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Proposed Plan for Amendment of Operable Unit 1 Record of Decision Mound, Ohio, Site

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U.S. DEPARTMENT OF ENERGY | Legacy Management

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Abbreviations

^{227}Ac	actinium-227
AR	Administrative Record
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
COC	contaminant of concern
COPC	contaminant of potential concern
CSM	conceptual site model
DCA	dichloroethane
DOE	U.S. Department of Energy
ELCR	excess lifetime cancer risk
EPA	U.S. Environmental Protection Agency
FS	Feasibility Study
ft	feet
HI	Hazard Index
HQ	Hazard Quotient
IC	institutional control
LLRW	low-level radioactive waste
MCL	maximum contaminant level
µg/L	micrograms per liter
MNA	monitored natural attenuation
NCP	National Contingency Plan
NFA	No Further Action
Ohio EPA	Ohio Environmental Protection Agency
O&M	operations and maintenance
ORC	*Ohio Revised Code*
OU-1	Operable Unit 1
PCE	tetrachloroethene
pCi/L	picocuries per liter
PRG	preliminary remediation goal

PRS	potential release site
P&T	pump-and-treatment
Pu	plutonium
RAO	Remedial Action Objective
ROD	Record of Decision
RRE	residual risk evaluation
SVE	soil vapor extraction
TCE	trichloroethene
VC	vinyl chloride
VI	vapor intrusion
VISL	vapor intrusion screening level
VOC	volatile organic compound
yd^3	cubic yards

1.0 Introduction

This *Proposed Plan for Amendment of Operable Unit 1 Record of Decision Mound, Ohio, Site*, hereafter called the Proposed Plan, identifies the preferred alternatives for addressing residual volatile organic compound (VOC) contamination remaining in the Operable Unit 1 (OU-1) area in Parcel 9 at the Mound, Ohio, Site. The U.S. Department of Energy (DOE) is proposing to amend the *Operable Unit 1 Record of Decision, Mound Plant, Miamisburg, Ohio* (DOE 1995), hereafter called the 1995 OU-1 Record of Decision (ROD), to modify the remedy that addresses VOCs in groundwater in OU-1 and identify a remedial action to mitigate potential vapor intrusion (VI) exposure to future building occupants.

The Proposed Plan is being issued by DOE, the lead agency for site activities. In consultation with the U.S. Environmental Protection Agency (EPA) and Ohio Environmental Protection Agency (Ohio EPA), DOE will select a final remedy for Parcel 9 after reviewing and considering all information submitted during the 30-day public comment period. DOE may modify the preferred alternatives or select another remedial action presented in this Proposed Plan based on new information or public comments. Therefore, the public is encouraged to review and comment on all the alternatives presented in this Proposed Plan.

DOE is issuing this Proposed Plan to fulfill its public participation responsibilities under Section 117(a) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (Title 42 *United States Code* Section 9617 [42 USC 9617]), "Public Participation," and Title 40 *Code of Federal Regulations* Section 300.430(f)(2) [40 CFR 300.430(f)(2)]), "Remedial Investigation/Feasibility Study and Selection of Remedy," of the National Oil and Hazardous Substances Pollution Contingency Plan, also called the National Contingency Plan (NCP). This Proposed Plan is part of the remedy selection stage of the CERCLA remedial response process; it was prepared after completion of additional supporting investigations and studies and the Feasibility Study (FS) (DOE 2021) and presents to the public the preferred remedial alternatives that were derived from the information and evaluations explained in those documents.

This Proposed Plan provides information on the preferred remedial action alternatives for addressing residual VOCs in groundwater and subsurface vapors, outlines other remedial alternatives that were considered, and explains the basis for selecting the preferred alternatives. The Proposed Plan also provides basic information that can be found in more detail in the focused FS for OU-1 (DOE 2021), which evaluated remedial alternatives for addressing VOCs in groundwater in OU-1 and included an addendum that evaluated remedial alternatives to mitigate potential VI that might affect future building occupants. The FS, Proposed Plan, and other documents prepared to support the upcoming ROD Amendment will be placed in the Administrative Record (AR). Additional information for accessing the AR can be found in Section 9.0.

2.0 Background Information

The 1995 OU-1 ROD (DOE 1995) was signed by DOE on June 2, 1995, and by EPA on June 12, 1995. Ohio EPA concurred with the remedy described in the 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., pump-and-treatment [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

In addition to the operation of the P&T system to control contaminated groundwater, several removal actions were completed in the former OU-1 landfill area to support project activities and facility upgrades, expedite remediation times by addressing VOC contamination in the vadose zone, and facilitate future economic development of the landfill area. These actions are discussed in greater detail in Section 2.3 and include 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
- 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

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. The 2011 OU-1 ROD Amendment 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 this amendment included the following actions:

- Documenting the geographic expansion of the land area to be included in the amendment
- Identifying institutional controls (ICs) to be implemented for the OU-1 area in the Parcel 9 *Environmental Covenant* (DOE 2012)

When 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 contains language from the Parcel 9 *Environmental*

Covenant in accordance with Title 53 *Ohio Revised Code* Section 5301.80–5301.92 (53 ORC 5301.80–5301.92). The ICs for Parcel 9 are consistent with sitewide ICs previously identified for other portions of the Mound site and include the following:

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

2.1 Location and Site Description

The DOE 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; it operated from 1948 to 1995. To reconfigure and consolidate the nation's nuclear complex, DOE phased out the defense mission at the Mound site by 2003; the site was designated an environmental management site, and the plant was converted into an industrial/commercial site. The original area designated as OU-1 occupies approximately 4 acres in the southwestern portion of the Mound site (Figure 2). It includes the historical landfill site, former sanitary landfill site, former OU-1 overflow pond, OU-1 soil spoils area, and former production well area. As part of the 2011 ROD Amendment, the original 4-acre OU-1 area is now synonymous with Parcel 9 (Figure 3). The OU-1 landfill area that was the basis for the original 1995 OU-1 ROD covered only part of the land now comprising Parcel 9.

2.2 Site History, Contamination, and Remedy

During operation of the Mound Plant, an onsite landfill was created on the edge of the Great Miami Buried Valley Aquifer (BVA), a sole source aquifer that provides drinking water for much of the Miami Valley. The site was placed on the National Priorities List on November 21, 1989, after VOCs were discovered in site groundwater. DOE signed a CERCLA Section 120 Federal Facility Agreement with EPA that took effect in October 1990. A subsequent tripartite agreement was signed by DOE, EPA, and Ohio EPA in 1993.

The area designated as OU-1 initially was a historical landfill site that received plant waste materials (general trash and liquid waste) from 1948 to 1974; it later included the former sanitary landfill where much of the waste from the historical landfill was relocated and encapsulated in 1977 to facilitate construction of site surface water controls (overflow pond). During the mid-1950s, the landfill received potentially contaminated salvage material from the Dayton Unit (a Manhattan Project site in Dayton, Ohio). The material consisted of wood ash and debris from a fire that had consumed the polonium-contaminated flooring and polonium-210-contaminated sand from research and production activities. Approximately 2500 crushed, empty 55-gallon drums that were used to store thorium wastes were buried in the southwest corner of OU-1 in the 1960s. There were known releases of VOCs from the OU-1 landfill into the underlying BVA.

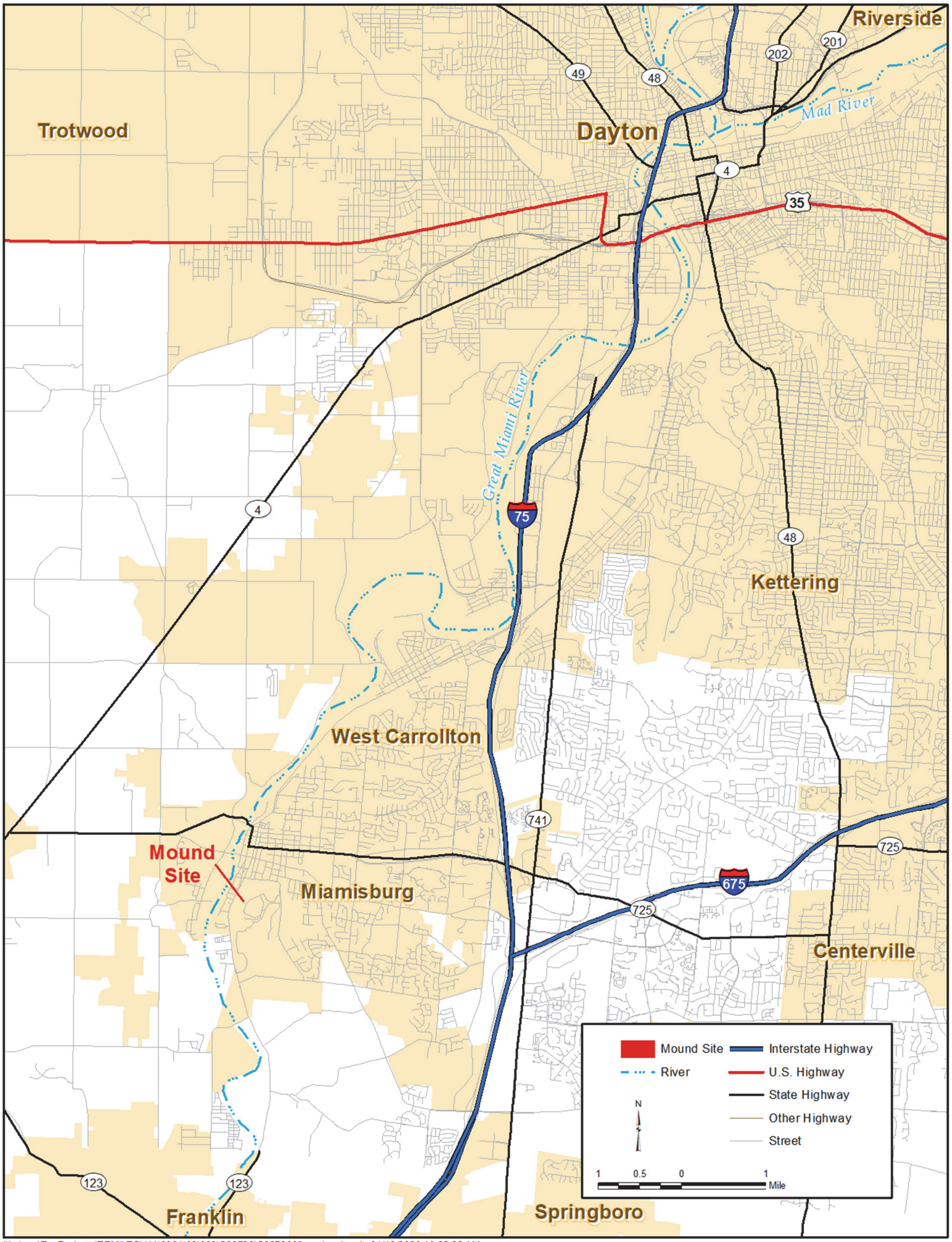

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Figure 1. Location of Mound, Ohio, Site

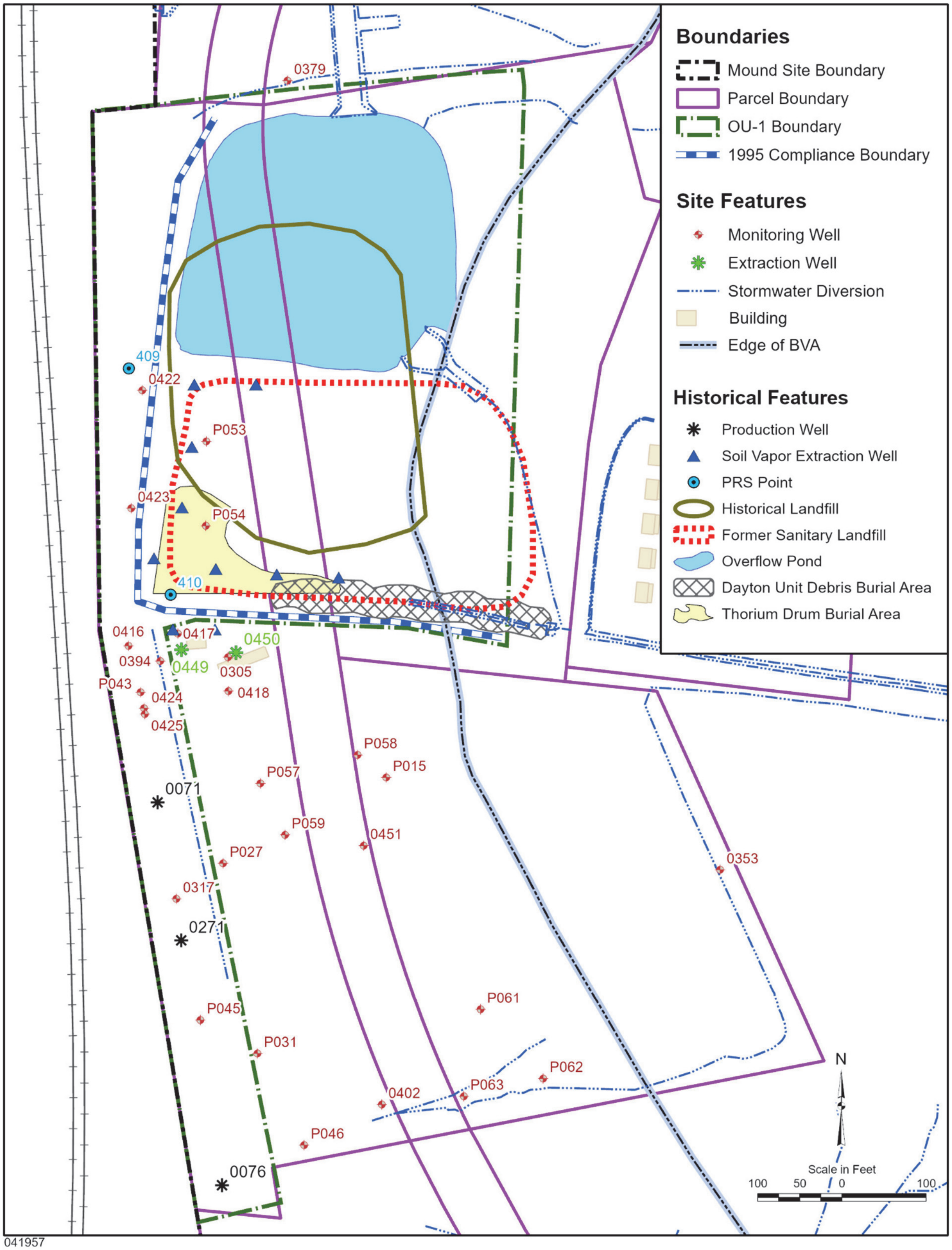

Figure 2. OU-1 Site Map

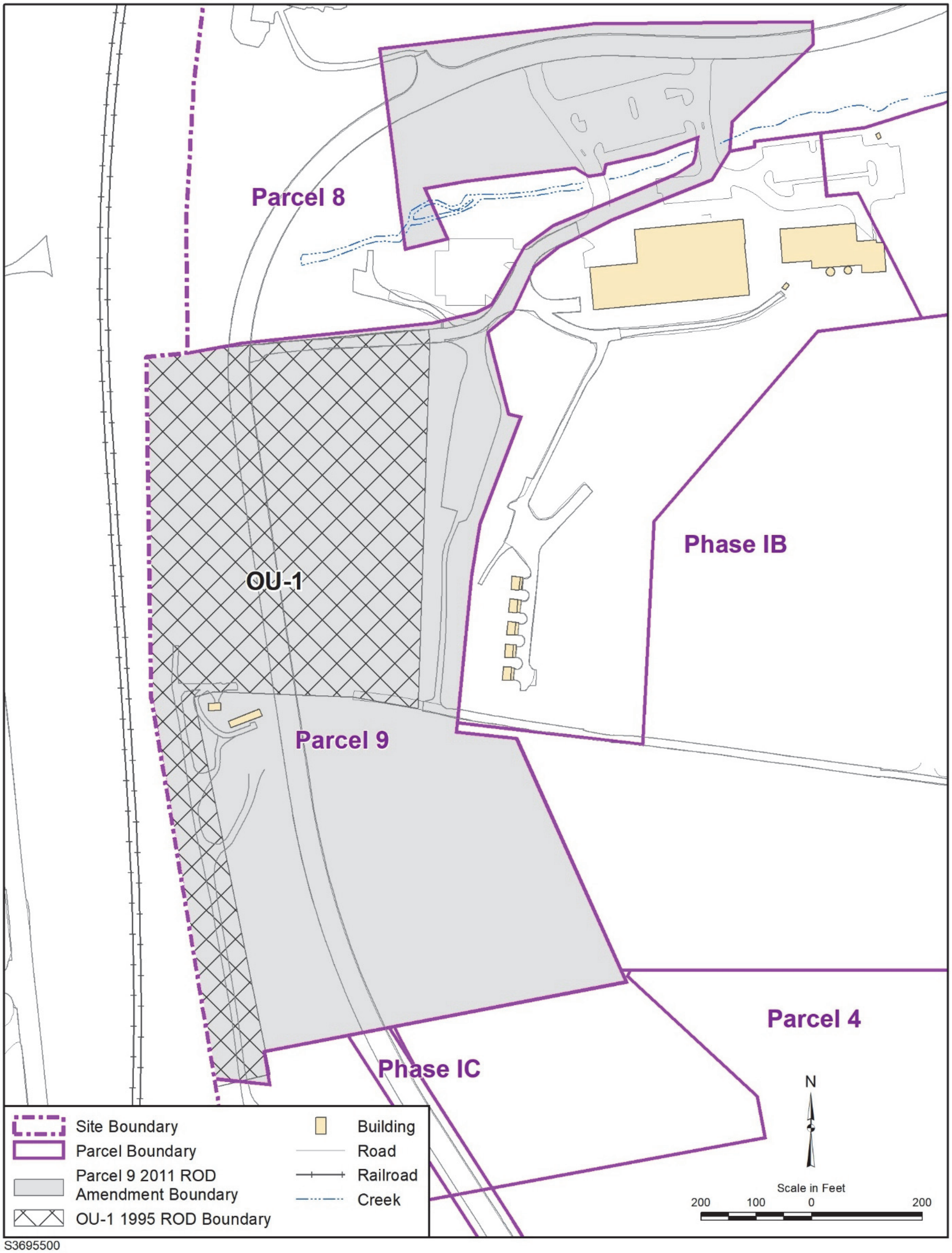

Figure 3. OU-1/Parcel 9 Map

When the 1995 OU-1 ROD was signed (DOE 1995), it called for the collection and treatment of contaminated groundwater and the disposal of treated water to prevent the VOCs in OU-1 groundwater from being captured by the Mound Plant production wells or future wells. Eight organic chemicals and four radiological constituents were retained as contaminants of concern (COCs) in groundwater in OU-1. These COCs with associated preliminary remediation goals (PRGs) listed in Table 8 of the 1995 OU-1 ROD are as follows:

- 1,2-dichloroethane (DCA) (0.1 micrograms per liter [µg/L])
- *cis*-1,2-dichloroethene (cDCE) (60 µg/L)
- Chlordane (alpha) (0.06 µg/L)
- Tetrachloroethene (PCE) (5 µg/L)
- Carbon tetrachloride (listed as tetrachloromethane) (0.2 µg/L)
- Trichloroethene (TCE) (2 µg/L)
- Chloroform (listed as trichloromethane) (2 µg/L)
- Vinyl chloride (VC) (1 µg/L)
- Actinium-227 (^{227}Ac) (2 picocuries per liter [pCi/L])
- Plutonium-238 (^{238}Pu) (0.2 pCi/L)
- Plutonium-239 and ^{240}Pu (0.6 pCi/L)
- Tritium (3000 pCi/L)

A P&T system consisting of three extraction wells and an air stripper began operation in 1997. These wells created a capture zone that hydraulically contained and collected the contaminated groundwater originating from beneath the former OU-1 landfill and prevented it from impacting the groundwater that was used as a drinking water source for the Mound Plant. Extracted groundwater was treated onsite using an air stripper before being discharged to the Great Miami River. All extracted groundwater was treated to levels that complied with the requirements of the CERCLA Authorization to Discharge (ATD). The pathways of concern for exposure were leaching of contaminants from site soils or disposed wastes to groundwater, transport in the groundwater flow, and withdrawal by the Mound Plant production wells or by other future wells. At the time the 1995 OU-1 ROD was signed, excavation and treatment of the residual subsurface contaminants within the OU-1 area was not considered practicable given the diffuse nature of contamination and lack of any identifiable contamination hot spots. DOE, EPA, and Ohio EPA determined the soils within the OU-1 area would not pose an unacceptable risk to future outdoor industrial workers if appropriate ICs (e.g., fencing and signage) were left in place. The selected remedy in the 1995 OU-1 ROD included surface water controls to reduce infiltration into the landfill and ICs to limit site access and restrict access to minimize contact with soils.

2.3 Additional Investigations and Removal Actions

In addition to the operation of the P&T system, a significant number of investigations and additional source removal activities have been performed since the 1995 OU-1 ROD remedy was implemented in 1996. The following sections provide a brief description of the activities and resulting conclusions. The focused FS (DOE 2021) provides information and references in greater detail.

2.3.1 Groundwater Extraction and Treatment (1996–2014)

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.

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 (as detailed in Section 2.3.9). 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 enhanced attenuation of VOCs in groundwater will be approved in a second amendment to the 1995 OU-1 ROD.

2.3.2 Excavation of VOC Contaminated Soils (1996)

Two areas along the western boundary of the former landfill were excavated in 1996 because of the suspected presence of VOC contamination in soil (Figure 2). Potential release site (PRS) 409was the site of a buried concrete pad that historically was used as a staging area for drums containing Stoddard solvent and PRS 410 was a suspected diesel fuel contaminated soil area that was identified based on surface soil staining and odor. Both areas were encountered during excavation activities associated with the installation of a 96-inch stormwater pipe along the western boundary of the former landfill area.

PRS 409 is a suspected contaminated soil area that was excavated in 1996. The area was sampled to identify the concentrations of organic compounds and radiological constituents remaining in soil (DOE 1997a). The area was backfilled after completion of construction activities and a portion of the concrete pad and associated contaminated soil may have remained beneath the adjacent roadway. In 1997, PRS 409 was designated (binned) as an area where additional response action would be required to address the remaining contamination. In September 2004, it was confirmed that the concrete pad had been completely excavated in 1996, and through additional sampling, it was determined that the full extent of contamination had been removed. The sampling results showed that concentrations of organic compound in soil were not greater than the cleanup objectives that are protective for commercial/industrial land use exposure scenarios. However, these cleanup objectives did not include protection of groundwater. Based on these data, a No Further Action (NFA) recommendation was approved by the Mound Core Team in 2005 (DOE 2006).

PRS 410 is where stained soil was encountered approximately 8 inches below grade in the southwestern corner of the former landfill area. To support completion of a stormwater drainage project, the soil was sampled, excavated, and the area backfilled in 1996. Sample results indicated that elevated total petroleum hydrocarbons were present and field screening of the area detected no radioactive contamination (DOE 1997b). In 1997, PRS 410 was designated (binned) as an area where additional response action would be required because the area had not been verified after excavation was completed. In May 2004, characterization sampling was performed to support the removal of soil from PRS 410. The characterization results indicated that concentrations of VOCs were below the cleanup objectives for soil established to be protective for commercial/industrial land use exposure scenarios but were not developed to be protective of groundwater. Based on these data, an NFA recommendation was approved by the Mound Core Team in 2004 (DOE 2005).

2.3.3 Soil Vapor Extraction (1997–2003)

A SVE system was installed in 1997 and operated until 2003 to accelerate the removal of chlorinated VOCs from the vadose zone. This system was voluntarily installed and operated by DOE and resulted in the removal of approximately 1862 kilograms of TCE, with 90% of the removal occurring within the first 3 years (DOE 2006). Operation of the SVE system was discontinued in 2003 because the mass of TCE removed became negligible, and the system was removed in 2007.

2.3.4 Rebound Study (2003–2004)

A rebound test (DOE 2005) was performed from May 2003 through February 2004. The test was stopped and the P&T system was restarted because predetermined VOC threshold concentrations were measured in a nearby downgradient well. Because this test was performed before the landfill was removed, materials in the landfill provided a VOC source to groundwater. It was concluded from this initial rebound study that increases and decreases in the VOC concentrations in groundwater may have been linked to rises in the groundwater table rather than being caused by a classic rebound of concentrations over time. During the test period, high groundwater levels were measured that were attributed to exceptionally high river stages. It was concluded that increases in VOCs were observed in the wells coincident with the high groundwater levels and resulted from groundwater coming in contact with impacted material in the landfill.

2.3.5 Excavation of Radiologically Contaminated Materials (2005)

PRS 11, also known as Area 2 and the Crushed Drum Area, was in the southwest portion of the OU-1 landfill. Approximately 2500 empty drums had been crushed in place and covered with soil. These drums had previously contained thorium process materials used for thorium projects in the 1960s. This location also contained buried wood ash and debris from a fire that burned polonium-contaminated flooring and sand from the Manhattan Project Dayton Unit (Area 13). This area of polonium- and thorium-contaminated soil and waste within the landfill footprint was further characterized, and a determination was made to remove it. Excavation of approximately 14,978 cubic yards (yd^3) of contaminated soil and debris was completed in 2005.

2.3.6 OU-1 Landfill Excavation (2007–2010)

Mound Development Corporation lobbied Congress for funds to remove the remaining onsite landfill to help market the property. In 2007, DOE received funding from Congress to perform non-CERCLA removal actions at OU-1 to excavate the site sanitary landfill. In 2009, DOE received funding through the American Recovery and Reinvestment Act to complete final excavation and site restoration activities. Excavation of the landfill occurred intermittently from 2007 through 2010, resulting in removal of most of the VOC source.

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

The three original extraction wells, which were installed within the footprint of the landfill, were removed during excavation in 2007 to accommodate the excavation of contaminated soil and debris from the landfill area. Two new extraction wells were installed in 2007 along the southern boundary of the landfill immediately outside the compliance boundary, and the P&T system was restarted to reestablish hydraulic containment of the impacted groundwater. The former OU-1 landfill area was backfilled to grade with clean soil after each excavation activity.

2.3.7 Rebound Study (2011)

After completion of the landfill excavation, a second rebound study was performed from June to December 2011 (DOE 2014). Data were collected to evaluate the changes in VOC concentrations in the monitoring network and changes in groundwater flow when the P&T system was not operating. Samples were collected at locations and frequencies that allowed adequate time to prevent unacceptable migration of VOC in groundwater. Water-level measurements were made to determine groundwater flow directions and changes caused by seasonal events. These data were to be used to determine if the existing monitoring network was adequate to detect migration of the VOC-impacted groundwater. Trigger values were set for locations downgradient of the compliance boundary and used to determine whether additional sampling was necessary, if new wells should be installed, or if the P&T system needed to be turned back on to prevent unacceptable migration of VOC-impacted groundwater. Triggers were set at levels that would allow the test to run for as long as possible without negatively impacting groundwater quality.

The study was designed so data from the rebound study could be used to determine the feasibility of implementing monitored natural attenuation (MNA) to address the residual VOCs in groundwater and the adequacy of the existing monitoring network to support an MNA remedy. If contaminant and groundwater behavior monitored during a rebound test met the following conditions, MNA would be evaluated as a viable alternative for groundwater in the OU-1 area:

- Decreasing trends in source area wells
- Stable concentrations that do not exceed the trigger values in the capture zone wells
- Concentrations lower than the trigger values in the downgradient wells
- Existence of a network deemed adequate for monitoring or that would be adequate with the installation of additional well locations identified from monitoring data (from wells or Geoprobe samples)

The rebound test was stopped in December 2011 when VOC concentrations in two downgradient boundary locations exceeded the maximum contaminant level (MCL) of 5 micrograms per liter (µg/L) for TCE (i.e., the predetermined threshold). Results from this most recent rebound study indicated that impact exceeding the MCL is present downgradient of the hydraulic barrier created by the extraction well system. VOC concentrations in wells near the landfill increased gradually but did not reach threshold values that would have prompted a restart of the P&T system.

2.3.8 Additional VOC Characterization (2011–2013)

Before the P&T system was restarted in December 2011, a large-scale groundwater sampling campaign was performed using push-point samplers to determine the areal extent of VOC impact in the OU-1 area. Push-point sampling had been performed periodically to evaluate the movement of VOC-impacted groundwater south of the extraction well system during the rebound study. This larger sampling event included an additional sample location downgradient of the P&T extraction wells capture zone.

Data from the existing monitoring wells and push-point locations collected in December 2011 were used to provide the distribution of TCE in groundwater at the end of the 2011 rebound study. The distribution indicated that areas of higher impact remained present in groundwater beneath the southern part of the former landfill. Elevated concentrations of TCE greater than the MCL were also measured in two push-point locations and a newer well (0451) outside the hydraulic capture of the P&T. The distribution of TCE in groundwater indicated that the source of impact in this area was not the residually impacted soil remaining within the landfill (DOE 2014).

Available information and data regarding VOC occurrence in the OU-1 area and upgradient areas to the north and east that may have a hydraulic connection to the OU-1 area were reviewed to prepare a recommendation regarding the elevated VOCs discovered during the rebound study. The historical investigation and verification data did not indicate any known areas of VOC impact that had a large areal extent or concentrations that could constitute a significant source to groundwater in the OU-1 area. However, soil-gas samples and push-point groundwater samples were collected from three areas (a nearby utility trench, an area near new well 0451 that was continuously wet, and a historical excavation pit along the eastern boundary of the former landfill) that were evaluated as potential sources of or migration pathways for VOC-impacted groundwater.

The results from the soil-gas sampling and push-point groundwater sampling did not indicate the presence of a residual soil source or the introduction of VOC-impacted groundwater along the utility corridor or near well 0451. Soil-gas results along the eastern side of the landfill indicated a residual soil source starting approximately 20 feet (ft) below ground surface (bgs) and extending to the water table. The primary VOCs were TCE and cDCE. The push-point groundwater samples from this area indicated that residually impacted soil acts as a source to groundwater, resulting in TCE concentrations greater than the MCL and increased cDCE concentrations (DOE 2014).

2.3.9 OU-1 Enhanced Attenuation Field Demonstration (2012–2018)

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

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

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

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

2.3.10 Sitewide VI Assessment (2016–ongoing)

As part of the sitewide VI assessment, the locations of soil with detectable concentrations of vapor-forming constituents listed in the EPA Vapor Intrusion Screening Level (VISL) Calculator and initially identified in the residual risk evaluation (RRE) reports for each area were mapped to determine possible source areas (DOE 2019). The results indicated four major sets of contaminants (see Table 1) with detectable concentrations or concentrations greater than background in post-excavation soil samples. The distributions of these contaminants are predominantly centered on the former OU-1 landfill, with some sporadic detections south of the former landfill area. Figures showing the occurrence of these contaminant groups in the OU-1 area can be found in the *Vapor Intrusion Assessment: Phase I Preliminary Screening and Conceptual Model for the Mound, Ohio, Site* (DOE 2019). Detections south of the landfill were results from verification samples collected from shallow depths, typically 0–1 ft 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 occurs at depths of 15 to 20 ft bgs.

Table 1. Contaminant Groups in Soil

Grouping	Contaminants
VOCs	PCE, TCE, VC, 1,2-DCA, and 1,1,1-trichloroethane
BTEX	Benzene, toluene, ethylbenzene, and total xylene
Polycyclic aromatic hydrocarbons	Benz[*a*]anthracene and naphthalene
Miscellaneous VOCs	2-butanone, 2-hexanone, carbon tetrachloride, and chloroform

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

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

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

Additional data from a soil-gas investigation that was conducted at the Mound site in early 2020 are documented in the *Vapor Intrusion Comparative Soil Gas Sampling Event at Former DOE Mound Facility* (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-DCA, PCE, TCE, and VC in soil-gas exceed risk-based screening levels. PCE, TCE, and VC concentrations also exceed the threshold levels in some locations.

2.4 Current Site Characteristics

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.

2.4.1 Groundwater

The results of the updated risk evaluation (DOE 2022) identified four contaminants remaining in groundwater that could pose a risk to human health and the environment. The COCs in groundwater are as follows:

- PCE
- TCE
- cDCE
- VC

Figure 4 illustrates the extent of residual VOC groundwater impact (greater than 1 µg/L) measured during 2019 and identifies specific wells where the concentrations of a VOC exceeded federal drinking water standards (MCLs) during at least one sampling event. Three discrete areas have VOC concentrations that exceed the MCLs, although concentrations were low. These areas are:

- Beneath the southwest corner of the former OU-1 landfill area (PCE and TCE greater than 5 µg/L and VC greater than 2 µg/L).
- Immediately downgradient of the former OU-1 landfill area (TCE greater than 5 µg/L).
- Downgradient of the hydraulic capture zone of the extraction wells (TCE greater than 5 µg/L and VC greater than 2 µg/L).

The areas of groundwater contamination resulted from VOCs in the landfill soil and wastes leaching into the underlying groundwater, releases caused by excavation of the landfill, and operation of the P&T system that resulted in bisecting the plume. The area of VOC groundwater impact downgradient of the hydraulic barrier created by the extraction wells was held in place because the barrier maintained through extraction wells operation limited recharge and created low hydraulic gradients.

2.4.2 Vapor Intrusion

Review of the available soil-gas vapor data from the OU-1/Parcel 9 area indicates that some locations exceed the suggested target concentrations of 1×10^{-6} ELCR and 0.1 HQ for noncancer risk calculated for several VOCs using an industrial/commercial risk-based scenario (EPA 2015). Several areas within the OU-1 landfill footprint have concentrations of VOCs (primarily TCE and VC) that exceed screening 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). 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 5. 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 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 6 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 on the figure.

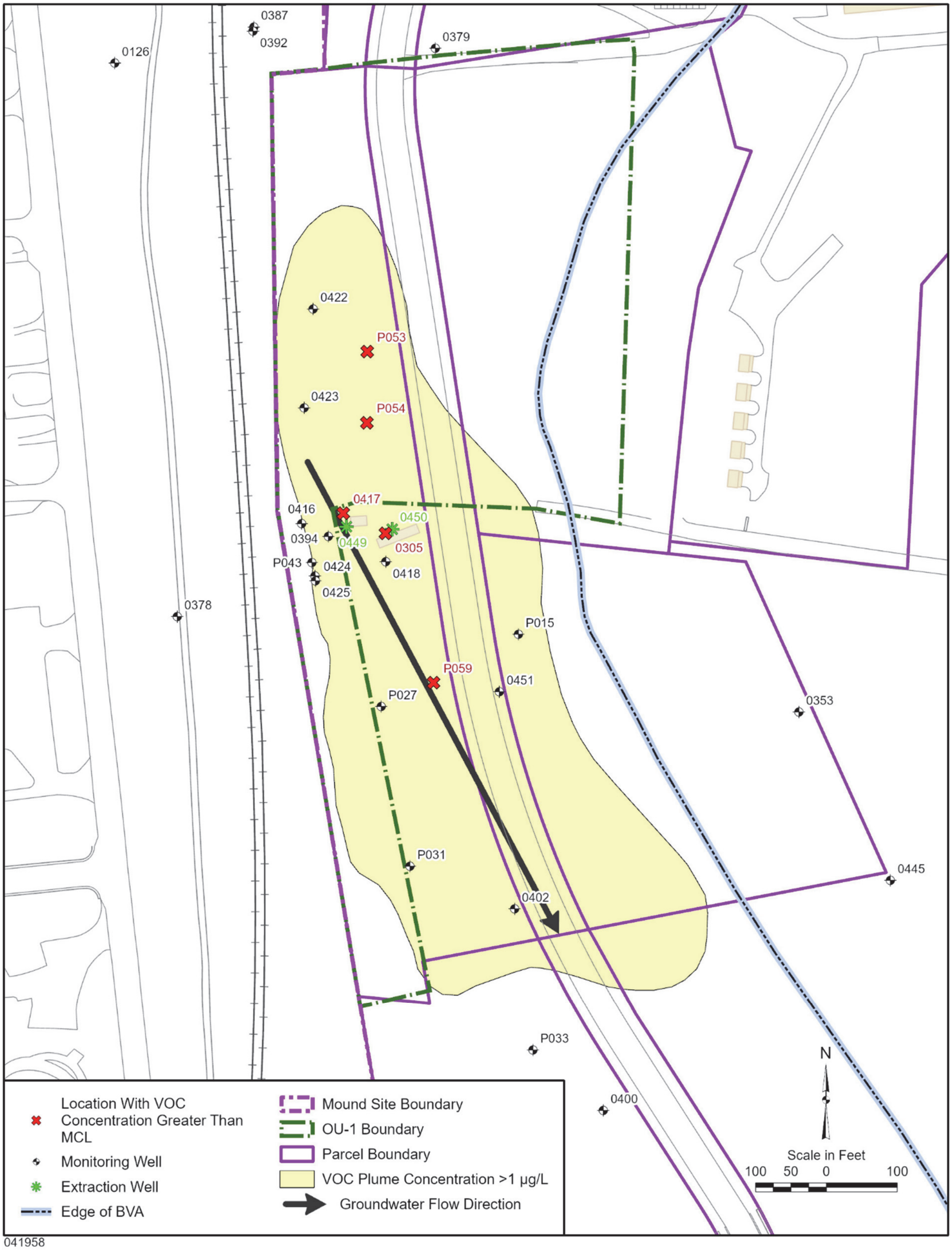

Figure 4. Locations with VOC Concentrations Greater Than MCL

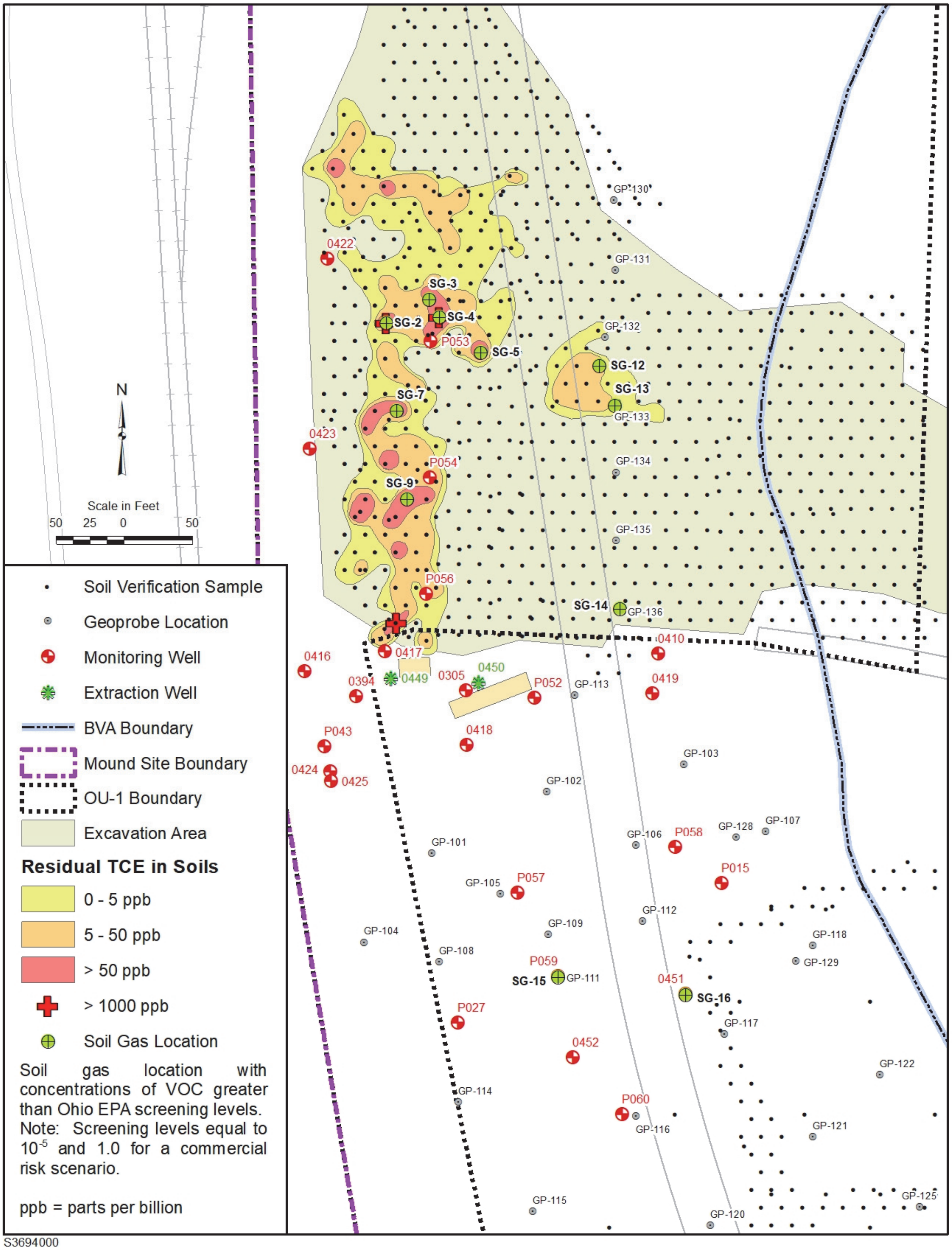

Figure 5. Occurrence of TCE in Soil and Soil-Gas in the OU-1 Landfill Area

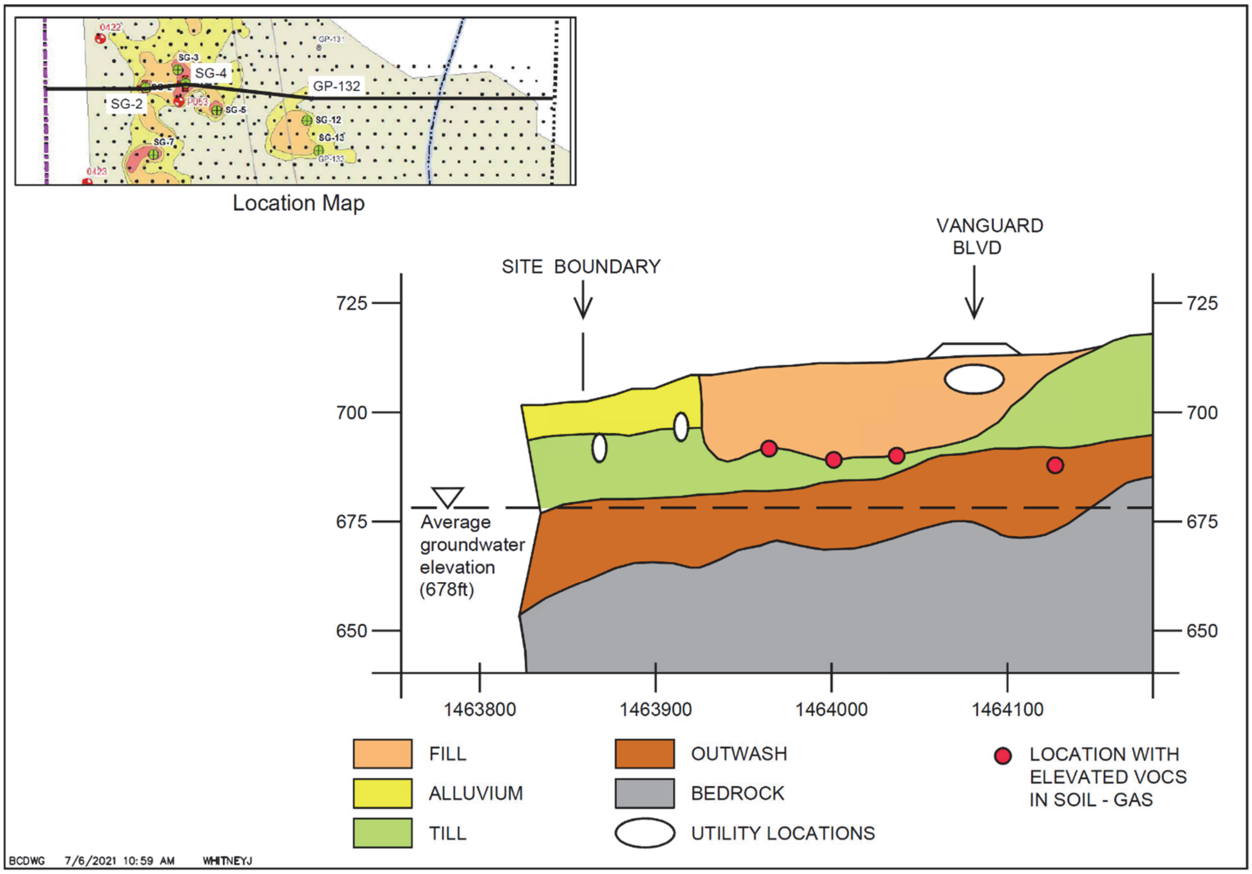

Figure 6. Generalized Cross Section Through OU-1 Landfill

2.5 Current Remedy

The current remedy for OU-1 is collection and treatment of contaminated groundwater and disposal of treated water contaminated with VOCs, which presented the principal risk concern (DOE 1995). All extracted groundwater is treated to levels that comply with the requirements of the CERCLA ATD. Extraction wells were installed to provide hydraulic capture along the compliance boundary, which is outside (south and west) of the road that bounded the former site sanitary landfill (Figure 2), as identified in the 1995 OU-1 ROD (DOE 1995). When operating, these wells create a capture zone that hydraulically contains and collects the contaminated groundwater originating from beneath the former OU-1 landfill. Extracted groundwater is treated onsite using an air stripper before being discharged to the river. The selected remedy in the 1995 OU-1 ROD also included surface water controls to reduce infiltration into the landfill and ICs to limit site access and restrict access to minimize contact with soils. Presently the P&T system has been placed in standby mode to support an ongoing field demonstration to assess enhanced attenuation as a viable alternative to hydraulic containment. Discontinuing operation of the P&T system to conduct the field demonstration was approved by EPA and Ohio EPA.

In 2007, the three original OU-1 P&T extraction wells were removed to allow excavation of the OU-1 landfill. Two new extraction wells were installed south of the landfill to provide hydraulic containment of the impacted groundwater. Surface water controls were modified during that time to direct water away from the excavation area. Also, the pond on the north end of the OU-1 landfill area was removed to allow excavation below the pond footprint. The OU-1 landfill, including the pond area, was backfilled to allow future reuse. Under the *OU-1 Operations and Maintenance Plan* (DOE 2000), which has been incorporated into the more recent *Operations and Maintenance Plan for the U.S. Department of Energy Mound Ohio Site* (O&M Plan) (DOE 2015), wells were sampled quarterly and analyzed for VOCs. A more frequent groundwater monitoring program has been implemented since 2007 in response to changes observed during and after the landfill excavation.

Since the landfill has been removed, access restriction and fencing have been removed, and Vanguard Boulevard was routed through the OU-1 area. ICs that control land and groundwater use were selected in the 2011 OU-1 ROD Amendment (DOE 2011a) and implemented via the Parcel 9 *Environmental Covenant* (DOE 2012). The ICs for Parcel 9 are consistent with sitewide ICs previously identified for other portions of the Mound site and include the following:

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

3.0 Rationale for Amending the 1995 OU-1 ROD

Subsequent investigations determined that the VOC concentrations in groundwater outside the OU-1 compliance boundary were higher than expected and in several locations exceed the MCL for TCE and 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/Parcel 9. The current configuration of the P&T system was not considered in the focused FS for this reason.

After the focused FS 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 and potential remedial alternatives. An addendum to the FS was prepared and presents information pertaining to VI in OU-1 and Parcel 9. 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.

4.0 Scope and Role of the Proposed Alternatives

This Proposed Plan 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 preferred 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 preferred 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 toxicity, mobility, and volume of contaminants in groundwater. The preferred 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 preferred VI alternative is to provide a cost-effective and permanent solution to the potential risk to future building occupants from vapor-forming chemicals present in the vadose zone in OU-1/Parcel 9. Although it will not reduce the toxicity or volume of the contaminants, the preferred 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. Currently, no permanent buildings are designed for occupancy in the OU-1 area. The data used to evaluate the VI risk are limited in scope (i.e., small dataset in area of known highest impact in the former landfill footprint).

5.0 Summary of Risks

As part of the RI and FS process for OU-1 and Parcel 9, an initial baseline risk assessment was completed in 1994 (DOE 1994) and then two subsequent 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. The reasonable and anticipated future land use for OU-1/Parcel 9 is commercial/industrial based on several ICs in place for the Mound site. One IC specifically restricts land use to industrial/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. This included assessing residual contamination remaining in soil, groundwater, and subsurface vapors. After completion of the landfill excavation in 2010, an RRE was prepared for Parcel 9 to document the risks from exposures to residual contamination remaining in soil. 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. The most recent risk evaluation (DOE 2022) 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 protectiveness if contaminants were to move offsite or if restrictions were removed in the future that could result in the use of groundwater. The risk from potential future exposure to vapors found in the vadose zone if a complete exposure pathway was present was also evaluated. It is DOE's current judgement that the preferred alternative identified in this Proposed Plan 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 7) 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* (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 did not consider the exposure of site or construction workers to vapors emitted from contaminated soil or groundwater. The exposure of site and construction workers to vapors emitted from contaminated soil can be considered complete. The exposure of site and construction workers to vapors emitted from contaminated groundwater is considered to be incomplete because groundwater is typically greater than 25 ft bgs (DOE 2021).

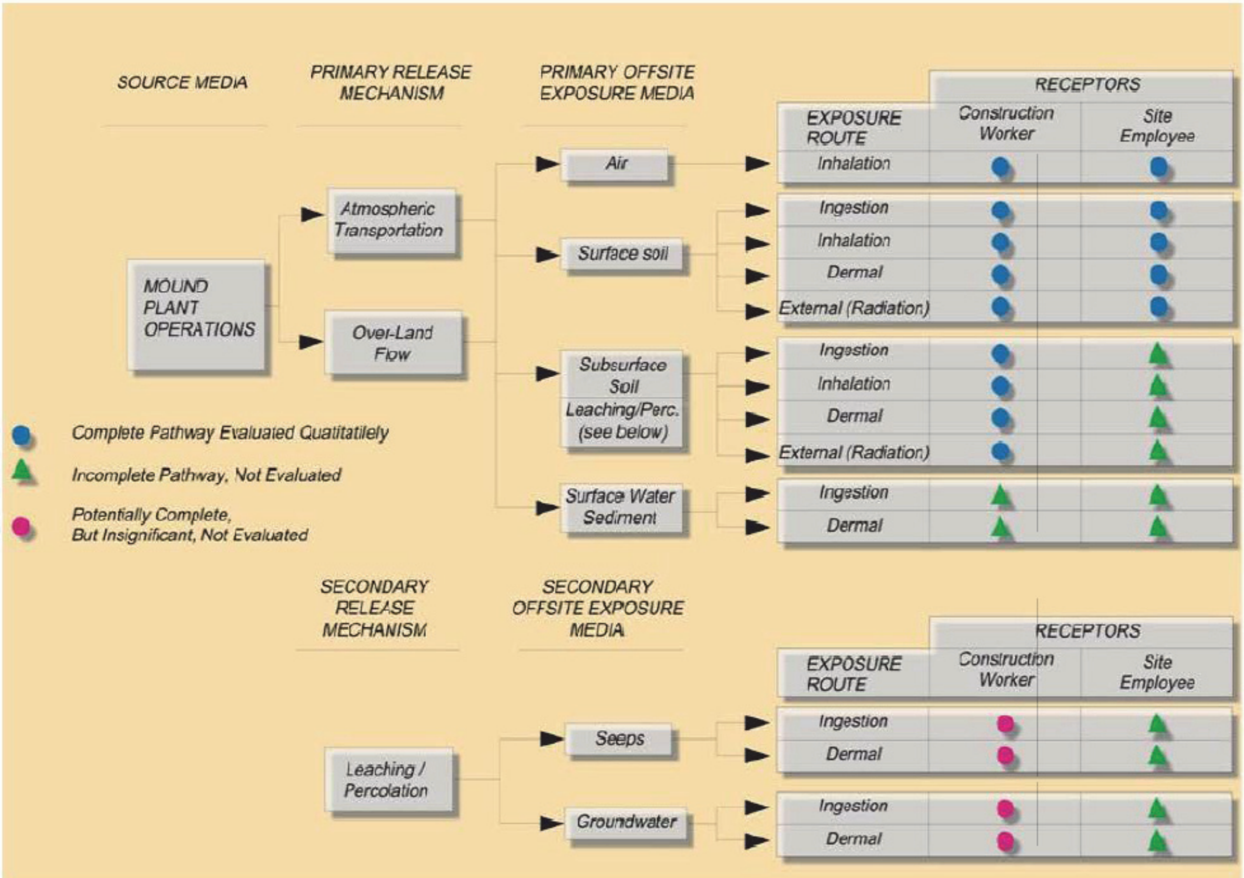

Figure 7. Conceptual Site Model for OU-1/Parcel 9

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 of potential concern (COPCs) and for all COPCs. 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 million), 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 (Ohio EPA 2009). If the HI is greater than 1, 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 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.

5.1 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 this groundwater remedy review. 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 million) 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.

5.2 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 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 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 is currently being 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 a 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

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 FS (DOE 2022) for a hypothetical resident using groundwater. The result of the risk evaluation indicates the following:

- The reasonable carcinogenic risk from the COPCs (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 COPCs is 0.56, which is less than the HI goal of 1.0, indicating 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.

5.3 Vapor Intrusion

Review of the available soil-gas vapor data from the OU-1/Parcel 9 area indicates that concentrations of VOCs in the subsurface could result in an unacceptable risk to site workers if a complete exposure pathway into a building was present. There are no buildings in Parcel 9, but the area is zoned as commercial/industrial and construction and occupancy of buildings is likely in the near future. Soil-gas vapor data from some locations exceed the suggested target concentrations for $1{\times}10^{-6}$ ELCR and 0.1 HQ for noncancer risk calculated using an industrial/commercial risk-based scenario (EPA 2015). Several areas within the OU-1 landfill footprint have concentrations of VOCs (primarily TCE and VC) that exceed screening values that equate to $1{\times}10^{-5}$ 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 limits the likelihood for 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 contact if it were to occur was considered insignificant and was not further considered.

6.0 Remedial Action Objectives

Remedial Action Objectives (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 for groundwater and VI that were identified for Parcel 9 based on the summary of risks for current and future exposure scenarios. Typically, PRGs are selected using either risk-based, conservative screening values used to identify areas and COPCs that may warrant further investigation and provide risk reduction targets or regulatory established value that have been determined to be applicable or relevant and appropriate requirements (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.

6.1 Groundwater

The RAOs for the current groundwater remedy identified in the 1995 OU-1 ROD (DOE 1995) are to:

- To protect human health, the objective is to prevent ingestion of water with contaminant concentrations more than the remediation goal of 1×10^{-4} aggregate ELCR for chemical and radiological risk combined.
- To protect environmental health, the objective is to reduce contaminant concentrations (to PRGs) throughout the VOC plume (both former landfill and downgradient), thereby restoring the groundwater to beneficial use.
- To protect human health, the objective is to prohibit groundwater with contaminant concentrations greater than the PRGs from moving outside the Parcel 9 boundary.

The proposed 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 proposed PRGs provided in Table 2.

Table 2. Preliminary Remediation Goals for Groundwater in OU-1

Contaminant (µg/L)	Risk-based Comparison Value[a]	Regulatory Limits	Maximum Concentration[b]	Proposed PRG	Lifetime Risk at Proposed PRG
PCE	11.3	5.0	5.82	5	4.4×10^{-7}
TCE	0.49	5.0	7.37	5	1.0×10^{-5}
cDCE	36.1	70.0	32.2	50.0	HI = 1
VC	0.019	2.0	14.2	1.0	5.3×10^{-5}
TOTAL					6.3×10^{-5}

Notes:

[a] Risk-based comparison value equates 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.

The PRGs for the proposed remedy will focus on those contaminants that could still pose a risk to human health and the environment based on the results of the updated risk evaluation. These values are similar to those presented in the 1995 OU-1 ROD for these same contaminants in groundwater and changes are due to updated risk characterization parameters. It is assumed that all carcinogens are additive, and for the purposes of establishing the PRGs, the combined carcinogenic risk cannot exceed 1×10^{-4}, but conservative PRGs have been set to maintain an ELCR closer to 1×10^{-5}, which is consistent with the Ohio EPA target risk.

The 1995 OU-1 ROD identified eight organic chemicals and four radiological constituents that were retained as COCs in groundwater in OU-1. The list of contaminants included PCE, TCE, cDCE, and VC. Several other VOCs (1,2-DCA, chlordane [alpha], carbon tetrachloride, and chloroform) and four radiological constituents (^{227}Ac, ^{238}Pu, ^{239}Pu, ^{240}Pu, and tritium) were also included as preliminary COCs in the 1995 OU-1 ROD. These additional VOCs and radiological constituents were screened out from further consideration as COCs based on more current data used in the updated risk evaluation (DOE 2022).

6.2 Vapor Intrusion

The RAO for the VI remedial alternatives in OU-1 is to mitigate potential health risks from contaminated vapor to future building occupants within OU-1/Parcel 9 by eliminating the VI pathway. There are no permanent buildings within the area of interest in OU-1/Parcel 9; therefore, there are no potential 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 excess cancer risk or 0.1 total HQ concentrations.

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 intrude into structures either through diffusion from sources or preferential migration through existing or future utility conduits. The performance goals of each contaminant are based on industrial/commercial use risk scenarios for indoor air based on an ELCR of 1×10^{-5} and HQ of 1.0 for industrial/commercial land use.

There are no federal or state ARARs for VI. However, guidance documents provided by both EPA (EPA 2015) and Ohio EPA (Ohio EPA 2020a) contain elements that are "to be considered" for selecting an approach to meet remedial objectives. Table 3 outlines PRGs that should be used to confirm the effectiveness of preemptive measures or actions. 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 8 depicts the geographic area (shaded blue) within Parcel 9 where PRGs would apply. This area does not include the northern portion of Parcel 9, which is being evaluated under the ongoing sitewide VI assessment.

Table 3. Indoor Air PRGs for VI in Parcel 9

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

Notes:
Levels are risk-based concentrations developed using the VISL Calculator; each is based on the specific ELCR and noncancer HQ of 1×10^{-5} and 1.0, respectively.
Calculated using the VISL Calculator on June 30, 2021.

Abbreviation:
µg/m^3 = micrograms per cubic meter

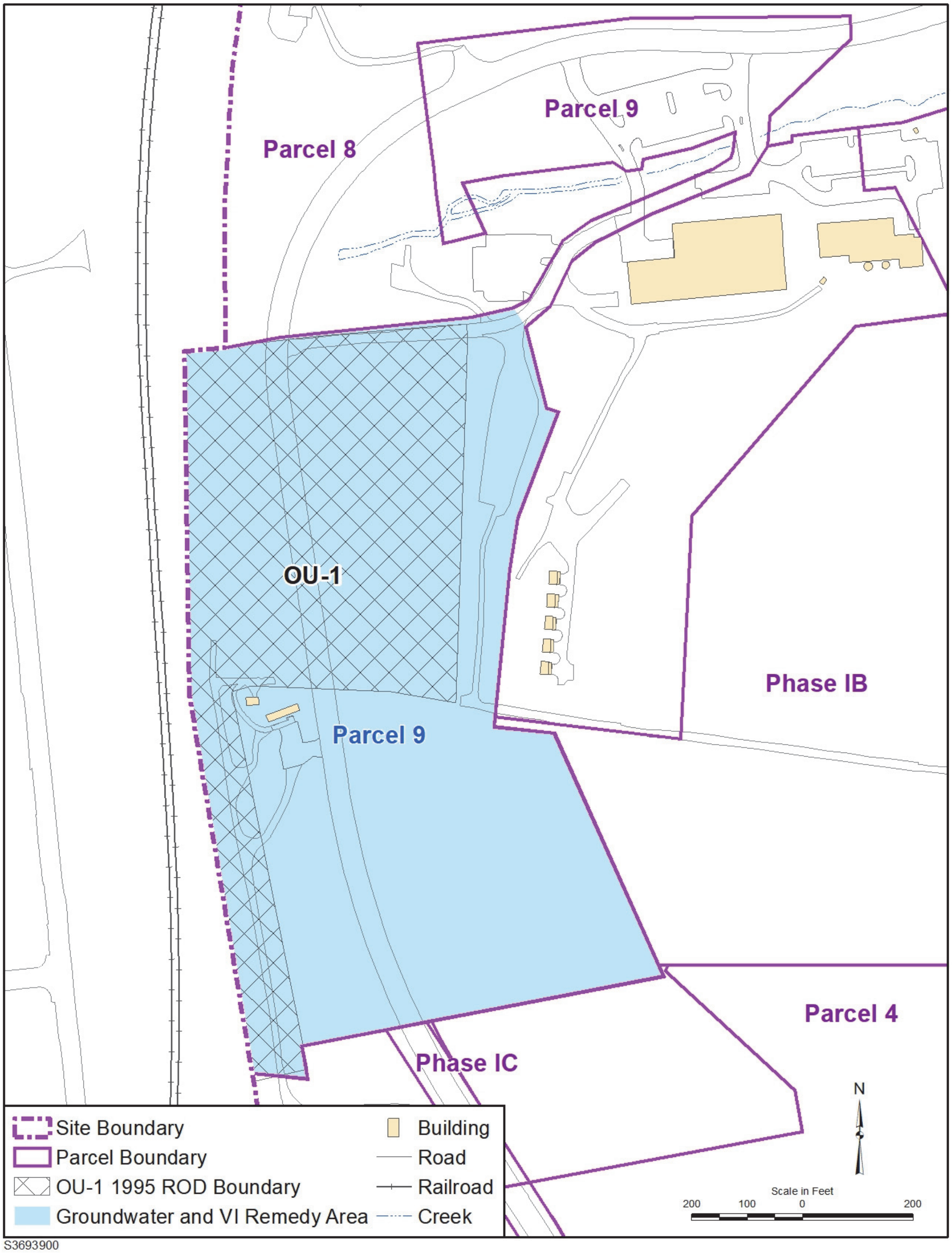

Figure 8. OU-1 Groundwater and VI Remedy Area

7.0 Summary 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 FS (DOE 2021).

The preferred alternatives to address residual VOC contamination are:

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

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.

7.1 Groundwater 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: P&T 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/commercial
- Allow federal and state agencies site access for sampling and monitoring

7.1.1 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 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 of 35 wells would be decommissioned.

7.1.2 Alternative GW–2: P&T 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 2014). 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 ATD. Sampling would be performed in a set of wells to monitor concentrations within the VOC plume. It is anticipated that a network of 8 to 10 wells selected from the existing 35 wells in the OU-1 area can achieve adequate coverage. Alternative 2 is expected to result in the attainment of MCLs and a reduction in 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. 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. 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 2014) 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.

7.1.3 Alternative GW–3: Monitored Natural Attenuation with ICs

The estimated costs for Alternative GW–3 are:

- 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) to monitor VOC concentrations in the downgradient portion of the plume to ensure plume expansion is not occurring. It is anticipated that a network of 8 to 10 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 toxicity, mobility, and volume of contaminants in groundwater. 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.

7.1.4 Alternative GW–4: Enhanced Attenuation with Monitoring and ICs

The estimated costs for Alternative GW–4 are:

- 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

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) for monitoring VOC concentrations in the downgradient portion of the plume to ensure plume expansion is not occurring. It is anticipated a network of 12 to 15 monitoring wells can achieve adequate coverage. Under this alternative, treatment associated with the new amendment to the 1995 OU-1 ROD, 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 toxicity, mobility, and volume of contaminants in groundwater. It was estimated that MCLs could be reached by design time frame of 2027 and current data trends supports that the timeframe 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.

7.2 VI 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/commercial
- Allow federal and state agencies site access for sampling and monitoring.

7.2.1 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 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.

7.2.2 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. Currently, there are no potential receptors to vapor, and prohibiting any new construction would protect future property users. This alternative does not reduce 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.

7.2.3 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 building. This alternative does not reduce 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 (Section 2.3) and the remaining residual contamination is being addressed by other remediation actions (Section 7.1). Alternative VI–3 allows new construction in the Parcel 9 area with the installation of preemptive measures or performing actions to prohibit exposure of building occupants to vapors. The measures of actions 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/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 COPCs 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 doing one of the following:

- Incorporating adequate engineering controls during construction of any new building and ensuring continued operation, maintenance, and testing to assure the controls are effective in the long term
- Providing sufficient information to demonstrate that the VI pathway is incomplete and engineering controls are not necessary

The above information would 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 actions would be documented in an environmental covenant (ORC 5301.80–5301.92). This covenant may contain restrictions for land use or occupancy status or may 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.

A future property owner can demonstrate that there is no risk from VI through sampling and evaluation data. This information would be provided to EPA, Ohio EPA, and DOE and must be approved before any construction. If the property owner can sufficiently demonstrate that the VI pathway is incomplete and there is no risk to building occupants from VI, then the mitigation remedy would not be required.

7.3 Comparative Analysis of Groundwater 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 4.

Table 4. 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 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 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 operation and maintenance 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.

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 with one another for each of the nine criteria analyzed. The results of the analysis are used to recommend a preferred remedial alternative.

7.3.1 Overall Protection of Human Health and the Environment

The goal of this criterion is to either eliminate the toxicity of VOC concentrations in groundwater or prevent exposure to human receptors. Alternative GW−1 does not include treatment of monitoring of contaminants in groundwater and would not provide information about the location of migration of the 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 drinking water standards.

7.3.2 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.

7.3.3 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, primarily by preventing exposure through ICs. Alternative GW−2 achieves additional long-term effectiveness by flushing residual VOC contamination from the aquifer. Alternatives GW−3 and GW−4 achieve additional long-term effectiveness by allowing ongoing natural attenuation to degrade VOCs in groundwater.

7.3.4 Reduction in Toxicity, Mobility, or Volume Through Treatment

Alternative GW−1 provides no reduction in toxicity, mobility, or volume of VOCs in groundwater. Alternatives GW−2, GW−3, and GW−4 achieve reduction in 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. Alternatives GW−3 and 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 toxicity and volume in 10, 5, and 2 years, respectively.

7.3.5 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.

7.3.6 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.

7.3.7 Cost

The estimated present worth costs ranked from lowest to highest are:

1. Alternative GW−1: No further action with ICs ($303,000).
2. Alternative GW−3: MNA with ICs ($371,000).
3. Alternative GW−4: Enhanced attenuation with monitoring and ICs ($843,000).
4. Alternative GW−2: P&T with monitoring and ICs ($1,200,000).

7.3.8 State Acceptance

Ohio EPA has had an opportunity to review and participate in evaluation of alternatives to address VOCs in OU-1/Parcel 9 groundwater and supports the selection of the preferred groundwater alternative presented in this Proposed Plan. Also, Ohio EPA concurred with the ICs established in the 2011 ROD amendment to maintain protectiveness.

7.3.9 Community Acceptance

The public will have an opportunity to review the preferred alternatives and provide comment to DOE. At the end of the public comment period, a responsiveness summary will be prepared and included with the ROD amendment that summarizes and responds to comments on the preferred alternative. Also, the public was provided formal opportunities to comment on the ICs established in the 2011 ROD amendment.

7.4 Comparative Analysis of VI Alternatives

In this section the potential remedial alternatives for VI are compared to one other against each of the balancing criteria analyzed in Table 4. Results of the analysis are used to determine a preferred remedial alternative.

7.4.1 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.

7.4.2 Compliance with ARARs

This criterion is used to determine if 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.

7.4.3 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 if 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.

7.4.4 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 in the vadose zone, but they do recognize that the majority 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.

7.4.5 Short-Term Effectiveness

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

7.4.6 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.

7.4.7 Cost

Cost is not discussed, 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. Annual costs to DOE for each of the alternatives include professional services, design, and IC maintenance and reporting that are applied to the Mound project as a whole and not broken out for each remedial alternative.

7.4.8 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 recommendation of the preferred alternative presented in this Proposed Plan.

7.4.9 Community Acceptance

The public will have an opportunity to review the preferred alternatives and provide comment to DOE. At the end of the public comment period, a responsiveness summary will be prepared and included with the ROD amendment that summarizes and responds to comments on the preferred alternative.

7.5 Preferred Alternative

Remedial alternatives were developed to address residual VOC contamination remaining in OU-1 and Parcel 9 at the Mound site. DOE proposes to amend the 1995 OU-1 ROD (DOE 1995) to modify the remedy that addresses VOCs in groundwater and to identify a remedial action to mitigate potential VI exposure to future building occupants. The preferred alternatives to address residual VOC contamination are:

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

7.5.1 Preferred Groundwater Remedy

Alternative GW–4 (enhanced attenuation with monitoring and ICs) is recommended as the preferred alternative to address VOC-contaminated groundwater in OU-1/Parcel 9. Alternative GW–4 will achieve all the RAOs and remediate groundwater throughout the plume within a reasonable time frame. From the evaluation using the CERCLA evaluation criteria, Alternative GW–4 presents the best balance of the criteria in addressing the risks in OU-1 groundwater. This alternative complies with ARARs, addresses all the 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.

7.5.2 Preferred VI Remedy

Alternative VI–3 (preemptive measures or actions to mitigate VI exposure with ICs) is recommended as the preferred alternative to address vapor-forming chemicals in the vadose zone in OU-1/Parcel 9. Alternative VI–3 will achieve all the RAOs by eliminating the VI pathway and preventing exposure to future building occupants. Although Alternative VI–3 does not reduce 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.

8.0 Statutory Determinations

Based on available information, DOE believes the preferred alternatives meet the threshold criteria and provide the best balance of tradeoffs among the other alternatives with respect to the balance and modifying criteria. EPA and Ohio EPA expect the preferred alternatives 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

9.0 Public Participation

The CERCLA process includes public input so that the selecting official can consider community input before selection of the remedy. In compliance with Section 117 of CERCLA and NCP Section 300.435(c)(2)(ii), this Proposed Plan presenting the proposed remedy change for OU-1 groundwater and the remedy to address VI in Parcel 9 will be published. The notice will indicate that a public meeting will take place on Wednesday, December 7, 2022, to explain the Proposed Plan and receive comments. The public comment period will begin on November 23, 2022, and close on December 23, 2022. Members of the public can attend the public meeting and participate in discussions of changes identified in this Proposed Plan.

Written comments, questions about the Proposed Plan or public meeting, and requests for information can be sent to:

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Public comments will be considered and presented with the discussion in the responsiveness summary of the forthcoming ROD Amendment. The public is encouraged to review the AR documents to gain a more comprehensive understanding of the Mound site and CERCLA activities that have been conducted. The AR can be accessed at https://www.lm.doe.gov/mound/Sites.aspx or at the Mound Cold War Discovery Center at 1075 Mound Road in Miamisburg, Ohio.

At the end of the public comment period on this Proposed Plan, a responsiveness summary will be prepared that summarizes and responds to comments on the preferred alternative. A formal decision document, the forthcoming ROD Amendment, will summarize the decision process and document selection of the remedy modification for the site and include the responsiveness summary.

10.0 References

40 CFR 300.430(f)(2). U.S. Environmental Protection Agency, "Remedial Investigation/Feasibility Study and Selection of Remedy," *Code of Federal Regulations*.

53 ORC 5301.80–5301.92. "Environmental Covenants," *Ohio Revised Code*.

42 USC 9617. "Public Participation," *United States Code.*

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Appendix A

Applicable or Relevant and Appropriate Requirements

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Regulation	Type	Regulation Application	Comments
Primary Drinking Water Rules OAC 3745-81	ARAR - Chemical	3745-81-11: Maximum contaminant levels and best available technologies for inorganic contaminants 3745-81-12: Maximum contaminant levels and best available technologies for organic contaminants 3745-81-27: Analytical techniques 3745-81-28: Acceptability of analytical results	Because of potential impacts to the BVA, this standard will be applied.
Safe Drinking Water Act 40 CFR 141	ARAR - Chemical	40 CFR 141.61: Maximum contaminant levels for organic contaminants 40 CFR 141.62: Maximum contaminant levels for inorganic contaminants	Compliance is specifically required by CERCLA 121(d), where relevant and appropriate. Because of potential impacts to the BVA, this standard will be applied.
Water Pollution Control ORC 6111	ARAR - Action	6111.04: Water pollution and sludge management violations prohibited	Pollution of waters of the state is prohibited. Pertains to any site that has contaminated onsite groundwater. Implementation of the substantive provisions of the state water requirements as ARARs as required by CERCLA 121 (d).
Underground Injection Control Program OAC Chapter 3745-34	ARAR - Action	3745-34-11: Class V wells 3745-34-16: Class V permit requirements 3745-34-18: Class V injection well area permits	If contingency actions (injection of additional oils or microbes) is required, implementation of the substantive provisions of the UIC requirements as ARARs as required by CERCLA 121(d).
Underground Injection Control Program 40 CFR 144	ARAR - Action	40CFR144.1: Purpose and scope of Chapter 144	The State of Ohio has primary enforcement authority for UIC activities. If contingency actions (injection of additional oils or microbes) is required, implementation of the substantive provisions of the UIC requirements as ARARs as required by CERCLA 121(d).

Water Well Standards OAC 3745-9	ARAR - Location	3745-9-08: Monitoring well	Regulation states the "Ohio EPA Technical Guidance Manual for Hydrogeologic Investigations and Ground Water Monitoring," or other standards adopted by the director, shall guide monitoring well construction and sealing to prevent the contamination of groundwater.

Abbreviations:
OAC = *Ohio Administrative Code*
ORC = *Ohio Revised Code*
UIC = Underground Injection Control