuation

Table 2. Summary of Decision Factors for Evaluation for MNA

Flowchart Decision Point	Yes or No	Comments
Are the risks acceptable?	Yes	The VOC plume remains onsite and ICs are in place to prevent groundwater receptors.
Is the plume stable or shrinking?	Yes	Plume stability analysis indicates that the PCE and TCE plumes are decreasing in size and mass. Plume stability analysis indicates that the cDCE and VC plumes have increased in mass. There has been some lateral spread of the cDCE plume, and the plume has become less uniform. It is not anticipated that cDCE will exceed the MCL in the plume. The VC plume footprint has been stable. The concentrations and trends in the sentinel wells demonstrate that the OU-1 plume is not expanding and that attenuation rates in the plume have been sufficient to mitigate the potential for plume expansion.
Are the conditions sustainable?	No	It has been projected that the time frame for complete utilization of the deployed oil is 44 years. The total organic carbon concentrations measured during the field demonstration have been low, although other indicator parameters support the maintenance of reductive zones. Other competing electron acceptors, such as sulfate and dissolved oxygen, may have transient impacts on the structured geochemical zones.
Is the remediation time frame acceptable?	No	PCE and TCE—attainment of MCLs within the 13-year design time frame (2027). cDCE—it is not anticipated that cDCE will exceed the MCL within the plume. VC—a time frame to reach the MCL cannot be determined at this time.
Are the cost-benefits acceptable?	Yes	Previous estimates for remedies utilizing natural attenuation are similar or less than the cost for the current P&T remedy.

It was concluded from the evaluation of MNA (Table 2) that a few existing conditions could impact the structured geochemical zones in the future; affecting both the sustainability of the attenuation zones and the remediation timeframes of the VOCs, primarily VC. Therefore, during remedy evaluations in the Focused Feasibility Study (DOE 2022a) and Proposed Plan (DOE 2022b), the enhanced attenuation approach was identified as a preferred alternative over MNA to address VOC contaminated groundwater in OU-1/Parcel 9. Alternative GW—4, "Enhanced Attenuation with Monitoring and ICs," acknowledges the above potential future impacts to the geochemical zones by allowing injection of amendments or microbes as part of the remedial action, if it is deemed necessary.

Since the completion of the OU-1 Enhanced Attenuation Field Demonstration, data continue to be evaluated for the lines of evidence of enhanced attenuation as outlined in the Field Demonstration Work Plan (DOE 2014b). Data continue to support the lines of evidence listed here with the following:

- The concentrations of PCE and TCE continue to decrease. At the start of the field demonstration, there were 27 exceedances of MCLs. By the end of 2022, the number of MCL exceedances was reduced to one (December 2022).
- Geochemical data continue to support the presence of both reducing and oxidizing zones, consistent with the design of structured geochemical zones.
- The data indicate that a robust microbial community was created after deployment of the emulsified oil and these communities have been maintained.
- The makeup of the microbial species and enzymes in some wells have adapted to account for the decrease in PCE and TCE and the presence of cDCE and VC.
- The areal extent of the parent compounds PCE and TCE in groundwater remained stable (not expanding), and concentrations within the plume are low.
- cDCE was observed through the OU-1 groundwater plume but remained low (significantly less than the MCL).
- VC is measured within the treatment zones. Only one exceedance of the MCL was measured by the end of 2022.

2.4.2 Basis for Addition of a VI Remedy

As part of the sitewide VI assessment, the locations of soil with detectable concentrations of vapor-forming constituents listed in the EPA VISL calculator and initially identified as potential COCs were mapped to determine possible source areas for vapor forming chemicals (DOE 2019). Areas where the concentrations of vapor-forming constituents measured in groundwater and soil gas greater than VISL were also included to identify possible source areas. The results indicated detectable concentrations or concentrations greater than background in post-excavation soil samples in Parcel 9. The distributions of these contaminants, chlorinated volatile organic compounds (cVOCs); benzene, toluene, ethylbenzene, and xylene (BTEX); PAHs; and other miscellaneous VOCs within Parcel 9, are predominantly centered around the former OU-1 landfill, with some sporadic detections south of the former landfill area. The detections south of the landfill were measured in verification samples collected from shallow depths, typically 0–1 ft below ground surface (bgs). Samples collected from depths less than 3 ft were not considered as potential investigation areas in the VI assessment. The deeper occurrence of contaminants was in the former landfill area and occur at depths 15–20 ft bgs.

Results from an extensive field investigation concluded that there are no additional areas exhibiting significant levels of VOCs in soil outside the boundary of the former landfill area (DOE 2014a). However, due to the historical migration of impacted groundwater prior to implementing the OU-1 groundwater remedy, low levels of VOCs may be present in the till and outwash materials near the water table near and downgradient of the former landfill. These materials are comprised of 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 risk-based (commercial/industrial) levels when compared to target soil-gas concentrations established using the EPA VISL calculator. The VISL calculator allows for 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 (15 °C). The present and expected future onsite land use is commercial.

Additional data analysis from a soil-gas investigation was conducted at the Mound site during early 2020 and is 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 levels compared to target soil-gas concentrations established using the VISL calculator. Table 3 presents the target near-source soil-gas concentrations used for evaluation for each of these contaminants and the maximum concentrations measured in the soil gas within the OU-1 area.

Table 3. Summary of Contaminants Exceeding Risk-Based Levels in OU-1

Contaminant	Media	Vapor Intrusion Screening Levels		Maximum Concentration
		1×10^{-6} ELCR or 0.1 HQ	1×10^{-5} ELCR or 1.0 HQ	
Benzene	Soil gas (µg/m^3)	52	524	256
	Groundwater (µg/L)	11	107	ND (< 1)
Chloroform	Soil gas (µg/m^3)	18	178	27.3
	Groundwater (µg/L)	5.3	53	0.43 (J)
Tetrachloroethene	Soil gas (µg/m^3)	584	5,840	17,700
	Groundwater (µg/L)	41	408	6.0
Trichloroethene	Soil gas (µg/m^3)	29	292	62,400
	Groundwater (µg/L)	3.4	34	4.1
Vinyl chloride	Soil gas (µg/m^3)	93	929	163,000
	Groundwater (µg/L)	3.1	31	3.5
1,2-dichloroethane	Soil gas (µg/m^3)	16	157	55.9
	Groundwater (µg/L)	16	155	ND (< 1)

Notes:
Risk-based values were calculated using the EPA VISL calculator on June 29, 2021. Values represent target soil-gas concentrations and target groundwater concentrations.
Levels are risk-based concentrations developed as outlined in Section 2.4.2 and each is based on specific ELCR and noncancer HQs.
Groundwater values were determined using an attenuation factor of 0.001 as recommended in EPA VI guidance.
Soil-gas data were from a special sampling event performed in 2020.
Groundwater data are from routine samples collected in 2022.

Abbreviations:
J = estimated value less than the reporting limit
µg/L = micrograms per liter
µg/m^3 = micrograms per cubic meter
ND = not detected

It was determined that vapor-forming chemicals were present at sufficient levels in the vadose zone within the former OU-1 landfill area to warrant the evaluation of health risks and potential remedial alternatives. The results of a historical data evaluation and several investigations conducted in the former landfill area indicate the presence of vapor-forming chemicals, namely TCE and VC, at levels that could result in an unacceptable risk to future building occupants if a complete exposure pathway were present. The limited soil-gas dataset suggests that the majority of the vapor-forming chemicals are associated with residually contaminated soils remaining within the former OU-1 landfill. Because there is a limited dataset, the geographic area where the remedial action should be fulfilled will cover the approximately 18.5-acre area that was designated for additional VI sampling (DOE 2019). This provides a conservative approach to where remedial action would be required. It also considers a buffer around the OU-1 landfill area where it is known that concentrations of VOCs are present at levels that could result in an unacceptable exposure if a complete exposure pathway into a building were present.

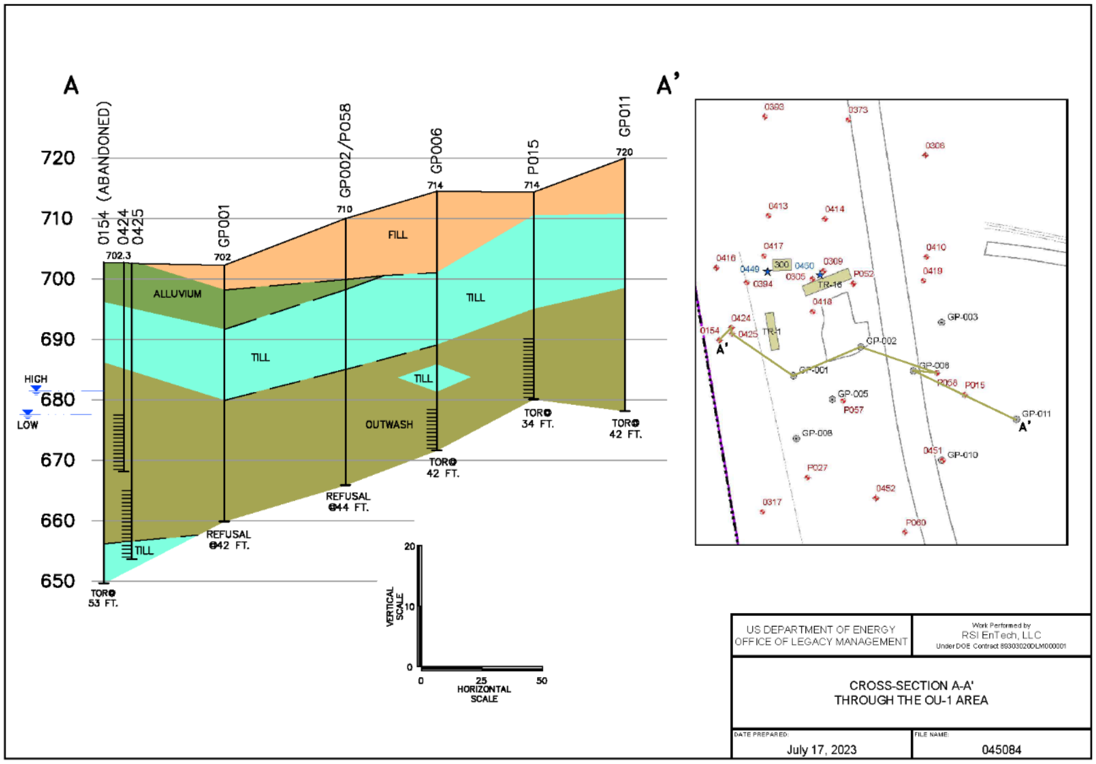
2.5 Site Characteristics

2.5.1 Geology and Hydrogeology

The geologic record preserved in the rocks underlying the site indicates that the area has been relatively stable since the beginning of the Paleozoic era more than 500 million years ago. There is no evidence indicating subsurface structural folding, significant stratigraphic thinning, or subsurface faulting in the underlying bedrock. The surficial geology of the Mound site consists of exposed bedrock and unconsolidated deposits (alluvium, glacial till, and glacial outwash). The limestone bedrock consists of the Ordovician Richmond Group and controls groundwater flow beneath the topographically higher eastern portions of the site. The Richmond Group is highly fossiliferous and is well known for its assemblage of rugose corals, well-preserved brachiopods, and broken parts of crinoids and bryozoans. No evidence of solution cavities or cavern development has been observed in any borings or outcrops in the Miamisburg area.

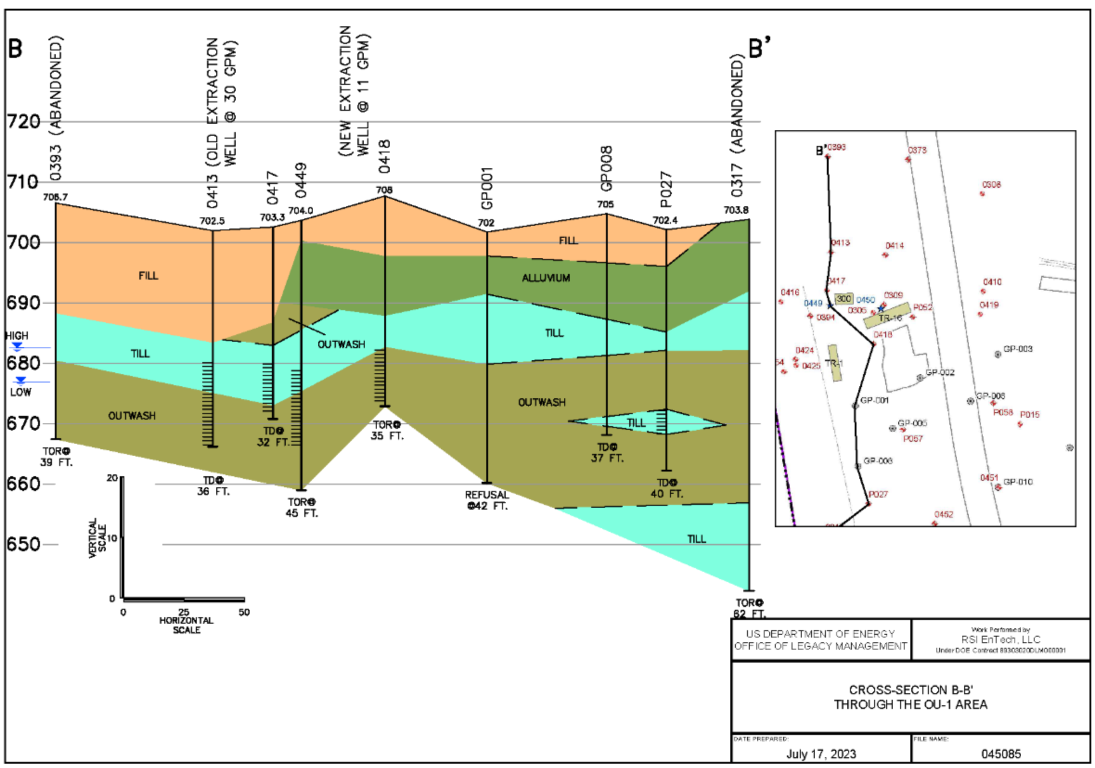
Unconsolidated materials in the OU-1 area consist primarily of glacial till and glacial outwash. Alluvial deposits associated with the Great Miami River are present. The till is composed of an unsorted, unstratified mixture of clay, silt, sand, and coarser materials. These materials typically have low permeability. The outwash is composed of well- to moderately well-sorted sand and gravel. In the OU-1 area, the outwash is interstratified with till. The outwash deposited in the site tributary valley and the Great Miami River valley form the BVA, which is suspected to be one of the primary contaminant migration pathways. The alluvium is mostly overbank deposits consisting of stratified fine sands, silts, and clays. Most of the fill material appears to be limestone rock fragments, sand, silt, and gravel moved from other portions of the Mound site.

Cross sections through the OU-1 area are provided in Figure 4 and Figure 5.



Abbreviation: TOR = top of rock

Figure 4. Cross Section A–A' Through the OU-1 Area



Abbreviations: GPM = gallons per minute, TD = total depth, TOR = top of rock

Figure 5. Cross Section B–B' Through the OU-1 Area

The aquifer system at the Mound site consists of two different hydrogeologic environments—groundwater flow through the bedrock beneath the hills and groundwater flowwithin the unconsolidated glacial deposits and alluvium associated with the BVA in the Great Miami River valley (Figure 6). The bedrock flow system is dominated by fracture flow and is not considered a highly productive aquifer. The surface of the bedrock is a pre-glacial erosional surface that is weathered and has secondary permeability. This permeable weathered zone varies in thickness but grades rapidly into essentially impermeable material. The percentage of groundwater contributed from the bedrock to the BVA is considered to be low due to the negligible bedrock permeability.

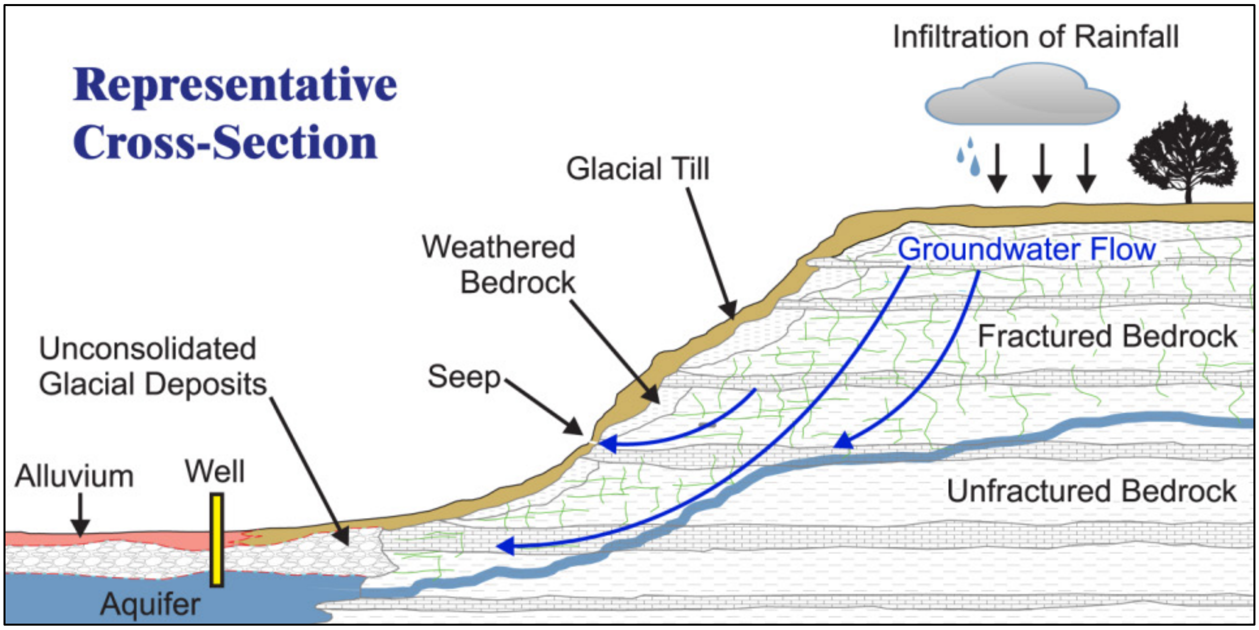


Figure 6. Generalized Cross Section of the Mound Site

The BVA is dominated by porous flow with interbedded gravel deposits providing the major pathway for water movement. The BVA is a highly productive aquifer capable of yielding a significant quantity of water and is designated a sole source aquifer. In the OU-1 area, the bedrock is overlain by Quaternary Age glacial outwash materials and glacial till, fluvial deposits (alluvium), and artificial fill. For the purpose of this conceptualization, outwash materials are water-deposited units or layers consisting of various mixtures of gravel, sand, silt, and clay. The glacial outwash is a continuous hydrostratigraphic unit of variable thickness, from a few feet to over 100 ft, throughout the OU-1 area. The glacial outwash material provides the most permeable pathway for groundwater flow. During various advances and retreats of the continental glaciers into what is now southwestern Ohio, unstratified sediment carried by meltwater was deposited at various depths within the BVA. These till deposits were differentially eroded by running water prior to the addition of other deposits of outwash and till. Sections of eroded till units are found at various depths in the BVA beneath the OU-1 area; however, these units lack complete areal coverage. Based on the lithology of the OU-1 area, the outwash aquifer is considered to be unconfined.

2.5.2 Groundwater Flow

A map of the average groundwater elevations measured in the OU-1/Parcel 9 area during 2022 (Figure 7) represents the two flow regimes present at the Mound site: bedrock and the unconsolidated materials of the BVA. The approximate location of contact of the BVA with the bedrock is indicated in this figure and occurs at an elevation of approximately 690 ft above mean sea level. Recharge from the bedrock to the outwash is low. The bedrock forms the eastern boundary of the BVA in the OU-1 area. The groundwater surface in the BVA is relatively flat when the extraction wells are not operating. The contoured groundwater elevations indicate that the flow beneath the landfill is to the southeast, parallel to the bedrock to the east.

To estimate a typical groundwater flow rate in the outwash aquifer across the OU-1 area, representative values for hydraulic conductivity of the outwash material (650 ft/day) and hydraulic gradient (0.00024 ft/ft) were used. A typical specific discharge (Darcian velocity or specific flux) of 0.156 ft/day or about 57 ft/year has been estimated for the OU-1 area (DOE 2014a).

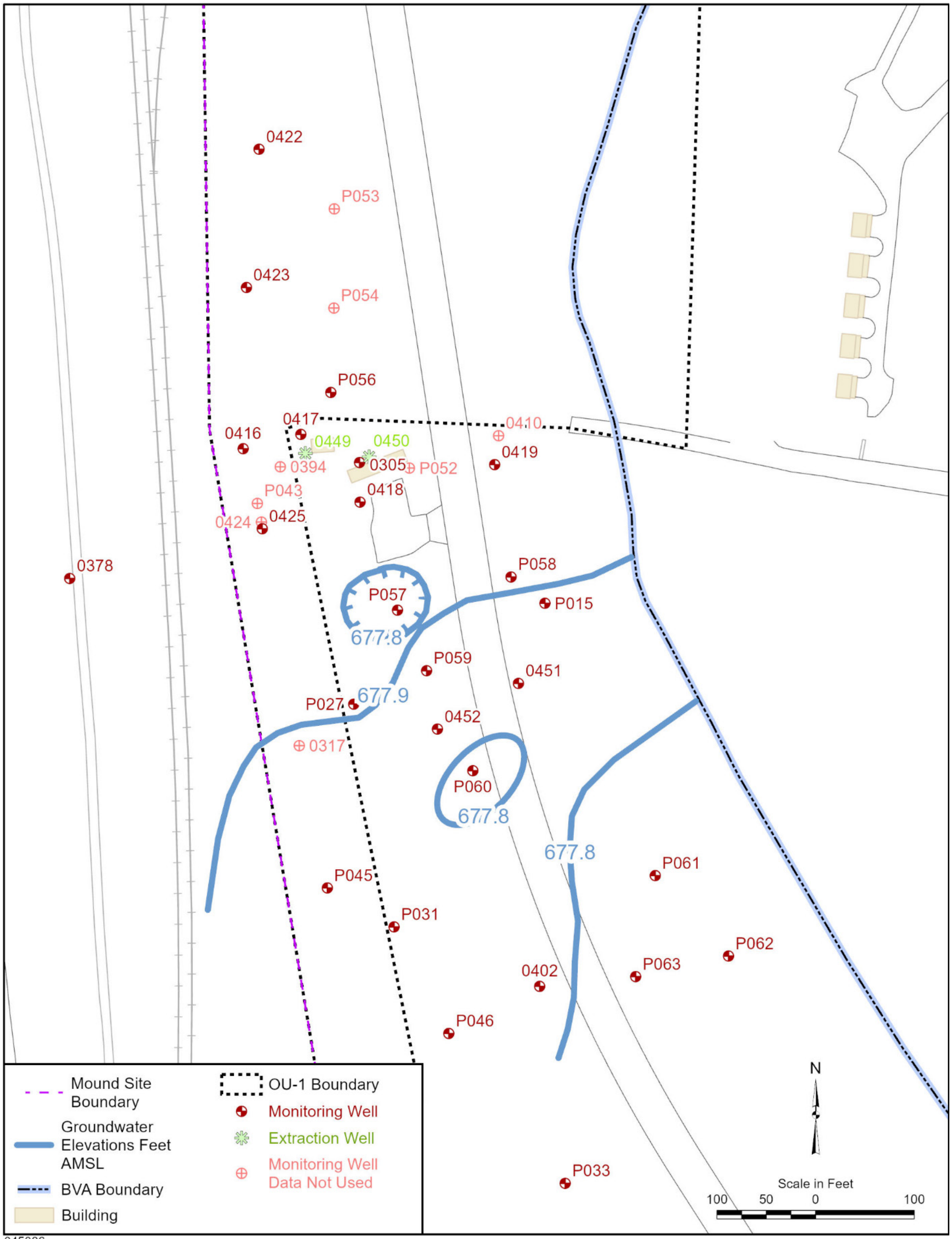
2.5.3 Nature and Extent of Contamination

The following sections discuss the current distribution of VOCs in groundwater in OU-1/Parcel 9. They also present the current understanding of the nature and extent of VOC contamination remaining in the footprint of the landfill excavation and the presence of vapor-forming chemicals.

2.5.3.1 Groundwater

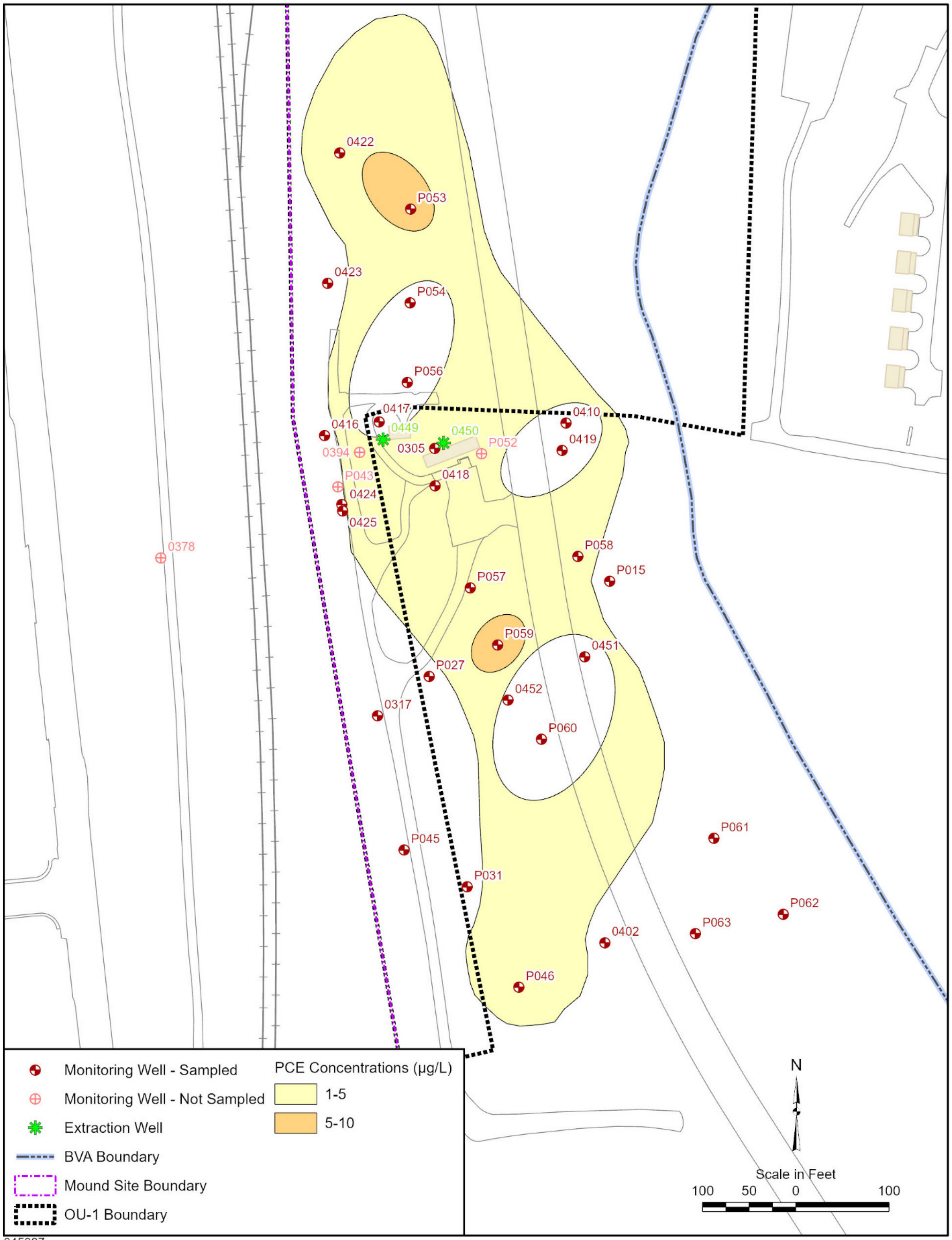
The results of the updated risk evaluation (DOE 2022a) identified four contaminants remaining in groundwater that could pose a risk to human health and the environment. The primary VOCs in groundwater are PCE, TCE, cDCE, and VC. Data collected from the wells during the third quarter (July and August) of 2022 were used to illustrate the distribution of VOCs in the groundwater. General observations are:

- The areal extent of the parent compound, PCE (Figure 8), in groundwater remained stable, and concentrations within the plume were low. Two discrete areas of elevated PCE concentrations continued to be present beneath the former landfill and the interior wells upgradient of the southern treatment zone.
- The areal extent of the parent compound, TCE (Figure 9), in groundwater remained stable, and concentrations within the plume were low. Elevated TCE concentrations continued to be present in the interior wells upgradient of the southern treatment zone.
- cDCE (Figure 10) was observed throughout the OU-1 groundwater with the highest concentrations occurring within the treatment zones.
- VC (Figure 11) was measured within the two treatment zones.



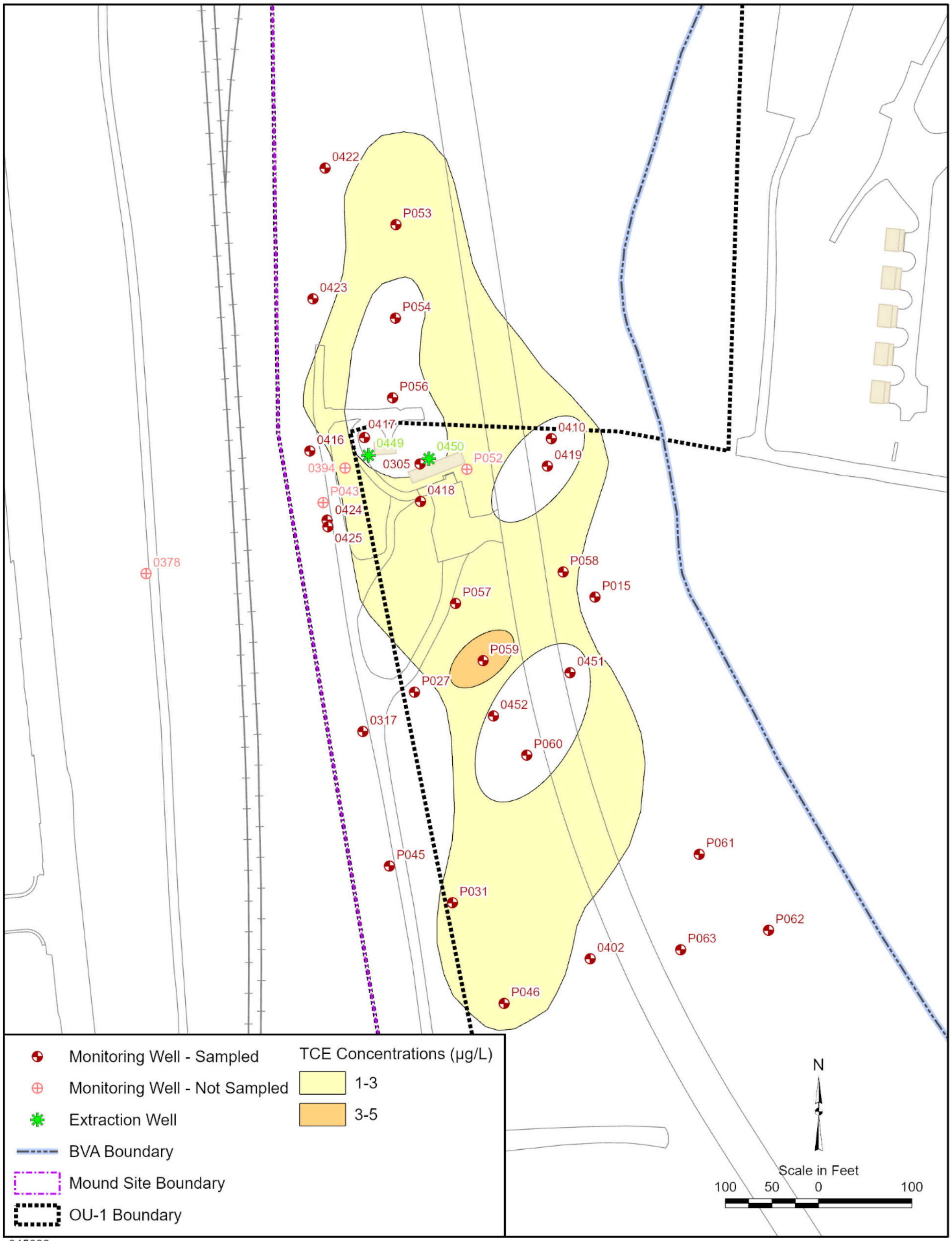
Abbreviation: AMSL = above mean sea level

Figure 7. Groundwater Elevations in OU-1, December 13, 2022



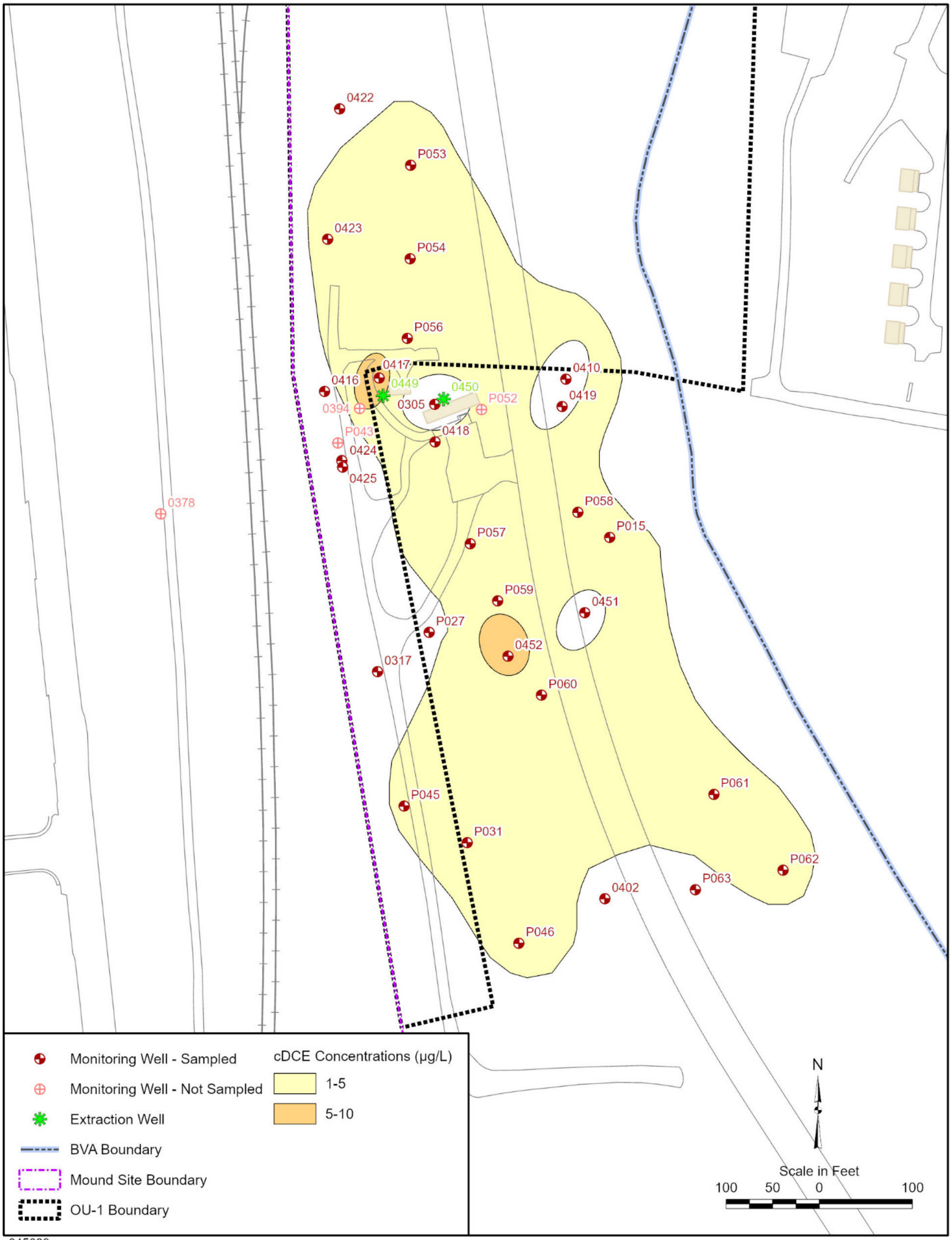
Abbreviation: µg/L = micrograms per liter

Figure 8. Distribution of PCE: Third Quarter (July/August) 2022



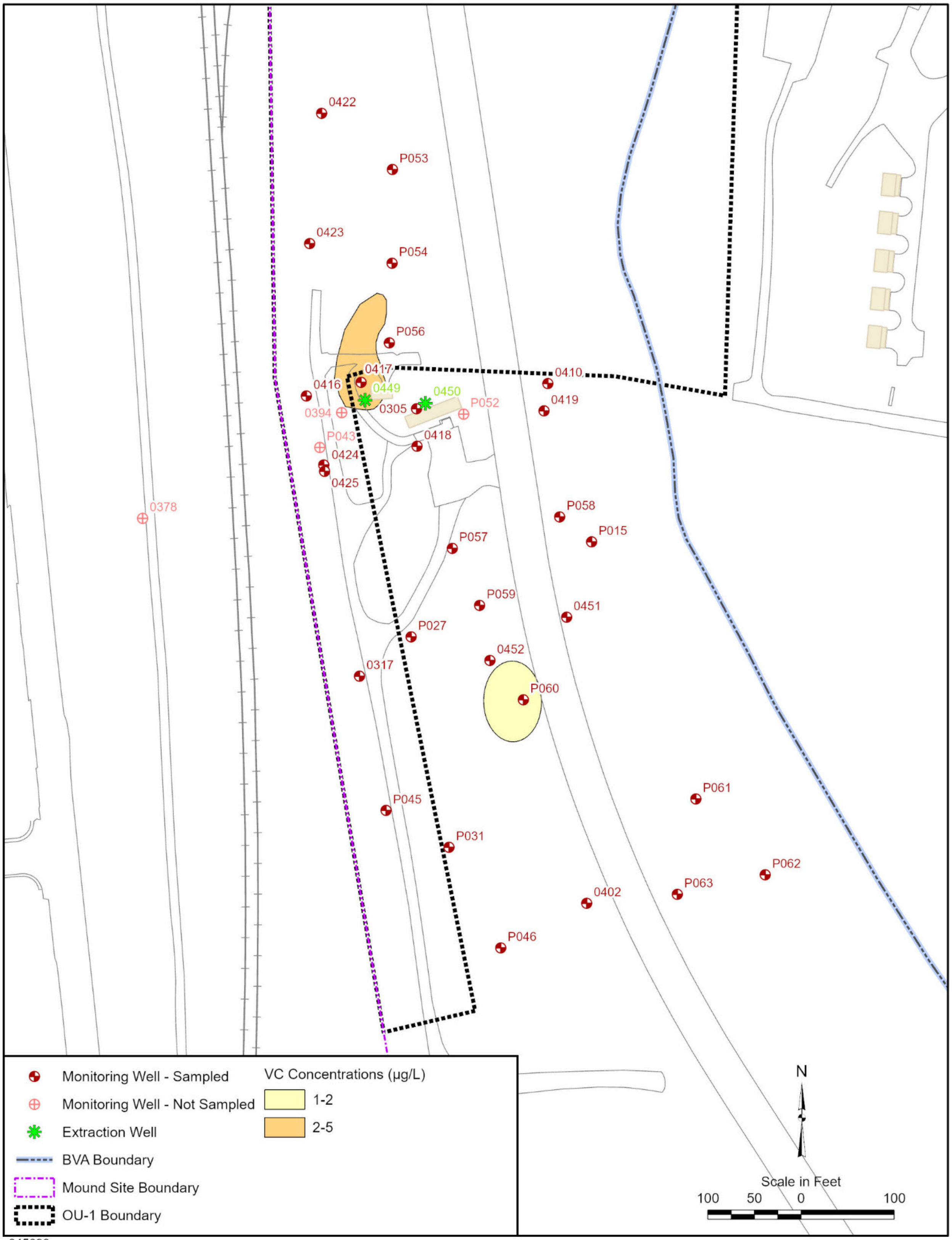
Abbreviation: µg/L = micrograms per liter

Figure 9. Distribution of TCE: Third Quarter (July/August) 2022



Abbreviation: µg/L = micrograms per liter

Figure 10. Distribution of cDCE: Third Quarter (July/August) 2022



Abbreviation: µg/L = micrograms per liter

Figure 11. Distribution of VC: Third Quarter (July/August) 2022

2.5.3.2 Vapor Intrusion

Review of the available soil-gas data from the OU-1/Parcel 9 area indicates that several areas within the OU-1 landfill footprint have concentrations of VOCs (primarily TCE and VC) that exceed risk-based values of 1×10^{-5} ELCR or 1.0 HQ for noncancer risk reference for vapors measured beneath a building (Table 3), and as recommended by Ohio EPA are concentrations that require additional evaluation (Ohio EPA 2020a). Vapors diffusing from sources in soil and groundwater can migrate upward or laterally through the vadose zone. The distribution of TCE in soil in the footprint of the excavation area is shown in Figure 12. For sources in soil, migration is influenced by source strength and soil characteristics (e.g., permeability and structure). Migration of vapors from sources in groundwater is influenced by groundwater flow direction and pathways, as well as properties of the overlying vadose zone materials.

Vertical diffusion of vapors from sources (soil and groundwater) to potential future buildings constructed in the OU-1 area may be limited by the compacted clean fill material placed within the landfill excavation and the heterogeneous, low permeability soil materials (till) that make up the unsaturated portions of the glacial outwash. These units consist of silts and clays intermixed with sand. At greater depths in the glacial outwash, silts and clays are intermixed with sand and gravel; however, this predominantly occurs within the saturated portions of the outwash.

The depth of the contaminants of interest, as well as the overlying soil materials may limit the vertical migration of diffused vapors, resulting in an incomplete pathway. Also, many contaminants can be sorbed onto low permeability clay and organic materials, reducing the likelihood of vertical migration.

Figure 13 is a cross section through the former landfill area and depicts the material types in the vadose zone and depth to groundwater in the area. Known areas with elevated soil-gas results and utility locations are indicated in the figure.

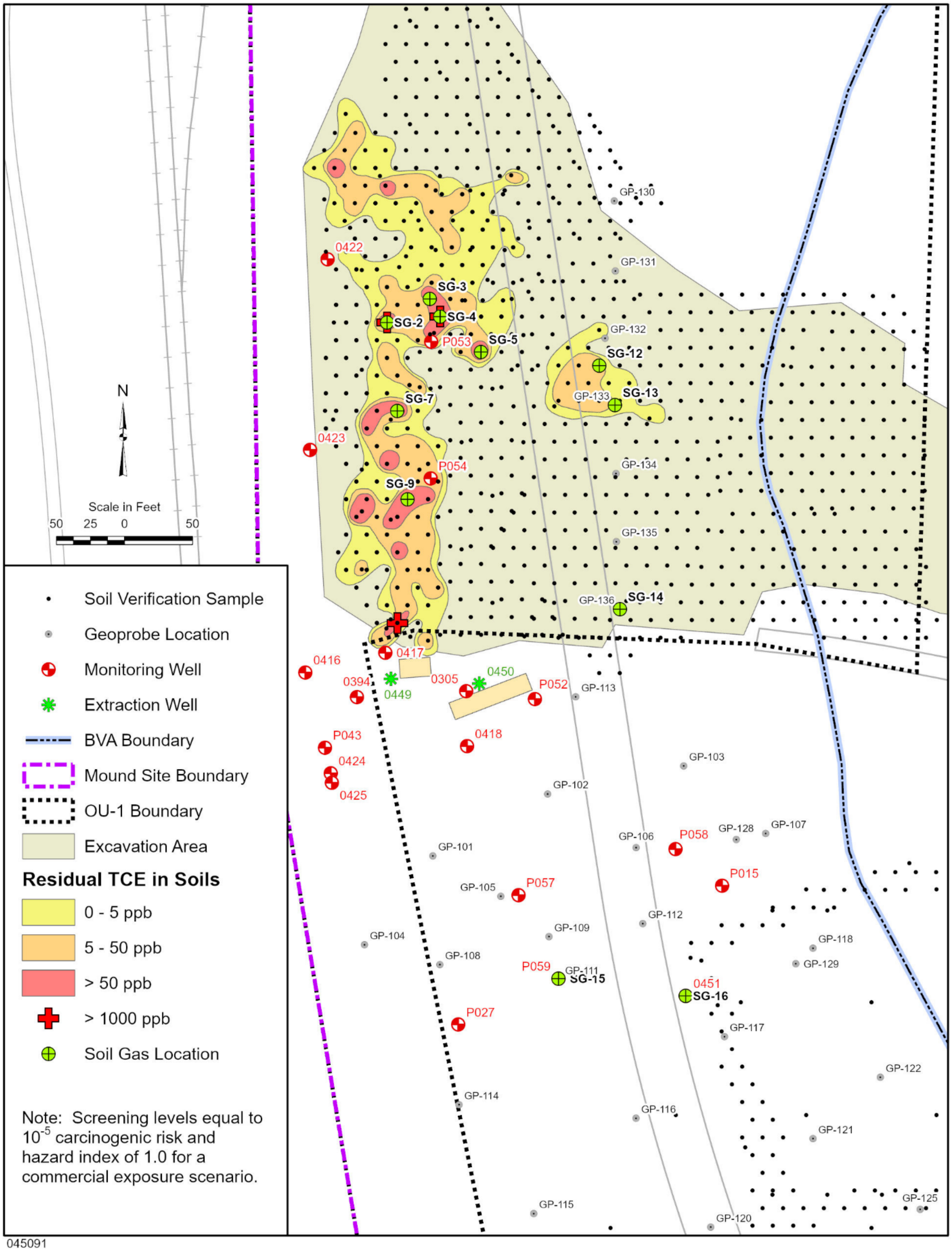
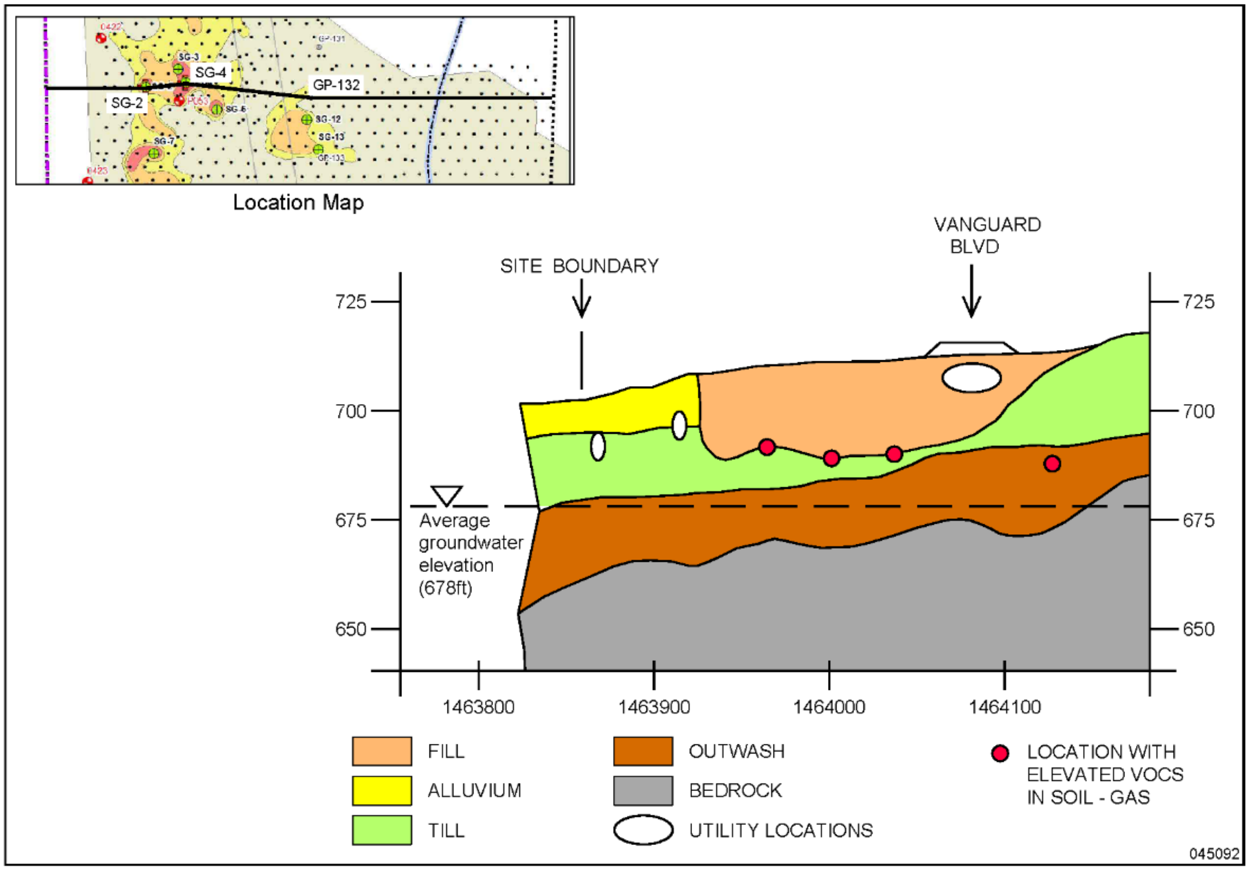


Figure 12. Occurrence of TCE in Soil and Soil Gas in the OU-1 Landfill Area



Abbreviation: BLVD = boulevard

Figure 13. Generalized Cross Section Through OU-1 Landfill

2.6 Current and Potential Future Land and Groundwater Uses

ICs currently restrict the land use of the Mound site to commercial or industrial use only. These ICs are described as restrictions and covenants in the quitclaim deeds or as activity and use limitations in the *Environmental Covenant* (DOE 2011b). ICs will run with the land through subsequent property transfers. Quitclaim deeds with environmental summaries, CERCLA 120(h) summary notices of hazardous substances, and environmental covenants are recorded with the Montgomery County, Ohio, Recorder's Office to ensure that future property owners are aware of the requirements and rationale behind each IC and quitclaim deed restriction.

The remedy for Parcel 9/OU-1 includes the following ICs as documented in the *Environmental Covenant* (DOE 2011b):

- Maintenance of industrial or commercial land use and prohibition against residential land use
- Prohibition against the use of groundwater without prior written approval from EPA and Ohio EPA

- Prohibition against the removal of soil from within the original Mound site boundary to offsite locations without prior written approval from EPA, Ohio EPA, and the Ohio Department of Health
- Allowing site access for federal and state agencies for the purpose of sampling and monitoring

An additional IC to address the VI pathway will be documented in an Environmental Covenant. This IC shall require future property owners to either mitigate potential VI by designing engineering controls (i.e., vapor mitigation systems) into new building design or providing sufficient information and evidence to document that a mitigation system is not required. This IC is defined in Section 2.12.2 and details regarding the remedial objectives and implementation of this IC are presented in Section 2.8.2 and Section 2.9.2.3.

State and local governments can limit the use of property through planning and zoning maps, subdivision plats, building permits, siting restrictions, and use restrictions. The City of Miamisburg codified the requirement of industrial- and commercial-use-only and other restrictions in the Mound Business Park special zoning district, MB-1, that limits types of businesses allowed. MB-1 section 1271.10 lists the ICs, and it states that IC compliance enforcement remains the responsibility of DOE. City Ordinance 5733 dated September 3, 2003, adopted the Mound Development Corporation's (MDC) *Comprehensive Reuse Plan Update* (MMCIC 2003) as the city's guide for review and approval of development of the Mound site.

LM has identified and implemented an additional, unrecorded layer of protectiveness at the Mound site by joining the Ohio 811 "call before you dig" program. Joining the 811 programs has allowed LM to raise awareness more effectively with the City and utility companies, as well as to alert site management of the potential for violation of ICs if the identified activities occurred as proposed. This means that in the absence of a conventional IC, DOE membership in a state-regulated entity that requires all contractors to obtain utility clearances before performing intrusive work acts as a de facto IC.

State programs or local ordinances are not often considered durable (i.e., lasting in perpetuity) by the governing state or federal agencies and, therefore, are regarded as nonrecorded ICs. Thus, while they provide benefit through maintaining protectiveness and reducing the chances of an IC violation, they cannot be used to regulatorily close a site.

2.6.1 Current Onsite Land Use

MDC has accepted ownership responsibility for approximately 92% of the site that is now known as the Mound Business Park. MDC actively markets buildings and unoccupied land for reuse and has replatted the site into multiple lots. As detailed in the *Comprehensive Reuse Plan Update* (MMCIC 2003), the conceptual lot layout is intended to make the best possible use of the site's natural and physical characteristics, provide lot sizes and arrangements that optimize the buildable area on each lot, minimize common areas that require maintenance, and protect and link open green space. The open green space encompasses those areas that are least suitable for building, due to steep slopes.

DOE plans to transfer ownership of remaining areas within Parcel 9 (of which OU-1 is a portion) after the approval of this ROD Amendment to MDC pursuant to 10 CFR 770, "Transfer of Real

Property at Defense Nuclear Facilities for Economic Development." DOE has jurisdictional responsibility for the entire Mound site and LM will continue to ensure that the selected remedies remain functional and effective so that conditions at the site remain protective of human health and the environment. This jurisdictional responsibility includes not only properties still owned by DOE but all areas within the original Mound site boundary.

2.6.2 Future Onsite Land Use

There are no restrictions on future sales of property, although there are ICs that restrict land use to commercial or industrial at the Mound site, as discussed above. Although currently there is no onsite use of groundwater and onsite use is unlikely in the foreseeable future, the evaluation of risk was done to ensure the opportunity for beneficial reuse of the onsite aquifer, as well as protectiveness of human health if contaminants were to move offsite where there are no groundwater use restrictions or if restrictions were removed in the future that could result in the use of groundwater.

2.6.3 Offsite Land Use

The area surrounding the site is a mix of residential areas, parks, recreational areas, businesses, and light industry. The current zoning for areas that surround the Mound site are a mix of land uses. There are residential properties adjacent to the site along the northeast boundary and the southeastern boundary. Many of the remaining properties that are adjacent to the site are zoned as residential but are not used as residential. These areas include the Mound Golf Course and Miamisburg Mound Park, both east of the Mound site on Mound Road, and the Miamisburg Community Park along the western boundary of the site. Agricultural and light industrial parcels are along Benner Road to the south and southeast of the Mound site.

2.7 Summary of Risks

As part of the remedial investigation and feasibility study process for OU-1, an initial baseline risk assessment was completed in 1994 (DOE 1994) and then two subsequent residual risk evaluations (RREs) were completed in 2011 and 2022 to determine the effects of remaining residual contaminants in soil, groundwater, and subsurface vapors on human health. A set of COCs were established for both soil and groundwater in the 1995 OU-1 ROD (DOE 1995). The reasonable and anticipated future land use for OU-1/Parcel 9 is commercial and industrial based on several ICs in place for the Mound site. One IC specifically restricts land use to industrial and commercial use for the entire Mound site. The potential future onsite use of groundwater is prohibited by another IC in place for the Mound site. There is no restriction on groundwater use outside the Mound site boundary because it is not anticipated that the groundwater plume will migrate offsite.

The subsequent RREs assessed human health risks associated with residual levels of contamination remaining within the OU-1/Parcel 9 after completion of soil excavation of the former landfill and completion of the OU-1 Enhanced Attenuation Field Demonstration to ensure that current and future land users will not be exposed to contaminant levels that would pose unacceptable risks from the COCs listed in the 1995 OU-1 ROD (DOE 1995). This included assessing residual contamination remaining in soil, groundwater, and subsurface vapors.

After completion of the landfill excavation in 2010, the *Miamisburg Closure Project Parcel 9 Residual Risk Evaluation, Mound Plant, Miamisburg, OH* (DOE 2011c), hereafter referred to as the Parcel 9 RRE was prepared to document the risks from exposures to residual contamination remaining in soil in Parcel 9. The scope of the Parcel 9 RRE was to evaluate risk associated with two exposure scenarios selected to represent reasonable maximum exposures in a commercial and industrial setting. The two scenarios are:

1. Construction workers who may be directly exposed to surface (0–2 ft bgs) and subsurface (all depths below 2 ft bgs) soil over a period of 5 years.
2. Site workers, such as office workers, who may be exposed to surface soil (0–2 ft bgs) over a period of 25 years.

It was documented that the risks from exposure to residual contamination in the remaining soil using the site worker and site construction worker scenarios were acceptable. It should be noted that the Parcel 9 RRE did take into consideration inhalation of fugitive dust and vapors emitted from soils excavated during construction work, and the risk levels were determined to be acceptable (DOE 2011c).

The most recent risk evaluation included in the *Operable Unit 1/Parcel 9 Focused Feasibility Study, Mound, Ohio, Site* (DOE 2022a) assessed the potential risks from exposure to residual contaminants remaining in groundwater and subsurface vapors. Although onsite use of groundwater is currently restricted and unlikely to be used in the foreseeable future, the evaluation of risk was necessary to ensure the opportunity for beneficial reuse of the onsite aquifer, as well as protectiveness of human health if contaminants were to move offsite where there are no groundwater use restrictions or if restrictions were removed in the future that could result in the use of groundwater. The risk to future building occupants from potential future exposure to vapors found in the vadose zone if a complete exposure pathway into a building was present was also evaluated. It is DOE's current judgement that the selected remedy identified in this ROD Amendment to address residual contamination in groundwater and subsurface vapors is necessary to protect human health or welfare or the environment from actual or threatened releases of hazardous substances into the environment.

A pictorial representation (Figure 14) of the conceptual site model (CSM) for Parcel 9 depicts exposure pathways identified for potential receptors included in the Parcel 9 RRE. The CSM summarizes the pathways that residual contaminants may take to reach potential receptors. Receptors are groups of people, such as industrial workers, construction workers, site visitors, or residents, that may have the opportunity to have contact with contaminants. A complete exposure pathway is one in which the chemical can be traced or expected to travel from the source to a receptor that can be affected by that chemical. An exposure route is the way a chemical enters the receptor upon contact and can include breathing in vapors, drinking contaminated groundwater, or skin contact. Exposure assumptions used to evaluate potential exposure pathways were taken from *Risk-Based Guideline Values, Mound Plant, Miamisburg, Ohio* (DOE 1997b) and *Mound 2000 Residual Risk Evaluation Methodology, Mound Plant* (DOE 1997a). Onsite use of groundwater is prohibited, and consumption of groundwater is considered unlikely. As indicated in the CSM, there is a potential for contact with contaminated groundwater through construction activities in deeper excavations; this contact was considered insignificant and was not further considered. The VI pathway to future building occupants was not included in the RRE methodology. The Parcel 9 RRE considered the exposure of site or construction workers to vapors emitted from contaminated soil but did not consider the exposure from vapors emitted from contaminated groundwater. The exposure of site and construction workers to vapors emitted from contaminated soil can be considered complete and the risk levels were determined to be acceptable (DOE 2011c). The exposure of site and construction workers to vapors emitted from contaminated groundwater is considered incomplete because groundwater is typically greater than 25 ft bgs (DOE 2022a).

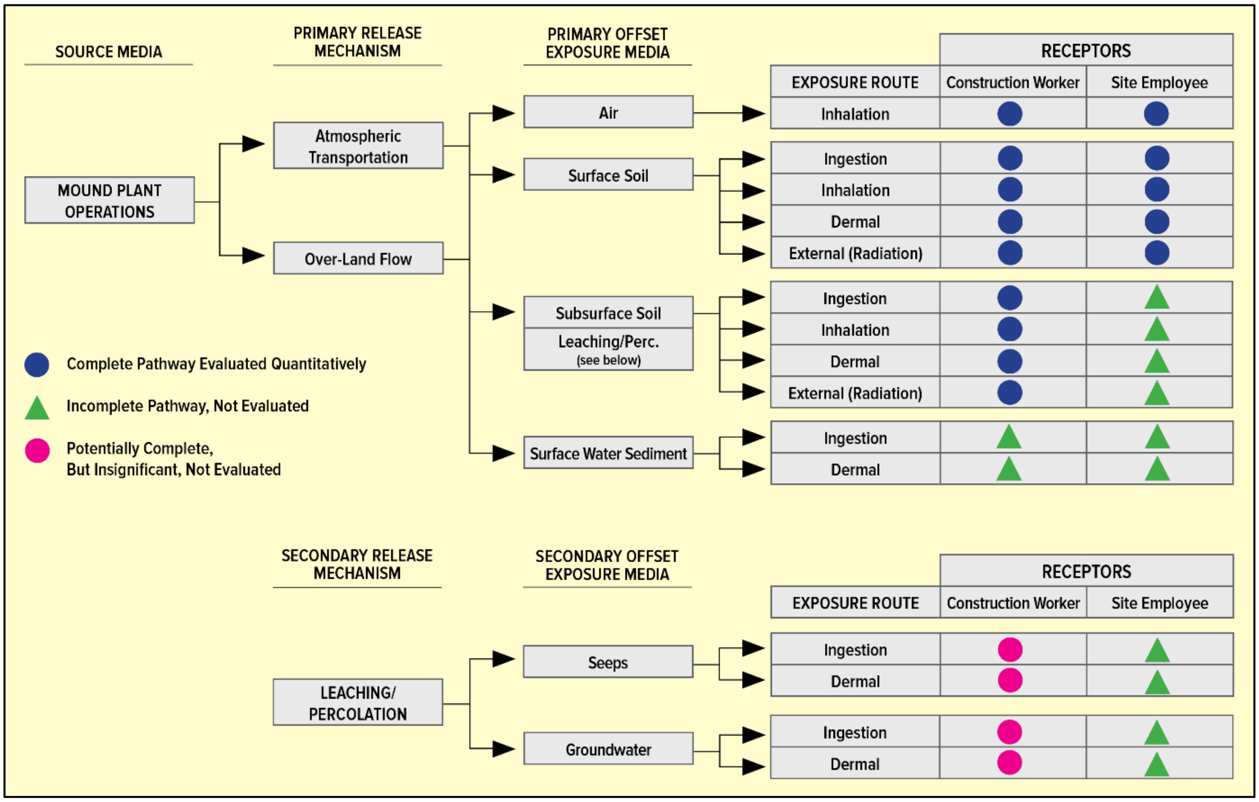


Figure 14. Conceptual Site Model for OU-1/Parcel 9

Cancer risks are expressed as the probability that a receptor will develop cancer over a lifetime of exposure to individual chemicals or multiple chemicals (e.g., 1 in 1,000,000). Cancer risks are expressed in terms of ELCR and are computed for individual contaminants and for all contaminants combined. EPA has established a target risk range of 1×10^{-4} to 1×10^{-6} (corresponding to an ELCR of 1 in 10,000 to 1 in 1,000,000), and Ohio EPA has adopted a cumulative ELCR goal of 1×10^{-5} (corresponding to an ELCR of 1 in 100,000) for all receptors and land uses (Ohio EPA 2009). The Ohio EPA ELCR goal is intended to be used as the level of acceptable excess cancer risk, while recognizing the need to retain flexibility during evaluation of future actions.

Noncarcinogenic risk is a measure of the likelihood that a receptor may develop noncancer health effects (e.g., kidney disease) due to long-term exposure to a given chemical or groups of chemicals. For noncarcinogenic effects, EPA and Ohio EPA have set the target Hazard Index (HI) of 1.0 (Ohio EPA 2009). If the HI is greater than 1.0, there is the potential for adverse health effects at site-specific exposure concentrations. In cases where the HQ for individual substances is less than 1.0 but multiple HQs sum to greater than 1, EPA recommends segregating the compounds into groups with like or common toxicological effects and reevaluating the potential for various adverse health effects.

2.7.1 Soil

The total, background, and incremental risks from exposures to residual contamination remaining in soil were calculated in the Parcel 9 RRE for current exposure scenarios for a construction worker and site worker working within the Parcel 9 boundary. The Parcel 9 RRE was prepared in 2011 after completion of the landfill excavation and was not reevaluated as part of risk evaluation included in the Focused Feasibility Study (DOE 2022a). The total, background, and incremental risks from exposures to residual contamination remaining in soil were calculated for both the construction worker and site worker scenarios. A summary of the risks are as follows:

- The reasonable carcinogenic risk to a construction worker from the contaminants of potential concern (COPCs) in soil is 1.3×10^{-5}. This risk falls within the EPA target carcinogenic risk range of 1×10^{-4} to 1×10^{-6}, but greater than the Ohio EPA target of 1×10^{-5}. The majority of the carcinogenic risk comes from radionuclides.
- The reasonable noncarcinogenic risk to a construction worker from the COPCs is 0.49, which is less than the HI goal of 1.0, indicating that there is less likelihood for noncancer health effects.
- The reasonable carcinogenic risk to a site worker from the COPCs in soil is 1.6×10^{-5}. This risk falls within the EPA target carcinogenic risk range of 1×10^{-4} to 1×10^{-6}, but greater than the Ohio EPA target of 1×10^{-5}. The majority of the carcinogenic risk comes from radionuclides.
- The reasonable noncarcinogenic risk to a site worker from the COPCs is 0.04, which is less than the HI goal of 1.0, indicating that there is less likelihood for noncancer health effects.

These risks have been compared to an acceptable risk range of 1×10^{-4} to 1×10^{-6} for carcinogenic risk (corresponding to an ELCR of 1 in 10,000 to 1 in 1,000,000) outlined in the NCP, as well as Ohio EPA's target risk of 1×10^{-5} (Ohio EPA 2009). Noncarcinogenic hazards were also compared to the EPA and Ohio EPA target hazard goal of 1.0 (Ohio EPA 2009). Total risk for both the construction worker and site worker scenarios slightly exceeds the Ohio EPA target risk goal, supporting the use and enforcement of the ICs as part of the final remedy.

2.7.2 Groundwater

The current remedy for OU-1 groundwater is the collection and treatment of contaminated groundwater and disposal of treated water until remediation goals are met (DOE 1995). The function of the remedial action is to protect human health by preventing ingestion of contaminated groundwater by controlling groundwater contamination and preventing migration of contamination toward the Mound Plant production wells (which were removed in 2005) or offsite, thereby minimizing exposure to potential receptors by other future wells. The remedial action also protects the environment by reducing or controlling contaminants until remediation goals are met. The objective of the proposed remedy would remain the same—to reduce (to remedial 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 (PRGs) from moving outside the boundary of

Parcel 9. The proposed 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 updated risk evaluation for groundwater assessed the potential risks from exposure to residual contaminants remaining in groundwater. Although onsite use of groundwater is currently unlikely and unlikely in the foreseeable future, the evaluation of risk is necessary to ensure protectiveness of human health if contaminants were to move offsite or if restrictions were removed in the future that could result in the use of groundwater. As previously discussed, VOC contamination in groundwater was addressed by the continued operation of the OU-1 P&T system to maintain hydraulic capture of contaminated groundwater until such time as cleanup levels are achieved. The P&T was placed in standby in 2014 with approval of the regulators initially to support the OU-1 Enhanced Attenuation Field Demonstration and then to support the proposal to modify the treatment approach to enhanced attenuation. Since implementation of the P&T remedy, the following actions have been performed that have had a direct impact on the concentrations of VOCs in groundwater:

- Excavation of the wastes and contaminated soil from the former landfill (i.e., source removal)
- Operation of an SVE system from 1996 until 2003 that reduced the mass of VOCs in the vadose zone in the former landfill area
- Completion of a 4-year field demonstration to evaluate the remediation of residual VOC contamination in groundwater using enhanced attenuation methods that resulted in a reduction in the mass and concentrations of VOCs in groundwater

The updated risk evaluation identified PCE, TCE, cDCE, and VC as COPCs. PCE and cDCE were carried forward into the risk evaluation, even though the maximum concentrations of PCE and cDCE are well below those that would be considered an unacceptable risk (i.e., 1×10^{-6} ELCR or HI of 1.0). This is being done because (1) PCE is a parent compound that is being addressed as part of the remedy reevaluation, and (2) cDCE is the primary daughter product generated as part of the reductive dechlorination of PCE and TCE. The total, background, and incremental risks from exposures to residual contamination remaining in groundwater are calculated in the Focused Feasibility Study (DOE 2022a) for a hypothetical resident using groundwater. A summary of the risks are as follows:

- The reasonable carcinogenic risk from PCE, TCE, cDCE, and VC is 6.3×10^{-5}. This risk falls within the EPA target carcinogenic risk range of 1×10^{-4} to 1×10^{-6}, but greater than the Ohio EPA target of 1×10^{-5}. The majority of the carcinogenic risk comes from VC.
- The reasonable noncarcinogenic risk from the PCE, TCE, cDCE, and VC is 0.56, which is less than the HI goal of 1.0, indicating that there is less likelihood for noncancer health effects. The majority of the noncarcinogenic risk comes from TCE.

Risk from exposure to groundwater under the site worker and construction worker scenarios were not evaluated. Groundwater in the OU-1 area occurs at depths greater than 25 ft bgs limiting the likelihood for contact during most construction activities. There is a potential for contact with contaminated groundwater through construction activities in deeper excavations; however, this contact, if it were to occur, was considered insignificant and was not further considered. Site workers would not have contact with groundwater.

2.7.3 Vapor Intrusion

Currently, there are no permanent buildings in Parcel 9; therefore, there is no risk from VI. However, the area is zoned as industrial and commercial, and construction and occupancy of buildings is likely in the near future.

Review of the available soil-gas data from the OU-1/Parcel 9 area indicates that concentrations of VOCs are present in the subsurface which could result in an unacceptable risk to future building occupants if a complete exposure pathway into a building was present. Soil-gas vapor data (Table 3) were compared to risk-based values generated using the EPA VISL calculator for vapors measured beneath a building. It was determined that some locations exceed the suggested target concentrations for 1×10^{-6} ELCR and 0.1 HQ for noncancer risk calculated using an industrial and commercial risk-based scenario (EPA 2015). Several areas within the OU-1 landfill footprint have concentrations of VOCs (primarily TCE and VC) that also exceed risk-based values that equate to 1×10^{-5} ELCR or 1.0 HQ for noncancer risk reference and as recommended by Ohio EPA are concentrations that require additional evaluation (Ohio EPA 2020a).

The risk from exposure of construction workers to vapors coming from VOC-contaminated soil was determined to be insignificant and was not further considered. The elevated VOC measurements were obtained from locations that targeted known areas of deeper soil contamination at the bottom of the excavation footprint of the former landfill and occur at depths ranging between 20 and 30 ft bgs. There is potential for contact with vapors during construction activities in deeper excavations; however, if this contact were to occur, it would be of a limited duration.

The risks from exposure of site workers or construction workers to vapors coming from VOC-contaminated groundwater were evaluated. Groundwater in the OU-1 area occurs at depths greater than 25 ft bgs, which limits the likelihood for direct contact. The exposure pathway to groundwater is incomplete for the site worker; there is no contact with groundwater. There is a potential for contact with contaminated groundwater through construction activities in deeper excavations; however, this direct contact, if it were to occur, was considered insignificant and was not further considered.

2.8 Remedial Action Objectives and Remediation Goals

RAOs are site-specific statements that convey the goals for minimizing or eliminating risk to the public or environment. The following subsections discuss the RAOs and remediation goals for groundwater and VI that were identified for Parcel 9 based on the summary of risks for current and future exposure scenarios. Typically, remediation goals are selected using either risk-based, conservative screening values used to provide risk reduction targets or regulatory established value 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 situation sufficiently similar to those at a site and that their use is well suited to the site. 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.

2.8.1 Groundwater

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. The selected remedy is intended to reduce contaminant concentrations and maintain control of plume expansion until remediation goals are reached. Figure 15 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.

The selected remedy will reduce ELCR associated with potential exposure to contaminated groundwater to a risk range of 1×10^{-4} to 1×10^{-6}. This will be achieved by reducing the concentration of the groundwater contaminants to the remediation goals provided in Table 4.

Table 4. Remediation Goals for Groundwater in OU-1

COCs (µg/L)	Risk-Based Comparison Value[a]	Regulatory Limits	Maximum Concentration[b]	Remediation Goal	Lifetime Risk at Proposed PRG
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 1×10^{-6} ELCR or an HI of 1.0 and were estimated using the EPA Regional Screening Level calculator.
[b] Maximum concentrations were obtained from 2019–2021 groundwater data.

Abbreviation:
µg/L = micrograms per liter

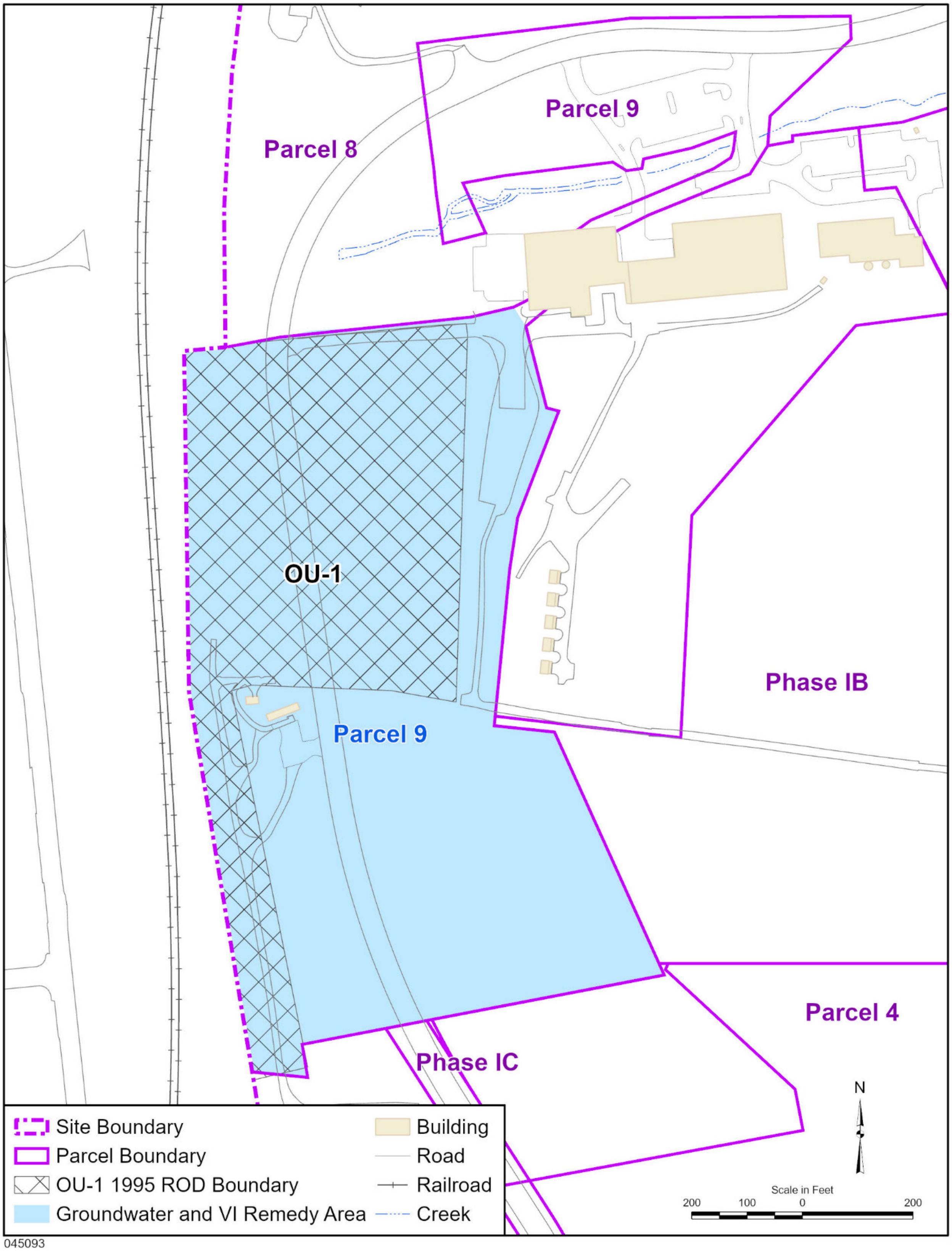


Figure 15. OU-1 Groundwater and VI Remedy Area

2.8.2 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/Parcel 9 by addressing the VI pathway. There currently are no permanent buildings within the area of interest in OU-1/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 with concentrations that exceed risk-based target levels greater than 1×10^{-6} total ELCR or 0.1 total HQ concentrations for vapors measured beneath a building.

The RAO is to address the potential for VI risk within OU-1/Parcel 9 in newly constructed buildings. The primary receptors to vapors sources in the future are occupants of buildings that may be constructed within the boundaries of OU-1/Parcel 9. Since 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 into structures either through diffusion from sources or preferential migration through existing or future utility conduits. The remediation goal 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 1×10^{-5} and HQ of 1.0 for industrial and commercial land use.
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 into a building.

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

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)

Table 5 outlines risk-based concentration limits that should be used to confirm the effectiveness of preemptive measures (engineering controls). These values could change in the future based on updated information and should be reevaluated when a building is considered for construction on Parcel 9. Figure 15 depicts the geographic area (shaded blue) within Parcel 9 where this remedy would apply. This area includes the southern portion of Parcel 9 and does not include the remainder of Parcel 9 because that portion is being evaluated under the ongoing sitewide VI assessment. If it is determined based on data collected during the ongoing assessment that VI should be addressed, a decision for that area of the site will be presented in a future decision document.

Table 5. Indoor Air Limits for VI in Parcel 9

COCs	Indoor Air Goal (µg/m³)	Contaminant	Indoor Air Goal (µg/m³)
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 1×10^{-5} and 1.0, respectively.
Calculated using the EPA VISL calculator on June 30, 2021.

Abbreviation: µg/m³ = micrograms per cubic meter

As an alternative, a future property owner can provide information and evidence that supports there is no 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 what contaminants are present beneath the property and determine whether the contaminants can be considered safe by comparison to risk-based values of 1×10^{-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.

2.9 Description of Alternatives

Remedial alternatives were developed to address residual VOC contamination remaining in OU-1/Parcel 9. DOE proposes to amend the 1995 OU-1 ROD (DOE 1995) to modify the remedy addressing VOCs in groundwater in OU-1 and to identify a remedial action to mitigate potential VI exposure to future building occupants. The following sections discuss the remedial alternatives that were evaluated as part of the Focused Feasibility Study (DOE 2022a).

Each alternative is intended to represent a valid conceptual approach to remedial action rather than a specific design. The following sections present a detailed discussion of each alternative and an estimate of cost and time frame. Costs were prepared as recommended in *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study* (EPA 2000). Costs provided are present worth costs and were calculated by determining capital costs, annual O&M costs, periodic costs, and closeout costs. Capital costs are applied in Year 0, and closeout costs are applied in the final year of the remedy. O&M costs are applied starting in Year 1 and are discounted annually until the final year of the remedy. Any periodic costs are applied to specified years. An annual discount rate of 7% was used to convert the O&M and periodic costs to present worth costs as required by federal guidelines (Executive Office of the President 2018). Costs for professional services, design, IC maintenance, and reporting are not included in the estimates as they are costs that apply to the entire Mound site. Cost is not discussed for the VI alternatives as there are no capital or closeout costs to DOE associated with any of these alternatives. It is anticipated that any design, construction, monitoring, and maintenance costs will be the responsibility of future building owners.

2.9.1 Groundwater Alternatives

DOE evaluated four alternatives in the Proposed Plan in order to arrive at the selected amended remedy for OU-1/Parcel 9. CERCLA guidance generally requires that the “no action” alternative be evaluated to establish a baseline for comparing the action alternatives. The remedial alternatives that were evaluated to fulfill the RAOs of (1) reducing the contaminant concentrations (to MCLs) throughout the VOC plume in OU-1/Parcel 9 and (2) prohibiting groundwater with contaminant concentrations greater than MCLs from moving outside the Parcel 9 boundary are as follows:

- Alternative GW—1: No further action with ICs
- Alternative GW—2: Pump and treatment with monitoring and ICs
- Alternative GW—3: Monitored natural attenuation with ICs
- Alternative GW—4: Enhanced attenuation with monitoring and ICs

Common to each of these alternatives are the following existing ICs that apply to Parcel 9:

- 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

2.9.1.1 Alternative GW—1: No Further Action with ICs

The estimated costs for Alternative GW—1 are as follows:

- Initial (capital) cost: $303,000
- Annual O&M cost: $0
- Closeout cost: $0
- Estimated present worth cost: $303,000

Alternative 1 was developed from the NCP provision that requires consideration of a limited or no action response to serve as a baseline for evaluating other remedial alternatives. Alternative 1 is not expected to result in the attainment of MCLs, nor is it expected to reduce the toxicity, mobility, or volume of contaminants in groundwater. This alternative does not allow any active measures to address VOC-contaminated groundwater or include sampling of groundwater to monitor for concentrations of contaminants above the MCL, nor does it guarantee that VOC-contaminated groundwater above the MCL will remain onsite.

To represent a No Further Action alternative, Alternative 1 incorporates the existing sitewide ICs but excludes the current P&T remedy and groundwater monitoring. Under this alternative, the operation of the P&T system and monitoring of groundwater would discontinue. The air stripper, extraction wells, and monitoring network would be decommissioned.

2.9.1.2 Alternative GW—2: Pump and Treatment with Monitoring and ICs

The estimated costs for Alternative GW—2 are as follows:

- Initial (capital) cost: $239,000
- Annual O&M cost: $124,000
- Closeout cost: $166,000
- Estimated present worth cost: $1,200,000

Alternative 2 includes groundwater collection and extraction using existing well 0452, which was installed to perform hydraulic studies (DOE 2014a). It was determined that this well can create a capture zone that hydraulically contains and collects the contaminated groundwater plume. Extracted groundwater is treated onsite using the existing air stripper before being discharged to the river in accordance with the existing CERCLA Authorization to Discharge (ATD). Sampling would be performed in a set of wells to monitor concentrations within the VOC plume. It is anticipated that a smaller network of wells selected from the existing well network in the OU-1 area can achieve adequate coverage. Alternative 2 is expected to result in the attainment of MCLs and a reduction in the toxicity, mobility, and volume of contaminants in groundwater. The estimated time needed to achieve MCLs is estimated to be approximately 10 years once the P&T is restarted.

The current status of OU-1 includes a functioning P&T system implemented under the 1995 OU-1 ROD (DOE 1995). A comprehensive groundwater monitoring program associated with the operation of this system is ongoing. The two existing extraction wells were installed to provide hydraulic capture along the compliance boundary, which is the outside (south and west) of the road that bounded the former site sanitary landfill, as identified in the 1995 OU-1 ROD (DOE 1995). Subsequent investigation has determined that VOC contamination in groundwater is present beyond this compliance boundary, and part of the plume is not within the hydraulic capture of the existing extraction wells; therefore, a different configuration of extraction wells will be necessary for this remedy to be effective. It has been determined that one new extraction well installed near the downgradient edge of the plume can be used to adequately collect and contain the VOC plume (DOE 2014b) and the operation of the two existing extraction wells can be discontinued.

Extraction well systems are easy to implement and can be operated under numerous aquifer conditions. Existing well 0452 would be converted to an extraction well for this remedial alternative. The existing air stripper would continue to remove VOCs before discharge. If the P&T system were to be reactivated, a pretreatment system would be added to meet ATD requirements to remove from the influent the oil and total organic carbon resulting from the injection of edible oil as part of the OU-1 Enhanced Attenuation Field Demonstration before the extracted groundwater goes through the air stripper.

2.9.1.3 Alternative GW—3: Monitored Natural Attenuation with ICs

The estimated costs for Alternative GW—3 are as follows:

- Initial (capital) cost: $233,000
- Annual O&M cost: $13,000
- Closeout cost: $91,000
- Estimated present worth cost: $371,000

Alternative GW—3 allows for natural geochemical and biological processes to degrade contaminant concentrations in groundwater to MCLs within an established remediation time. This alternative relies on the attenuation mechanisms to be sustained throughout the remediation time frame with no actions to manipulate or enhance these processes if conditions are not sustained. This alternative includes a comprehensive program to (1) monitor trends for VOC concentrations and verify degradation processes within the plume and (2) monitor VOC concentrations in the downgradient portion of the plume to ensure that plume expansion is not occurring. It is anticipated that a smaller network of monitoring wells can achieve adequate coverage. Under this alternative, the treatment associated with the amendment to the 1995 OU-1 ROD (DOE 1995), the operation of the P&T system, would terminate. The air stripper and extraction wells would be decommissioned thereafter. Alternative GW—3 is expected to result in the attainment of MCLs and a reduction in the toxicity, mobility, and volume of contaminants in groundwater through treatment promoted by the injection of neat and emulsified oils introduced during the OU-1 Enhanced Attenuation Field Demonstration completed in 2018. It has been estimated that MCLs could be reached by 2027.

This remedial alternative recognizes that the current distribution of VOCs and biogeochemical conditions are the result of injecting neat and emulsified oils during the OU-1 Enhanced Attenuation Field Demonstration that was completed in 2018. The injection of oils enhanced the existing redox conditions in the aquifer and microbial communities in the VOC plume. A series of structured geochemical zones have been established that allow for attenuation of VOCs in groundwater, and contaminant concentrations have been trending downward while the microbial communities have remained robust.

2.9.1.4 Alternative GW—4: Enhanced Attenuation with Monitoring and ICs

The estimated costs for Alternative GW—4 are as follows:

- Initial (capital) cost: $198,000
- Annual O&M cost: $26,000
- Possible one-time cost to inject amendments or microbes to stimulate attenuation process (if deemed necessary): $230,000 has been applied as a periodic cost in Year 5
- Closeout cost: $136,000
- Estimated present worth cost: $613,000 or $843,000, if injection of amendments is necessary

Alternative GW—4 allows natural geochemical and biological processes to degrade contaminant concentrations in groundwater to MCLs within an established remediation time; however, the additional enhancement of natural geochemical and biological processes is considered an option to ensure that conditions are sustained throughout the remediation period. Enhancements may include deploying amendments that help establish specific geochemical regimes within the aquifer, deploying amendments as nutrients to existing microbes, or deploying microbes. This alternative includes a program for (1) monitoring concentration trends, verifying degradation processes, and assessing the types and number of microbial communities present within the VOC plume; and (2) monitoring VOC concentrations in the downgradient portion of the plume to ensure that plume expansion is not occurring. It is anticipated that a smaller network of monitoring wells can achieve adequate coverage. Under this alternative, treatment associated with the new amendment to the 1995 OU-1 ROD (DOE 1995), operation of the P&T system, would terminate. The air stripper and extraction wells would be decommissioned thereafter. Alternative GW—4 is expected to result in the attainment of MCLs and to reduce the toxicity, mobility, and volume of contaminants in groundwater through treatment promoted by the injection of neat and emulsified oils introduced during the OU-1 Enhanced Attenuation Field Demonstration that was completed in 2018. It was estimated that MCLs could be reached by the design time frame of 2027, and current data trends support that the time frame may be shorter and MCLs could be reached by 2024. It is anticipated that the injection of additional emulsified oil or microbes would occur only if the VOC plume was observed to be expanding or VOC concentrations increased unexpectedly; however, it is unlikely that additional injections would alter the remediation time frame substantially.

This remedial alternative, like Alternative GW—3, recognizes that the current distribution of VOCs and biogeochemical conditions result from the injection of neat and emulsified oils 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 the structured geochemical zones. If it is determined that the structured zones cannot be maintained throughout the remediation time frame (DOE 2020), then additional enhancement may be necessary.

2.9.2 Vapor Intrusion Alternatives

DOE evaluated three alternatives in the Proposed Plan in order to arrive at the selected amended remedy for OU-1/Parcel 9. CERCLA guidance generally requires that the “no action” alternative be evaluated to establish a baseline for comparing the action alternatives. The remedial alternatives that were evaluated to fulfill the RAO of mitigating human health risk by eliminating the VI pathway in OU-1/Parcel 9 are the following:

- Alternative VI—1: No Further Action
- Alternative VI—2: No-build restrictions through ICs
- Alternative VI—3: Preemptive measures or actions to mitigate VI exposure with ICs

Common to each of these alternatives are the following existing ICs that apply to Parcel 9:

- 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

2.9.2.1 Alternative VI—1: No Further Action

Alternative VI—1 was developed from the NCP provision that requires consideration of a limited or no action response to serve as a baseline for evaluating other remedial alternatives. Alternative VI—1 is not expected to result in the attainment of PRGs, nor is it expected to reduce the toxicity, mobility, or volume of contaminants in the vadose zone. Alternative VI—1 does not allow for any measures or actions to address VI, nor does it include sampling of indoor air quality to monitor for concentrations of contaminants above the PRGs.

2.9.2.2 Alternative VI—2: No-Build Restrictions Through ICs

Alternative VI—2 would prohibit the construction of any new buildings within a designated portion of Parcel 9, and this prohibition would be enforced through an IC (i.e., a deed restriction). Currently, there are no potential receptors to vapor, and prohibiting any new construction would protect future property users. This alternative does not reduce the toxicity, mobility, and volume of contaminants in the vadose zone. Alternative VI—2 does not allow for any measures or actions to address VI, nor does it include sampling of indoor air quality to monitor for concentrations of contaminants above the PRGs.

2.9.2.3 Alternative VI—3: Preemptive Measures or Actions with ICs

The goal of Alternative VI—3 is to mitigate the VI exposure pathway by preventing vapors from entering a future building in Parcel 9. This alternative does not reduce the toxicity, mobility, and volume of contaminants in the vadose zone, but it does recognize that all of the major VOC source areas have been removed, the original VOC groundwater plume has been reduced, and the remaining residual contamination is being addressed by other remedial actions. Alternative VI—3 allows new construction in the Parcel 9 area with the installation of preemptive measures (i.e., vapor mitigation system) to prohibit exposure of building occupants to vapors or by performing other actions such as soil-gas sampling to determine that concentrations of vapors could not result in an unacceptable risk to building occupants. The preemptive measures must be designed case by case and installed, maintained, and monitored by the future building owner.

This remedial alternative recognizes that the majority of the VOC source has been removed through numerous actions, but the distribution of residual VOCs in the vadose zone has not been fully characterized. There are sufficient data to indicate that concentrations of TCE and VC in soil gas at depths greater than 20 ft are greater than industrial and commercial use risk-scenario concentrations for vapors measured beneath a building (subslab). It is possible that residual VOC sources could degrade by the time future construction occurs; therefore, additional data could be collected in the future that would indicate that the concentrations of the COCs are below levels that could result in an unacceptable exposure to building occupants or that the exposure pathways are incomplete.

This alternative relies on the future property owner choosing to perform one of the alternatives presented below prior to new building construction in the portion of Parcel 9 (property) shown in Figure 15:

1. Incorporate engineering controls (i.e., vapor mitigation system) at the property or portion thereof at the time of construction and ensure 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 prior to 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 demonstrates 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 risk from VI should be obtained through samples collected from the property. A final determination of the risk the concentrations of subsurface vapors could pose on building occupants shall be provided in writing to the parties identified in the environmental covenant.

The above information shall be provided to EPA, Ohio EPA, and DOE and must be approved before any construction. The requirement for the submittal and preapproval of any mitigative measures or other actions will be documented in an environmental covenant (53 ORC 5301.80–5301.92). This covenant will contain restrictions for land use or occupancy status or will require the property owner to report compliance with restrictions or occupancy status to the regulators. Environmental covenants provide future occupants and landowners information about the VI concerns on the property and identify required restrictions and actions that must occur before building on the property.

2.10 Comparative Analysis of Alternatives

To conduct a comprehensive analysis of the remedial alternatives, CERCLA requires that each proposed alternative be assessed against the evaluation criteria developed to address the statutory considerations listed under CERCLA (EPA 1988). These criteria are separated into three categories: threshold, balancing, and modifying. Threshold criteria relate to the statutory requirements that the alternatives must satisfy. Balancing criteria are technical and are used as the primary basis for evaluation. Modifying criteria relate to state and public acceptance of the alternatives and are assembled formally after the public comment period. The nine criteria are listed in Table 6.

2.10.1 Groundwater Alternatives

This section uses the results of the detailed evaluation of remedial alternatives to address contaminated groundwater to conduct a comparative analysis of the alternatives to identify the relative advantages and disadvantages of each. The potential remedial alternatives are compared to each of the nine balancing criteria analyzed in Table 5. The results of the analysis were used to select a final groundwater remedy.

Table 6. Nine CERCLA Evaluation Criteria

Criteria Type	Criteria	Description
Threshold	1. Overall protection of human health and the environment	This criterion addresses whether an alternative provides adequate protection of human health and the environment and describes how risks posed through each exposure pathway are eliminated, reduced, or controlled through treatment, engineering control, or ICs.
	2. Compliance with ARARs	This criterion is used to determine how an alternative complies with ARARs.
Balancing	3. Long-term effectiveness and permanence	This criterion addresses the results of a remedial action in terms of the risk remaining after RAOs have been met. The primary focus of the evaluation is to determine the extent and effectiveness of the controls that may be required to manage the risk posed by residual contamination. The factors to be evaluated include the magnitude of risk remaining at the end of the remedial activities and the adequacy and reliability of controls used to manage remaining waste.
	4. Reduction in toxicity, mobility, and volume	This criterion addresses the statutory preference for selecting a remedial action that employs treatment to reduce the toxicity, mobility, or volume of the contamination. The factors to be evaluated include the remediation process employed; the amount of hazardous material destroyed or treated; the degree of reduction expected in the toxicity, mobility, or volume; and the type and quantity of residuals.
	5. Short-term effectiveness	This criterion addresses the effects of an alternative during the construction and implementation phases until the remedial actions have been completed and the selected level of protection has been achieved. Each alternative is evaluated with respect to its effect on the community and onsite workers, environmental impacts resulting from implementation, and the amount of time until protection is achieved.
	6. Implementability	This criterion addresses the technical and administrative feasibility of implementing an alternative and the availability of various services and materials required during its implementation. Technical feasibility considers construction and operation difficulties, reliability, ease of undertaking additional actions (if required), and the ability to monitor its effectiveness. Administrative feasibility considers activities needed to coordinate with other agencies in regard to obtaining permits or approvals for implementing remedial actions during the construction and implementation phase until the remedial actions have been completed and the selected level of protection has been achieved. Each alternative is evaluated with respect to its effect on the community and onsite workers, environmental impacts resulting from implementation, and the amount of time until protection is achieved.
	7. Cost	This criterion addresses the capital costs, annual O&M costs, and present worth analysis.
Modifying	8. State acceptance	This criterion evaluates the technical and administrative issue and concerns the State of Ohio may have regarding each of the alternatives. This criterion is addressed in the forthcoming ROD and the responsiveness summary.
	9. Community acceptance	This criterion incorporates public concerns into the evaluation of the remedial alternatives. This criterion is addressed in the forthcoming ROD and the responsiveness summary.

2.10.1.1 Overall Protection of Human Health and the Environment

The goal of this criterion is to adequately protect human health and the environment. It can be achieved by reducing or eliminating the VOC concentrations in groundwater or preventing exposure to human receptors. Alternative GW—1 does not include treatment or monitoring of contaminants in groundwater and would not provide information regarding the possible migration of contaminated groundwater, including whether it has moved outside the boundary of Parcel 9 or potentially offsite. Alternatives GW—2, GW—3, and GW—4 achieve protection of human health and the environment by preventing exposure of human receptors to site contaminants in groundwater and restoring the contaminated aquifer to goals set at or below drinking water standards.

2.10.1.2 Compliance with ARARs

Alternative GW—1 does not comply with ARARs. Alternatives GW—2, GW—3, and GW—4 would comply with ARARs. Each of these alternatives is expected to achieve ARARs within 10, 5, and 2 years, respectively.

2.10.1.3 Long-Term Effectiveness

Alternative 1 does not include monitoring; therefore, it cannot be confirmed that this alternative would be effective in the long term because it would not be known if contaminated groundwater moved outside the boundary of Parcel 9 or offsite and resulted in potential exposure. Alternatives GW—2, GW—3, and GW—4 achieve long-term effectiveness, by preventing exposure through ICs and by restoring the groundwater to goals set at or below the drinking water standards. Alternative GW—2 achieves long-term effectiveness by flushing residual VOC contamination from the aquifer. Alternatives GW—3 and GW—4 achieve long-term effectiveness by allowing ongoing natural attenuation, as promoted by the injection of neat and emulsified oils introduced during the OU-1 Enhanced Attenuation Field Demonstration that was completed in 2018, to degrade VOCs in groundwater, with potential additional enhancements provided in GW—4.

2.10.1.4 Reduction in Toxicity, Mobility, or Volume Through Treatment

Alternative GW—1 provides no reduction in the toxicity, mobility, or volume of VOCs in groundwater. Alternatives GW—2, GW—3, and GW—4 achieve reduction in the toxicity, mobility, and volume of VOCs in groundwater. Alternative GW—2 provides ex situ treatment of groundwater, whereas Alternatives GW—3 and GW—4 provide in situ treatment of VOCs in groundwater, as promoted by the injection of neat and emulsified oils introduced during the OU-1 Enhanced Attenuation Field Demonstration that was completed in 2018. Alternatives GW—3 and GW—4 could achieve the greatest reduction in the toxicity and volume of VOCs in groundwater based on the results of the OU-1 Enhanced Attenuation Field Demonstration. Alternatives GW—2, GW—3, and GW—4 are expected to achieve the MCLs and reduce the toxicity and volume in 10, 5, and 2 years, respectively.

2.10.1.5 Short-Term Effectiveness

There are no substantial risks to the community or the environment associated with any of the alternatives. Workers operating the P&T system have a slight potential for exposure associated with implementation of Alternative GW—2. Workers performing sampling required in Alternatives GW—2, GW—3, and GW—4 have a slight potential for exposure. All of these risks can be minimized by the use of personal protective equipment and engineering controls.

2.10.1.6 Implementability

No significant technical implementability issues are associated with Alternatives GW—2, GW—3, and GW—4. Alternative GW—2 could have implementability issues associated with operation of the P&T and pretreatment systems. Alternative GW—4 could have an implementability issue associated with the design of additional amendment or microbe deployment, if it is necessary.

There are no action-specific administrative implementability issues associated with any of the alternatives.

2.10.1.7 Cost

The estimated present worth costs for the groundwater remedial alternatives ranked from lowest to highest are:

1. Alternative GW—1: No Further Action with ICs ($303,000)
2. Alternative GW—3: Monitored natural attenuation with ICs ($371,000)
3. Alternative GW—4: Enhanced attenuation with monitoring and ICs ($843,000)
4. Alternative GW—2: Pump and treatment with monitoring and ICs ($1,200,000)

There are no costs associated with the VI remedial alternatives.

2.10.1.8 State Acceptance

Ohio EPA has had an opportunity to review and participate in the evaluation of alternatives to address VOCs in OU-1/Parcel 9 groundwater and supports the selection of the groundwater remedy presented in this Amendment to the 1995 ROD, "Enhanced Attenuation with Monitoring and ICs" (Alternative GW—4). Also, Ohio EPA concurred with the ICs established in the 2011 OU-1 ROD Amendment (DOE 2011a) to maintain protectiveness.

2.10.1.9 Community Acceptance

The public had an opportunity to review the preferred alternatives and provide comment to DOE. No comments were received during the comment period.

2.10.2 Vapor Intrusion Alternatives

In this section the potential remedial alternatives for VI are compared to each of the balancing criteria analyzed in Table 6. Results of the analysis were used to determine a selected remedy for VI.

2.10.2.1 Overall Protection of Human Health and the Environment

The goal of this criterion is to either eliminate the toxicity of contaminants or prevent exposure to human receptors.

- None of the alternatives eliminate the toxicity of contaminants.
- Alternatives VI—2 and VI—3 eliminate the VI pathway and prevent exposure of future building occupants to vapors.
- Alternative VI—2 achieves protection of human health by prohibiting the construction of buildings in the specified portion of OU-1/Parcel 9 and eliminating the VI pathway.
- Alternative VI—3 achieves protection of human health through the use of preemptive measures or actions to mitigate exposure to vapors and provides evidence of vapor mitigation through monitoring.

2.10.2.2 Compliance with ARARs

This criterion is used to determine whether an alternative complies with ARARs. There are no ARARs for VI. However, both EPA and Ohio EPA have VI mitigation guidance that should be considered.

- Alternative VI–1 does not comply with either the EPA or Ohio EPA guidance documents.
- Alternative VI–2 complies with the guidance by eliminating the VI pathway and the potential for VI exposure.
- Alternative VI–3 uses the concepts of guidance documents by using preemptive measures or actions to mitigate the VI pathway and provides data that support the effectiveness of preemptive measures or actions.

2.10.2.3 Long-Term Effectiveness

This criterion addresses the risk remaining after RAOs have been met and focuses on the effectiveness of controls that may be required to manage risk posed by residual contamination.

- Alternative VI–1 does not meet RAOs because the vapor sources or potential VI pathways are not addressed. It cannot be confirmed that this alternative would be effective in the long term because it does not include monitoring to determine whether vapors that could result in exposure are present in the vadose zone or in future buildings.
- Alternatives VI–2 and VI–3 achieve long-term effectiveness, primarily by eliminating the VI pathway and preventing exposure. Alternative VI–2 achieves long-term effectiveness by prohibiting the construction of buildings through ICs. Alternative VI–3 achieves long-term effectiveness by requiring the installation and maintenance of preemptive measures (engineering controls) or performance of preemptive actions and monitoring if required through an environmental covenant or deed restriction.

2.10.2.4 Reduction in Toxicity, Mobility, or Volume Through Treatment

The goal of this criterion is to select a remedial action that employs treatment to reduce toxicity, mobility, or volume of the contamination.

- None of the alternatives reduce toxicity, mobility, or volume of vapors through treatment; however, they do recognize that the majority of VOC source areas have been removed and remaining residual sources are currently being addressed by other remediation methods.
- Alternative VI–3 can reduce the mobility of vapors into buildings by employing preemptive measures (engineering controls) or actions to mitigate the VI pathway.

2.10.2.5 Short-Term Effectiveness

There are no substantial risks to the community or the environment associated with the implementation of any of the alternatives.

2.10.2.6 Implementability

This criterion addresses the technical and administrative feasibility of implementing an alternative and the availability of various services and materials required during its implementation.

- No significant administrative implementability issues are associated with any of the alternatives.
- Alternative VI–3 could have implementability issues associated with (1) determining the adequacy of a preemptive measure (engineering control) or actions and (2) defining the associated maintenance and monitoring requirements.

2.10.2.7 Cost

Cost is not discussed, because there are no capital or closeout costs to DOE associated with any of these alternatives. It is anticipated that any design, construction, monitoring, and maintenance costs will be the responsibility of future building owners. Annual costs to DOE for each of the alternatives include professional services, design, and IC maintenance and reporting that are applied to the Mound site project as a whole and not broken out for each remedial alternative.

2.10.2.8 State Acceptance

Ohio EPA has had an opportunity to review and participate in evaluation of alternatives to address the VI exposure pathway in OU-1/Parcel 9 and supports the selection of the remedy presented in this Amendment to the 1995 ROD, "Preemptive Measures or Actions to Mitigate VI Exposure with ICs" (Alternative VI–3). Also, Ohio EPA, concurred with the ICs established in the 2011 OU-1 ROD Amendment (DOE 2011a) to maintain protectiveness.

2.10.2.9 Community Acceptance

The public had the opportunity to review the preferred alternatives and provide comment to DOE. No comments were received during the comment period.

2.11 Principal Threat Wastes

Principal threat waste is site-related waste that includes or contains hazardous substances, pollutants, or contaminants that act as a source for migration of contamination to groundwater, surface water, or air, or act as a source for direct exposure. The NCP states that EPA expects to:

- Use treatment to address principal threats posed by a site, wherever practicable.
- Use engineering controls, such as containment, for wastes that pose a relatively low long-term threat or where treatment is impractical.
- Use a combination of methods, as appropriate, to achieve protection of human health and the environment, with a priority placed on treating waste that is liquid, highly toxic, or highly mobile.
- Use ICs to supplement engineering controls as appropriate for short- and long-term management to prevent or limit exposure to hazardous substances.

Principal threat waste was not identified for this ROD Amendment. The primary sources of contaminants were addressed through the following additional removal actions:

- Reducing the mass of VOCs in the vadose zone by operating an SVE system from 1996 until 2003
- Removing the bulk of the contaminated soil and waste materials from the former landfill from 2007 through 2010
- Demonstrating the feasibility of addressing VOCs in groundwater during the multiyear field demonstration performed from 2012 through 2018 that resulted in a reduction in the mass and concentrations of VOCs in groundwater

2.12 Selected Remedy

Based on the information presented in this ROD Amendment, DOE has elected to modify the groundwater remedy selected in the 1995 OU-1 ROD and has identified a remedial action to mitigate potential VI exposure to future building occupants in OU-1/Parcel 9. These remedies were developed to address residual VOC contamination remaining in OU-1 and Parcel 9 at the Mound site.

The selected remedial actions to address residual VOC contamination are:

- Enhanced attenuation with monitoring and ICs (Alternative GW—4).
- Preemptive measures or actions to mitigate VI exposure with ICs (Alternative VI—3).

2.12.1 Modified Groundwater Remedy (Alternative GW—4)

"Enhanced Attenuation with Monitoring and ICs" is selected as the remedial alternative to address VOC-contaminated groundwater in OU-1/Parcel 9. Alternative GW—4 will achieve all RAOs and remediate groundwater throughout the plume within a reasonable time frame. Based upon an evaluation conducted using the CERCLA evaluation criteria, Alternative GW—4 presents the best balance in addressing the risks from OU-1 groundwater. 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 indicate that sustainable geochemical and biological processes will degrade contaminants to MCLs within a reasonable time frame.

Since the implementation of the P&T remedy, three significant changes have occurred in OU-1: decommissioning of the Mound Plant production wells (used as drinking water), removal of the landfill that acted as a source for VOCs to OU-1 groundwater, and implementation of ICs to restrict groundwater use. These changed site conditions, in conjunction with evolving science, resulted in DOE performing investigations and amassing a large body of data to evaluate whether an attenuation-based remedy would accelerate reaching the MCLs and be more effective than a P&T remedy to address the remaining VOC contamination in groundwater.

Modifying the groundwater remedy to an attenuation-based remedy is considered a superior change from hydraulic containment for the following reasons:

- The majority of the source has been removed from the former landfill
- 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

Alternative GW—4 will achieve all RAOs and will result in the attainment of MCLs and a reduction in the toxicity, mobility, and volume of contaminants in groundwater within a reasonable time frame. The results of the OU-1 Enhanced Attenuation Field Demonstration indicate that geochemical and biological processes are present and sustainable that will degrade contaminants to MCLs within a reasonable time frame (approximately 10 years). The primary components of Alternative GW—4 are:

- Decommissioning of the P&T system, including the two existing extraction wells.
- Decommissioning of monitoring wells not retained as part of the long-term network.
- Attenuation of VOCs via reductive dechlorination, aerobic cometabolism, and biological degradation.
- Enhancement of attenuation processes though 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.
- Data evaluation to ensure that biogeochemical conditions remain favorable for attenuation processes.
- Maintenance of 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

2.12.2 Vapor Intrusion Remedy (Alternative VI—3)

"Preemptive Measures or Actions to Mitigate VI Exposure with ICs" is the selected as the remedy to address vapor-forming chemicals in the vadose zone in OU-1/Parcel 9. Alternative VI—3 will achieve all RAOs by eliminating the VI pathway and preventing exposure to future building occupants. Although Alternative VI–3 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, it 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 of 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 Alternative VI–3 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 the *Ohio Revised Code*, "Conveyances; Encumbrances" (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 Parcel 9:

1. Incorporate engineering controls (i.e., vapor mitigation system) at the property or portion thereof at the time of construction and ensure 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 demonstrates 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 risk from VI should be obtained through samples collected from the property. A final determination of the risk to concentrations of subsurface vapors could pose to building occupants shall be provided in writing to the parties identified in the environmental covenant.

Future property owners shall also be required to adhere to the ICs existing under the 2011 OU-1 ROD Amendment (DOE 2011a) as follows:

- 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

2.13 Statutory Determinations

Based on available information, DOE believes the selected remedy meets the threshold criteria and provides the best balance of tradeoffs among the other alternatives with respect to the balancing and modifying criteria. EPA and Ohio EPA expect the selected remedies for groundwater and VI to satisfy the statutory requirements of CERCLA Section 121(b) (42 USC 9621) as follows:

- Protect human health and the environment
- Comply with ARARs
- Be cost-effective
- Utilize permanent solutions to the maximum extent practicable
- Satisfy the preference for treatment as a principal element or explain why the preference for treatment will not be met

2.14 Summary of Support Agency Comments on the ROD Amendment

The director of Ohio EPA is provided with the ROD Amendment for review and concurrence.

3.0 Responsiveness Summary

This section of the ROD Amendment presents stakeholder potential concerns about Parcel 9 and explains how those concerns were addressed prior to issuance of the ROD Amendment.

3.1 Overview

At the time of the public comment period, DOE had identified preferred alternatives to address VOC-contaminated groundwater in OU-1 and potential VI exposure to future building occupants. The recommended alternative, as published in the Proposed Plan, were Alternative GW—4, "Enhanced Attenuation with Monitoring and ICs," and Alternative VI—3, "Preemptive Measures or Actions to Mitigate VI Exposure with ICs."

3.2 Summary of Public Comments

In compliance with Sections 113(k)(2)(B) and 117 of CERCLA and NCP Section 300.435(c)(2)(ii), a notice of public review and public meeting on the Proposed Plan highlighting the modified remedy was published in the *Dayton Daily News* on November 20, November 21, and November 25, 2022. The issued notice stated that a public meeting would be held on December 7, 2022, to explain the Proposed Plan and receive comments. The public comment period on the Proposed Plan began on November 23, 2022, and closed on December 23, 2022. Members of the public could attend the public meeting (in person or virtually) and be involved in discussions of the changes identified in the Proposed Plan.

No formal comments were received during the public meeting or during the review period. Therefore, no responses are required and no substantive changes to the proposed amended remedy were made.

4.0 References

10 CFR 770. "Transfer of Real Property at Defense Nuclear Facilities for Economic Development," *Code of Federal Regulations*.

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

40 CFR 300.825(a)(2). "Record Requirements After the Decision Document is Signed," *Code of Federal Regulations*.

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

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

53 ORC 5301.80-5301.92. "Conveyances; Encumbrances," *Ohio Revised Code.*

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DOE (U.S. Department of Energy), 1997a. *Mound 2000 Residual Risk Evaluation Methodology, Mound Plant*, prepared by the Miamisburg Closure Project for the U.S. Department of Energy, Ohio Field Office, Final, January.

DOE (U.S. Department of Energy), 1997b. *Risk-Based Guideline Values, Mound Plant, Miamisburg, Ohio*, prepared by the Miamisburg Closure Project for the U.S. Department of Energy, Ohio Field Office, March.

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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, August.

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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), 2019. *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.

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Appendix A

Concurrence Letter from Ohio EPA

Ohio Environmental Protection Agency

EPA.Ohio.gov

Mike DeWine, *Governor* Jon Husted, *Lt. Governor* Anne M. Vogel, *Director*

September 13, 2023

Tiffany Drake
U.S. Department of Energy
Office of Legacy Management
7295 Highway 94 South
St. Charles, MO 63304

Re: **US DOE Mound Fac, Miamisburg**
Remediation Response
Project Records
Federal Facilities
ROD
Montgomery County
557000864003

Transmitted via email to: tiffany.drake@lm.doe.gov

Subject: **Record of Decision Amendment Concurrence**
Mound Site, Miamisburg, Ohio

Dear Ms. Drake:

Ohio EPA has reviewed the Amendment to the Record of Decision (ROD) for Operable Unit 1[1] dated August 2023, for the Mound Site, Miamisburg, Ohio. Ohio EPA concurs with DOE's amended ROD, which includes the following selected remedial alternatives to address volatile organic compounds in ground water and mitigate potential vapor intrusion exposure:

- Alternative GW-4: Enhanced attenuation with monitoring and institutional controls for ground water
- Alternative VI-3: Preemptive measures or actions to mitigate vapor intrusion exposure with institutional controls

We look forward to working with DOE and U.S. EPA on implementing the selected alternative remedies for Operable Unit 1. If you have any questions, please contact Scott Glum at (937) 285-6065 or by email at scott.glum@epa.ohio.gov.

Sincerely,

Melisa Witherspoon

Melisa Witherspoon, Chief
Division of Environmental Response and Revitalization

[1] https://edocpub.epa.ohio.gov/publicportal/ViewDocument.aspx?docid=2486396

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