Final Main Installation Focused Feasibility Study Report

Defense Depot Memphis, Tennessee
U.S. EPA I.D. Number TN4210020570

July 2024

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Department of the Army

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Acronyms and Abbreviations

ARAR	Applicable or Relevant and Appropriate Requirement
AS	air sparging
bgs	below ground surface
BRAC	Base Realignment and Closure
cDCE	cis-1,2-dichloroethene
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CF	chloroform
CFR	Code of Federal Regulations
cm/s	centimeters per second
COC	constituent of concern
COPC	constituent of potential concern
CT	carbon tetrachloride
CVOC	chlorinated volatile organic compound
CY	cubic yard
DCE	1,1-dichloroethene
DDMT	Defense Depot Memphis, Tennessee
DPE	dual-phase extraction
e2M	engineering-environmental Management, Inc.
EBT	enhanced bioremediation treatment
ESD	Explanation of Significant Differences
ET&D	excavation, transport and off-site disposal
FDAQ	Fluvial Deposits Aquifer
FFA	Federal Facility Agreement
FFS	Focused Feasibility Study
FS	Feasibility Study
ft	feet/foot
ft/d	feet per day
GAC	granular activated carbon
GRA	General Response Action
HHRA	Human Health Risk Assessment
HHERA	Human Health and Ecological Risk Assessment
IAQ	Intermediate Aquifer
IC	institutional control
IRACR	Interim Remedial Action Completion Report
ISCO	in situ chemical oxidation
ISCR	in situ chemical reduction
IW	injection well
lb/hr	pounds per hour
lbs	pounds

LNAPL	light non-aqueous phase liquid
LTM	long-term monitoring
LUC	land use control
LUCIP	Land Use Control Implementation Plan
MAQ	Memphis Aquifer
MCL	maximum contaminant level
µg/L	micrograms per liter
µg/m^3	micrograms per cubic meter
MI	Main Installation
MIP	membrane interface probe
MNA	monitored natural attenuation
MW	monitoring well
N-C	North-Central
NAPL	non-aqueous phase liquid
NAVD	North American Vertical Datum of 1988
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NLUR	Notice of Land Use Restrictions
NPL	National Priorities List
O&M	operations and maintenance
OSHA	Occupational Safety and Health Administration
PCBs	polychlorinated biphenyls
PCE	tetrachloroethene
PCP	pentachlorophenol
PDI	Pre-Design Investigation
PID	photoionization detector
PMW	performance monitoring well
POTW	publicly owned treatment works
ppbV	parts per billion by volume
PPE	personal protective equipment
PRB	permeable reactive barrier
PRG	Preliminary Remediation Goal
psi	pounds per square inch
RA	remedial action
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
RI	Remedial Investigation
ROD	Record of Decision
ROI	radius of influence
RSL	Regional Screening Level
S-C	South-Central

scfm	standard cubic feet per minute
SCHD	Shelby County Health Department
SRI	Supplemental Remedial Investigation
SVE	soil vapor extraction
TBC	to be considered
TCE	trichloroethene
tDCE	trans-1,2-dichloroethene
TDEC	Tennessee Department of Environment and Conservation
THQ	target hazard quotient
TR	target risk
TTA	target treatment area
US	United States
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
UU/UE	unlimited use and unrestricted exposure
VC	vinyl chloride
VI	vapor intrusion
VISL	vapor intrusion screening level
VMP	vapor monitoring points
VOC	volatile organic compound
W-C	West-Central
WC	water column
ZVI	zero-valent iron

1 Introduction

1.1 Purpose and Organization of the Report

This Focused Feasibility Study (FFS) Report for the Main Installation (MI) of the former Defense Depot Memphis, Tennessee (DDMT) has been prepared to identify an appropriate alternative to the remedy selected in *Memphis Depot Main Installation Record of Decision* (MI ROD; CH2M Hill, 2001). The site is on the National Priorities List and the Department of the Army (Army) is operating as the lead agency for environmental remediation. This FFS was prepared under United States Army Corps of Engineers (USACE), Mobile District Contract W91278-16-D-0061, Task Order W9127819F0535. The environmental restoration program at DDMT is directed by the Army, Office of the Deputy Chief of Staff, G9, Installation Services Environmental Division, Base Realignment and Closure (BRAC) Branch. The regulatory oversight agencies are United States Environmental Protection Agency (USEPA), Region 4, and Tennessee Department of Environment and Conservation (TDEC). The USEPA Identification Number for DDMT is TN4210020570.

1.1.1 Purpose

This FFS is being submitted to update the *Main Installation Groundwater Feasibility Study Report* (MI Groundwater FS) (CH2MHILL 2000b). Specifically, the FFS has been prepared to:

- Review source areas, groundwater flow and contaminant extent based on site investigations, groundwater monitoring and remedial action over the past 20 years;
- Review remedial action objectives (RAOs) and evaluate remedial alternatives to address contamination from volatile organic compounds (VOCs) with impacts to subsurface soil vapor and groundwater; and
- Identify and perform an engineering and cost analysis of technologies and process operations to support a modification to the implemented remedy.

The FFS was prepared using data from the *2020 Supplemental Remedial Investigation* (2020 SRI; HDR, 2021), *Human Health and Ecological Risk Assessment* (HHERA; HDR 2020b), *Main Installation Source Areas Investigation* (SAI; e2M 2009) and DDMT long term monitoring and five-year review reports. Historical MI documents were also reviewed, including the *Main Installation Remedial Investigation Report* (2000 MI RI; CH2MHILL, 2000a), the MI Groundwater FS and the *Main Installation Remedial Design (*MI RD; CH2MHILL, 2004b).

This FFS has been conducted in accordance with Office of Solid Waste and Emergency Response Directive 9355.3-01, *Guidance for Conducting Remedial Investigation/Feasibility Studies under the Comprehensive Environmental Response, Compensation, and Liability Act* (USEPA, 1988) and *Department of Defense (DoD) Manual Number 4715.20*, *Defense Environmental Restoration Program [DERP] Guidance* (DoD, 2012).

1.1.2 Organization of the Report

This FFS report is comprised of four sections as described below.

- Section 1 – Introduction: Provides a brief summary of the supplemental investigation and risk assessment activities completed since the 2000 FS including a site description, site history, risk assessment update, nature and extent of contamination, and contaminant fate and transport.
- Section 2 – Identification and Screening of Technologies: Presents applicable or relevant and appropriate requirements (ARARs), preliminary remediation goals (PRGs) and RAOs for addressing human health posed by contaminants in soil vapor and groundwater, and general response actions (GRAs) for soil and groundwater; identifies areas in which GRAs might be applied; identifies and screens remedial technologies and process options; and identifies and evaluates technology process options to select a representative process for each technology type retained for further analysis.
- Section 3 – Development and Screening of Alternatives: Presents a range of remedial alternatives developed by combining the feasible technologies and process options. The alternatives are then refined and screened to reduce the number of alternatives that will be analyzed in further detail. This screening aids in streamlining the FS process while ensuring that the most promising alternatives are considered.
- Section 4 – Detailed Analysis of Alternatives: Provides the detailed analysis of each alternative with respect to the following seven National Contingency Plan (NCP; USEPA, 1994b) criteria: (1) overall protection of human health and the environment; (2) compliance with ARARs; (3) long-term effectiveness and permanence; (4) reduction of toxicity, mobility, or volume through treatment; (5) short-term effectiveness; (6) implementability; and (7) cost. A comparative analysis of alternatives is developed following the detailed analysis.

1.2 Background Information

1.2.1 Site Location

DDMT is located in southeastern Memphis, Shelby County, Tennessee, approximately 5 miles east of the Mississippi River and 2 miles north of Memphis International Airport (Figure 1). DDMT originated as a military facility in the early 1940s; supplies were received, warehoused, and distributed to all United States (US) military services and some civil agencies located primarily in the southeastern US, Puerto Rico, and Panama. Stocked items included food; clothing; petroleum products; construction materials; and industrial, medical, and general supplies. In 1995, DDMT was placed on the list of the Department of Defense facilities to be closed under BRAC. Storage and distribution of materiel continued until the facility closed in September 1997.

DDMT includes approximately 634 acres and consists of the MI and Dunn Field; an aerial photograph is shown on Figure 2. The MI covers approximately 567 acres and had open storage areas, warehouses, military family housing, and outdoor recreational areas. Dunn Field, which is located across Dunn Avenue from the north-northwest portion of the MI, covers approximately 67 acres and had mineral storage and waste disposal areas.

1.2.2 Land Use

All property on the MI has been transferred by the Army through public benefit or economic development conveyances. Transfer deeds for the MI restrict the property to industrial use, except for the former Administrative and Residential Areas along the eastern boundary, which are designated for unrestricted use.

The MI is primarily used for warehousing and logistics in the Memphis Depot Industrial Park and for operations at Barnhart Crane and Rigging (Barnhart). The former administrative area is used for Barnhart offices and parking and for the Memphis Police Department Airways Police Station. The former MI housing area is used by Alpha Omega Veterans Services (Alpha Omega) for veterans housing and support activities. Vietnam Veterans Association Chapter 1113 operates the golf course under a lease from the City of Memphis. MI property ownership and land use are shown on Figure 3. The MI is located in an area of mixed residential, commercial and industrial land use; the area zoning is shown on Figure 4.

1.2.3 Geology and Hydrogeology

1.2.3.1 Physiographic Setting

The Memphis area is located within two major subdivisions of the Coastal Plain physiographic province, the Gulf Coastal Plain in the east and the Mississippi Alluvial Plain in the west. The principal river in the area is the Mississippi River; the major tributaries are the Wolf River, the Loosahatchie River, and Nonconnah Creek. The MI is located approximately 3 miles east of the bluffs at the edge of the Mississippi Alluvial Plain. Ground surface at the MI is nearly level, with elevations generally from 290 to 305 ft; the highest point is at 312 ft along Dunn Avenue near the northwest MI and the lowest point is at 267 ft below the earthen dam for Lake Danielson on the golf course in the southeast MI.

There are no naturally flowing streams or creeks on DDMT. Site drainage occurs by overland flow via swales, ditches, concrete-lined channels, and a storm drainage system, which directs storm water into a series of storm drains for transport to discharge points around the perimeter (Figure 5). DDMT is generally level with or above surrounding terrain, so it receives little runoff from adjacent areas. Two surface water features are located on the MI, Lake Danielson and the Golf Course Pond; they serve primarily as drainage reservoirs.

Groundwater is at a depth of approximately 54 to 95 ft below ground surface (bgs) in the water-table aquifer on the MI and does not discharge to surface water in the immediate area of DDMT. There is no apparent effect on groundwater elevations from surface water features on the MI.

1.2.3.2 Geology

The geologic units of interest at DDMT are (from youngest to oldest): loess, including surface soil; fluvial deposits; Jackson Formation/upper Claiborne Group (Jackson/upper Claiborne); and Memphis Sand.

1.2.3.2.1 Loess

The loess consists of wind-blown and deposited brown to reddish-brown clayey silt to silty clay. The loess deposits, including surface soil, are continuous at about 20 to 30 ft thick throughout the DDMT area.

1.2.3.2.2 Fluvial Deposits

The fluvial deposits are present in two general layers. The upper layer is silty, sandy clay to clayey sand and ranges from about 0 to 30 ft thick. The lower layer is composed primarily of sand and gravel with minor lenses of clay and thin layers of iron-oxide cemented sandstone or conglomerate, and ranges from 30 to 100 ft thick; the sand and gravel generally have some reddish to yellow coloring.

1.2.3.2.3 Upper Claiborne Group

The Jackson Formation and the Cockfield and Cook Mountain Formations are in the upper part of the Claiborne Group, separating the Fluvial Deposits Aquifer (FDAQ) from the Memphis Sand aquifer. These formations consist of inter-fingering fine sand, silt, clay, and local lenses of lignite and are referred to as the Upper Confining Unit; its thickness is highly variable, ranging from 0 to 360 ft. A dark gray clay layer of the Upper Confining Unit is generally found immediately below the fluvial deposits at DDMT and forms the base of the FDAQ. Hydraulic conductivity in this clay ranges from 2.5×10^{-7} to 1.2×10^{-8} centimeters per second (cm/s), which indicates very low permeability typical of fat clay (CH2MHILL, 2000a).

1.2.3.2.4 Memphis Sand

The Memphis Sand, which occurs throughout the Memphis area, consists of a thick body of sand with subordinate lenses of clay and silt at various horizons and ranges from about 500 to 900 ft in thickness. Three long-term monitoring (LTM) wells (MW-67, MW-254 and MW-255) were installed in the Memphis Sand at DDMT. The top of the Memphis Sand was identified at 254.5 to 283 ft bgs (21.0 to 10.2 ft North American Vertical Datum of 1988 [NAVD]); the borings were advanced approximately 30 ft into the Memphis Sand for well installation. The depths to the Memphis Sand are similar to depths at the Allen Well Field production wells, which are located 1 to 2 miles west of the MI.

1.2.3.3 Hydrogeology

1.2.3.3.1 Fluvial Deposits Aquifer

The unconfined FDAQ consists of the saturated portion of the lower fluvial deposits. The saturated thickness ranges from 0 ft (dry) to approximately 70 ft and is controlled by the surface of the uppermost clay in the upper Claiborne. The average hydraulic conductivity in the FDAQ from slug tests averaged 2.2×10^{-3} cm/s, which is moderate permeability typical for a clean to silty sand (CH2MHILL, 2000a). Hydraulic conductivity from a 1992 pump test was 3.5×10^{-2} cm/s, about an order of magnitude higher than the slug test average (Engineering Science, 1994). The FDAQ groundwater elevations and contours from the April 2021 LTM event are shown on Figure 6. Groundwater elevations in the FDAQ at the MI range from a high of approximately 246 ft NAVD in the northeast to a low of approximately 209 ft NAVD in the central area.

The groundwater in the FDAQ and IAQ are not a drinking water source for area residents. Although not currently in use, this groundwater is a potential drinking water sources and is classified as General Use (TDEC Chapter 1200-04-03).

1.2.3.3.2 Intermediate Aquifer

The groundwater in sand lenses within the upper Claiborne forms the Intermediate Aquifer (IAQ). The uppermost clay of the upper Claiborne is absent over a large section of the central MI. In this area, the sand layers of the fluvial deposits and the upper Claiborne form a single water table aquifer in that area; a lower clay layer in the upper Claiborne forms a base for the combined aquifer and limits connection to the Memphis Aquifer (MAQ). IAQ groundwater elevations and contours from the April 2021 LTM event are shown on Figure 7; groundwater elevations in IAQ wells were approximately 224 to 180 ft NAVD. In the northwestern MI away from areas of FDAQ recharge, the groundwater elevations were approximately 182 to 180 ft NAVD.

1.2.3.3.3 Memphis Aquifer

The Memphis Sand (and its equivalents) is a regional aquifer in Tennessee, Missouri, Kentucky, and northeastern Arkansas (Parks, 1990). The average hydraulic conductivity is approximately 66 ft per day (ft/d), which is typical for a sand aquifer (2020 SRI; HDR, 2021). The MAQ groundwater elevations and contours from the April 2021 LTM event are shown on Figure 8. Water level measurements are from the three wells installed in the Memphis Sand (MW-67, MW-254 and MW-255) and from three wells installed in the lower section of the upper Claiborne with consistent groundwater elevations (MW-140, MW-229 and MW-290). Groundwater elevations measured at MW-254 and MW-255 were approximately 179 to 178 ft NAVD. The elevations are only 2 to 3 ft lower than the range for IAQ wells located away from areas of FDAQ recharge.

The MAQ currently provides about 95% of the water used for municipal and industrial water supplies in the Memphis area. Groundwater withdrawals, which have increased at an irregular rate since 1886, are responsible for an almost continuous decline of water levels in wells throughout the Memphis area. Water-level data show a broad, regional cone of depression in the potentiometric surface of the Memphis Sand, which includes individual cones at the eight municipal well fields (HDR, 2021).

1.2.3.3.4 Hydraulic Connections and Groundwater Flow

Historically, the MAQ was thought of as an ideal aquifer overlain by a thick, impermeable clay layer that served as a confining unit and protected the aquifer from contamination from near-surface sources. Studies have shown that the upper confining unit is thin or absent in places and contains ‘sand windows’ that allow contaminants to reach the MAQ. Downward leakage from the water-table aquifers (alluvium and fluvial deposits) to the MAQ has been identified at several locations in the Memphis area.

An erosional window in the northwestern MI has been identified through soil borings and water level measurements. The FDAQ and IAQ groundwater elevation maps (Figures 6 and 7) show decreasing groundwater elevations within the window. Another hydraulic connection between the FDAQ and the IAQ is indicated by the extended depression (sink) in FDAQ groundwater elevations with low points at MW-39 in the central MI to MW-259 in the south-central MI (Figure 6).

Groundwater elevation contours for the FDAQ (Figure 6) show groundwater flow is onto the MI from all sides and migrates vertically to the IAQ through the erosional window in the northwestern MI and the extended sink in the central MI. Groundwater flow direction vectors for the October 2021 LTM event (Figure 9) show that FDAQ flow into the erosional window is limited to only a portion of the northeastern quadrant of the MI.

The groundwater flow direction for the upper Claiborne/IAQ wells (Figure 7) in the northwestern MI, including those within the window, is to the northwest. The flow direction in upper Claiborne/IAQ wells to the southeast (MW-215A, MW-268, MW-311, and MW-302) is to the south. The groundwater flow direction for the MAQ wells (Figure 8) is to the southwest, which is consistent with the location of the closest extraction wells in the Allen Well Field.

Historical groundwater flow direction was evaluated through review of groundwater extraction rates and water level changes from two United Sates Geological Survey (USGS) reports (USGS WRI-76-67 and USGS SI Map 3415). Groundwater extraction from the MAQ began in 1886 and reached 70 million gallons per day (MGD) in 1940, 100 MGD in 1950, 130 MGD in 1960 and 170 MGD in 1970. As groundwater extraction from the MAQ increased and additional well fields began operation, the regional cone of depression increased in area and depth, with localized cones of depression at the individual well fields. Groundwater extraction at the Allen Well Field began in 1953. Approximate groundwater elevations in the MAQ from potentiometric surface maps in the referenced USGS reports and in the FDAQ from the 2015 LTM report (HDR, 2016) are listed in the following table.

Year	Allen Well Field	DDMT MAQ	DDMT-FDAQ
1886	245	250	-
1960	<130	140-150	-
1970	<110	140-150	-
2015	<160	160-170	199-244

Groundwater elevations in the FDAQ on the MI is controlled by the surface of the uppermost clay in the upper Claiborne and would not be expected to decrease significantly. The elevations clearly show the vertical gradient between the FDAQ to the MAQ was present in 1960, and FDAQ groundwater flow directions would have been onto the MI from all sides since at least 1960 and possibly well before.

The cross-section on Figure 10 illustrates the variation in stratigraphic units on the MI and differences in groundwater elevations for the three aquifers. The section extends from MW-43 beyond the northwest boundary of the MI through the erosional window in the northwest MI and the sink in the south-central MI to MW-275 beyond the southeast boundary of the MI.

1.2.4 Site History

Activities at the MI from the 1940s to closure in September 1997 included repackaging hazardous substances for storage or shipment, pesticide application, painting and sandblasting, vehicle maintenance, and hazardous material handling/storage. Other historical activities in open and enclosed storage areas included storing transformers with polychlorinated biphenyls (PCBs), storing and using pesticides/herbicides, and treating wood products with pentachlorophenol (PCP). These activities resulted in the presence of metals, pesticides, and other less frequently detected chemicals in surface soil, surface water, and sediment, and chlorinated volatile organic compounds (CVOCs) in groundwater at the MI.

In October 1992, USEPA added DDMT to the National Priorities List (NPL) (57 Federal Register 47180 No. 199). In March 1995, USEPA, TDEC, and the Defense Logistics Agency entered into a Federal Facility Agreement (FFA) under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, 42 United States Code §9601 et. seq.), Section 120.The FFA outlines the process for investigation and cleanup of environmental sites at DDMT under CERCLA and the National Oil and Hazardous Substances Pollution Contingency Plan (40 Code of Federal Regulations [CFR] Part 300).

1.2.4.1 2001 Record of Decision

The MI ROD (CH2MHILL, 2001) received final approval in September 2001. The MI ROD specified the following RAOs:

<u>Surface Soil RAO for Protection of Industrial Workers</u>

- Prevent direct contact/ingestion of surface soils contaminated with lead in excess of industrial worker risk-based criteria (1,536 milligrams/kilogram).

<u>Surface Soil RAOs for Protection of Future On-Site Residents</u>

- Prevent direct contact/ingestion of surface soils contaminated with dieldrin and arsenic in excess of human health risk assessment (HHRA) criteria for residents; and
- Prevent direct contact/ingestion of surface soils contaminated with lead in excess of risk-based criteria for protection of residential children.

<u>Groundwater RAOs</u>

- Prevent ingestion of water contaminated with VOCs in excess of Maximum Contaminant Levels (MCLs) from potential future on-site wells;
- Restore groundwater to levels at or less than MCLs; and
- Prevent migration horizontally and vertically off-site of groundwater contaminants in excess of MCLs.

The selected remedy presented in the MI ROD contained the following components:

- Excavation, transport and off-site disposal (ET&D) of lead-contaminated surface soil near Building 949.
- Deed restrictions and land use controls (LUCs) to prevent residential land use on the MI, except at the existing housing area; to implement daycare restrictions; to prevent production/consumptive use of groundwater in the FDAQ and drilling into deeper aquifers on the MI; and to eliminate casual access through maintenance of a boundary fence around the golf course.
- Enhanced bioremediation treatment (EBT) of CVOCs in the most contaminated part of the groundwater plume.
- Long-term groundwater monitoring to document changes in plume concentrations and to detect potential plume migration to off-site areas or into deeper aquifers.

1.2.4.2 Remedy Implementation

1.2.4.2.1 Soil Excavation

ET&D for lead contamination adjacent to Building 949 was completed prior to final execution and approval of the MI ROD and was noted as a significant change in the MI ROD; the early completion effectively eliminated it as part of the selected remedy.

1.2.4.2.2 Land Use Controls

In accordance with the MI ROD, restrictions in transfer deeds for property on the MI prevent residential use, including children's daycare; production/consumptive use of groundwater in the FDAQ and drilling into deeper aquifers on the MI; and casual access to the golf course. These restrictions apply to all of the MI except the former administrative and housing areas, which are currently occupied by the Barnhart Crane offices and parking, the Memphis Police Department Airways Precinct and the Alpha Omega Veteran's Housing (Figure 3).

These deed restrictions provide an additional layer of protection above the existing city/county land use controls, which include zoning restrictions and restrictions on installation of groundwater wells. The Shelby County Zoning Atlas identifies only the former housing area for residential use (Figure 4). Shelby County Health Department (SCHD), Water Quality Branch is responsible for administering and enforcing the Rules and Regulations of Wells established and adopted by the Shelby County Groundwater Quality Control Board; the regulations do not allow installation of water wells within a half-mile of the designated boundary of a mandated or voluntary remediation site involving groundwater contamination, or at property where public water is available. Together the deed restrictions and city/county requirements limit residential use to the existing housing area and prevent construction of water wells on the MI or surrounding area within 0.5 miles.

The Notice of Land Use Restrictions (NLUR) was recorded at the City of Memphis/Shelby County Register of Deeds Office in January 2005. The *Land Use Control Implementation Plan* (LUCIP) in Appendix C of the MI RD (CH2MHILL, 2004b) requires annual inspections to document compliance with the deed restrictions and the city/county requirements; changes to the zoning and groundwater use restrictions are also identified. Annual inspections have been performed since 2005, with no significant deficiencies or violations of the LUCs identified.

1.2.4.2.3 Long-Term Monitoring

LTM on the MI has been conducted since 2004 to document changes in plume concentrations, to detect potential plume migration from or to off-site areas or into deeper aquifers, and to track progress toward RAOs. There are currently 188 LTM wells with 146 wells in the FDAQ, 37 wells in the IAQ/upper Claiborne and 5 wells in the MAQ. The well locations and plume designations are shown on Figure 11.

1.2.4.2.4 Enhanced Bioremediation Treatment

The MI RD, approved by USEPA in August 2004, used groundwater concentrations equal to or greater than 100 micrograms per liter (µg/L) for tetrachloroethene (PCE) and trichloroethene (TCE) to delineate the EBT treatment areas. The initial remedy implementation (EBT-1) included sodium lactate injections into the FDAQ within the two target treatment areas (TTA-1 and TTA-2) from September 2006 through February 2009 and performance monitoring from October 2006 through March 2009. CVOC concentrations for parent compounds PCE, TCE, and carbon tetrachloride (CT) were reduced over 90% in injection wells (IWs) and over 80% in monitoring wells at locations with baseline concentrations above 100 µg/L. The *Interim Remedial Action Completion Report, Main Installation, Revision 1* (MI IRACR) (HDR|e2M, 2010), including an operating properly and successfully determination, was approved by USEPA in March 2010.

Following rebound in CVOC concentrations in 2010 LTM samples, EBT-2 was conducted in areas where individual CVOC concentrations of parent compounds PCE, TCE and CT exceeded 100 µg/L: TTA-1, TTA-2, the West-Central plume and the Building 835 plume. Quarterly injections were made from November 2012 to August 2014 and performance monitoring was conducted from February 2013 to November 2014. The final report for EBT-2, *Main Installation Year Four Enhanced Bioremediation Treatment Report* (HDR, 2015), was approved by USEPA and TDEC in May 2015. The CVOC concentrations in the final samples (November 2014) decreased from the baseline samples (December 2011) by an average of 80% for IWs and 28% for performance monitoring wells (PMWs); the total number of EBT wells exceeding MCLs decreased from 55 wells to 17 wells over the same period. While EBT-2 reduced CVOC concentrations, it was not sufficient to meet the groundwater RAOs for the MI.

After completion of EBT-2, the *Fourth Five-Year Review* (HDR, 2018) determined that the remedy was protective in the short term. Although no exposures to constituents of concern (COCs) were occurring, it was recommended that the Army improve the selected remedy to reduce COC concentrations below MCLs throughout the MI in a reasonable period of time with long-term protectiveness to be verified by LTM and compliance monitoring.

1.2.4.3 Supplemental Investigations

Supplemental site investigations were conducted after each implementation of EBT to better understand the nature and extent of contamination.

1.2.4.3.1 2009 Source Area Investigation and Groundwater Model Update

The *Main Installation Source Area Investigation* (MI SAI) (e2M 2009) was performed to identify potential source areas for CVOCs at the MI. The magnitude and extent of CVOCs in soil were characterized by a membrane interface probe (MIP) survey in the upgradient area of plumes with soil samples to confirm MIP results. Several areas of possible soil contamination were identified. Soil sample analytical results were compared to site-specific soil screening levels for protection of groundwater from the *Memphis Depot Dunn Field Record of Decision* (Dunn Field ROD) (CH2MHILL, 2004a). Only 5 of 70 soil samples had CVOC concentrations above the screening levels, and 3 of those samples only slightly exceeded levels for a single CVOC.

The groundwater model in the MI Groundwater FS (CH2MHILL, 2000b), Appendix B *Conservative VOC Transport Calculations in the Memphis Sand Aquifer* was updated to incorporate the expanded monitoring well network and improved knowledge of site hydrogeology and plume delineation since 2000. The updated model, included in the MI SAI as Appendix F *Groundwater Modeling Report*, estimated CVOC concentrations resulting from vertical contaminant migration from the FDAQ to the MAQ on the MI and then migration in the MAQ from the MI to the Allen Well Field. The model used BIOSCREEN for the vertical migration component and MODFLOW/MT3D for migration through the MAQ. The BIOSCREEN model predicted that concentrations reaching the MAQ at DDMT would decrease over time from 34 to 16 µg/L for PCE and from 13 to 10 µg/L for TCE, which exceeds the concentrations reaching the MAQ based on LTM sample results. The MODFLOW/MT3D model predicted PCE and TCE concentrations would be below 1 µg/L within approximately 2,000 ft of the source area on the MI.

1.2.4.3.2 Supplemental Remedial Investigation

The SRI was performed in four phases from 2015 through 2019 to improve plume delineation and understanding of groundwater flow in the FDAQ and IAQ/upper Claiborne. The SRI included installation of 55 new monitoring wells (MW-262 to MW-316): 46 wells in the FDAQ, 8 wells in the upper Claiborne/IAQ, and 1 well in the MAQ. In addition, two nested wells (MW-317-NW and MW-318-NW) were installed, each with two wells screened in the FDAQ and two wells screened in the upper Claiborne. The SRI wells have been incorporated in LTM, which now includes 188 monitoring wells on and adjacent to the MI. The well locations are shown on Figure 11; the well symbols are color-coded for the different plumes and background locations.

The 2020 SRI (HDR, 2021), with agency comments and responses appended, was submitted in July 2021. The report was approved by TDEC; USEPA provided a conditional approval letter in August 2021 stating neither approval nor agreement on SRI completion.

1.2.4.3.3 Natural Attenuation Evaluation

The initial evaluation of biodegradation of CVOCs in the FDAQ for the 2000 MI RI was inconclusive with regard to the significance of natural attenuation at DDMT. Additional evaluation was conducted for the MI Groundwater FS (CH2MHILL, 2000b) in Appendix A, *Evaluation of Biodegradation of VOCs in Groundwater at the Memphis Depot*. This second evaluation stated the aquifer exhibits 'Type 3' conditions (low carbon content and high dissolved oxygen) where reductive dechlorination should not occur; however, the evaluation also stated limited biodegradation was occurring and biodegradation rates were provided for use in evaluation of remedial alternatives.

The effectiveness of natural attenuation as a component of the selected remedy was reviewed in Section 2.2.4 of the 2020 SRI. The review found naturally occurring biodegradation of CVOCs was not a significant contributor to natural attenuation in the FDAQ at the MI based on the absence of cis-1,2-dichlorethene (cDCE) and vinyl chloride (VC), which are reductive dechlorination products for PCE and TCE, outside of the EBT areas. However, 1st order decay rates calculated for the 2009 groundwater model had good agreement with PCE and TCE concentrations at wells along the flow paths, which indicates attenuation by physical processes (dispersion, dilution, sorption, and volatilization) is occurring. Therefore, physical components of natural attenuation (dispersion, dilution, sorption, and volatilization) are still applicable and are considered in developing remedial alternatives in this FFS. The 2009 groundwater model in Appendix F of the MI SAI (e2M, 2009) showed agreement between April 2008 concentrations in LTM wells along the flow paths and estimated concentrations from the Bioscreen groundwater model; the first order attenuation decay rates were 0.5/year for PCE and 0.8/year for TCE. The model input parameter and figures showing concentrations from the LTM well and the model estimates are included in Appendix B-1, 2009 Groundwater Model Input and Attenuation Calibration Plots.

Determining 1st order decay rates for most plumes on the MI is no longer possible due to EBT, contaminant migration onto the MI and the SVE pilot test in TTA-2; the South-Central plume is the only ‘undisturbed’ location. BIOCHLOR Natural Attenuation Decision Support System (USEPA, 2002) was used to evaluate the fate and transport of TCE in the FDAQ South-Central plume (Appendix B-2, Attenuation of TCE Technical Memorandum). The first order decay rate was estimated at 0.05 /year, which is reflective of the geochemical conditions that limit anerobic biodegradation at DDMT; this rate is an order of magnitude lower than used in the 2009 model for the Building 835 plume migration into the window. The model was used to approximate the length of time for TCE to meet its MCL through natural attenuation alone, and through a combination of source remediation and natural attenuation. The evaluation concluded that under the geochemical conditions present in the FDAQ at the MI, TCE concentrations in the plume would not meet its MCL in a reasonable time (> 100 years) through natural attenuation alone. However, with a combination of active source remediation and natural attenuation, TCE concentrations would meet the MCL in a reasonable period of time, estimated to range from 21 to 34 years.

1.2.4.3.4 Vertical Profiling

Concurrent with Phase 4 of the SRI, two vertical profile borings were to evaluate changes in lithology, subsurface VOC concentrations and hydraulic conductivity with depth in the fluvial deposits and the upper Claiborne sediments. Site conditions, including compacted and cemented sands and gravel/cobbles, limited the depth reached by the vertical profile borings to 120 ft bgs. The profile sections within the saturated zone, which was the area of interest, were limited to 25 ft. Intervals with high estimated hydraulic conductivity values (100 ft/d) observed on the profiles were selected for upper nested well screen placement in the adjacent wells, 102 ft bgs in MW-

317-NW and 117 ft bgs in MW-318-NW. The high conductivity values are similar to the FDAQ aquifer test result (Section 1.2.3.3.1).

Geotechnical test borings and the SRI nested wells (MW-317 and MW-318) were installed adjacent to the vertical profile borings. Soil samples were collected for geotechnical testing from the test borings and the nested well borings. Samples were collected from the loess, the upper fluvial deposits (fine-grained), the lower fluvial deposits (coarse-grained) and an upper Claiborne sand. The loess and upper fluvial deposits samples had low hydraulic conductivity values at $1.6x10^{-7}$ to $4.5x10^{-8}$ cm/s. These values are similar to the test results for the upper Claiborne clay (Section 1.2.3.2.3). The deeper samples of primarily sand had higher hydraulic conductivity values. The lower fluvial deposits samples had hydraulic conductivity results at $7.0x10^{-3}$ to $2.1x10^{-4}$ cm/s, which are similar to the FDAQ slug test results (Section 1.2.3.3.1), and the upper Claiborne samples with fine-grained sand had lower results at $9.5x10^{-4}$ to $1.3x10^{-5}$ cm/s.

1.2.4.4 Soil Vapor Extraction Pilot Test

Successful source removal was demonstrated using soil vapor extraction (SVE) at Dunn Field, Operable Unit 1. In 2018, soil vapor samples were collected on the MI at three suspected subsurface soil source areas (TTA-1, TTA-2, and Building 720) based on elevated groundwater concentrations of PCE, TCE and/or CT; results were compared against the protective soil vapor concentrations from the Dunn Field ROD (CH2MHILL, 2004a). TTA-2 was selected for the SVE pilot study based on significantly higher soil vapor concentrations.

The *Final SVE Pilot Test Report* (HDR, 2020c), included as Appendix I-3 of the 2020 SRI (HDR, 2021), stated approximately 200 pounds of CVOCs were removed from August 2019 to May 2020. The estimated mass removed indicated a significant source in the TTA-2 area near Buildings 261/265. Groundwater concentrations decreased 5 to 91% at 11 of 14 LTM wells in proximity to the SVE well; the other three wells in the area had increased concentrations. The pilot test showed that SVE could be an effective remedial technology on the MI where high concentrations of CVOCs are observed in soil vapor.

1.2.5 Risk Assessment Summary

The HHERA (HDR, 2020b) was prepared to evaluate potential baseline health risks for current and future human receptor exposure to constituents of potential concern (COPCs) in the FDAQ, IAQ and MAQ. The HHERA included an update to the groundwater HHRA and reviews of the soil HHRA and the screening level ecological risk assessment in the 2000 MI RI. COPC screening in the groundwater HHRA update identified 30 COPCs from sampling events conducted from 2012 to 2017. The potential exposure scenarios considered were drinking water ingestion, dermal contact and inhalation as well as inhalation of indoor air via vapor intrusion from groundwater vapors for a current/future on-site worker and future on-site resident adult and child.

The groundwater HHRA update indicated that there are several COPCs, now identified as COCs, whose concentrations in groundwater are the primary contributors to the cumulative risks and hazards, and exposure to these COCs may result in potential adverse health effects.

- The evaluation of potential cancer risks and non-cancer hazards to on-site current/future workers indicates that CT, chloroform (CF), methylene chloride, TCE, 1,2,3-trichloropropane and VC are COCs in the FDAQ; VC and TCE are COCs for the IAQ, and there are no COCs in the MAQ. Potential for vapor intrusion (VI) of CT, CF, PCE, TCE and VC into buildings from groundwater is also a potential health risk to workers.
- The evaluation of potential cancer risks and non-cancer hazards to future on-site residents indicates that CT, CF, methylene chloride, TCE, 1,2,3-trichloropropane and VC are COCs in the FDAQ; VC, TCE and PCE are COCs in the IAQ, and TCE is the only COC in the MAQ. The VI pathway was not evaluated for a resident.

As long as the existing land use restrictions are maintained, the exposure pathways to the contaminated groundwater are not complete, with the possible exception of VI.

An evaluation of the VI pathway was not conducted for the HHERA. A separate VI study for the MI was begun at approximately the same time as the HHERA. Only limited soil vapor data has been collected to date. The *VI Conceptual Site Model, Revision 1* was submitted to USEPA and TDEC in June 2022 and the *2022 VI Sampling and Analysis Plan, Revision 1* (VI SAP) was submitted to USEPA and TDEC on 3 May 2022. The 2022 VI SAP presents a phased approach for vapor sampling, risk assessment and reporting. Vapor sampling phases are: an initial phase of passive soil vapor screening, a second phase for installation of vapor monitoring points (VMPs) and active vapor sampling, and a final phase of sub-slab and indoor air samples at buildings with greater potential for VI. The passive vapor screening phase was completed in September 2023 and VMP installation began in October 2023. The final VI study report is scheduled for completion in March 2025.

1.2.6 Nature and Extent of Contamination

Remedial actions, long term groundwater monitoring, supplemental investigations and the SVE pilot test have identified groundwater contamination and suspected source areas on the MI. Sampling results have indicated that significant groundwater contamination is generally limited to the FDAQ. The risk assessment summary identified several COCs in groundwater: PCE, TCE and VC are detected above MCLs in FDAQ wells across the MI; CT is detected above the MCL in only TTA-2 wells; CF is detected at low concentrations (<15 µg/L) at wells in the eastern MI; 1,2,3-trichloropropane is detected at low concentrations (<10 µg/L) at a few TTA-2 wells; and methylene chloride is rarely detected and a potential laboratory contaminant.

CVOC plumes on the MI are believed to be the result of multiple small-volume releases and migration of off-site contaminants onto the MI (Figure 11). Monitoring wells installed for the SRI identified groundwater plumes migrating on to the MI from the northeast and the southwest. Land use (Figure 4) is industrial northeast of the MI and residential west of the MI. Residential use to the west does not preclude the use and release of chlorinated solvents. An environmental database search report of environmental sites with potential contaminant sources within a 2-mile radius of the Memphis Depot was obtained in 2017. Numerous sites with potential contaminant sources around DDMT, including sites to the west, were identified (Appendix B-3, EDR Report Overview Map). The FDAQ groundwater analytical results for PCE, TCE, CT and VC for the most recent samples as of April 2021 are listed on Table 1 and shown on Figures 12, 13, 14, and 15, respectively.

Groundwater contamination in the IAQ and MAQ is limited and the result of FDAQ plume migration in the areas where the limited thickness or absence of clay layer(s) facilitates downward contaminant migration.

1.2.6.1 Subsurface Soil Vapor Source Areas

Soil sampling in suspected source areas for the MI RI (CH2MHILL, 2000a) did not identify areas with VOC concentrations above soil screening levels. However, since the 2000 FS was completed, source area investigations and remediation activities in the adjacent OU-1, Dunn Field, determined that soil and soil vapor data together provide a more complete representation of source areas and impacts to FDAQ groundwater and potential indoor air impacts for industrial workers. Site-specific soil screening levels and protective soil vapor levels were established in the Dunn Field ROD. These screening levels were applied at potential MI source areas (TTA-1 North [TTA-1N], TTA-2, and Building 720) to select the location for the SVE pilot test. Consistent with previous MI sampling results, soil concentrations did not exceed Dunn Field soil screening levels. However, soil vapor sampling results exceeded Dunn Field soil vapor screening levels in each of these areas. The results for each area are summarized below:

TTA-1N: CVOCs reported above the soil vapor remedial goals from the Dunn Field ROD (CH2MHILL, 2004a) were PCE, TCE and CF. TCE concentrations ranged from 550 micrograms per cubic meter (µg/m3) to 30,100 µg/m3.

TTA-2: CVOCs reported above the Dunn Field soil vapor remedial goals were TCE, PCE CF, CT, cDCE and methylene chloride. Maximum concentrations included PCE at 95,000 µg/m3, CT at 94,500 µg/m3, CF at 3,300 µg/m3 and cDCE at 1,000 µg/m3.

Building 720: CVOCs reported above the Dunn Field soil vapor remedial goals were PCE, TCE and cDCE. TCE and PCE were reported above remedial goals in all samples but were generally lower as compared to TTA-1N and TTA-2.

The Dunn Field soil vapor remedial goals, which were developed for protection of groundwater, are 6.7 µg/m3 for PCE, 11.1 µg/m3 for TCE, 157 µg/m3 for cDCE, 89.5 µg/m3 for CT and 159 µg/m3 for CF. The vapor intrusion screening level (VISL) for a commercial scenario at a target risk (TR) of $1x10^{-4}$ and target hazard quotient (THQ) of 1 (USEPA, 2022b) are 5,840 µg/m3 for PCE, 292 µg/m3 for TCE, 117,000 µg/m3 for cDCE, 6,810 µg/m3 for CT and 1,780 µg/m3 for CF.

Based on these results, it was determined that subsurface soil source areas are present at the MI with soil vapor concentrations exceeding the protective soil vapor concentrations established for Dunn Field.

1.2.6.2 Groundwater

The FDAQ is the primary location of groundwater contamination on the MI. Contamination in the IAQ and MAQ is the result of migration of FDAQ groundwater where clay layers are thin in the sink and absent in the erosional window. The FDAQ was the focus for implementation of EBT-1 and EBT-2 (Section 1.2.4.2.4) and although concentrations have been reduced, multiple areas of elevated concentrations still remain and are discussed below. CVOC concentration trends at selected wells in each plume are provided in Appendix B-4, Trend Plots.

1.2.6.2.1 TTA-1

TTA-1, located in the southwest area of the MI (Figure 11), has been differentiated into two subareas: North (TTA-1N) and South (TTA-1S). Both areas were included in EBT-1 and EBT-2 and historical CVOC concentrations were reduced. Elevated concentrations of CVOCs remain and are higher at TTA-1N where an apparent off-site source is observed. The groundwater flow direction is to the east-northeast toward the sink in the central MI near MW-39.

In the TTA-1N area, maximum concentrations in the April 2021 LTM event were 280 µg/L PCE at MW-219 (Figure 12) and 55.8 µg/L TCE at PMW21-04 (Figure 13); PMW21-04 is located in a suspected historical source area between Buildings 1089 and 972 and MW-219 is located in the power line corridor west of Building 1089. In the off-site, upgradient portion of the TTA-1N plume, the highest PCE and TCE concentrations are located in an apparent off-site source area: 268 µg/L PCE and 21.9 µg/L TCE in MW-269. When compared to historic concentrations in this area, PCE and TCE concentrations are stable to increasing over time. This is due to off-site sources, at least in part.

In the TTA-1S area, the April 2021 LTM event identified maximum concentrations of 35.9 µg/L PCE at PMW101-06A (Figure 12) and 61.9 µg/L TCE at PWM101-07B (Figure 13); both wells are in a suspected historical source area between Buildings 970 and 972. Overall, the PCE and TCE concentrations within the TTA-1S plume are stable to decreasing over time.

1.2.6.2.2 TTA-2

TTA-2 is located in the southeast section of the MI (Figure 11). The groundwater flow direction is to the west-southwest towards the sink near MW-259. Historical CVOC concentrations in the area were reduced by EBT-1 and EBT-2. Maximum concentrations in the April 2021 LTM event were 40.3 µg/L PCE in MW-294, located downgradient of a suspected PCE source area near Building 249 (Figure 12); 24.6 µg/L TCE in MW-218, located to the north of Building 360 (Figure 13); and 73.4 µg/L CT in MW-217, located south of Building 360 (Figure 14). CVOC concentrations at wells in the vicinity of Buildings 260/261 and 265 were significantly reduced following the SVE pilot test from August 2019 to May 2020. The natural trend of PCE, TCE, and CT concentrations at TTA-2 is not clear due to the recent SVE pilot test.

1.2.6.2.3 North-Central Area

The North-Central (N-C) Area extends from MW-310, located north of the property boundary, to downgradient well MW-318, south of Building 650 (Figure 11). The groundwater flow direction is to the southwest toward the erosional window and the sink in the south-central MI. EBT was not implemented in the N-C Area.

Maximum concentrations in the April 2021 LTM event were 50 µg/L PCE at MW-207B, southwest of Building 649 (Figure 12), and 42.9 µg/L TCE at MW-258 near the center of the N-C Area plume (Figure 13). The TCE concentration at upgradient, off-site well MW-310 was 41.5 µg/L. The TCE plume extends over the entire N-C area while the PCE plume is limited to the downgradient area, possibly due to a separate on-site source. Overall, the predominantly TCE concentrations within the N-C Area plume are stable and/or decreasing overtime. Concentrations of TCE in upgradient wells MW-310 and MW-263 indicate off-site TCE impacts to the N-C Area plume.

1.2.6.2.4 West-Central Area

The West-Central (W-C) Area is a generally undeveloped area bounded to the west by Building 970 and to the east by Building 770 (Figure 11). The groundwater flow direction is to the east-northeast toward the two low points at MW-39 and MW-259 in the extended sink. EBT-2 was implemented in the W-C Area.

Maximum concentrations in the April 2021 LTM event were 22 µg/L PCE and 19.6 µg/L TCE at MW-204B (Figures 12 and 13). Recent PCE and TCE concentrations within the W-C Area plume are relatively low and stable to decreasing over time. The CVOCs plume in the W-C Area is considered primarily due to contaminant migration from TTA-1.

1.2.6.2.5 Building 835

The Building 835 Area is an elongated TCE plume in the northwestern portion of the MI, which is oriented along the southern edge of the clay forming the southwest side of the erosional window. At the downgradient/southern end, the plume merges with the W-C and N-C Area plumes near Building 650 (Figure 11). The groundwater flow direction is to the southeast toward the sink near MW-39. EBT-2 was implemented in the Building 835 and TCE concentrations were reduced.

The maximum TCE concentration in the April 2021 LTM event was 51.4 µg/L at MW-212 downgradient of Building 835 (Figure 13). TCE concentrations within the Building 835 plume are stable to decreasing over time.

1.2.6.2.6 South-Central Area

The South-Central (S-C) Area is an elongated TCE plume extending from the undeveloped area between Buildings 970 and 689 toward Building 470 (Figure 11). The groundwater flow direction is to the east/northeast toward the sink near MW-259. EBT was not implemented in the S-C Area.

The maximum TCE concentration in June 2021 was 60.6 µg/L TCE at MW-330 (Figure 13). The TCE plume is believed to result from a spill or release during operations at Building 873, since demolished. The maximum PCE concentration,19.8 µg/L PCE at MW-296 (Figure 12), is considered to result from migration of the W-C and N-C plume.

1.2.6.2.7 Southeast Area

The Southeast Area is bounded by MW-52 and MW-270 located southeast of Building 490 (Figure 11). The groundwater flow direction is westerly toward the sink near MW-259. EBT was not implemented in the Southeast Area. CVOCs detected in these LTM wells are different and the extent is limited, based on surrounding wells; the area is not considered a plume.

Maximum concentrations in the April 2021 LTM event, were 14.2 µg/L PCE at MW-52 (Figure 12) and 32.7 µg/L TCE at MW-270 (Figure 13). The extent of PCE and TCE concentrations above the MCL are presently limited to small areas with one or two wells.

1.2.6.2.8 Hydraulic Connections – IAQ and MAQ

Hydraulic connections between the FDAQ and the IAQ are indicated by the depression (sink) in FDAQ groundwater elevation contours extending from monitoring well (MW)-39 in the central MI to MW-259 in the south-central MI (Figure 6) and by FDAQ and IAQ contours in the erosional window (Figures 6 and 7).

The surface elevation of the lower clay layer in the window decreases from MW-107 to MW-202 and is not observed at MW-140 and MW-255 (Figure 10) allowing a hydraulic connection to the MAQ. Maximum concentrations in FDAQ wells within the window for the April 2021 LTM event were PCE at 35.1 µg/L in MW-305 (Figure 12), while TCE was below the MCL (Figure 13); maximum concentrations in IAQ wells were PCE at 45.6 µg/L in MW-202B (Figure 16) and TCE at 7.7 µg/L in MW-34 (Figure 17). Off-site contaminant migration in the IAQ is shown at MW-309, across Dunn Avenue from the northwest boundary of the MI, where PCE was detected at 11.3 µg/L and TCE at 3.84 µg/L.

Maximum CVOC concentrations in MAQ wells within the window for the April 2021 LTM event (Figure 18) were PCE at 11.2 µg/L in MW-140 and TCE at 3.97 µg/L in MW-254, which is located near the MI boundary. These exceedances are isolated but indicate a potential undefined plume in the MAQ due to contaminant migration from upgradient IAQ wells. Due to the relatively low concentrations in MW-254 and MW-140, a monitoring well has not been installed downgradient (southwest) of MW-254.

1.2.7 Contaminant Fate and Transport

The *Final Conceptual Site Model Update Memorandum* (HDR, 2020a) in Appendix I-2 of the 2020 SRI (HDR, 2021) describes the fate and transport of contaminants. The conceptual site model was updated based on evaluation of preferential pathways and of CVOC migration and extent from different source areas. The major conclusions are:

- The plumes identified at the MI originate as PCE or TCE from multiple small sources based on molar fraction distributions.
- Molar fraction signatures in IAQ and MAQ wells are similar to signatures in FDAQ wells and are consistent with the coalescing of two or more plumes.
- Reductive dechlorination is occurring primarily where active EBT was performed. Parent material has degraded to cDCE or VC in EBT treatment areas but the impacts do not appear to extend to distal portions of the plumes.
- The presence of thin, discontinuous clay beds in the FDAQ may have local impact on groundwater levels and constituent concentrations measured by monitoring wells depending on their screen intervals but should not impede overall plume migration. Preferential pathways for contaminant migration within the FDAQ were not identified.
- The clay bed that rises above the water table around the erosional window in northwestern MI creates a no-flow boundary within the FDAQ. Groundwater entering the MI from the north must flow around this boundary.

- A large sand body comprises much of the IAQ at the MI. The orientation within the erosional window and the prevailing hydraulic gradient results in a preferential pathway for groundwater movement from the FDAQ to the MAQ.
- The extended sink in the central MI with low points at MW-259 and MW-39 appears to be indirectly connected to the sand body in the window and to be pathways for contaminant migration into the IAQ.

2 Identification and Screening of Technologies

This section presents the development of RAOs and selection of technologies to address contamination. The selected technology and process options are combined into remedial alternatives in Section 3.

2.1 Site-specific ARARs and TBCs

Section 121(d) of CERCLA specifies that remedial actions for cleanup of hazardous substances or pollutants and contaminants must comply with Federal or more stringent State environmental regulations and laws that either specifically address a substance or particular circumstance at a site, and are therefore directly applicable, or while not directly applicable, address situations that are sufficiently similar (relevant) and are well suited (appropriate) for use at the site. An environmental regulation or law that is not applicable, must be both relevant and appropriate to be considered an ARAR.

Section 121(d) of CERCLA mandates that selected remedies achieve or legally waive ARARs. This section provides a preliminary discussion of the regulations that are applicable or relevant and appropriate to the remediation of the contaminated media at the MI. Both Federal and State of Tennessee environmental regulations and public health requirements are evaluated. In addition, this section identifies Federal and State criteria, advisories, and guidance as sources of information that are to be considered (TBC).

2.1.1 Definitions and Types of ARARs

The NCP (40 CFR 300.5) defines “Applicable requirements” as “those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under Federal environmental or State environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site.” Applicable requirements must directly and fully address or regulate the hazardous substance, pollutant, contaminant, action being taken, or other circumstances at the site.

The NCP (40 CFR 300.5) defines “Relevant and Appropriate Requirements” as “while not ‘applicable’ to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site. Only those State standards that are identified in a timely manner and are more stringent than Federal requirements may be relevant and appropriate.”

ARARs are not currently available for every chemical, location, medium or action that may be encountered. When ARARs are not available, PRGs may be based upon site-specific risk-based concentrations that are developed based on acceptable human and/or ecological risk or other Federal or State criteria, guidance, or local ordinances. While various Federal and State environmental and public health programs’ criteria, advisories, guidance, and proposed standards are not legally binding, these TBC items may provide useful information or recommended procedures to determine the necessary level of protection for certain remedial alternatives and are generally used when ARARs do not exist or are not protective. USEPA guidance does not recommend the use of generic screening levels or default Regional Screening Levels (RSLs) as cleanup levels for Superfund sites but rather site-specific risks and ARARs.

The remedial alternatives developed in this FFS were analyzed for compliance with potential ARARs and TBC guidance or criteria. The analysis involves the initial identification of potential requirements for the alternative, the detailed evaluation of the potential requirements for applicability or relevance and appropriateness, and a determination of the ability of the remedial alternatives to achieve the ARARs. ARARs and TBC items generally fall into three broad categories, based on the manner in which they are applied at a site. These categories are as follows.

2.1.1.1 Chemical-Specific Requirements

Chemical-specific requirements set risk-based concentration limits or discharge limitations in various environmental media for specific hazardous substances, pollutants, or contaminants. Chemical-specific ARARs aim to meet the NCP threshold criterion of overall protection of human health and the environment.

Potential chemical-specific ARARs identified at the MI (Table 2) are the USEPA National Primary Drinking Water Regulations MCLs (USEPA, 2009) and TDEC General Water Quality Criteria, which are relevant and appropriate to evaluate groundwater, and standards and emission limits for process vents used in treatment of VOC wastes and groundwater, which are relevant and appropriate to SVE operations. No potential chemical-specific TBC items were identified for the MI.

2.1.1.2 Action-Specific Requirements:

Action-specific requirements generally set performance, design, technology, or other similar controls or restrictions on specific activities related to management of hazardous substances or pollutants.

Potential action-specific ARARs identified at the MI (Table 3) are requirements for the design, construction, operation, and closure of a SVE treatment system and requirements for characterization of solid waste, which are applicable, and requirements for activities causing fugitive dust emissions or storm water runoff, which are relevant and appropriate for remedial action construction activities. Potential action-specific TBCs identified at the MI are state requirements for emissions from an SVE treatment system.

2.1.1.3 Location-Specific Requirements

Location-specific requirements are design requirements or activity restrictions based on the geographical or physical position of the site and its surrounding area. Location-specific ARARs include activities on and near wetlands and floodplains, archeological and natural resources, historical landmarks, critical habitats of endangered or threatened species, etc. No location-specific ARARs or TBC items were identified for the MI.

2.2 Preliminary Remediation Goals

PRGs are selected based on Federal- or State-promulgated ARARs and risk-based levels with consideration also given to other requirements, such as analytical detection limits and guidance values, which are identified in Section 2.1.1.1 above.

2.2.1 Subsurface Soil Vapor Source Areas

Options for the soil vapor PRGs based on the VI exposure pathway are presented on Table 4 and a list of chosen PRGs is provided at the end of the table. The list of soil vapor COCs on the table (PCE, TCE, VC, CT, CF, and cDCE) is based on the primary CVOCs that were identified under the commercial worker scenario in the HHERA Revision 1 (HDR, 2020b). Existing ICs allow no residential land use or other child-occupied facilities, including daycare, on the MI, except at the existing Housing Area; therefore, options for the PRGs consist of values that address both commercial and residential exposure scenarios. For all COCs except chloroform, the chosen soil vapor PRGs are the USEPA VISLs for a commercial scenario (TR of $1x10^{-4}$ and THQ of 1). However, the USEPA VISLs for a residential scenario at a TR of $1x10^{-4}$ and THQ of 1 can be applied to the former housing area. Chloroform has been determined by USEPA to be a threshold carcinogen for all routes of exposure; therefore, in consultation with USEPA Region 4, the soil vapor PRGs were calculated considering only the noncancer endpoint.

2.2.2 Groundwater

Options for the groundwater PRGs based on the drinking water and VI exposure pathways are presented on Table 5 and a list of chosen PRGs is provided at the end of the table. In addition, the groundwater remedial goals from the Dunn Field ROD (CH2MHILL, 2004a) are included in Table 5 for comparison. The list of groundwater COCs on the table (PCE, TCE, VC, CT, CF, cDCE, trans-1,2-dichloroethene [tDCE], methylene chloride, and 1,2,3-trichloroproane) is based on the primary CVOCs that were identified under industrial and residential scenarios in the HHERA Revision 1 (HDR, 2020b) and with consideration of their breakdown products. The chosen groundwater PRGs are the USEPA MCLs (USEPA, 2009); COCs without an MCL (i.e., 1,2,3-trichloropropane) were supplemented with the USEPA Tapwater RSLs at a TR of $1x10^{-4}$ and THQ of 1 (USEPA, 2022a). Chloroform's groundwater PRG, in consultation with USEPA Region 4, was determined to be the MCL Goal of 70 ug/L, which was derived based on the noncancer endpoint.

2.3 Remedial Action Objectives

COC concentrations are to be reduced to levels that present an acceptable risk to human health and the environment. RAOs have been identified to mitigate the potential present and/or future risks associated with the site.

2.3.1 Subsurface Soil Vapor Source Areas

The following RAOs will be added to the MI ROD:

- Prevent human exposure via inhalation of the following COCs in indoor air due to vapor intrusion by reducing soil vapor concentrations in micrograms per cubic meter (µg/m3) below the following remedial goals (i.e., cleanup levels):

COC	Commercial (µg/m^3)	Residential (µg/m^3) (former housing area only)
PCE	5,840	1,390
TCE	292	69.5
VC	9,290	559
CT	6,810	1,560
CF	14,000	3,300
cDCE	117,000	27,800

2.3.2 Groundwater

The following RAOs will replace the existing groundwater RAOs in the MI ROD:

- Reduce COC concentrations in groundwater to 1) prevent human exposure via direct contact (ingestion and dermal) and inhalation pathways; 2) prevent impacts to groundwater from migration of COCs in soil vapor through the vadose zone; 3) restore groundwater quality in the FDAQ and IAQ for designated use(s) and for the protection of the MAQ, and 4) prevent impacts to MAQ groundwater from vertical migration of groundwater COCs from the FDAQ and IAQ. Groundwater concentrations are to be reduced below the following remedial goals (i.e., cleanup levels):

COC	Remedial Goal (µg/L)
PCE	5
TCE	5
VC	2
CT	5
CF	70
cDCE	70
tDCE	100
Methylene chloride	5
1,2,3-Trichloropropane	0.075

2.4 Areas of Contamination

2.4.1 Subsurface Soil Vapor Source Areas

Suspected sources of potential indoor air impacts have been identified in subsurface soils at TTA-1N, TTA-2, and Building 720. An SVE pilot test at TTA-2 has successfully removed 200 pounds of VOCs and reduced groundwater contamination in that area. These suspected source areas and other presumed small release areas on the MI will be further characterized during the preliminary design investigation (PDI) to target areas for subsurface soil vapor remediation efforts.

2.4.2 Groundwater

Groundwater plumes have been identified in the FDAQ and IAQ aquifers. These plumes are the focus of groundwater remediation and are discussed below.

2.4.2.1 FDAQ

The FDAQ has historically been and continues to be the primary location of groundwater contamination at the MI. Multiple, distinct plumes of PCE and TCE are present (Figures 12 and 13). The CT plume is limited to TTA-2 (Figure 14), and VC concentrations above the MCL are present in isolated areas where EBT was implemented (Figure 15). The highest concentrations of PCE are present in TTA-1N (280 µg/L), North-Central (50.0 µg/L), TTA-2 (40.3 µg/L) and Window (35.1 µg/L) areas. The TTA-1N area has PCE impacts from off-site sources as is demonstrated by off-site wells MW-269 (268 µg/l) and MW-278 (121 µg/l). The highest concentrations of TCE are present in the TTA-1S (61.9 µg/L), South-Central (60.6 µg/L), TTA-1N (55.8 µg/L), Building 835 (51.4 µg/L) and North-Central (42.9 µg/L) areas.

2.4.2.2 IAQ

IAQ groundwater contamination is limited to PCE and TCE plumes. These plumes are the result of migration from the FDAQ at the sinks and erosional window (Figures 16 and 17). The highest concentrations of PCE are present in the Window (45.6 µg/L) and North-Central (33.8 µg/L) areas. The highest concentration of TCE is present in the North-Central area (25.5 µg/L).

2.5 General Response Actions

General Response Actions (GRAs) are broad types of activities that will potentially satisfy the RAOs. Following the development of GRAs, one or more remedial technologies and process options are identified for each GRA category. The technologies and process options remaining after screening in Section 3 have been assembled into alternatives that are evaluated in Section 4. The alternatives primarily focus on remediating groundwater on the MI; however, presumptive remedies of institutional controls (ICs) and SVE have been included to address impacted subsurface VOC source areas on the MI.

The GRAs for groundwater are:

- No Action: The no action option is included as a basis for comparison and is required by the NCP (40 CFR 300.430(e)). If no action is taken, the contaminants will remain in place and the RAOs will not be met.
- Institutional Controls: Restricting property or resource use to prevent or limit direct contact of contaminants by potential receptors.
- Monitored Natural Attenuation (MNA): MNA makes use of naturally occurring processes such as dilution, volatilization, biodegradation, adsorption, and/or chemical reactions with subsurface materials reduce contaminant concentrations to acceptable levels over time.
- Containment: Containment options are often implemented to prevent or significantly reduce the migration of contaminants in groundwater. They include hydraulic control activities which may include physical barriers or extraction.
- Treatment: Treatment of contaminants can be achieved either in situ or ex situ and includes several types of technologies that encompass biological, thermal, and physical/chemical treatment approaches.

2.6 Identification and Screening of Technology Types and Process Options

The initial screening considered effectiveness of the technologies for treating the contaminants present on the MI, implementability of the technology given site-specific conditions, and costs. Remedial technologies that were deemed to be impracticable or cost-prohibitive were removed from further analysis, in accordance with guidance (USEPA, 1988).

Site-specific conditions, including site geology and hydrogeology, contamination type, concentration, location (aerial extent and depth), findings/observations from the EBT RA implemented from 2006 to 2014 and the SVE pilot test were incorporated into the analyses performed during the initial screening process.

The technology identification and process option screening process for VOCs impacting subsurface soil and groundwater at the site, organized by GRA (i.e., ICs, containment and treatment), is summarized on Table 6. The most promising technologies, combined into remedial alternatives, are described in Section 3.

2.6.1 Technologies and Process Options for Subsurface Soil Vapor Source Areas

As discussed in Section 1.2.6.1, VOCs were detected in soil vapor at concentrations greater than the soil vapor screening levels. A presumptive remedy, SVE, has been identified to actively remediate contaminants in subsurface soil source areas: SVE, in combination with ICs requiring notification of the property owner of the potential for VI, are described below and included in remedial alternatives described in Section 3.

2.6.1.1 Soil Vapor Extraction

SVE is a vadose zone soil remediation technology in which a vacuum is applied to induce the controlled flow of air through the soil and allow removal of volatile contaminants from the soil. The gas leaving the soil may be treated to recover or destroy the contaminants, depending on local and State air discharge regulations. Geomembrane covers may be placed over the ground surface to prevent short circuiting and increase the radius of influence of the wells. SVE removed approximately 4,000 lbs of VOCs at Dunn Field and over 200 lbs of VOCs in the pilot test at TTA-2. It can be implemented at potential subsurface soil source areas on the MI to effectively remove VOCs.

2.6.1.2 Vapor Intrusion Institutional Controls

The presumptive includes the use of ICs to notify landowners of the potential for VI and to recommend assessment and vapor mitigation, based on sampling results.

ICs in the form of property and government controls are part of the selected remedy for the MI and have been implemented in accordance with the MI LUCIP. The NLUR was recorded at the City of Memphis/Shelby County Register of Deeds Office in 2005, and deed restrictions have been included in property transfers. The existing ICs do not allow residential land use or other child-occupied facilities, including daycare, on the MI (except at the existing Housing Area), and no production/consumptive use of groundwater or drilling groundwater wells on the MI.

No ICs exist to address potential VI for overlying structures of existing or future construction. Additional notification ICs will be included in the MI LUCIP and NLUR to notify landowners of potential VI issue and recommend monitoring and vapor mitigation, if necessary, in accordance with applicable guidance (USEPA, 2015).

2.6.2 Technologies and Process Options for VOCs in Groundwater

As discussed in Section 1.2.6.2, the FDAQ is the primary location of groundwater contamination at the MI (primarily PCE, TCE and CT) and vertical migration of VOC contaminants from the FDAQ impacts the IAQ and MAQ. The technology identification and process option screening process for groundwater contamination at the site, organized by GRA, is presented in the following subsections and summarized on Table 6. Process options associated with each GRA for groundwater contaminants are discussed below.

2.6.2.1 No Action

This option would discontinue LTM for groundwater and annual inspections for ICs and activities to contain or remediate contaminants. It provides no legal or administrative mechanisms for protection of human health or the environment beyond establishing cleanup criteria and recognizing those mechanisms that are in place (e.g., restrictions on zoning and well installation) under other State and Federal environmental regulatory program (non-Superfund) authority. This option would not be effective in achieving the RAOs. This option is retained for further analysis, as required by the NCP.

2.6.2.2 Institutional Controls

Land use controls are part of the selected remedy for the MI and have been implemented in accordance with the MI LUCIP. The NLUR was recorded at the City of Memphis/Shelby County Register of Deeds Office on January 26, 2005, and deed restrictions have been included in property transfers. The current ICs being implemented through LUCs at the MI pertaining to groundwater use prevent production/consumptive use and drilling into aquifers on the MI.

ICs are low cost and easy to implement. Operation and maintenance (O&M) costs are low. The current MI ICs have been retained for further analysis. These ICs will be used in conjunction with engineering measures such as containment or treatment during all stages of the cleanup process to accomplish RAOs.

2.6.2.3 Monitored Natural Attenuation

MNA relies on naturally occurring attenuation processes to achieve restoration RAOs within a reasonable time frame. Natural attenuation processes (including dilution, dispersion, volatilization, biodegradation, adsorption, and chemical reactions with subsurface materials) are allowed to reduce contaminant concentrations to acceptable levels over time.

MNA was considered as a component of EBT for plume control in the current selected remedy. The 2020 SRI (HDR, 2021) stated naturally occurring biodegradation of CVOCs is not a significant contributor to MNA in the FDAQ at the MI due to site-specific conditions (low carbon content and high dissolved oxygen) and demonstrated by the absence of reductive dechlorination products (cDCE and VC) outside of the EBT areas. Although MNA by naturally occurring biodegradation is not a significant contributor, the SRI groundwater model review indicated that natural attenuation by physical processes (dispersion, dilution, sorption, and volatilization) is occurring.

MNA is a low-cost remedy with O&M costs impacted by the number of wells sampled and analyzed. However, sites conditions of aerobic aquifer conditions and the low concentrations of naturally-occurring organic carbon and analytical results from LTM are not consistent with guidance (USEPA, 1999). Therefore, MNA has not been retained for further analysis.

2.6.2.4 Containment

Containment options include structures to reduce contaminant mobility. These barriers may support groundwater restoration activities but do not directly impact contaminant toxicity or volume. Containment options considered in this evaluation are physical barriers and hydraulic barriers.

2.6.2.4.1 Physical Barriers

Physical barriers (e.g., slurry walls, grout curtains, funnel & gate, block displacement, sheet pile walls) are used to slow groundwater flow, minimize migration of contaminated groundwater, divert contaminated groundwater from a drinking water intake, and/or provide a hydrodynamic barrier to enhance the efficacy of an extraction and treatment system. Physical barriers often are used where the waste mass is too large for treatment and where soluble and mobile constituents pose an imminent threat to a sensitive receptor (USEPA, 1998).

The cost and difficulty of implementing physical barriers increases significantly with depth. Physical barriers beyond 60 ft deep are generally cost prohibitive and technically impracticable. Depth to groundwater is greater than 60 ft bgs at most MI LTM wells. Furthermore, the clay unit between the FDAQ and the IAQ is absent in the central MI, which creates a hydraulic connection between the FDAQ and IAQ and greatly extends the required depth of a barrier.

For these reasons, the containment technology using physical barriers has not been retained for further analysis.

2.6.2.4.2 Hydraulic Barriers

Hydraulic barriers remove dissolved phase contaminants and/or achieve hydraulic containment of contaminated groundwater to prevent migration by pumping from an aquifer and treating the groundwater. The treatment train is typically a series of physical, chemical, or biological processes, with ultimate discharge or disposal of the treated water (FRTR, 2020a; USEPA, 1994a).

Hydraulic barriers, with treatment and monitoring of extracted groundwater, is an established technology with known design standards and performance. System design is straightforward, as extraction well positions and flow rates can be determined using groundwater models. Water treatment requirements are also well-established. Discharge of treated water may include surface water discharge, groundwater recharge, or discharge to a publicly owned treatment works (POTW). Discharge to surface water consists of discharging treated groundwater to surface or stormwater drainage; this approach can be an effective and implementable discharge method where surface water standards can be met. Groundwater recharge requires Federal and State permits with stringent requirements and is not a viable option at the site. Discharge to an off-site POTW is also not a viable option as the City of Memphis is not currently authorized to receive CERCLA-generated waste.

Since this technology is being used for containment, extraction and treatment will be required for a long period of time or until the groundwater is restored. While this option can help prevent plume migration and support restoration, costs for remediation of extensive plumes as found on the MI can be prohibitive.

Extraction, treatment, and surface water discharge has been retained for further analysis due to its potential to provide a hydraulic barrier, as well as remediate the contaminated groundwater at the MI, based on site hydrogeology, hydraulic conductivity of the aquifer, and contaminant properties.

2.6.2.5 Treatment

Available groundwater treatment technologies include biological, thermal, and physical/chemical treatments. In situ and ex situ treatment options are also available for these groundwater remedial technologies.

2.6.2.5.1 In-situ Biological Treatment

Biological process options considered include enhanced bioremediation and phytoremediation. These technologies will be implemented for treatment of contaminated groundwater in an effort to support restoration, an RAO for groundwater.

2.6.2.5.1.1 Enhanced Bioremediation

Generally, in situ bioremediation technologies employ engineered systems to heighten the effects of naturally occurring degradation mechanisms. The engineered systems are designed to enhance bioremediation and accelerate the natural biodegradation process by introducing nutrients, electron acceptors, and/or contaminant-degrading microorganisms to the subsurface. Various bioremediation technologies can be used in situ to treat soils and groundwater without removing it from the ground. Ex situ processes require removal of contaminated soil or groundwater to be treated (USEPA, 2000a).

Depending on the COC and the media, bioremediation may work through aerobic or anaerobic metabolism. In selecting a bioremediation technology, the COC, media, biological pathways of degradation, and site conditions must all be considered.

The components of in situ bioremediation technologies can be implemented in different general configurations, including direct injection, groundwater recirculation, permeable reactive barriers (PRBs), and bioventing. The configurations include vertical/horizontal wells and trenches for both injection and extraction of groundwater or injection of amendments to support the biodegradation processes. Any of these systems is used to enhance degradation through the addition of microbes, nutrients, oxidants, or reductants into the aquifer or soil.

The selected remedy in the MI ROD included EBT in the most contaminated areas and was implemented from 2006 to 2009 and from 2012 to 2014 to address rebound and to improve progress toward RAOs. Although EBT was successful in reducing CVOC concentrations, the RA was not sufficient to meet the RAOs for the MI within the timeframe estimated in the 2000 FS. Factors that limited the applicability and effectiveness of EBT processes at the site included difficulty of maintaining anaerobic conditions in the aerobic FDAQ, the time needed to remediate the plume, and the potential incomplete degradation of CVOCs to toxic by-products (e.g., VC).

Therefore, while implementable on a technical basis, in-situ bioremediation (or referenced herein as EBT) has not been retained for further analysis due to limited effectiveness in the treatment of site contaminants.

2.6.2.5.1.2 Phytoremediation

Phytoremediation uses plants to remove, transfer, stabilize, and destroy organic/inorganic contamination in groundwater. Plants are selected based on their ability to extract or degrade the COCs, local growing conditions, biomass, root depth and structure, growth rate, water uptake, and other factors.

Generally, the use of phytoremediation is limited to shallow groundwater with lower contaminant concentrations and requires a large surface area of land for remediation (ITRC, 2009). Due to the depth to groundwater, phytoremediation technology for groundwater remediation has not been retained for further analysis.

2.6.2.5.2 In-situ Physical/Chemical Treatment

In-situ physical treatment options use various processes to oxygenate, agitate or flush contamination through the subsurface for removal. Physical process options considered for this evaluation include air sparging and in-situ well stripping. In-situ chemical treatment options use various chemical processes to degrade contaminants.

In-situ physical and chemical treatment included for the groundwater treatment option are discussed below.

2.6.2.5.2.1 Air Sparging

Air sparging (AS) is a physical treatment that involves injecting air directly into the aquifer to volatilize contaminants from groundwater to the vadose zone for treatment or removal, and to enhance biodegradation of contaminants via the introduction of oxygen. It is effective in treating volatile organic compounds. AS uses commercially available equipment and is a relatively simple, lower cost technology. The equipment can be readily installed and may require minimal oversight, as no waste streams are generated and the technology is compatible with other technologies (e.g., SVE).

Sites treated with AS technology have sometimes shown significant rebound of contaminants after treatment, possibly due to untreated residuals or the influence of preferential pathways in the subsurface. These complications can result in the incorrect conclusion that contamination levels are truly trending downward when that may not be the case. It is recommended that sites continue to be sampled for at least one year after AS is stopped.

AS increases the rate of contaminant volatilization, and therefore results in potential migration of VOC-impacted vapor. SVE (Section 2.6.1.1) is used to address this problem. AS has been proven to be effective in remediating CVOCs from high permeability aquifers such as FDAQ and has been successfully implemented in the off-site area west of Dunn Field at DDMT. Based on these reasons, AS has been retained for further evaluation and will be coupled with SVE to assemble alternatives.

2.6.2.5.2.2 Bioslurping

Bioslurping is another physical treatment option that combines the two remedial approaches of bioventing and vacuum-enhanced free-product recovery to address light non-aqueous phase liquids (LNAPL) contamination. Bioventing stimulates the aerobic bioremediation of hydrocarbon-contaminated groundwater. Vacuum-enhanced free-product recovery extracts LNAPL from the capillary fringe and the water table without extracting large quantities of groundwater.

Conditions that may limit the applicability of this technology include that it can be less effective in tight (low-permeability) soils; aerobic biodegradation of chlorinated compounds may not be effective; and collected vapor and/or groundwater generally requires treatment.

Separate-phase non-aqueous phase liquid (NAPL) was not observed at the MI and aerobic bioremediation is not effective for the CVOCs present at the MI. Therefore, bioslurping has not been retained for further consideration.

2.6.2.5.2.3 <u>In-situ Chemical Oxidation/In-situ Chemical Reduction</u>

Chemical process options considered for this evaluation include in situ chemical oxidation (ISCO) and in situ chemical reduction (ISCR). These technologies will be implemented for treatment of contaminated groundwater in order to support restoration, an RAO for this media. Some of these technologies, based on implementation strategy, can also provide plume management, another RAO for the site. These process options are discussed below.

ISCO chemically converts contaminants to less toxic compounds that are more stable, less mobile, and/or inert. It involves injecting a solution of oxidizing agent into the subsurface via an injection well to treat dissolved-phased contaminants. The oxidizing agents most commonly used are ozone, hydrogen peroxide, potassium permanganate, hypochlorites, zerovalent iron (ZVI), chlorine, and chlorine dioxide. Newer reagents (i.e., alkaline activated persulfate and nanoscale ZVI) may also be considered.

ISCR refers to the transferring of electrons to contaminants from reduced metals or reduced minerals. ISCR can utilize either ZVI or dual-valent iron (DVI) to facilitate the chemical reduction of these contaminants through the creation of low redox potential and production of hydrogen.

ISCO and ISCR technologies can be viable remediation technologies as they are effective for mass reduction of organic compounds in groundwater, have a relatively rapid treatment time, and are implementable with commercially available equipment. There are safety requirements for handling and administering large quantities of hazardous chemicals and a need to monitor the fate and transport of the chemicals in the aquifer.

Delivery methods for ISCO and ISCR can range from: injections throughout the contaminated plume footprint; injection of chemicals in a barrier wall configuration; or impregnation of a funnel and gate or continuous trench barrier wall, referred to as a permeable reactive barrier, or PRB, with oxidant or reductant. Matching the chemical treatment approach and delivery system to the COCs and the site conditions is a key factor in successful implementation and achieving performance goals. Groundwater at the MI is approximately 60 to 100 ft bgs, which is deeper than can practicably be reached by a PRB; only an injection approach would reasonably be used for chemical injection.

ISCO/ISCR are not efficient at treating low-concentration contaminant plumes but are widely used to treat the contaminant source. Although these technologies can be effective in reducing CVOC contaminant mass rapidly in groundwater, they would require multiple injection events, handling large quantities of potentially hazardous chemicals, and a large number of injection points considering the nature and extent of the existing low-concentration groundwater plume. While implementable on a technical basis, ISCO/ISCR have not been retained for further analysis based on the low concentrations of the PCE/TCE plumes and the potential difficulties with implementation and safety concerns

2.6.2.5.2.4 *Dual Phase Extraction*

Dual-phase extraction (DPE), also known as multi-phase extraction or vacuum-enhanced extraction, utilizes a vacuum system to physically remove various combinations of contaminated groundwater, separate-phase product (LNAPL), and soil vapor from the subsurface. Extracted liquids and vapor are treated and collected for disposal or discharge, under applicable State regulations.

Based on plume extent and low CVOC concentrations, and the fact CVOCs do not form LNAPL, DPE has not been retained for further consideration.

2.6.2.5.2.5 *In-situ Thermal Treatment*

Thermal process options can be used to separate contaminants from groundwater. They are typically performed in-situ and employ steam, hot air or hot water injection, or electrical resistance or radio frequency heating that volatize contaminants. Volatized contaminants are extracted from the subsurface. Thermal treatment techniques are most effective to remove soil contamination in “tight soil matrices” or mobilizing and removing high concentration, dense non-aqueous phase liquids. Although extremely effective and a proven technology, thermal technologies can also have a high capital cost for implementation.

Based on plume extent and low concentrations of VOCs in groundwater and high costs associated with implementation, thermal treatment has not been retained for further consideration.

2.6.2.5.2.6 *In-Well Air Stripping*

In-well air stripping is a physical treatment technology, in which air is injected into a vertical well screened at two depths. The lower screen is set in the groundwater saturated zone, and the upper screen is set in the unsaturated zone. Pressurized air is injected into the well below the water table, aerating the water. The aerated water rises in the well and flows out of the system at the upper screen, inducing localized movement of groundwater into (and up) the well as contaminated groundwater is drawn into the system at the lower screen. VOCs vaporize within the well at the top of the water table, where the air bubbles out of the water. The air injection removes volatiles and establishes a circulation pattern of oxygen-saturated water in the aquifer that may also enhance the biodegradation rate.

The contaminated vapors accumulating in the wells are collected via vapor extraction contained within the well. Vapor phase treatment typically occurs above grade. For effective in-well treatment, the contaminants must be adequately soluble and mobile so they can be transported by the circulating groundwater. In general, in-well air strippers are more effective at sites containing high concentrations of dissolved contaminants with high Henry's Law constants. The radius of influence (ROI) and groundwater flow regime around the well requires careful consideration in design and operation of the system (FRTR, 2002b).

The complex hydrogeology and the large areal footprints of the low-concentration CVOC plumes in the highly permeable FDAQ make air-stripping ineffective/cost prohibitive to implement at the MI. The limited number of vendors available to design/construct the remedy also makes obtaining competitive bids difficult. Based on these reasons, in-well air stripping has not been retained for further evaluation.

2.6.2.5.2.7 Passive/Reactive Treatment Barrier

A permeable reactive barrier (PRB) is a passive in-situ treatment zone that removes contaminants as groundwater flows through it. Hydrogeology must be conductive (relatively shallow depth to groundwater and to an underlying hydraulic barrier) and a relatively shallow confining layer is needed to “key” into and thereby contain the system. Most PRBs are installed as either a funnel-and-gate or continuous trench.

Groundwater contamination at the MI is approximately 60 to 100 ft bgs, which is deeper than can practicably be reached by passive/reactive treatment barriers. The effectiveness of barriers is limited by the thin, inconsistent and/or absence of a low permeability confining clay unit into which the barrier could be keyed. Therefore, a PRB has not been retained for further evaluation.

2.6.2.5.3 Extraction with Biological/Chemical/Physical Treatment

For this process option, groundwater is extracted by pumping groundwater from an aquifer to remove dissolved phase contaminants to support groundwater restoration. Processes typically evaluated or used in extraction and treatment systems include ex-situ physical, chemical, and biological treatments. Generally, treatment and monitoring of extracted groundwater is required. A multiple treatment train may be required for groundwater with multiple types of contaminants. A groundwater monitoring program is a component of any extraction system to verify its effectiveness. As discussed in regard to hydraulic barriers (Section 2.6.2.4.2), discharge to surface water is the only viable discharge option for treated groundwater at the site. Potentially long time periods are required for extraction to achieve remediation goals. Operation and maintenance considerations associated with treatment may be more expensive than other treatment technologies. The following ex-situ treatment technologies are considered in conjunction with the extraction technology, as that technology requires impacted groundwater be pumped to the surface prior to treatment.

2.6.2.5.3.1 Bioreactors

Contaminants in extracted groundwater are put into contact with microorganisms in attached or suspended growth biological reactors. Contaminated groundwater is circulated in suspended media, such as activated sludge, within an aeration basin. In attached systems, such as rotating biological contractors and trickling filters, microorganisms are established on an inert support matrix.

Given the dilute nature of the contamination and low biochemical oxidant demand in the groundwater, this technology will not readily support a microbial population density adequate for remedial purposes. Therefore, bioreactors have not been retained for further consideration.

2.6.2.5.3.2 Constructed Wetlands

The constructed wetlands-based treatment technology uses natural geochemical and biological processes inherent in a wetland ecosystem to accumulate and fixate/remove metals and other contaminants from influent waters. The wetland technology can utilize filtration or the degradation process for CVOCs, although removal of high concentrations of CVOCs has not been well-established with these systems.

The land area required to establish adequate treatment wetlands is not readily available at DDMT, and the wetland components would need to be monitored and maintained (FRTR, 2002c). Therefore, constructed wetlands technology has not been retained for further consideration.

2.6.2.5.3.3 Adsorption

The adsorption process consists of passing contaminated groundwater through a sorbent media. Contaminants are adsorbed onto the media, reducing their concentration in the bulk liquid phase. The most common adsorbent is granular activated carbon (GAC) which is also a presumptive remedy.

Adsorption is a viable technology for VOC treatment of extracted groundwater and vapors. Therefore, adsorption via GAC has been retained for further evaluation.

2.6.2.5.3.4 Advanced Oxidation Processes

Advanced oxidation processes, including UV radiation, ozone, and/or hydrogen peroxide, are used to destroy organic contaminants as impacted water is pumped into a treatment vessel. If ozone is used as the oxidizer, an ozone destruction unit(s) may be required to treat off-gases from the treatment tank and where ozone gas may accumulate or escape.

Advanced oxidation technology is associated with high energy requirements and requires considerable cost to operate. Therefore, advanced oxidation process technology has not been retained for further consideration.

2.6.2.5.3.5 Ex-Situ Air Stripping

Air stripping is a presumptive remedy that involves the mass transfer of volatile contaminants from water to air. VOCs are separated from extracted groundwater by exposing the contaminated water to a flow of air. Air stripping configurations include packed towers, diffused aeration, tray aeration, and spray aeration. Given the large size of the plume, flow rates of an extraction and treatment system are likely to be in a range where air stripping would be relatively cost-effective. Treatment of the air stripper effluent air stream with vapor-phase GAC would be required with this process option.

This well-established technology can be effective in reducing contaminant toxicity, mobility, and concentration through the use of readily available treatment equipment, but it has relatively high capital and operational costs. Air stripping has been retained for further consideration.

2.7 Evaluation of Process Options

A total of 6 GRAs and 22 groundwater remedial process options (Table 6) were screened for potential applicability, effectiveness, reduction in toxicity, mobility, or volume of contaminants, and implementation at the MI. GRAs and remedial technologies/process options retained for more detailed analysis are:

- No action
- ICs
- Containment

  - Groundwater Extraction
- Treatment
  - AS/SVE
- Extraction, Treatment and Surface Water Discharge
  - Adsorption
  - Air Stripping

These technologies, as well as presumptive remedial technology, SVE, for subsurface soil source areas have been incorporated in the remedial alternatives and will be further evaluated based on their applicability to site conditions and potential effectiveness in meeting the RAOs.

The retained remedial technologies were assembled into process options and an evaluation of those process options completed. Process options were evaluated based on effectiveness, reduction of toxicity, mobility, or volume of contamination through treatment, implementability, and cost. Process options that cannot be effectively implemented within the site area due to site characteristics or other restrictions were eliminated from further consideration.

2.8 Groundwater Process Options

Groundwater remedial options retained for detailed analyses include AS/SVE, and extraction, treatment, and discharge to surface water.

The no action and IC options were also included for evaluation. ICs are a critical component of any remedy option, as the results of the HHERA (HDR, 2020b) indicate that risks from groundwater (via ingestion, dermal contact, and inhalation exposure routes) exceed acceptable levels for carcinogenic and non-carcinogenic effects in a future scenario that assumes exposure to impacted groundwater (i.e., that the engineering and ICs are no longer in-place).

Any remedy proposed will incorporate the protection of public health and the environment and ICs already in place, as these have achieved significant risk reduction and contribute to keeping human exposure under control. These existing controls are enforceable under local, State, and Federal regulatory authority. The existing ICs being implemented through LUCs are:

- Prevention of residential land use on the MI (except at the existing Housing Area);
- Daycare restrictions;
- Production/consumptive use groundwater controls for the FDAQ and for drilling into aquifers below the FDAQ on the MI; and,
- Elimination of casual access by adjacent off-site residents through maintenance of a boundary fence for the Southeast Golf Course.

The remedial technologies were assembled into process options and evaluated based on site-specific and contaminant characteristics. A summary of secondary screening and the groundwater process option evaluation is summarized in Table 7 and discussed in greater detail below.

2.8.1 No Action

The no action option will not meet the RAOs for the site and will not be acceptable to the local community or the state. There is no cost associated with this option as the existing LTM program and maintenance of ICs are assumed to be discontinued under the no action option. The no action option has been retained only to provide a basis for comparison with other active remedial process options as required under CERCLA.

2.8.2 AS/SVE

AS is a physical treatment that involves injecting air directly into the subsurface to volatilize contaminants from the liquid phase to the vapor phase for treatment. It is effective in treating chlorinated solvent contamination. AS is very effective for high permeability aquifers such as the FDAQ found at the site, and CVOCs are effectively remediated via AS.

While AS increases the rate of contaminant volatilization, it results in the potential for migration of VOC-impacted vapor. The contaminants move upward into the unsaturated zone where an SVE system will be implemented to remove the vapor-phase contamination. Contaminants captured in the extracted soil vapor will be treated ex-situ, via adsorption by GAC. AS/SVE will be an applicable remediation technology for the site because of its effectiveness in removing VOCs in groundwater. The SVE component will also remove VOCs from residual soil contamination in the vadose zone within the treatment area.

Based on site-specific geology/hydrogeology (such as highly permeable aquifer with surficial fine-grained low permeability soils assisting in SVE process), as well as its effectiveness for CVOCs, AS/SVE has been retained for further evaluation.

2.8.3 Extraction, Treatment and Discharge/Disposal

Extraction, treatment and discharge/disposal can be effective in contaminant mass removal, depending on site conditions and implementation over a long timeframe. Groundwater extraction can establish hydraulic control of the aquifer limiting migration of contaminants into deeper aquifers, thereby limiting the amount of clean water inflow needed for cost-effective remediation of the plume. However, implementation of an extraction and treatment system as an interim remedial action at nearby Dunn Field was determined to be ineffective in providing hydraulic control for the FDAQ.

The treatment system could use air stripping or vapor-phase GAC and discharge to surface water. Extraction and treatment will likely be relatively less effective than other alternatives and have a higher expense due to extent of the plumes and the number of extraction wells, collection infrastructure and required discharge to surface water. Extraction and treatment systems are typically required to operate for long periods of time and over the lifetime of the remedy, the yearly O&M costs would be significantly greater than the other in-situ technologies.

Given the extent of the low-concentration CVOCs plume and hydrogeologic conditions, a relatively large treatment plant would be required for extraction and treatment. The MI area is highly developed and locating a suitable property for the treatment system would be challenging.

The discharge of the treated effluent would also require creating new recharge ponds and installation of a transmission pipe to the nearest surface water streams. For these reasons, extraction and treatment has been screened out and not carried forward for developing site alternatives.

3 Development and Screening of Remedial Alternatives

Preliminary remedial alternatives for the site have been developed by combining the remedial technologies and process options that have successfully passed the screening stage into a range of alternatives. The areas being considered for active remediation are shown on Figure 19 and described below:

- Subsurface VOC Source Areas: VOCs in soil vapor exceeding the Dunn Field protective soil vapor screening levels were used to identify suspected source areas at TTA-1N, TTA-2 and Building 720. The SVE pilot test conducted at TTA-2 confirmed a source based on the CVOC mass removed (Section 1.2.4.4). The source areas are each estimated to be approximately 100-ft by 100-ft; the vadose zone in the coarse-grained, lower fluvial deposits at the three locations ranges from 40 to 60 ft.
- Groundwater: Active groundwater remediation will be conducted in the FDAQ and IAQ.
  - FDAQ: Two boundary areas and eight on-site areas are potential locations for remedial action.
    - CVOC concentrations in groundwater exceed cleanup levels at the MI property boundary at TTA-1N and the N-C area due to impacts from off-site sources; these areas are continuing sources of groundwater contamination migrating onto the MI. The PCE/TCE plumes migrating into TTA-1N and the N-C area are estimated to be 250 ft in width with a saturated thickness of 25 to 30 ft; the vadose zone thickness in the upper fluvial deposits above the plumes is 25 to 50 ft.
    - Multiple, distinct plumes of PCE, TCE or CT have been identified on the MI. Eight on-site areas, each approximately 100-ft by 100-ft, have concentrations greater than 40 µg/L. Saturated thickness ranges from 11 ft in TTA-2 to 61 in TTA-1S, with an average thickness of about 30 ft; the vadose zone thickness in the upper fluvial deposits above the plumes is 35 to 60 ft.
  - IAQ: PCE/TCE plumes in the FDAQ have migrated to the IAQ through the erosional window. The TCE plume is limited to the downgradient area near MW-34 and concentrations are less than 10 µg/L The PCE plume extends through the erosional window and has higher concentrations (>40 µg/L). The PCE plume's estimated width is 250 with saturated thickness of about 65 ft; the vadose zone thickness in the upper fluvial deposits above the plume is approximately 55 ft.
  - CVOC plumes outside the selected areas have low concentrations, which are expected to decrease following remedial action in the selected areas.

The criterion in the FFS used to identify areas requiring active treatment (source control) is individual concentrations of parent CVOCs (PCE, TCE or CT) at or above 40 µg/L. The RAOs in Section 2.3 list the Contaminants of Concern and cleanup levels used to determine if remedial objectives are met; cleanup levels for groundwater are MCLs, where established.

Selection of 40 µg/L as the target concentration for treatment (remedial action) is based on concentrations previously selected for treatment on the MI and Dunn Field. The MI ROD selected "the most contaminated part of the groundwater plume" for EBT and the MI RD used 100 µg/L to identify "contaminated portions of the MI plumes" as the basis for treatment. The Dunn Field ROD Amendment stated "The AS-SVE system will be installed to intercept the majority of the Off-Depot CVOC plume and reduce individual CVOC concentrations to below 50 µg/L."

The original selection of 100 µg/L for treatment on the MI is not considered sufficient and eliminates most on-site plumes from treatment. Since the selected alternatives and site conditions are similar to Dunn Field, 50 µg/L was considered appropriate and was lowered to 40 µg/L to allow for variability in groundwater concentrations.

The RAOs in Section 2.3 list the Contaminants of Concern and cleanup levels that will be used to determine if remedial objectives are met; cleanup levels for groundwater are MCLs, where established.

Remedial alternatives for the MI were developed based on the retained technologies and site-specific conditions as described above. The technologies retained for further analysis include:

- Groundwater:
  - No action
  - AS/SVE
- Subsurface Soil Vapor Source Areas
  - SVE
  - Vapor Intrusion ICs

LTM and ICs, updated to include VI notification, will continue to be implemented in conjunction with, or as enhancements, to the remedial treatment. The alternatives focus active measures on FDAQ and IAQ areas of higher contaminant concentrations and/or provide treatment to mitigate further migration of off-site groundwater contamination onto the MI and migration of on-site groundwater contamination to the IAQ and MAQ.

The alternatives expected to meet the RAOs based on the screening are summarized in Table 8. The alternatives and any assumptions used in the screening process are discussed in detail below. The remedial alternatives evaluated further within this FFS included:

- Alternative 1 – No Action
- Alternative 2 – AS/SVE and SVE
- Alternative 3 – Expanded AS/SVE and SVE

3.1 Alternatives 2 and 3 – Common Components

Alternatives 2 and 3 include the use of existing MI ICs, updated to include VI notifications, and an ongoing groundwater LTM program as common components.

3.1.1 Institutional Controls

ICs on the MI have been implemented through a LUCIP since 2005 as part of the selected remedy for the MI. These controls do not reduce the subsurface contamination or promote groundwater restoration but instead provide notice to future residents of current conditions and restrict activities to limit exposure to levels protective of human health. The purposes of the ICs for the VI remedy are to (1) provide information to property owners of VI potential for existing or new structures; (2) notify building owners and occupants regarding any VI remedy implemented at a property; and (3) provide recommendations for assessment and mitigation, should monitoring identify the need.

VI assessment will be conducted to evaluate potential indoor air impacts from subsurface VOC contamination for current structures and construction of future structures and evaluate whether more active measures are needed to address the VI pathway. The potential for VI to occur at a particular building is dependent upon a number of factors, or multiple lines of evidence, including extent of residual VOC contamination in soil, VOC concentrations in groundwater, subsurface geology and hydrogeology and the existing or planned structural characteristics of each building. Each assessment will be tailored to the property/building and will include a sampling plan, data collection, analysis, and development of recommendations. All property within the MI has been transferred to the city of Memphis or to private landowners. The Army is implementing a VI sampling plan (Section 1.2.5) to evaluate VOC concentrations in soil vapor throughout the MI and the potential for VI at existing buildings. VI assessment for new buildings are the responsibility of the property owner. The need for vapor mitigation at existing buildings or for new construction will be determined in accordance with current guidance (USEPA 2015).

3.1.2 Long Term Monitoring

The existing LTM program will continue to be implemented to confirm progress in contaminant reduction to achieve RAOs. It is anticipated that, as the remedy progresses, there will be a reduction in the number of wells and sample frequency. LTM will continue until RAOs have been met.

Groundwater performance monitoring will utilize the existing monitoring well network and new wells that may be installed during the PDI. The selection of performance monitoring wells will be made during the remedial design phase and modified as necessary during implementation based on review of remedy effectiveness.

The effectiveness of both ICs and LTM will be assessed over the course of the remedial action. The need for changes to the ICs and LTM will be reviewed in the annual monitoring reports.

3.2 Alternative 1 – No Action

The NCP requires that a “No Action” alternative be evaluated to establish a baseline for comparison with other groundwater remedial alternatives. The existing LTM program and maintenance of ICs are assumed to be discontinued under the no action alternative. If no active remedial action is taken, contaminants already present in the groundwater will remain and RAOs for the MI will take the longest to achieve. It is assumed that land and groundwater resource use will not change over time; however, potential for human health and environmental risks identified in the HHERA (HDR, 2020b) would be increased due to halting implementation of ICs and LTM.

3.3 Alternative 2 – AS/SVE and SVE

3.3.1 Overview

Alternative 2 includes AS/SVE in the FDAQ along the property boundary at TTA-1N and N-C plumes to prevent migration of off-site contamination onto the MI, AS/SVE within the window to reduce migration to the IAQ and MAQ, and SVE in TTA-2 to remove residual subsurface soil vapor contamination and reduce groundwater impacts. The SVE component of AS/SVE systems at TTA-1N and Building 720 will also remove residual contamination in subsurface soil vapor in those areas. AS/SVE is expected to reduce the overall time to achieve the groundwater RAOs. ICs and LTM (Section 3.1) will be implemented as part of this Alternative.

AS/SVE is an in-situ physical/chemical treatment alternative that utilizes two remedial technologies for remediation of contaminated groundwater. The AS system uses an air compressor to deliver compressed air under pressure into the target aquifer via sparge wells. The SVE system uses a blower(s) to create a vacuum in the unsaturated (vadose) zone above the aquifer to remove VOC-contaminated vapor via vacuum extraction wells. The aboveground AS/SVE system components include a process control system to monitor and adjust both air delivery and vapor extraction to optimize contaminant removal. A typical AS/SVE Process Schematic is shown on Figure 20.

Under this alternative, AS/SVE configured in a single line (transect) of offset AS wells and SVE wells would treat groundwater through the injection of air into the groundwater to sparge volatile contaminants and the collection of the contaminated vapor via vacuum extraction. Separate AS/SVE systems would be installed across the TTA-1N and N-C plumes to intercept the plumes migrating onto the MI and in the window area to intercept the low concentration CVOC plume migrating from the FDAQ into the IAQ. Each AS/SVE system would have injection and vapor extraction wells in a single transect configuration. The AS/SVE systems at TTA-1N and in the window area near Building 720 will address the soil sources in those areas; separate SVE systems are not necessary.

As groundwater passes through each treatment zone created by the AS/SVE transect, contaminants will be physically removed from the groundwater via sparging, reducing CVOC concentrations to levels less than MCLs. CVOCs volatized from groundwater by sparging will be collected and permanently removed from the vadose zone via SVE wells. Soil vapor will be treated ex-situ using GAC adsorption, if necessary to meet SCHD discharge limits. Groundwater immediately downgradient of each transect, with CVOC concentrations less than MCLs, will flow downgradient mixing with the existing plume resulting in a general decrease in CVOC concentrations.

SVE is an in-situ physical treatment alternative that uses a blower(s) connected to one or more extraction wells in order to create a partial vacuum in the vadose zone, which increases volatilization of CVOCs from source area soil and removes VOC-contaminated vapor from the vadose zone. The existing SVE system in TTA-2 consists of extraction well SVE-1, the blower, and a moisture separator prior to discharge to the atmosphere; instruments and sample ports allow measurements of flow, temperature, and pressure and vapor sampling. A dilution valve upstream from the moisture separator allows addition of ambient air to reduce flow from the SVE well and decrease the VOC concentration in the discharge. A typical SVE Process Schematic is shown on Figure 20.

3.3.2 Goals

The AS/SVE active remediation goals are to reduce concentrations immediately downgradient of the transects below MCLs soon after implementation and to maintain that treatment objective until system operations cease. The goal for the downgradient portion of the TTA-1N and N-C plumes is for concentrations to be reduced below 20 μg/L through prevention of further contaminant migration and facilitate attenuation by dilution in FDAQ and IAQ plumes. CVOC contaminants in the upgradient, off-site portion of the plumes will resume migration onto the MI after operations cease unless the source areas are remediated. In that case, system shutdown will need to be based on a determination that further migration onto the MI will not impact human health and the environment.

The AS/SVE active remediation goals in the window area are to reduce CVOC concentrations immediately downgradient of the transect below MCLs during the first year of operation and to maintain that treatment objective until system operations cease. Individual CVOC concentrations in groundwater at upgradient FDAQ wells and downgradient FDAQ and IAQ wells are to be reduced below 10 μg/L, a concentration that will prevent further contaminant migration and facilitate attenuation by dilution in the IAQ plume. The reduced concentration in IAQ wells should prevent future impacts to the MAQ.

The SVE active remediation goals are to reduce CVOC concentrations in the vapor effluent asymptotically and concentrations in groundwater below MCLs in wells within the ROI (100 ft). The criteria for the plume downgradient of the SVE system is for concentrations to be reduced below 20 μg/L. Successful implementation of SVE will reduce groundwater impacts and enhance attenuation by dilution to reduce VOC concentrations and limit downward migration of the plume to the IAQ and MAQ.

3.3.3 Description

The AS/SVE system transects will span the central portion of each plume with individual CVOC concentrations greater than 10 to 20 μg/L; each transect is estimated to have a required length of 250 ft. Individual transects are proposed at three locations (Figure 23):

- TTA-1N – Along the service road west of Building 1089 near monitoring wells MW-21 and PMW21-01.
- N-C – South of the boundary fence along Dunn Avenue near MW-263.
- Window Area – Northeast of the intersection of Amido and Heyde Avenues near MW-305.

The areas are relatively undeveloped and have sufficient open space for AS and SVE well installation and placement of treatment system trailers.

A preliminary assessment of the AS/SVE system configuration, ROI, and air flow rates has been made based on a typical application and on site-specific geologic and hydrogeologic information. Site conditions in the treatment areas for the three AS/SVE transects and SVE at TTA-2 based on existing wells in each area are shown on Table 9. The approximate depth to groundwater and thickness of the FDAQ is different at the three AS/SVE locations: TTA-1N has groundwater depth at 79 ft btoc and saturated thickness at 32 ft; the N-C area has groundwater depth at 54 ft btoc and saturated thickness at 25 ft; and the window area has groundwater depth at 91 ft btoc and saturated thickness at 67 ft. A PDI will be conducted to include installation of additional monitoring wells to confirm the length and position of the transects and depths to the top of sand and the clay layer at the base of the FDAQ.

Although the depth to water differs for the TTA-1N and N-C areas, the similar saturated thickness allows a similar design. The preliminary design of each system has a total of 8 AS wells with an assumed ROI of 20 ft and 5 ft of overlap. AS wells would have 2-ft screens with average total depth of approximately 110 ft for TTA-1N and 80 ft for N-C. The air compressor unit is expected to produce a total AS flow rate of approximately 80 scfm at 15 psi (approximately 10 scfm per AS well).

The SVE system at each transect would have a combined flow rate at least 2.5 times the combined AS flow rate. With an assumed ROI of 50 ft and 10 ft of overlap, a total of 4 SVE wells will remove CVOCs from the unsaturated zone. The SVE wells would have screens extending from approximately 5 ft below the top of sand to approximately 10 ft above groundwater; the SVE wells would average screen length of 35 ft and total depth of 70 ft bgs at TTA-1N and average screen length of 20 ft and total depth of 45 ft bgs at N-C. The blower is expected to produce a total SVE flow rate of approximately 200 scfm at 40 in WC (approximately 50 scfm per well).

For the Window area, the system design would be the same as the other two areas except for greater pressure required for the AS compressor because of the greater aquifer thickness and depth. The preliminary design would have a total of 8 AS wells with an assumed ROI of 20 ft and 5 ft of overlap. AS wells would have 2-ft screens with average depth of approximately 150 ft. The air compressor unit is expected to produce a total AS flow rate of approximately 80 scfm at 30 psi (approximately 10 scfm per AS well). A total of 4 SVE wells are required based on an assumed ROI of 50 ft and 10 ft of overlap. The SVE wells would have average screen length of 40 ft and total depth of 80 ft bgs. The blower is expected to produce a total SVE flow rate of approximately 200 scfm at 40 in WC (approximately 50 scfm per well).

A field test will be required to confirm requirements for the AS compressor and SVE blower and the radii of influence for AS wells and SVE wells at each transect. The test will require installation of two AS wells and one SVE well in each of the three transect locations and operation with a compressor and blower for one week. Effluent sampling during the field test will be used to evaluate the need for GAC treatment. The field test results will be used in the remedial design to determine the number, placement, and depth of AS and SVE wells, the AS compressor and SVE blower requirements and other system components.

The existing SVE well and blower for the pilot test at TTA-2 will be used to remove CVOCs from the vadose zone. The blower produces a total SVE flow rate of approximately 120 standard cubic feet per minute (scfm) at 90 inches of water (in WC). An ROI of 100 feet for each SVE well is assumed, as seen in the pilot test. The existing vapor monitoring points (VMPs) will be used to confirm the radius of influence.

The remedial design to be completed prior to implementation will consider estimated combined emissions from the three AS/SVE systems, the SVE system at TTA-2 and the Dunn Field Off Depot AS/SVE system with regard to the SCHD permit limit of 5.71 lb/hr and the de minimus criterion of 0.1 lb/hr below which a permit is not required. Based on the evaluation, a permit should be requested from SCHD, or GAC treatment included in the design, if it appears the combined emissions will exceed the de minimus level. Adjusting system operations to reduce CVOC removal from groundwater in order to meet the de minimus criterion will increase the time required for remedial action.

Vapor extraction piping will be sloped to allow moisture and condensate to drain into the SVE wells. Condensate will be collected in a knockout tank and periodically disposed at an off-site facility approved for receipt of CERCLA waste. Condensate volume is conservatively estimated at 20 gallons per month. The SVE blower selection will include consideration of the heat imparted to the vapor stream and maintenance of relative humidity within satisfactory limits.

System operations will be adjusted during startup to optimize removal of CVOCs in accordance with regulatory requirements. Effluent vapor samples (pre- and post-treatment) will be collected to evaluate VOC mass removal relative to the SCHD criteria and evaluate whether vapor treatment with GAC is needed. The cost-estimate includes GAC usage for the systems.

Effluent vapor samples will also be collected during system operations to evaluate VOC removal and compliance with SCHD requirements. Groundwater samples will be collected during performance monitoring for each transect location and TTA-2, and during LTM for the entire MI. Analytical results will be used to determine whether expected progress toward RAOs is being achieved and whether changes to system operations are required.

The time required for system operations at the AS/SVE transects is based on the groundwater seepage velocity and the travel time from the treatment area to the downgradient extent of individual CVOC concentrations equal to 20 µg/L, one-half the treatment target of 40 µg/L. The seepage velocity is hydraulic conductivity multiplied by the gradient and divided by the soil porosity. The hydraulic conductivity in the FDAQ is estimated at 100 ft/d based on the past aquifer test results and vertical profiling (Section 1.2.4.3.4); the hydraulic conductivity in the IAQ is estimated at 40 ft/d, the value used in the 2009 groundwater model (e2m, 2009). The porosity is estimated at 20% and the gradient is based on April 2021 groundwater elevations for one or more segments of the approximate flow path. The estimated travel time for the three AS/SVE transects are shown on Table 10 with the gradient calculation for each segment of the flow path.

- The TTA-1N groundwater flow path from MW-219 near the western MI boundary to DR1-7 has total length of 1,048 ft and two segments with hydraulic gradients of 0.004 and 0.002; the travel time is estimated at 890 days or 2.4 years.

- The N-C groundwater flow path from MW-263 near the northern MI boundary to MW-318 has total length of 3,059 ft and three segments with hydraulic gradients of 0.005 to 0.0131; the travel time is estimated at 865 days or 2.4 years.
- The window area groundwater flow path from MW-305 to IAQ well MW-256 has total length of 1,749 ft and one segment with a hydraulic gradient of 0.0183; the travel time is estimated at 478 days or 1.3 years.
- The time required for groundwater treated by the AS/SVE transect to flow through the plume four times is estimated to be sufficient to meet the treatment goal of 20 µg/L, absent on-site sources within the plume. The estimated treatment period is 10 years for TTA-1N and the NC area and 5 years for the window area.

Travel time calculations were not made for SVE at TTA-2 as the treatment goal of 20 µg/L has been met in the source area near SVE-1 and downgradient. SVE operations are planned to further reduce source concentrations and prevent significant increase of CVOC concentrations in groundwater after operations cease. CVOC concentrations in vapor effluent and mass emission rates were reduced approximately 94% over 14 months of operation. Two years of operations are expected to reduce the current concentrations by 90% and reach 99% reduction from initial concentrations.

3.3.4 Cost Estimate Assumptions

The time required to meet the active remediation goals is estimated as 10 years for the TTA-1N and N-C AS/SVE systems, 5 years for the window area AS/SVE system and 2 years for the TTA-2 SVE system. System O&M and monitoring of effluent and groundwater will be performed regularly throughout active remediation with annual comprehensive reports; systems operations, contamination migration trends, and source area soil and groundwater analytical results will be evaluated to determine whether progress is sufficient to meet the MI RAOs in the estimated timeframe. Upon completion of operations, the AS/SVE and SVE systems will be maintained for additional use, if necessary.

An additional 10 years of LTM, for a total of 20 years for implementation of ICs and LTM, are estimated to be necessary to meet the RAOs. LTM is assumed to be conducted semiannually for Years 1 through 5 using the existing extensive well network, followed by annual monitoring at 50 wells for Years 6 to 10 and at 30 monitoring wells for Years 11 through 20.

Once the RAOs are met, the AS/SVE and SVE systems will be removed and wells plugged and abandoned in accordance with TDEC and Shelby County regulations. ICs will continue to be implemented in accordance with the revised LUCIP until conditions for UU/UE are met.

Primary components of Alternative 2 include:

- Pre-Design Investigation
    - Work Plan
    - Field Work – Installation and development of 9 monitoring wells between the three AS/SVE areas with groundwater sampling and analysis.

- Data validation and reporting
- Pilot Tests
  - Work Plan
  - Installation of 2 AS wells and 1 SVE well in each AS/SVE area
  - Field tests with AS compressor and SVE blower for one week in each area
  - Reporting
- Remedial Design
- AS/SVE
  - Construction
    - Install 6 AS wells,3 SVE wells and 3 VMPs in each area
    - Build equipment pad with power connection
    - Install piping from wells to equipment pad
    - Install trailer-mounted AS and SVE systems at equipment pad and connect piping and power
  - Startup
    - Baseline sampling of performance monitoring wells (9 wells in each area) and VMPs
    - Start-up testing of AS/SVE systems with GAC vapor treatment if needed per design
    - Effluent vapor sampling to confirm treatment requirements
    - Remedial Action Construction Report
  - System Operations
    - Year 1
      - Operation, monitoring, and optimization of the AS/SVE systems
      - Quarterly groundwater monitoring at performance well network and PID/pressure at VMPs
      - Interim Remedial Action Completion Report
    - Years 2 to 10
      - Operation, monitoring, and optimization of the AS/SVE systems
      - Semiannual groundwater monitoring at performance well network and PID/pressure at VMPs
      - Annual Report
  - System Shutdown

- SVE
  - TTA-2 System
    - Years 1 and 2
      - Operation, monitoring, and optimization as in pilot test
      - Semiannual groundwater monitoring at performance well network and PID/pressure at VMPs
      - Annual Report
- Monitoring
  - ICs implemented per LUCIP Years 1 to 20
  - LTM
    - Semi-annual monitoring of existing LTM well network in Years 1 to 5
    - Annual monitoring of reduced LTM network (50 wells) in Years 6 to 10
    - Annual monitoring of reduced LTM network (30 wells) in Years 11 to 20
- Remedial Action Completion Report
- Abandonment of LTM, AS and SVE wells

3.4 Alternative 3 – Expanded AS/SVE and SVE

3.4.1 Overview

Alternative 3 consists of the remedial system components from Alternative 2 with the addition of portable in-situ remedial systems for implementation of SVE and AS/SVE in additional, on-site areas with PCE, TCE, or CT groundwater concentrations greater than 40 µg/L. The additional remedial action is expected to reduce the time required to operate the AS/SVE transects and the overall time to achieve RAOs. ICs and LTM (Section 3.1) will be implemented as part of this Alternative.

As described in Section 3.3, AS/SVE transects at two locations on the boundary and one location within the window would treat groundwater through the injection of air into the groundwater to sparge volatile contaminants and collection of the contaminated vapor via vacuum extraction. As groundwater passes through each AS/SVE treatment zone, contaminants will be physically removed reducing CVOC concentrations to levels less than MCLs. Groundwater immediately downgradient of each transect will flow downgradient mixing with the existing plume and resulting in a general decrease in CVOC concentrations. SVE at TTA-2 will volatilize CVOCs in source area soil and remove VOC-contaminated vapor from the vadose zone reducing the contaminant source and limiting further impacts to groundwater.

The addition of portable remedial systems would be used to remove CVOCs in subsurface soil source areas by SVE and in groundwater by AS/SVE. Locations would be selected based on parent contaminant concentrations in groundwater above the target concentration (40 µg/L).

This alternative assumes operation of separate trailer-mounted portable systems for AS/SVE and SVE. Each treatment system would be operated for up to 12 months at a location and then moved to another area. The SVE system, with one SVE well and one VMP, would be used at locations with CVOC concentrations indicative of source area soils. The AS/SVE system, with three AS wells, one SVE well and one VMP, would be used at locations with elevated CVOC concentrations in groundwater with or without source area soils indicated.

3.4.2 Goals

The goals for the AS/SVE at the transects and SVE at TTA-2 were described in Section 3.3. The goals for the portable remedial systems are similar.

The AS/SVE active remediation goals are to reduce concentrations immediately downgradient of the additional transects below MCLs soon after implementation and to maintain that treatment objective until system operations cease. The goal for the plumes downgradient of the portable AS/SVE system is for concentrations to be reduced below 20 µg/L through prevention of further contaminant migration and attenuation by dilution .

The SVE active remediation goals are for CVOC concentrations in the vapor effluent to be reduced asymptotically and for CVOC concentrations in groundwater to be below the MCL in wells within the ROI (100 ft). The goal for the plumes downgradient of the portable SVE system is for concentrations to be reduced below 20 µg/L through the downgradient flow of groundwater from the treatment area and attenuation by dilution.

3.4.3 Description

The AS/SVE systems on the boundary and in the window area and the SVE system in TTA-2 were described in Section 3.3. The portable AS/SVE system transects will span the central portion of smaller plumes with individual CVOC concentrations at the ends less than 20 µg/L. Transects are estimated to have a length of 100 ft.

Eight areas have been identified for potential use of the portable remedial systems (Figure 23):

• TTA-1N at PMW21-03 • TTA-1S at PMW101-07B • TTA-2 at MW-217 • TTA-2 at MW-294	• N-C Area at MW-258 • N-C Area at MW-207B • S-C Area at MW-330 • Building 835 at MW-212

All areas, except the S-C Area at MW-330, are in developed areas and will require additional review for siting, especially for AS/SVE which has multiple AS wells with piping connected to the compressor. Siting for SVE is not expected to be an issue due to limited drilling and a smaller equipment footprint.

The preliminary assessment of the AS/SVE system configuration, ROI, and air flow rates made for Alternative 2 will also be used for the portable AS/SVE and SVE systems. Site conditions in the treatment areas for the portable systems based on existing wells in each area are shown on Table 11. The depth to the top of sand in the lower fluvial deposits ranges from 25 to 51 ft bgs, the depth to groundwater ranges from 71 to 92 ft bgs and the depth to the top of clay ranges from 82 to 167 ft bgs. The thickness of the sand and gravel vadose zone for implementation of SVE ranges from 35 to 58 ft and the saturated thickness ranges for sparging ranges from 11 to 75 ft.

The PDI described in Section 3.3 will be expanded to include installation of a few additional monitoring wells to confirm the length of the transects; VMPs will also be installed to evaluate CVOC concentrations in the vadose zone for selection of SVE or AS/SVE.

The portable remedial AS/SVE system would have similar design requirements as in Alternative 2. The preliminary design of the portable system has a total of 3 AS wells with an assumed ROI of 20 ft and 5 ft of overlap. AS wells would have 2-ft screens with average total depth of 110 ft. The air compressor unit is expected to produce a total AS flow rate of approximately 40 scfm at 30 psi, (approximately 13 scfm per AS well). The SVE system would have a combined flow rate at least 2.5 times the combined AS flow rate. The single SVE well would have an assumed ROI of 50 ft to remove CVOCs from the unsaturated zone and would have a screen extending from approximately 5 ft below the top of sand to approximately 10 ft above groundwater. SVE well screen lengths would average 30 ft with average total depths of 70 ft. The blower is expected to produce a total SVE flow rate of approximately 120 scfm at 90 in WC.

The field test required for Alternative 2 is expected to be sufficient to confirm requirements for the AS compressor and SVE blower and the radii of influence for AS wells and SVE wells for the smaller treatment areas to be created by the portable systems.

The remedial design to be completed prior to implementation will consider estimated combined emissions from portable SVE and AS/SVE systems operating at the same time. As noted in Section 3.3, a permit should be requested from SCHD, or GAC treatment included in the design, if it appears the combined emissions will exceed the SCHD de minimus level. Adjusting system operations to reduce CVOC removal from groundwater in order to meet the de minimus criterion will increase the time required for remedial action.

Vapor extraction piping will be sloped to allow moisture and condensate to drain into the SVE wells. Condensate will be collected in a knockout tank and periodically disposed at an off-site facility approved for receipt of CERCLA waste. Condensate volume for the smaller systems is conservatively estimated at 10 gallons per month.

AS/SVE and SVE system operations and monitoring will be conducted as described in Section 3.3. Effluent vapor samples will be collected during operations to evaluate VOC removal and compliance with SCHD requirements. Groundwater samples will be collected during performance monitoring for each remedial system location and during LTM for the entire MI. Analytical results will be used to determine whether expected progress toward RAOs is being achieved and whether changes to system operations are required.

The time required for system operations at the AS/SVE transects and the portable SVE and AS/SVE systems is based on the groundwater seepage velocity and the travel time from the treatment area to the downgradient extent of individual CVOC concentrations equal to 20 µg/L, one-half the treatment target of 40 µg/L. The seepage velocity calculation and the hydraulic conductivity and porosity values are as stated in Section 3.3.3. The estimated flow path for TTA-1N and the N-C area are reduced due to use of portable systems in the downgradient areas of those plumes; the estimated flow path for the window area does not change. The estimated travel times for each treatment area are shown on Table 12 with the gradient calculation for each segment of the flow path.

- AS/SVE Transects
  - The TTA-1N (transect) groundwater flow path from MW-219 near the western MI boundary to PMW21-03 has total length of 316 ft and one segment with a hydraulic gradient of 0.004; the travel time is estimated at 158 days or 0.4 years.
  - The N-C (transect) groundwater flow path from MW-263 near the northern MI boundary to MW-291 has total length of 1,028 ft and one segment with a hydraulic gradient of 0.005; the travel time is estimated at 411 days or 1.1 years.
  - The window area groundwater flow path from MW-305 to IAQ well MW-256 has total length of 1,749 ft and one segment with a hydraulic gradient of 0.005; the travel time is estimated at 478 days or 1.3 years.
- Portable SVE and AS/SVE
  - The TTA-1N (portable) groundwater flow path from PMW21-03 to DR1-7 has total length of 732 ft and one segment with a hydraulic gradient of 0.002; the travel time is estimated at 732 days or 2.0 years.
  - The TTA-1S (portable) groundwater flow path from PMW101-07 to DR1-3 has total length of 453 ft and one segment with a hydraulic gradient of 0.0017; the travel time is estimated at 519 days or 1.4 years.
  - The TTA-2-NW (portable) groundwater flow path from MW-217 to MW-259 has total length of 857 ft and one segment with a hydraulic gradient of 0.0033; the travel time is estimated at 533 days or 1.5 years.
  - The TTA-2-NW (portable) groundwater flow path from MW-294 to MW-259 has total length of 1,883 ft and two segments with hydraulic gradients of 0.0341 and 0.0046; the travel time is estimated at 618 days or 1.7 years.
  - The N-C (portable) groundwater flow path from MW-258 to MW-288 has total length of 567 ft and one segment with a hydraulic gradient of 0.0125; the travel time is estimated at 91 days or 0.2 years.
  - The N-C (portable) groundwater flow path from MW-207B to MW-318A has total length of 323 ft and one segment with a hydraulic gradient of 0.0009; the travel time is estimated at 718 days or 2.0 years.
  - The S-C (portable) groundwater flow path from MW-330 to MW-297 has total length of 777 ft and one segment with a hydraulic gradient of 0.0034; the travel time is estimated at 457 days or 1.3 years.

- The Building 835 (portable) groundwater flow path from MW-62 to MW-199B has total length of 897 ft and one segment with a hydraulic gradient of 0.0023; the travel time is estimated at 780 days or 2.1 years.

The shorter flow paths for the TTA-1N and N-C area AS/SVE transects decrease the estimated time to meet the treatment goal of 20 µg/L to 1.6 and 4.4 years, respectively. The estimated time to meet the same treatment goal for the portable systems ranges from 0.8 to 8.4 years; this will be re-evaluated after the PDI. The estimated treatment period is 5 years for the three AS/SVE transects and 5 years for operation of the portable SVE and AS/SVE systems at the on-site source areas.

3.4.4 Cost Estimate Assumptions

The time required to meet the active remediation goals is estimated at 5 years for the TTA-1N, N-C and Window Area AS/SVE systems, 2 years for the TTA-2 SVE system, and 4 years for the portable SVE and AS/SVE systems. System O&M and monitoring of effluent and groundwater will be performed regularly throughout active remediation with semiannual summary and annual comprehensive reports; systems operations, contamination migration trends, and source area soil and groundwater analytical results will be evaluated to determine whether progress is sufficient to meet the MI RAOs in the estimated timeframe. Upon completion of operations, the AS/SVE and SVE systems will be maintained for additional use, if necessary.

An additional 10 years of LTM, for a total of 15 years for implementation of ICs and LTM, are estimated to be necessary to meet the RAOs. LTM is assumed to be conducted semiannually for Years 1 through 5 using the existing extensive well network, followed by annual monitoring at 50 wells for Years 6 to 10 and at 30 monitoring wells for Years 11 through 15.

Once the RAOs are met, the AS/SVE and SVE systems will be removed and wells will be plugged and abandoned in accordance with TDEC and Shelby County regulations. ICs will continue to be implemented in accordance with the revised LUCIP until conditions for UU/UE are met.

Primary components of Alternative 3 include:

- Pre-Design Investigation
  - Work Plan
  - Field Work
    - Installation and development of 9 monitoring wells with groundwater sampling and analysis as described for Alternative 2.
    - Installation and development of 8 monitoring wells between the eight on-site areas with groundwater sampling and analysis.
    - Installation of 12 vapor monitoring points between the eight on-site areas with vapor sampling and analysis
  - Data validation and reporting
- Pilot Tests as described for Alternative 2

- Remedial Design – As described for Alternative 2, with addition of portable AS/SVE systems design, selection of areas for implementation of AS/SVE and the sequence.
- AS/SVE
  - Construction
    - As described for Alternative 2
    - Implement portable AS/SVE system at one location per year
      - Install 3 AS wells,1 SVE well and 1 VMP
      - Build equipment pad with power connection
      - Install piping from AS wells to equipment pad; SVE well to be located adjacent to equipment pad
      - Move trailer-mounted AS/SVE system to equipment pad; connect piping and power
  - Startup
    - Baseline sampling of performance monitoring wells and VMPs at the three transects, TTA-2 and the initial portable AS/SVE area
    - Start-up testing of AS/SVE systems with GAC vapor treatment per design
    - Effluent vapor sampling to confirm treatment requirements
    - Remedial Action Construction Report
  - System Operations
    - Year 1
      - Operation, monitoring, and optimization of the AS/SVE systems
      - Quarterly groundwater monitoring at performance well network and PID/pressure at VMPs
      - Interim Remedial Action Completion Report
    - Years 2 to 4
      - Install additional portable AS/SVE system with startup testing and effluent monitoring
      - Operation, monitoring, and optimization of the AS/SVE systems
      - Semiannual groundwater monitoring at performance well network and PID/pressure at VMPs for the boundary and window transects; quarterly monitoring for the portable AS/SVE system
      - Annual Report
    - Year 5
      - Use of portable AS/SVE system completed; move trailer to storage bay
      - Operation, monitoring, and optimization of the AS/SVE systems at the boundary and window transects
      - Semiannual groundwater monitoring at performance well network and PID/pressure at VMPs

            - Annual Report
    - System Shutdown
- SVE
    - TTA-2 System
        - Years 1 and 2
            - Operation, monitoring, and optimization as in pilot test
            - Semiannual groundwater monitoring at performance well network and PID/pressure at VMPs
            - Annual Report
    - Portable SVE System
        - Operate system at one location per year
            - Install 1 SVE well and 1 VMP at one location per year
            - Build equipment pad with power connection
            - Move trailer-mounted SVE system to equipment pad; connect piping and power
            - Conduct start-up testing and effluent monitoring
            - Operation, monitoring, and optimization as in TTA-2
            - Quarterly groundwater monitoring at performance well network and PID/pressure at VMPs
            - Annual Report
        - System Shutdown after Year 4
- Monitoring
    - ICs implemented per LUCIP Years 1 to 15
    - LTM
        - Semi-annual monitoring of existing LTM well network in Years 1 to 5
        - Annual monitoring of reduced LTM network (50 wells) in Years 6 to 10
        - Annual monitoring of reduced LTM network (30 wells) in Years 11 to 15
- Remedial Action Completion Report
- Abandonment of LTM, AS and SVE wells

4 Detailed Analysis of Alternatives

This section presents the detailed evaluation of the remedial alternatives developed within Section 3. The purpose of the evaluation is to identify the advantages and disadvantages of each alternative as well as key trade-offs among the alternatives. The detailed evaluation of alternatives consists of an individual analysis of each alternative against the NCP evaluation criteria and a comparative analysis among the alternatives to assess the relative performance of each alternative with respect to these criteria. Additional alternative details are provided as necessary, with respect to the volumes or areas to be addressed, primary technologies, and potential enhancements to improve efficacy, or any performance requirements associated with the technologies.

4.1 Evaluation Criteria

The nine NCP evaluation criteria have been developed to address CERCLA statutory requirements and additional technical and policy considerations that have proven to be important for selecting among remedial alternatives (40 CFR 300.430(e)(9)(iii)(A)-(I)). The evaluation criteria are as follows:

4.1.1 Overall Protection of Human Health and the Environment

This criterion is an evaluation of the alternative's ability to protect public health and the environment, assessing how risks for each existing or potential pathway of exposure identified in the human health risk assessment are eliminated, reduced, or controlled through removal, treatment, engineering controls, or ICs. The alternative's ability to achieve each of the RAOs is evaluated.

4.1.2 Compliance with ARARs

This criterion evaluates how the alternative complies with the ARARs, or if an ARAR waiver is required and the justification for a waiver, if needed.

4.1.3 Long-Term Effectiveness and Permanence

Each alternative is evaluated for its long-term effectiveness after implementation. If contamination or treated residuals remain after the selected remedy has been implemented, the following items are evaluated:

- The magnitude of the remaining risks (i.e., any significant threats, exposure pathways, or risks to the community and environment remaining);
- The adequacy of the engineering and institutional controls intended to mitigate the risk;
- The reliability of these controls; and
- The ability of the remedy to continue to meet RAOs in the future.

Should the results of this evaluation indicate concerns with the risks or reliability of the remedy, the utilization of technological enhancement, contingency, and/or alternative remedies may need to be considered.

4.1.4 Reduction of Toxicity, Mobility, or Volume of Contamination through Treatment

The alternative's ability to reduce the toxicity, mobility, and/or volume of site contamination is evaluated. Preference should be given to remedies that permanently and significantly reduce the toxicity, mobility, or volume of the contamination at the site.

4.1.5 Short-Term Impacts and Effectiveness

The potential short-term adverse impacts and risks of the remedy upon the community, workers, and the environment during the construction and/or implementation are evaluated. Discussion of how identified potential adverse impacts to the community or workers at the site will be controlled and the effectiveness of the controls is presented. Engineering controls that could be used to mitigate short-term impacts (e.g., dust control measures) are also provided. The length of time needed to achieve the remedial objectives is also estimated.

4.1.6 Implementability

The technical and administrative feasibility of implementing each alternative is evaluated for this criterion. Technical feasibility includes such things as the difficulties associated with construction and the ability to monitor the effectiveness of the remedy. For administrative feasibility, the availability of the necessary personnel and material is evaluated along with potential difficulties in, for example, obtaining specific operating approvals or access for construction and implementation of the remedy.

4.1.7 Relative Cost

This criterion evaluates the estimated capital, operations, maintenance, and monitoring costs for each alternative. Relative costs are estimated and presented on a present worth basis.

4.1.8 State Acceptance

TDEC's comments, concerns, and overall perception of the remedy are evaluated in a responsiveness summary that responds to all questions raised.

4.1.9 Community Acceptance

The public's comments, concerns, and overall perception of the remedy are also evaluated in a responsiveness summary.

The eighth and ninth criteria, state and community acceptance, will be evaluated following comments on this FFS report and the proposed plan and will be addressed in preparing the decision document.

Individual analyses of the remedial alternatives in regard to NCP threshold and primary balancing evaluation criteria are presented in Sections 4.2.1, 4.2.2 and 4.2.3 and summarized on Table 13.

Tables showing individual alternative costs with net present value calculations are provided in Appendix A. A total cost comparison of the remedial alternatives is provided in Section 4.3.7.

4.2 Individual Analysis of Alternatives

4.2.1 Alternative 1 – No Action

The No Action alternative provides a baseline for comparison with other remedial alternatives. The existing LTM program and maintenance of ICs are assumed to be discontinued under the no action alternative. Because no remedial activities would be implemented under the No Action alternative, long-term human health and environmental risks for the site identified in the HHERA (HDR, 2020b) would be increased due to halting implementation of ICs and LTM.

4.2.1.1 Overall Protection of Human Health and the Environment

Alternative 1 provides no control of exposure to contaminated groundwater and no reduction in risk to human health or the environment. No monitoring will occur to warn groundwater users if plumes migrate off-site or into deeper aquifers. The No Action alternative does not attain the groundwater RAOs (e.g., prevention of contaminant migration and restoration of the resource) and does not enhance the protection of human health. The alternative allows for the continued migration of contaminated groundwater onto the MI and migration to deeper aquifers.

4.2.1.2 Compliance with ARARs

This alternative will not meet ARARs (e.g., Federal and State MCLs). Under the No Action alternative, chemical-specific ARARs would continue to be exceeded in the areas being considered for active groundwater remediation.

4.2.1.3 Long-Term Effectiveness and Permanence

This alternative does not provide a degree of long-term effectiveness and permanence. Existing groundwater contamination at the site poses potential unacceptable human health risks under current and likely future groundwater use scenarios as presented in the human health risk assessment. Under the No Action alternative, these risks would remain unchanged over the long-term for expected groundwater uses. SCHD restrictions on well drilling and use of private wells serve as an effective institutional control to assure protection of human health over the long-term. Potable water is supplied by a regulated water purveyor and is treated to remove contaminants prior to its distribution and use, in accordance with the Safe Drinking Water Act. However, it would take more than 30 years before the plumes are reduced to the MCLs.

4.2.1.4 Reduction of Toxicity, Mobility, or Volume of Contamination through Treatment

This alternative provides no reduction of toxicity, mobility or volume contamination in groundwater. Natural attenuation would continue at the current level.

4.2.1.5 Short-Term Impacts and Effectiveness

This alternative results in potentially higher short-term risks to the community, workers and the environment, as no monitoring will occur and ICs will not be enforced. No additional short-term impacts would occur as there would be no remedial construction and no immediate environmental impacts of this remedy.

4.2.1.6 Implementability

This alternative has no implementability concerns, as no RA will occur.

4.2.1.7 Relative Cost

The capital, operations and maintenance, and net present value costs incurred by this alternative are estimated to be $0.

4.2.2 Alternative 2 – AS/SVE and SVE

Alternative 2 includes active treatment through use of AS/SVE to limit contaminated groundwater migration onto the MI and into deeper aquifers, attenuation by dilution to restore groundwater in the FDAQ and IDAQ aquifers and SVE to remove residual soil contamination, improve groundwater quality with further attenuation by dilution in the downgradient plume. ICs, modified to include notification for VI, will continue for protection of human health. LTM will continue to document changes in plume concentrations, to detect potential plume migration to off-site areas or into deeper aquifers and to track progress toward RAOs.

4.2.2.1 Overall Protection of Human Health and the Environment

This alternative would protect the environment by limiting further migration of off-site contaminants onto the MI and from the FDAQ into deeper aquifers and by removing residual soil contamination in TTA-2 to limit impact to the FDAQ and improve groundwater quality. There will be significant reduction in contaminant concentrations within the on-site portion of the FDAQ as well as decreasing trend in contaminant concentrations as contaminant migration onto the MI is prevented.

The existing ICs prevent installation of water wells on the MI and within 0.5 mile of the designated boundaries of this site. Additionally, active treatment in the Window Area under this alternative would limit further migration into deeper aquifers. There is no evidence of off-site plume migration in the FDAQ. Because there are no complete pathways to direct contact either through inhalation or ingestion, this alternative will be protective of human health. The existing 20 to 30 ft thick low-permeable loess deposits that are continuous throughout the DDMT area limits exposure to contamination at the surface; SVE flow rates in excess of AS (injection) flow rates would further reduce vapor migration from the vadose zone. LTM will document changes in plume concentrations, plume migration, and progress toward RAOs. Modification of ICs to include notification of VI potential and to inform assessment and mitigation will enhance protection of human health.

4.2.2.2 Compliance with ARARs

This alternative will comply with MCLs at the southwest and north site boundaries as well as in the Window Area where active treatment zones are proposed and will prevent or minimize migration of off-site contaminants onto the MI and from the FDAQ into deeper aquifers. Progress toward MCLs will occur on-site as contaminant migration from off-site is prevented through active remediation and natural attenuation. Chemical-specific ARARs for groundwater use (MCLs) would be met at completion of the remedial action.

This alternative will comply with (1) TDEC rules for the installation of AS/SVE and additional monitoring wells to be installed for PDI, (2) Clean Air Act and Tennessee Rule 1200-3-1 for VOCs emissions to the air when discharging either the treated or untreated soil vapor before the AS/SVE system startup and during the RA, (3) RCRA for disposal of the waste generated during well installation and groundwater monitoring, and (4) OSHA for worker protection during well installation, AS/SVE operations, and groundwater monitoring.

4.2.2.3 Long-Term Effectiveness and Permanence

AS/SVE has been demonstrated to be effective and reliable at numerous sites for groundwater treatment of VOCs, including the Dunn Field Off Depot Area at this site. An AS/SVE system will significantly and permanently remove VOCs from the environment as contaminated groundwater passes through the treatment zones. Off-gas treatment using GAC has not been required for the existing AS/SVE system at the Dunn Field or SVE in TTA-2 as the operations are in compliance with the SCHD de minimus emission criterion of 0.1 lb/hr. However, GAC will be used to adsorb VOCs in soil vapor, if required based on start-up testing. If GAC is required, the contamination will be permanently destroyed when the GAC is re-activated and will not pose a risk to human health or the environment.

This alternative reduces the migration on to the MI in the FDAQ and off-site through deeper aquifers as VOC concentrations in the groundwater plume passes through the treatment zones. However, remediation of large areas of the plume will be limited to attenuation by dilution.

ICs prevent exposure to contaminants and will continue to be in-place until the site meets requirements for UU/UE. LTM will document changes in CVOC concentrations and plume extent and will indicate whether further on-site active remediation is required. Five-Year Reviews will be conducted to determine whether ICs are being enforced, plumes are reduced, and migration is prevented.

4.2.2.4 Reduction of Toxicity, Mobility, or Volume of Contamination through Treatment

AS/SVE will reduce the volume of contamination through treatment by injecting air into sparging wells, volatilizing CVOCs from the groundwater to the unsaturated zone, and extracting the volatilized contaminants for discharge. The SVE system will reduce the volume of contamination in the unsaturated zone. Vapor-phase GAC treatment prior to discharge will be implemented, if needed. Both systems use physical processes to remove contaminants from the groundwater and permanently reduce toxicity. The volume of plume contamination will continue to decrease through attenuation by dilution downgradient of the AS/SVE transects and SVE well.

4.2.2.5 Short-Term Impacts and Effectiveness

Short term impacts will result from the installation of AS/SVE wells along the proposed transects, which are located in easily accessible areas on the MI along the northeast and southwest boundaries and an undeveloped area near the intersection of Amido and Heyde Avenues. The locations of these transects were determined with consideration of utilities and open space available within the targeted active treatment areas. Installation of monitoring, AS and SVE wells and placement of trailers is expected to result in minimal, if any, short-term impacts other than noise impacts during drilling. Water and drill cuttings generated well installation and will be properly handled to prevent risks to workers. Risk to community is not increased by the AS/SVE operations. A pilot study will be conducted to determine treatment and monitoring requirements for air emissions from SVE operations.

4.2.2.6 Implementability

Given the available open space on the MI, this alternative can easily be implemented along the planned AS/SVE transects with the equipment compound in the active remediation zones. AS/SVE is a well-established technology, and the equipment and services to install and operate the SVE system and to sample groundwater monitoring wells are commercially available. The PDI and pilot testing will be help in determining the appropriate design of AS/SVE wells and equipment, including the appropriate depths and radii of influence for air sparge and vapor extraction wells, appropriate air injection rates and pressures, vacuum and discharge vapor flow rates, anticipated equipment sizing, and vapor treatment. AS/SVE wells, VMPs, monitoring wells, and the systems equipment can also be easily maintained over the operational period.

ICs have been implemented since 2005; TDEC and USEPA monitor the implementation of the ICs through annual site inspection reports prepared by Army and Five-Year Reviews. LTM has been implemented since 2004 with a semiannual summary report and a more detailed annual report submitted to TDEC and USEPA.

4.2.2.7 Relative Cost

Capital costs for Alternative 2 include the PDI, pilot tests, remedial design, remedial action work plan, installation and start-up of the three AS/SVE transects, and Year 1 operation of the AS/SVE systems and SVE in TTA-2, LTM and implementation of ICs. O&M costs for this alternative include operations and performance monitoring at AS/SVE transects in Years 2 to 10, SVE at TTA-2 in Year 2, LTM and ICs in Years 2 to 20. Periodic costs include routine repairs and maintenance of LTM wells, decommissioning the TTA-2 and AS/SVE systems with abandonment of SVE and AS wells and VMPs, and site close-out with abandonment of LTM wells and the MI RA Completion Report. A discount rate of 7% was assumed when calculating O&M present worth costs. The costs associated with this alternative are presented in Appendix A, Table A-1; the total present worth costs are $5,941,000.

4.2.3 Alternative 3 – Expanded AS/SVE and SVE

The approach to site remediation under Alternative 3 includes Alternative 2 components (active treatment to limit contaminated groundwater migration onto the MI and into deeper aquifers, to remove source area contamination in TTA-2) and actions to reduce contaminant concentrations in isolated CVOC groundwater plumes. ICs, modified to address VI, and LTM are included for protection of human health and the environment as stated in Section 4.2.2.

4.2.3.1 Overall Protection of Human Health and the Environment

Alternative 3 would protect the environment by preventing further contaminant migration of off-site onto the MI and from FDAQ into the deeper aquifers as well as actively reducing contaminants in groundwater in on-site treatment zones and source areas. The alternative would also permanently and irreversibly remove contamination in the aquifer as groundwater passes through the active treatment zones. There will be significant reduction in contaminant concentrations within the on-site portion isolated plume areas with concentrations greater than 40 µg/L in the FDAQ. SVE treatment will help remove soil contamination from suspected small releases in the unsaturated zone within the MI. Additionally, on-site contaminant concentrations will decrease over time as off-site contaminant migration onto the MI is limited at the site boundary and on-site contamination is reduced.

There are no users of groundwater from the FDAQ beneath the MI. Existing ICs prevent the installation of water wells within 0.5 mile of the designated boundaries of this site. Active treatment proposed in the window area in this alternative would prevent further migration into deeper aquifers. There is no evidence of off-site plume migration in the FDAQ. Because there are no complete pathways to direct contact either through inhalation or ingestion, this alternative will also be protective of human health. The existing 20 to 30 ft thick low-permeable loess deposits that are continuous throughout the DDMT area would prevent exposure to contamination at the surface mitigating the risk of exposure due to movement of extracted soil vapor. The LTM program would monitor and ensure contamination does not result in additional risks to human health and the environment.

Existing ICs will be modified to include VI ICs which will focus on property owner VI awareness and inform assessment and mitigation, if deemed necessary, for current and future buildings overlying contaminated areas. LTM will document changes in plume concentrations, plume migration, and progress toward RAOs.

4.2.3.2 Compliance with ARARs

Alternative 3 will prevent or minimize contaminant migration of off-site onto the MI and from FDAQ into deeper aquifers, remove residual soil contamination in subsurface VOC source areas and reduce on-site groundwater contamination in areas with concentrations greater than 40 µg/L. There will be no significant reduction in low-level contaminant (5 to 40 µg/L) plumes within the on-site area through active remediation, but there will be a rapid decreasing trend in contaminant concentrations over time as the contaminant's migration from the off-site source onto MI is prevented and elevated concentrations are reduced through active remediation. The overall plume area is expected to decrease as contaminant concentrations decrease via attenuation by dilution. Chemical-specific ARARs for groundwater use (MCLs) would be met at completion of the remedial action.

This alternative will comply with (1) SCHD rules for the installation of AS/SVE and additional monitoring wells to be installed for PDI and performance monitoring, (2) Clean Air Act and Tennessee Rule 1200- 3-1 for VOCs emissions to the air when discharging either the treated or untreated soil vapor before the permanent and portable AS/SVE system startup and during the RA, (3) RCRA for the disposal of the waste generated during well installation and groundwater monitoring, and (4) OSHA for worker protection during well installation, AS/SVE operations, and groundwater monitoring.

4.2.3.3 Long-Term Effectiveness and Permanence

AS/SVE has been demonstrated to be effective and reliable at numerous sites for removal of VOCs in groundwater and is expected to be effective at this site. SVE will remove VOCs from source areas and prevent contaminant migration to groundwater in the treatment area. VOC contaminants will be converted to the vapor phase. Off-gas treatment using GAC has not been required for the existing AS/SVE system at the Dunn Field or SVE in TTA-2 as the operations are in compliance with the SCHD emission criterion of 0.1 lb/hr. However, GAC will be used to adsorb the soil vapor if required based on the pilot test. When GAC is re-activated, the contamination will be permanently destroyed and no longer pose a risk to human health or the environment. This alternative also maximizes mass removal within a reasonable time through multiple treatment areas. This alternative also assists in reducing contaminant migration on to the and off-site through deeper aquifers.

ICs prevent exposure to contaminants and will continue to be in-place until the site meets requirements for UU/UE. Monitoring will assess the reduction of the CVOCs plumes, if MCLs are met and will warn if further on-site active remediation is required. Five-Year Review will confirm that ICs are being enforced and that plume reduction is occurring, and migration is prevented. Review will also ensure that adequate plume controls are working, and no unacceptable risks were identified during monitoring.

4.2.3.4 Reduction of Toxicity, Mobility, or Volume of Contamination through Treatment

The AS/SVE system would reduce the volume of contamination through treatment by injecting air into sparging wells, volatilizing CVOCs from the groundwater to the unsaturated zone, and extracting the volatilized contaminants for vapor-phase GAC treatment. The SVE system would reduce the volume of contamination by extracting the volatilized contaminants from unsaturated zones of potential source areas, hence eliminating minor on-site sources of groundwater contamination. The system uses physical processes to remove contaminants from the groundwater and permanently reduces toxicity when the GAC is re-activated. The volume of remaining plume contamination will continue to decrease through natural attenuation processes, although slowly.

4.2.3.5 Short-Term Impacts and Effectiveness

Short term impacts will result from the installation of the AS/SVE wells along the transects located in easily accessible areas on the MI along the northeast and southwest boundaries and an undeveloped area at the intersection of Amido and Heyde Avenues. The locations of these transects were determined with consideration of the overhead utilities and open space available within the targeted active treatment areas on the MI. Installation of monitoring, AS and SVE wells and placement of trailers is expected to result in minimal, if any, short-term impacts other than noise impacts during drilling. Water and drill cuttings generated during well installation will be properly handled to prevent risks to workers. Risk to community is not increased by the AS/SVE operations. A pilot study will be conducted to determine treatment and monitoring requirements for air emissions from SVE operations.

Installation of monitoring, AS and SVE wells for the portable systems will require access between the existing on-site buildings and underground utilities clearance. Installation of the monitoring wells and placement of trailers systems is expected to result in minimal, if any, short-term impacts other than some noise impacts from the drill rig. Contaminated water and drill cuttings will be generated from well installation and will pose some risk to workers; however, these risks can be mitigated with proper material handling and personal protective equipment (PPE).

4.2.3.6 Implementability

Given the available open space where the AS/SVE can be implemented within the MI, Alternative 3 can easily be implemented in the transect configuration, as well as can accommodate the treatment trailers in the proposed active remediations zones. The portable SVE and AS/SVE systems will require access between the buildings and utilities clearance. To provide power supply, both systems will require either an installation of electrical infrastructure for the permanent systems or generators to run the portable systems. An AS/SVE system is a well-established technology, and the equipment and services to install and operate the SVE system and to sample the groundwater monitoring wells are commercially available. The pilot testing will be help in determining the appropriate design of AS/SVE wells and equipment, including: the appropriate depths and radii of influence for air sparge and vapor extraction wells, appropriate air injection rates and pressures, vacuum and discharge vapor flow rates, anticipated equipment sizing, and vapor treatment. AS/SVE wells, monitoring wells, and the systems equipment can also be easily maintained over the operational period.

ICs have been implemented since 2005. TDEC and USEPA monitor the implementation of through annual site inspection reports prepared by Army and through Five-Year Reviews. The addition of ICs to address VI will not significantly alter implementation of ICs. LTM will be easily implemented since permanent monitoring wells are being used for ongoing LTM.

4.2.3.7 Relative Cost

Capital costs for Alternative 3 include the PDI; pilot tests; remedial design; remedial action work plan; installation and start-up of the AS/SVE systems and initial locations for the portable SVE and AS/SVE systems; Year 1 operations of the AS/SVE system, SVE in TTA-2 and portable SVE and AS/SVE systems, LTM and implementation of ICs. O&M costs for this alternative include operations and performance monitoring at AS/SVE transects in Years 2 to 5 and SVE at TTA-2 in Year 2; installation, start-up and operations at the portable SVE and AS/SVE systems at new locations in Years 2 to 4; and for LTM and ICs in Years 2 to 20. Periodic costs include routine repairs and maintenance of LTM wells; decommissioning the TTA-2 SVE, AS/SVE and portable systems with abandonment of SVE and AS wells and VMPs; and site close-out with abandonment of LTM wells and the MI RA Completion Report. A discount rate of 7% was assumed when calculating O&M present worth costs. The costs associated with this alternative are presented in Appendix A, Table A-2; the total present worth costs are $6,778,000.

4.3 Comparative Analysis of Alternatives

A comparative analysis was completed with the alternatives evaluated in relation to each other using the NCP evaluation criteria. The purpose of this analysis is to identify the relative advantages and disadvantages of the alternatives subject to detailed analysis in Section 4.2.

- Alternative 1 – No Action
- Alternative 2 – AS/SVE and SVE
- Alternative 3 – Expanded AS/SVE and SVE

For comparison, the individual evaluations from Section 4.2 are summarized in Table 13. During the comparative analysis, the alternatives are compared to identify key differences in the following evaluation criteria:

- Overall protection of human health and the environment
- Compliance with ARARs
- Long-term effectiveness
- Reduction of Toxicity, Mobility, or Volume
- Short-term effectiveness
- Implementability
- Cost

The comparative analysis of the alternatives is presented in the following subsections.

4.3.1 Overall Protection of Human Health and the Environment

Alternative 1 provides no protection of human health and the environment. Alternative 2 provides protectiveness of the environment by limiting further contaminant migration onto the MI and into the window and reduces contaminant mass in the soil source area at TTA-2. Alternative 3 provides additional protectiveness of the environment by adding reduction of contaminant mass within the on-site source areas of groundwater plumes to Alternative 2. Alternative 3 will reach RAOs faster than Alternative 2 due to the additional active, on-site groundwater remedial action and would be more protective.

There are no complete pathways to direct contact with contaminated groundwater either through inhalation or ingestion within the MI due to existing LUCs. Alternative 1 would increase long-term human health and environmental risks identified in the HHERA (HDR, 2020b) due to halting implementation of ICs and LTM.

Alternatives 2 and 3 will be protective of human health due to continued implementation of ICs and LTM. The LTM program proposed will monitor and ensure contamination does not result in a risk to human health and the environment. The alternatives are effective in treating CVOCs in the FDAQ with surficial fine-grained low permeability soils present at the MI enhancing SVE. Alternatives 2, and 3 involve removing contaminants from the unsaturated portion of the subsurface via a vacuum extraction system and adding ICs to address VI to the LUCIP. Therefore, Alternatives 2 and 3 should be considered protective of human health.

4.3.2 Compliance with ARARs

Alternative 1 will not achieve compliance with ARARs. Alternatives 2 and 3 will comply with the ARARs immediately downgradient from the active remediation zones including the Window Area. These treatment efforts will reduce timeframes to comply with groundwater MCLs in through attenuation by dilution. As groundwater flows across the treatment zones, groundwater contaminants will be reduced to less than the MCLs. The flow of treated groundwater and natural processes of attenuation will reduce contaminant concentrations in the downgradient plume over time. After a period of time, the groundwater contaminant concentrations will achieve the RAOs. Due to treatment of on-site source areas and expanded footprint for AS/SVE, Alternative 3 will achieve RAOs faster than Alternative 2.

4.3.3 Long-Term Effectiveness and Permanence

Alternative 1 provides no active reduction in contaminant levels or risk and therefore does not provide long-term effectiveness or permanence. Alternatives 2 and 3 will provide significant reduction in contaminant concentrations migrating onto the MI leading to decreasing trends in contaminant concentrations within the MI; they will also significantly reduce subsurface soil contaminant concentrations migration of residual soil contamination to groundwater. AS/SVE in Alternatives 2 and 3 is an effective technology for removing volatile contaminants from groundwater. Contamination will be stripped from the aquifer and permanently removed via vacuum extraction. If off-gas treatment using GAC is necessary, the contaminants will be adsorbed on the vapor phase GAC and destroyed during re-activation.

Under Alternative 3, active remediation in the on-site portion of the plume is expected to achieve the RAOs in a relatively shorter time period compared to Alternative 2. Alternatives 2 and 3 will rely on LTM to monitor groundwater contaminants until RAOs are met.

4.3.4 Reduction of Toxicity, Mobility, Volume of Contamination through Treatment

Alternative 1 will not reduce toxicity, mobility, or volume of soil and groundwater contamination. Alternatives 2 and 3 will both reduce the volume of VOC contaminants in groundwater and soil. With an expanded groundwater treatment footprint, Alternative 3 will provide greater reduction of VOC contaminants in groundwater.

4.3.5 Short-Term Impacts and Effectiveness

Alternative 1 creates no short-term impacts to human health or the environment, because no action is conducted. Alternatives 2 and 3 will have minor short-term impacts to remediation workers, the public, and the environment during implementation. Most of the short-term impacts are nuisance-related (i.e., noise, vehicle traffic, road closures, etc.). Alternative 3 will have a higher degree of short-term impacts compared to Alternative 2 due to the number of injection/sparging/extraction wells needed for the isolated treatment zones, requirements for multiple power sources, and access between the buildings. The technologies to be employed (AS/SVE and SVE) will begin removal of contaminants from groundwater and soil upon implementation, providing short-term effectiveness.

4.3.6 Implementability

Alternative 1, which has no action, is the easiest to implement. Alternatives 2 and 3 utilize technologies with proven implementability. The treatment areas for Alternative 2 are relatively open and should not interfere with existing site infrastructure. Alternative 3 includes installation of injection/sparging wells in the on-site portion of the plumes MI between buildings and/or access roadways; however, the treatment areas are relatively small and sufficient space for implementation is considered to be available without interfering with existing site infrastructure.

4.3.7 Relative Cost

There are no costs associated with Alternative 1.

An explanation of costs for Alternatives 2, and 3 is presented in Section 4.2 and the costs are itemized in Appendix A. Total present worth costs for these alternatives are summarized below:

	Alternative 1	Alternative 2	Alternative 3
Description	**No Action**	**AS/SVE and SVE**	**Expanded AS/SVE and SVE**
Estimated Project Duration (Years)	–	21 (10 years active remediation)	16 (5 years active remediation)
Capital Cost	$0	$2,293,000	$2,955,000
Total O&M Cost	$0	$3,427,000	$3,481,000
Total Periodic Cost	$0	$221,000	$304,000
Total Present Value of Alternatives	$0	$5,941,000	$6,740,000

4.3.8 State Acceptance

To be addressed in the decision document.

4.3.9 Community Acceptance

To be addressed in the decision document.

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Tables

TABLE 1
PCE, TCE, AND CT CONCENTRATIONS IN GROUNDWATER, APRIL 2021
FOCUSED FEASIBILITY STUDY REPORT
Main Installation, Defense Depot Memphis, Tennessee

				PCE	TCE	CT
			MCL	5	5	5
Well ID	Aquifer	Area	Date	µg/L	µg/L	µg/L
DR1-2	Fluvial	TTA-1N	10/14/2020	1.12	-	-
DR1-7	Fluvial	TTA-1N	4/21/2021	**34.5**	3.24	-
DR1-8	Fluvial	TTA-1N	10/14/2020	0.398 J	0.741 J	-
MW-21	Fluvial	TTA-1N	4/20/2021	**6.42**	**10.6**	-
MW-66A	Fluvial	TTA-1N	10/11/2020	-	-	-
MW-100B	Fluvial	TTA-1N	4/20/2021	3.18	2.8	-
MW-219	Fluvial	TTA-1N	4/19/2021	**280**	**32.9**	-
MW-269	Fluvial	TTA-1N	4/19/2021	**268**	**21.9**	-
MW-278	Fluvial	TTA-1N	4/19/2021	**121 J**	**8.36**	-
MW-315	Fluvial	TTA-1N	4/20/2021	**5.23**	-	-
MW-315-RE	Fluvial	TTA-1N	4/20/2021	**15.3**	**7.04**	-
MW-316	Fluvial	TTA-1N	4/19/2021	0.384 J	-	-
PMW21-01	Fluvial	TTA-1N	4/20/2021	**5**	4.66	-
PMW21-02	Fluvial	TTA-1N	4/20/2021	**48.9**	**24.4**	-
PMW21-03	Fluvial	TTA-1N	4/20/2021	**45.5**	**21.9**	-
PMW21-04	Fluvial	TTA-1N	4/20/2021	**68.9**	**55.8**	-
PMW21-05	Fluvial	TTA-1N	4/20/2021	**24.8**	**13.1**	-
DR1-1	Fluvial	TTA-1S	10/14/2020	0.261 J	-	-
DR1-1A	Fluvial	TTA-1S	10/14/2020	-	-	-
DR1-3	Fluvial	TTA-1S	4/21/2021	**12.7**	2.49	-
DR1-4	Fluvial	TTA-1S	4/21/2021	**34.9**	0.274 J	-
DR1-5	Fluvial	TTA-1S	10/14/2020	2.69	0.668 J	-
DR1-5A	Fluvial	TTA-1S	10/14/2020	-	-	-
DR1-6	Fluvial	TTA-1S	10/13/2020	1.76	0.27 J	-
DR1-6A	Fluvial	TTA-1S	4/21/2021	-	-	-
MW-22	Fluvial	TTA-1S	10/14/2020	-	-	-
MW-101B	Fluvial	TTA-1S	4/21/2021	**5.25**	-	-
MW-101T	Fluvial	TTA-1S	4/21/2021	**5.18**	-	-
MW-279	Fluvial	TTA-1S	4/20/2021	**14.9**	-	-
MW-314	Fluvial	TTA-1S	4/19/2021	3.87	-	-
MW-314-RE	Fluvial	TTA-1S	4/19/2021	4.83	-	-
PMW101-02A	Fluvial	TTA-1S	10/14/2020	1.23	1	-
PMW101-02B	Fluvial	TTA-1S	10/14/2020	2.44	-	-
PMW101-03A	Fluvial	TTA-1S	4/21/2021	4.08	1.44	-
PMW101-03B	Fluvial	TTA-1S	4/21/2021	**6.41**	0.568 J	-
PMW101-04A	Fluvial	TTA-1S	4/20/2021	**5.47**	1.36	-
PMW101-04B	Fluvial	TTA-1S	4/20/2021	**11.1**	0.470 J	-
PMW101-06A	Fluvial	TTA-1S	4/21/2021	**35.9**	0.460 J	-
PMW101-06B	Fluvial	TTA-1S	4/21/2021	**14.5**	**5.75**	-
PMW101-07A	Fluvial	TTA-1S	4/21/2021	**16.5**	1.1	-
PMW101-07B	Fluvial	TTA-1S	4/21/2021	**29.9**	**61.9**	-
DR2-1	Fluvial	TTA-2	4/19/2021	4.11	0.652 J	1.68
DR2-2	Fluvial	TTA-2	10/11/2020	1.32	0.32 J	-
DR2-3	Fluvial	TTA-2	10/15/2020	3.2	0.515 J	1.09
DR2-4	Fluvial	TTA-2	10/11/2020	**6.3**	0.264 J	2.1
DR2-5	Fluvial	TTA-2	10/14/2020	2.24 J	1.98 J	-
DR2-6	Fluvial	TTA-2	4/20/2021	0.950 J	0.570 J	-
MW-25A	Fluvial	TTA-2	10/12/2020	-	1.07	-
MW-26	Fluvial	TTA-2	4/20/2021	**10.3**	0.510 J	1.5
MW-50	Fluvial	TTA-2	10/15/2020	2.22	1.13	-
MW-64	Fluvial	TTA-2	4/20/2021	**15.8**	**21.4**	1.47
MW-85	Fluvial	TTA-2	4/19/2021	**21.2**	4.83	**17.6**
MW-88	Fluvial	TTA-2	4/19/2021	4.3	0.791 J	1.43
MW-92	Fluvial	TTA-2	4/19/2021	**17.3**	0.891 J	-
MW-96	Fluvial	TTA-2	10/12/2020	**8.11**	0.617 J	0.281 J

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				PCE	TCE	CT
			MCL	5	5	5
Well ID	Aquifer	Area	Date	µg/L	µg/L	µg/L
MW-113	Fluvial	TTA-2	4/19/2021	4.52	0.336 J	-
MW-217	Fluvial	TTA-2	4/20/2021	**26.1 J**	**18.7**	**73.4**
MW-218	Fluvial	TTA-2	4/20/2021	**16.5**	**24.6**	3.92
MW-259	Fluvial	TTA-2	4/20/2021	**13.6**	2.68	2.55
MW-266	Fluvial	TTA-2	10/15/2020	0.284 J	0.271 J	-
MW-267	Fluvial	TTA-2	4/20/2021	**23.4**	**11.4**	1.72
MW-280	Fluvial	TTA-2	10/13/2020	**6.5**	1.11	-
MW-292	Fluvial	TTA-2	4/21/2021	**9.82**	2.48	**6.75**
MW-294	Fluvial	TTA-2	4/21/2021	**40.3**	21.9	1.83
MW-295	Fluvial	TTA-2	10/14/2020	2.62	4.79	1.67
MW-303	Fluvial	TTA-2	4/20/2021	**5.49**	0.447 J	-
PMW85-01	Fluvial	TTA-2	4/19/2021	**20.7**	**5.38**	**25.7**
PMW85-05	Fluvial	TTA-2	4/19/2021	**7.38**	2.35	0.752 J
PMW92-02	Fluvial	TTA-2	4/19/2021	**5.79**	0.250 J	-
PMW92-03	Fluvial	TTA-2	4/19/2021	0.320 J	0.250 J	-
MW-39	Fluvial	W-C	10/14/2020	**5.17**	**5.27**	-
MW-94A	Fluvial	W-C	4/20/2021	**10.5**	**6**	-
MW-98	Fluvial	W-C	4/20/2021	-	1.48	-
MW-197B	Fluvial	W-C	4/20/2021	**7.29**	**13**	-
MW-200	Fluvial	W-C	10/13/2020	4.11	**5.68**	-
MW-203B	Fluvial	W-C	4/20/2021	0.422 J	**11.9**	-
MW-204A	Fluvial	W-C	4/20/2021	**11.8**	0.860 J	-
MW-204B	Fluvial	W-C	4/20/2021	**22**	**19.6**	-
MW-205B	Fluvial	W-C	10/14/2020	**12.4**	**7.64**	-
MW-206A	Fluvial	W-C	10/14/2020	**6.07**	**13.4**	-
MW-206B	Fluvial	W-C	10/14/2020	**8.31**	**6.55**	-
MW-208B	Fluvial	W-C	10/14/2020	2.43	**5.79**	-
MW-210B	Fluvial	W-C	10/15/2020	1.88	**17.8**	-
MW-62	Fluvial	B-835	4/21/2021	-	**6.52**	-
MW-142	Fluvial	B-835	10/13/2020	0.311 J	4.44	-
MW-143	Fluvial	B-835	10/13/2020	0.694 J	3.35	-
MW-198	Fluvial	B-835	10/13/2020	-	2.49	-
MW-199B	Fluvial	B-835	4/21/2021	2.65	1.67	-
MW-209B	Fluvial	B-835	4/21/2021	2.67	**8.31**	-
MW-212	Fluvial	B-835	4/21/2021	1.12	**51.4**	-
MW-213	Fluvial	B-835	4/20/2021	0.290 J	**7.45**	-
MW-299	Fluvial	B-835	10/13/2020	0.417 J	3.18	-
MW-300	Fluvial	B-835	10/13/2020	0.388 J	3.62	-
MW-63A	Fluvial	N-C	10/12/2020	1.75	1.72	-
MW-63B	Fluvial	N-C	10/12/2020	1.23	**5.22**	-
MW-103	Fluvial	N-C	10/12/2020	0.379 J	3.03	-
MW-104	Fluvial	N-C	4/20/2021	0.346 J	**18.6**	-
MW-207B	Fluvial	N-C	4/20/2021	**50**	3.58	0.490 J
MW-215B	Fluvial	N-C	10/15/2020	3.89	1.33	0.943 J
MW-258	Fluvial	N-C	4/20/2021	**13.1**	**42.9**	-
MW-260	Fluvial	N-C	10/11/2020	0.957 J	1.39	-
MW-263	Fluvial	N-C	4/20/2021	0.650 J	**14.8**	-
MW-265	Fluvial	N-C	10/12/2020	**9.64**	**12.6**	-
MW-281	Fluvial	N-C	4/20/2021	3.53	**33.3**	-
MW-284	Fluvial	N-C	4/20/2021	**12.6**	**5.82**	0.806 J
MW-287	Fluvial	N-C	10/13/2020	0.25 J	4.27	-
MW-288	Fluvial	N-C	4/20/2021	**8.22**	**13.5**	-
MW-289	Fluvial	N-C	10/13/2020	3.7	1.77	-
MW-291	Fluvial	N-C	4/20/2021	1.73	**15.5**	-
MW-304	Fluvial	N-C	4/20/2021	**25.5**	4.27	0.970 J

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				PCE	TCE	CT
			MCL	5	5	5
Well ID	Aquifer	Area	Date	µg/L	µg/L	µg/L
MW-306	Fluvial	N-C	4/20/2021	**10.9**	**9.9**	-
MW-307	Fluvial	N-C	4/20/2021	1.83	0.330 J	1.12
MW-310	Fluvial	N-C	4/20/2021	**7.55**	**41.5 J**	-
MW-318A	Fluvial	N-C	4/20/2021	**25.1**	**18**	1.6
MW-318B	Fluvial	N-C	4/20/2021	**20.4**	**16.2**	1.61
MW-216	Fluvial	S-C	10/13/2020	-	-	-
MW-261	Fluvial	S-C	4/20/2021	-	**7.75**	-
MW-271	Fluvial	S-C	10/13/2020	-	**7.36**	-
MW-296	Fluvial	S-C	4/20/2021	**19.8**	**5.24**	-
MW-297	Fluvial	S-C	4/20/2021	2.99	**15.6**	-
MW-298	Fluvial	S-C	10/13/2020	-	0.531 J	-
MW-330	Fluvial	S-C	6/13/2021	-	**60.6**	-
MW-52	Fluvial	SE	4/19/2021	**14.2**	2.17	-
MW-270	Fluvial	SE	4/20/2021	0.362 J	**32.7**	-
MW-301	Fluvial	SE	4/19/2021	**9.63**	1.26	-
MW-313	Fluvial	SE	4/19/2021	2.54	0.456 J	-
MW-313-RE	Fluvial	SE	4/19/2021	**13.4**	2.95	-
MW-285	Fluvial	Window	10/12/2020	**5.44 J**	3.91 J	-
MW-286	Fluvial	Window	4/20/2021	4.45	-	-
MW-305	Fluvial	Window	4/20/2021	**35.1 J**	0.610 J	0.600 J
MW-308	Fluvial	Window	4/20/2021	-	-	-
MW-317A	Fluvial	Window	4/20/2021	3.09	-	-
MW-317B	Fluvial	Window	4/20/2021	-	-	-
MW-16	Fluvial	Background	10/15/2020	-	-	-
MW-19	Fluvial	Background	10/12/2020	-	1.6	-
MW-23	Fluvial	Background	10/13/2020	-	-	-
MW-24	Fluvial	Background	10/13/2020	-	-	-
MW-53	Fluvial	Background	10/12/2020	1.31	-	-
MW-55	Fluvial	Background	10/13/2020	-	0.504 J	-
MW-93	Fluvial	Background	10/13/2020	-	-	-
MW-99	Fluvial	Background	10/13/2020	-	-	-
MW-102B	Fluvial	Background	10/14/2020	-	-	-
MW-272	Fluvial	Background	10/13/2020	-	-	-
MW-274	Fluvial	Background	10/12/2020	3.23	1.89	-
MW-275	Fluvial	Background	10/12/2020	-	-	-
MW-276	Fluvial	Background	10/13/2020	-	-	-
MW-277	Fluvial	Background	10/13/2020	-	-	-
MW-282	Fluvial	Background	10/11/2020	-	-	-
MW-283	Fluvial	Background	10/11/2020	-	-	-
MW-312	Fluvial	Background	4/19/2021	-	-	-
MW-268	Upper Claiborne	TTA-2	10/13/2020	-	-	-
MW-302	Intermediate	TTA-2	10/13/2020	**5.61**	2.54 J	2.54 J
MW-39A	Upper Claiborne	W-C	10/14/2020	1.43	3.67 J	-
MW-108	Upper Claiborne	W-C	10/12/2020	1.45	1.6	-
MW-197A	Upper Claiborne	W-C	4/20/2021	**8.64**	0.590 J	-
MW-203A	Upper Claiborne	W-C	10/15/2020	-	-	-
MW-205A	Upper Claiborne	W-C	10/14/2020	**6.78**	4.74	-
MW-208A	Upper Claiborne	W-C	10/14/2020	4.05	**9.45**	-
MW-210A	Intermediate	W-C	10/15/2020	3.08	3.23	-
MW-199A	Intermediate	B-835	10/13/2020	-	4.04	-
MW-209A	Intermediate	B-835	10/13/2020	0.414 J	**6.16**	-

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				PCE	TCE	CT
			MCL	5	5	5
Well ID	Aquifer	Area	Date	µg/L	µg/L	µg/L
MW-207A	Upper Claiborne	N-C	10/15/2020	4.36	**7.73**	-
MW-214A	Upper Claiborne	N-C	10/13/2020	**9.78**	**7.86**	0.43 J
MW-214B	Upper Claiborne	N-C	10/13/2020	**8.46**	**6.14**	0.392 J
MW-215A	Upper Claiborne	N-C	10/14/2020	**6.86**	4.7	-
MW-264	Upper Claiborne	N-C	10/11/2020	-	-	-
MW-311	Upper Claiborne	N-C	4/20/2021	**14.6**	**20.1**	0.860 J
MW-318C	Upper Claiborne	N-C	4/20/2021	**27.5**	**19.5**	1.69
MW-318D	Upper Claiborne	N-C	4/20/2021	**33.8**	**25.5**	1.2
MW-34	Intermediate	Window	4/19/2021	1.23	**7.7**	0.321 J
MW-38	Intermediate	Window	10/15/2020	-	-	-
MW-89	Intermediate	Window	10/13/2020	0.538 J	0.323 J	-
MW-90	Intermediate	Window	4/21/2021	**14.1**	2.11	-
MW-107B	Upper Claiborne	Window	4/20/2021	0.364 J	-	-
MW-107T	Upper Claiborne	Window	4/20/2021	0.327 J	-	-
MW-141	Intermediate	Window	4/21/2021	**10.4**	2.68	-
MW-202A	Intermediate	Window	10/13/2020	-	-	-
MW-202B	Intermediate	Window	4/21/2021	**45.6**	1.67	0.279 J
MW-211	Intermediate	Window	10/12/2020	0.323 J	0.268 J	-
MW-252	Intermediate	Window	10/12/2020	-	-	-
MW-253	Intermediate	Window	10/13/2020	-	-	-
MW-256	Intermediate	Window	4/21/2021	**15.2**	3.86	0.253 J
MW-262	Intermediate	Window	10/12/2020	-	-	-
MW-273	Intermediate	Window	10/15/2020	-	-	-
MW-293	Upper Claiborne	Window	10/12/2020	1.35	0.836 J	-
MW-309	Intermediate	Window	4/20/2021	**11.3**	3.84	-
MW-317C	Upper Claiborne	Window	4/20/2021	0.545 J	-	-
MW-317D	Upper Claiborne	Window	4/20/2021	-	-	-
MW-140	Memphis	Window	4/20/2021	**11.2**	0.442 J	-
MW-229	Memphis	Window	10/12/2020	-	-	-
MW-254	Memphis	Window	4/21/2021	**7.2**	3.97	0.691 J
MW-255	Memphis	Window	4/21/2021	3.4	1.33	-
MW-290	Memphis	Background	10/14/2020	-	-	-

Notes:
1) Results equal to or above MCL shown in **bold** font.
MCL: Maximum Contaminant Level
µg/L: micrograms per liter
-: Analyte not detected
DQE Flags
J: Estimated

TABLE 2
POTENTIAL CHEMICAL-SPECIFIC ARARS AND TBCS
FOCUSED FEASIBILITY STUDY
Main Installation, Defense Depot Memphis Tennessee

Applicable or relevant and appropriate requirement (ARAR):

Title	Medium	Requirement	Prerequisite	Citation	Remedial Alternative
USEPA National Primary Drinking Water Regulations	Restoration of groundwater to its designated uses(s)	Constituents shall not exceed the federal primary standards that were established as MCLs under the Safe Drinking Water Act for the protection of human health via drinking water exposure.	**FEDERAL:** Applies to public water systems or water associated with sources of drinking water. **Relevant and Appropriate.**	40 CFR Part 141.61(a) and (c)	Alternatives 2 and 3
TDEC General Water Quality Criteria - Criteria	Restoration of groundwater to its designated uses(s)	Except for naturally occurring levels, General Use Groundwater shall not contain constituents that exceed those levels specified in TDEC 0400-40-03-.03 subparagraphs (1)(j) and (k), and shall contain no other constituents at levels and conditions which pose an unreasonable risk to the public health or the environment. VOCs shall not exceed the MCLs listed in TDEC 0400-45-1-.25 in community water systems and non-transient non-community water systems.	**STATE:** Applies to General Use Groundwater with constituents exceeding standards listed in TDEC 0400-40-03-.03 and TDEC 0400-45-1-.25. **Applicable.**	TDEC 0400-40-03-.08(2) TDEC 0400-45-01-.25	Alternatives 2 and 3
National Emission Standards for Hazardous Air Pollutants	General standards for process vents used in treatment of VOC wastes and groundwater	Select and meet one of the options below: (1) Control HAP emissions from the affected process vents according to the standards specified in 40 CFR 63.7890 through 63.7893. (2) Determine for the remediation material treated or managed by the process vented through the affected process vents that the average total VOHAP concentration, as defined in 40 CFR 63.7957, of this material is less than 10 ppmw. Determination of the VOHAP concentration is made using the procedures specified in 40 CFR 63.7943. (3) Control HAP emissions from affected process vents subject to another subpart under 40 CFR 61 or 40 CFR 63 in compliance with the standards specified in the applicable subpart.	**FEDERAL:** Process vents as defined in 40 CFR 63.7957 used in site remediation of media that could emit HAP listed in Table 1 of Subpart GGGGG of Part 63 and vent stream flow exceeds the rate in 40 CFR 63.7885(c)(1) of 0.005 m3/min at standard conditions or 6.0 m3/min and the total concentration of HAP listed in Table 1 is less than 20 ppmv. **Relevant and Appropriate.**	40 CFR 63.7885(b)	Alternatives 2 and 3
National Emission Standards for Hazardous Air Pollutants	Emission limits for process vents used in treatment of VOC wastes and groundwater	Control HAP emissions from each new and existing process vent subject to 40 CFR 63.7885(b)(1) according to emissions limitations and work practice standards in this section that apply to your affected process vents. Meet one of the facility-wide emission limit options specified below. For multiple affected process vent streams, comply with this paragraph using a combination of controlled and uncontrolled process vent streams that achieve the facility-wide emission limit that applies. (1) Reduce from all affected process vents the total HAP emissions to a level less than 1.4 kg/hr and 2.8 Mg/yr (3.0 lb/hr) and 3.1 tpy); or (2) Reduce from all affected process vents the emissions of total organic compounds (minus methane and ethane) to a level below 1.4 kg/hr and 2.8 Mg/yr (3.0 lb/hr and 3.1 tpy); or (3) Reduce from all affected process vents the total emissions of the HAP listed in Table 1 of this subpart by 95 percent by weight or more; or (4) Reduce from all affected process vents the emissions of total organic compounds (minus methane and ethane) by 95 percent by weight or more.	**FEDERAL:** Process vents as defined in 40 CFR 63.7957 used in site remediation of media that could emit HAP listed in Table 1 of Subpart GGGGG of Part 63 and vent stream flow exceeds the rate in 40 CFR 63.7885(c)(1) of 0.005 m^3/min at standard conditions or 6.0 m^3/min and the total concentration of HAP listed in Table 1 is less than 20 ppmv. **Relevant and Appropriate.**	40 CFR 63.7890(a) and (b)	Alternatives 2 and 3
		Demonstrate initial compliance by meeting the requirements in 40 CFR 63.7890(b) and 63.7950.		40 CFR 63.7891(a),(b), and (d)	
		Demonstrate continuous compliance by meeting the requirements in 40 CFR 63.7890 and 63.7952.		40 CFR 63.7893(a),(b), and (d)	

TABLE 2
POTENTIAL CHEMICAL-SPECIFIC ARARS AND TBCS
FOCUSED FEASIBILITY STUDY
Main Installation, Defense Depot Memphis Tennessee

Title	Medium	Requirement	Prerequisite	Citation	Remedial Alternative
National Emission Standards for Hazardous Air Pollutants	Monitoring and inspection of process vents used in treatment of VOC wastes and groundwater	Must monitor and inspect the closed vent system and control device according to the requirements in 40 CFR 63.7927 that apply to the affected source.	**FEDERAL:** Process vents as defined in 40 CFR 63.7957 used in site remediation of media that could emit HAP listed in Table 1 of Subpart GGGGG of Part 63 and vent stream flow exceeds the rate in 40 CFR 63.7885(c)(1) of 0.005 m3/min at standard conditions or 6.0 m3/min and the total concentration of HAP listed in Table 1 is less than 20 ppmv. **Relevant and Appropriate.**	40 CFR 63.7892 40 CFR 63.7927	Alternatives 2 and 3

Notes:

1) The MI groundwater in the Fluvial and Intermediate aquifers is not used as a drinking water source. The LUCs prohibits production or consumptive use of groundwater and drilling of groundwater supply wells are not allowed on the MI or within 0.5 miles of the MI.
2) No potential TBC guidance was identified.
3) Although the description for the requirement for the monitoring of process vents applies the term "closed vent", the regulation is categorized under the Process Vents section of 40 CFR 63.

Abbreviations:

ARAR = Applicable or relevant and appropriate requirement
CFR = Code of Federal Regulations
HAP = hazardous air pollutant
kg/hr = kilogram per hour
lb/hr = pound per hour
LUC = Land use control
m^3/min = cubic meters per minute
MCL = Maximum Contaminant Level
Mg/yr = megagram per year
MI = Main Installation
ppmv = part per million by volume
ppmw = part per million by weight
TBC = To be considered
TDEC = Tennessee Department of Environment and Conservation
tpy = ton per year
USEPA = United States Environmental Protection Agency
VOC = volatile organic compound
VOHAP = volatile organic hazardous air pollutant

TABLE 3
POTENTIAL ACTION-SPECIFIC ARARS AND TBCS
FOCUSED FEASIBILITY STUDY
Main Installation, Defense Depot Memphis Tennessee

Action	Requirement	Prerequisite	Citation	Website	Remedial Alternative
Treatment System - Emissions					
Design, construction, operation, and closure of treatment system.	Unit must be located, designed, constructed, operated and maintained, and closed in a manner that will ensure protection of human health and the environment. Protection of human health and the environment includes, but is not limited to prevention of any release that may have adverse effects on human health or the environment due to migration of waste constituents in the air, considering the factors listed in 40 CFR 264.601(c)(1) to (7).	**FEDERAL:** Treatment, storage, and disposal of hazardous waste in miscellaneous units, except as provided in 40 CFR 264.1. **Applicable.**	40 CFR 264.601	https://www.ecfr.gov/current/title-40/chapter-I/subchapter-I/part-264/subpart-X	Alternatives 2 and 3
Solid Waste Characterization					
Characterization of solid waste	- Must determine if solid waste is hazardous waste or if waste is excluded under 40 CFR 261.4; and - Must determine if waste is listed as a hazardous waste in Subpart D of 40 CFR 261; or - Must characterize waste by using prescribed testing methods or applying generator knowledge based on information regarding material or processes used in Subpart C of 40 CFR 261. - Must refer to 40 CFR 261, 264, 265, 266, 267, 268, and 273 for possible exclusions or restrictions pertaining to management of the specific waste.	**FEDERAL:** Generation of solid waste as defined in 40 CFR 261.2, which is not excluded under 40 CFR 261.4 and is subject to regulation as hazardous waste. **Applicable.**	40 CFR 262.11(a) to (e)	https://www.ecfr.gov/current/title-40/chapter-I/subchapter-I/part-262/subpart-A/section-262.11	Alternatives 2 and 3
Soil Vapor Extraction (SVE) Treatment System - Emissions					
Emissions from treatment system	Operating permit exemptions: Single stack of an air contaminant source that emits no hazardous air contaminants or pollutants, and which does not have the potential for emitting more than 0.50 pounds per hour of nonhazardous particulates and 0.5 pounds per hour of any regulated nonhazardous gas (particulates and gases not defined as hazardous air contaminants or pollutants), provided that the total potential particulate emissions from the air contaminant source amounts to less than two pounds per hour, and the total regulated gaseous emissions from the air contaminant source amounts to less than two pounds per hour. For the purpose of this part, an air contaminant source includes all sources located within a contiguous area, and under common control. Any process emission source emitting less than 0.1 pounds per hour of a pollutant.	**STATE / COUNTY:** Emissions of air pollutants from air contaminant sources. **TBC.**	No regulatory citation	https://publications.tnsosfiles.com/rules/1200/1200-03/1200-03.htm https://law.justia.com/codes/tennessee/2010/title-68/chapter-201/part-1/68-201-115	Alternatives 2 and 3
Fugitive Dust Emissions					
Activities causing fugitive dust emissions	Shall take reasonable precautions to prevent particulate matter from becoming airborne; reasonable precautions shall include, but are not limited to, the following: - Use, where possible, of water or chemicals for control of dust in demolition of existing buildings or structures, construction operations, grading of roads, or the clearing of land; - Application of asphalt, water, or suitable chemicals on dirt roads, materials stock piles, and other surfaces, which can create airborne dusts. Shall not cause or allow fugitive dust to be emitted in such a manner as to exceed 5 minutes per hour or 20 minutes per day beyond property boundary lines on which emission originates.	**STATE:** Use, construction, alteration, repair or demolition of a building, or appurtenances or a road or the handling, transport, or storage of material. **Relevant and Appropriate.**	TDEC 1200-3-8-.01	https://publications.tnsosfiles.com/rules/1200/1200-03/1200-03.htm	Alternatives 2 and 3
Storm Water Runoff					
Activities causing storm water runoff	Implement good construction management techniques (including sediment and erosion controls, vegetative controls, and structural controls) in accordance with the substantive requirements of General Permit No. TNR10-0000 ("General Permit for Stormwater Discharges Associated with Construction Activities") to ensure that storm water discharge: - Does not violate water quality criteria as stated in TDEC 0400-40-03-.03, including, but not limited to, prevention of discharges that cause a condition in which visible solids, bottom deposits, or turbidity impairs the usefulness of waters of the State for any of the designated uses for that water body by TDEC 0400-40-04; - Does not contain distinctly visible floating scum, oil, or other mater; - Does not cause an objectionable color contrast in the receiving stream; and - Results in no materials in concentrations sufficient to be hazardous or otherwise deterimental to humans, livestock, wildlife, plant life, or fish and aquatic life in the receiving stream.	**STATE:** Dewatering or storm water runoff discharges from land disturbed by construction activity for disturbance of >= one acre total. **Relevant and Appropriate.**	TCA 69-3-108(l) TDEC 0400-40-10-.03(2)(a) General Permit No. TNR10-0000	https://publications.tnsosfiles.com/rules/0400/0400-40/0400-40.htm https://www.tn.gov/environment/permit-permits/water-permits1/npdes-permits1/npdes-stormwater-permitting-program/npdes-stormwater-construction-permit.html	Alternatives 2 and 3

Abbreviations:
ARAR = Applicable or relevant and appropriate requirement
CERCLA = Comprehensive Environmental Response, Compensation and Liability Act
CFR = Code of Federal Regulations
RCRA = Resource Conservation and Recovery Act
TBC = To be considered
TCA = Tennessee Code Annotated
TDEC = Tennessee Department of Environment and Conservation
µg/L = Micrograms per liter
USEPA = United States Environmental Protection Agency

TABLE 4
PRELIMINARY REMEDIAL GOALS FOR SOIL VAPOR
FOCUSED FEASIBILITY STUDY
Main Installation - Defense Depot Memphis, Tennessee

COC	CAS Number	Federal Criteria						Soil Vapor PRG	
		TBC	TBC	TBC	TBC	TBC	TBC		
		USEPA VISL Commercial Target Soil Gas (TR = 1E-06, THQ = 1)	USEPA VISL Commercial Target Soil Gas (TR = 1E-05, THQ = 1)	USEPA VISL Commercial Target Soil Gas (TR = 1E-04, THQ = 1)	USEPA VISL Resident Target Soil Gas (TR = 1E-06, THQ = 1)	USEPA VISL Resident Target Soil Gas (TR = 1E-05, THQ = 1)	USEPA VISL Resident Target Soil Gas (TR = 1E-04, THQ = 1)	Value	Basis
1,2-Dichloroethene, cis-	156-59-2	117,000	117,000	117,000	27,800	27,800	27,800	117,000	VISL Commercial (TR = 1E-04, THQ = 1)
Carbon tetrachloride	56-23-5	68.1	681	6,810	15.6	156	1,560	6,810	VISL Commercial (TR = 1E-04, THQ = 1)
Chloroform	67-66-3	See footnote 6.						14,000	Industrial Noncancer (THQ = 1)
Tetrachloroethene	127-18-4	1,570	5,840	5,840	360	1,390	1,390	5,840	VISL Commercial (TR = 1E-04, THQ = 1)
Trichloroethene	79-01-6	99.7	292	292	15.9	69.5	69.5	292	VISL Commercial (TR = 1E-04, THQ = 1)
Vinyl chloride	75-01-4	92.9	929	9,290	5.59	55.9	559	9,290	VISL Commercial (TR = 1E-04, THQ = 1)

Notes:

1) All values are presented in units of μg/m^3.
2) The COC list is based on the soil vapor COCs for the worker scenario identified in the Human Health and Ecological Risk Assessment, Revision 1 (HDR, 2020).

3) USEPA Target Sub-Slab and Near-source Soil Gas VISLs were calculated using default parameters. Since cis-1,2-dichloroethene does not have established inhalation toxicity values, its VISLs were calculated by using the trans-1,2-dichloroethene inhalation MRL of 0.2 ppm (converted to 0.8 mg/m^3 using a standard temperature of 25 degrees Celsius and standard pressure of 1 atmosphere [STP] in the USEPA's Indoor Air Unit Conversion calculator [USEPA, 2021]) as the noncancer chronic reference concentration. This methodology was requested by USEPA for the Dunn Field Post -ROD Supplemental Investigation Report (HDR, 2022).
4) For all COCs, except chloroform (see note below), the PRGs for soil vapor via the vapor intrusion pathway are the USEPA VISLs for a commercial scenario at a TR = 1E-04 and THQ = 1.
5) Land use controls prevent the construction of residential development or child daycare facilities, except in the UU/UE area in Functional Unit 6 in the eastern portion of the MI. Currently, residential use occurs in the

6) Chloroform has been identified by USEPA as a threshold carcinogen for all routes of exposures; therefore, the soil vapor PRGs were calculated using the noncancer endpoint. The noncancer Indoor Air Screening Levels (THQ = 1) of 100 μg/m^3 for resident and 430 μg/m^3 for industrial were converted to soil vapor levels using an attenuation factor of 0.03. The soil vapor PRGs are 3,300 μg/m^3 for resident and 14,000 μg/m^3 for industrial.

Abbreviations:

CAS - Chemical Abstracts Service
COC = Constituent of concern
mg/m^3 = Milligrams per cubic meter
MI = Main Installation
NC = No criterion
ppm = Parts per million
PRG = Preliminary Remediation Goal
RG = Remedial Goal
TBC = To Be Considered
THQ = Target hazard quotient
TR = Target risk
μg/m^3 = Micrograms per cubic meter
USEPA = United States Environmental Protection Agency
UU/UE = Unlimited use and unrestricted exposure
VISL = Vapor intrusion screening level

References:

CH2M HILL 2001. Memphis Depot Main Installation Record of Decision, Revision 2. Prepared for the U.S. Army Engineering and Support Center, Huntsville. February.
HDR 2020. Human Health and Ecological Risk Assessment, Revision 1. Former Defense Depot Memphis, Tennessee. Prepared for U.S. Army Corps of Engineers, Mobile District. February.
HDR. 2022. Dunn Field West Post-ROD Supplemental Investigation Report, Revision 0. Former Defense Depot Memphis, Tennessee. Prepared for U.S. Army Corps of Engineers, Mobile District. March.

USEPA 2021. Indoor Air Unit Conversion, EPA On-line Tools for Site Assessment Calculation. Last Updated August 31. Available online: https://www3.epa.gov/ceampubl/learn2model/part-two/onsite/ia_unit_conversion.html
USEPA 2022. Vapor Intrusion Screening Levels (VISL) Calculator. May. Available online: https://www.epa.gov/vaporintrusion/vapor-intrusion-screening-level-calculator

TABLE 5
PRELIMINARY REMEDIAL GOALS FOR GROUNDWATER
FOCUSED FEASIBILITY STUDY
Main Installation - Defense Depot Memphis, Tennessee

CVOC	CAS Number	Federal Criteria																Dunn Field	Groundwater PRG	
		ARAR	TBC		TBC		TBC		TBC	TBC	TBC	TBC	TBC	TBC	TBC	TBC	RG / TBC		
		USEPA MCL or MCLG	USEPA RSL Tapwater (TR = 1E-06, THQ = 1)		USEPA RSL Tapwater (TR = 1E-05, THQ = 1)		USEPA RSL Tapwater (TR = 1E-04, THQ = 1)		USEPA VISL Commercial Target Groundwater (TR = 1E-06, THQ = 1)	USEPA VISL Commercial Target Groundwater (TR = 1E-05, THQ = 1)	USEPA VISL Commercial Target Groundwater (TR = 1E-04, THQ = 1)	Site-Specific USEPA VISL Commercial Target Groundwater (TR = 1E-04, THQ = 1)	USEPA VISL Resident Target Groundwater (TR = 1E-06, THQ = 1)	USEPA VISL Resident Target Groundwater (TR = 1E-05, THQ = 1)	USEPA VISL Resident Target Groundwater (TR = 1E-04, THQ = 1)	Site-Specific USEPA VISL Resident Target Groundwater (TR = 1E-04, THQ = 1)	Groundwater Cumulative Target Concentration (TR = 1E-04, THI = 1)	Value	Basis
			Value	Basis	Value	Basis	Value	Basis											
1,2,3-Trichloropropane	96-18-4	NC	0.00075	c	0.0075	c	0.075	c	93.7	93.7	93.7	246	22.3	22.3	22.3	58.5	NC	0.075	RSL (TR = 1E-04, THQ = 1)
1,2-Dichloroethene, cis-	156-59-2	70	36	n	36	n	36	n	NC	NC	NC	NC	NC	NC	NC	NC	35	70	MCL
1,2-Dichloroethene, trans-	156-60-5	100	68	n	68	n	68	n	457	457	457	1,090	109	109	109	260	50	100	MCL
Carbon tetrachloride	56-23-5	5	0.46	c	4.6	c	46	c	1.81	18.1	181	440	0.415	4.15	41.5	101	3	5	MCL
Chloroform	67-66-3	70	0.22	c	2.2	c	22	c	3.55	35.5	355	856	0.814	8.14	81.4	196	12	70	MCLG
Methylene chloride	75-09-2	5	11	c	107	n	107	n	9,230	19,800	19,800	47,000	763	4,710	4,710	11,200	NC	5	MCL
Tetrachloroethene	127-18-4	5	11	c	41	n	41	n	65.2	242	242	615	14.9	57.6	57.6	147	2.5	5	MCL
Trichloroethene	79-01-6	5	0.49	c	2.8	n	2.3	n	7.43	21.8	21.8	54	1.19	5.18	5.18	12.8	5	5	MCL
Vinyl chloride	75-01-4	2	0.019	c	0.19	c	1.9	c	2.45	24.5	245	547	0.147	1.47	14.7	32.9	NC	2	MCL

Notes:
1) All values are presented in units of µg/L.
2) The COC list is based on the groundwater COCs identified in the Human Health and Ecological Risk Assessment, Revision 1 (HDR, 2020) and with consideration of their breakdown products (cis- and trans-1,2-dichloroethene). While PCE was not a significant contributor to the risks and hazards in the aquifer, it was included here as it was identified as a COC in the Record of Decision (CH2M HILL, 2001).
3) The MCLG for chloroform of 70 µg/L was chosen because it was derived based on the noncancer endpoint and this is consistent with USEPA's identification of chloroform as a threshold carcinogen. The MCL of 80 µg/L for trihalomethanes was derived based on both noncancer and cancer endpoints.
4) USEPA Tapwater RSLs and Target Groundwater VISLs were calculated using default parameters. RSL Basis: c = cancer, n = noncancer.
5) Site-specific USEPA VISLs for Commercial and Residential Scenarios (TR = 1E-04, THQ = 1) were calculated by using an average groundwater temperature of 20.3 degrees Celsius, which is based on the 2020 and 2021 longterm monitoring sampling events, and a "semi-site-specific" groundwater to indoor air attenuation fac 0.0005 to account for the extensive low permeability fine-grained soil encountered on the MI (USEPA, 2015).
6) The Dunn Field RGs were previously developed to evaluate the combined concentration levels of COCs so as to not exceed a cumulative upper bound target risk of 1E-04 and hazard index of 1 within the plumes. Refer to Section 2.7.3 of the Dunn Field ROD (CH2M HILL, 2004).
7) The Groundwater PRGs are primarily the USEPA MCLs or MCLGs and supplemented by the USEPA Tapwater RSLs at a TR = 1E-04 and THQ = 1.

Abbreviations:
ARAR = Applicable or Appropriate and Relevant
CAS - Chemical Abstracts Service
COC = Constituent of concern
MCL = Maximum contaminant level
MCLG = Maximum contaminant level goal
NC = No criterion
PRG = Preliminary Remediation Goal
RG = Remedial Goal
ROD = Record of Decision
RSL = Regional screening level
TBC = To Be Considered
TDEC = Tennessee Department of Environment and Conservation
THQ = Target hazard quotient
THI = Target hazard index
TR = Target risk
µg/L = Micrograms per liter
USEPA = United States Environmental Protection Agency
VISL = Vapor intrusion screening level

References:

CH2M HILL 2001. Memphis Depot Main Installation Record of Decision, Revision 2. Prepared for the U.S. Army Engineering and Support Center, Huntsville. February.
CH2M HILL 2004. Memphis Depot Dunn Field Record of Decision. Prepared for the U.S. Army Engineering and Support Center, Huntsville. March.
HDR 2020. Human Health and Ecological Risk Assessment, Revision 1. Former Defense Depot Memphis, Tennessee. Prepared for U.S. Army Corps of Engineers, Mobile District. February.
USEPA 2009. National Primary Drinking Water Regulations. Last Updated January 26, 2022. Available online: https://www.epa.gov/ground-water-and-drinking-water/national-primary-drinking-water-regulations
USEPA 2015. OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air. June. Available online: https://www.epa.gov/vaporintrusion
USEPA 2022a. Regional Screening Levels Calculator. May. Available online: https://www.epa.gov/risk/regional-screening-levels-rsls
USEPA 2022b. Vapor Intrusion Screening Levels (VISL) Calculator. May. Available online: https://www.epa.gov/vaporintrusion/vapor-intrusion-screening-level-calculator

TABLE 6
SCREENING OF REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS
FOCUSED FEASIBILITY STUDY REPORT
Main Installation - Defense Depot Memphis, Tennessee

General Response Action	Remedial Technology	Process Option	Description	Screening Comments
No Action	None	None	No remedial action.	Required for consideration by NCP.
Institutional Controls	Access and Use Restrictions	Deed Restrictions & Permits	Continuation of existing institutional controls with active remedial alternative(s). Deed restrictions issued for site to within potentially contaminated areas to restrict site use and well installation. Relies on natual attenuation to reduce VOC plume. Regulation promulgated to require permit for groundwater removal activities.	Considered in conjunction with all active remedial alternatives; MI is currently zoned Light Industrial. Shelby County imposes permit restrictions on wells near Superfund Sites.
Monitored Natural Attenuation with Long Term Monitoring	None	None	Natural subsurface processes (e.g., dilution, volatilization, adsorption, and chemical reactions) with subsurface materials reduce contaminant concentrations to acceptable levels. Long-Term Monitoring to assess performance and risk mitigation.	Considered in conjunction with active remedial alternatives as contingency remedy.
Containment	Physical Barriers	~~Slurry Wall; Sheet Piling; Grout Curtains;~~	Trench around areas of contamination is filled with a soil (or cement) bentonite slurry.	Not practicable, as the effectiveness is limited by the thin, inconsitent and/or absence of a low-permeability confining clay unit into which the physical barrier could be keyed. In addition, groundwater contamination at the MI is deeper than 60 feet bgs making it impractical be reached by physical barriers.
	Hydraulic Barrier	Groundwater Extraction	Groundwater is pumped from aquifer and treated ex-situ with discharge to surface water or POTW.	Groundwater extraction has a potential to provide a hydraulic barrier, as well as remediate the contaminated groundwater at the MI, given the hydrogeology, hydraulic conductivity of the aquifer, and contaminant properties.

Legend/Notes

~~Geologic Sequestration~~ - Process options that are screened out from further evaluation are grayed and struck-through.

TABLE 6
SCREENING OF REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS
FOCUSED FEASIBILITY STUDY REPORT
Main Installation - Defense Depot Memphis, Tennessee

General Response Action	Remedial Technology	Process Option	Description	Screening Comments
Treatment	In-Situ Biological Treatment	~~Enhanced Bioremediation~~	Process to accelerate the natural biodegradation process by introducing nutrients, electron acceptors, and/or competent contaminant-degrading microorganisms to the subsurface.	Although EBT implementations were successful in reducing CVOC concentrations, the previous RA was not sufficient to meet the RAOs for the MI within the timeframe estimated in the 2000 FS. Factors that limited the applicability and effectiveness of biodegradation processes include difficulty of maintaining anaerobic conditions in an aerobic FDAQ, the time needed to remediate the plume, which require years, and the potential incomplete degradation of CVOCs to toxic by-products (e.g., VC). While implementable on a technical basis, in-situ bioremediation (or referenced as EBT) has been screened out.
		~~Phytoremediation~~	Set of processes that use plants to remove, transfer, stabilize, and/or destroy contamination in groundwater.	Not practicable, as it requires a large area of land for remediation and would also not prevent the migration of contaminants off-site.
	In Situ Physical/Chemical Treatment	Air Sparging	Injected air traverses horizontally and vertically in channels through the soil column, creating a subsurface "air stripper" that removes contaminants by volatilization. AS is usually combined with soil vapor extraction which is an in-situ unsaturated (vadose) zone soil remediation technology where a vacuum is applied to the subsurface soil to induce air flow through the soil medium and remove VOCs.	Effective in treating the organic contaminants of concern, especially aromatic and chlorinated VOCs. Can be implemented at Site.
		~~Bioslurping~~	Combines the two remedial approaches of bioventing and vacuum-enhanced free-product recovery.	Not practicable, as separate phase-product (NAPL) not observed in groundwater at the site.
		~~ISCO/ISCR~~	Chemically converts contaminants to less toxic compounds that are more stable, less mobile, and/or inert.	Not practicable, as ISCO is not efficient at treating low-concentration contaminant plumes but widely used to treat the contaminant source. Although this technology can be effective in reducing CVOC contaminant mass rapidly in groundwater, it would require multiple injection events, handling large quantities of potentially hazardous chemicals, and a large number of injection points considering the nature and extent of the existing low-concentration groundwater plume.
		~~Dual Phase Extraction~~	Technology that utilizes a high vacuum system to remove various combinations of contaminated groundwater, separate-phase product (NAPL), and soil vapor from the subsurface.	Not practicable, as separate phase-product (NAPL) not observed in groundwater at the site.

Legend/Notes

~~Dual Phase Extraction~~ - Process options that are screened out from further evaluation are grayed and struck-through.

TABLE 6
SCREENING OF REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS
FOCUSED FEASIBILITY STUDY REPORT
Main Installation - Defense Depot Memphis, Tennessee

General Response Action	Remedial Technology	Process Option	Description	Screening Comments
Treatment (Cont'd)	In Situ Physical/Chemical Treatment (Cont'd)	~~In-situ Thermal Treatment~~	Steam is forced into an aquifer through injection wells to vaporize volatile and semi-volatile contaminants.	Not practicable based on the large size of the treatment area and low concentration of contaminants, as well as the fact that DNAPL has not been observed at the site.
		~~In-Well Air Stripping~~	Air is injected into a vertical well that has been screened at two depths.	Not practicable, due to limited number of vendors that are available to design and construct the remedy, making it difficult to obtain competitive bids and evaluate it against other technologies for cost effectiveness.
		~~Passive / Reactive Treatment Barriers~~	PRBs (consisting of iron with a bulking agent) are used to treat groundwater contaminated with chlorinated solvents. A PRB is installed across the flow path of a contaminant plume, allowing the water portion of the plume to passively move through the wall. Use of horizontal wells could also deliver reagents to contaminated areas.	Not practicable; groundwater contamination at the MI is approximately 60 to 100 feet bgs which is deeper than can practicably be reached by permeable reactive barriers.The effectiveness of barriers is limited by the thin, inconsistent and/or absence of a low permeability confining clay unit into which the barrier could be keyed.
	Ex Situ Biological Treatment	~~Bioreactors~~	Contaminants in extracted groundwater are put into contact with microorganisms in attached- or suspended-growth biological reactors.	Not practicable, due to low contaminant concentrations and insufficient biochemical oxygen demand (BOD) in on-site groundwater to support an adequate microbial population density.
		~~Constructed Wetlands~~	Constructed wetlands-based treatment technology uses natural geochemical and biological processes inherent in an artificial wetland ecosystem to accumulate and fixate/remove metals and other contaminants from influent waters.	Not practicable, as it requires a large area of land for remediation.

Legend/Notes

~~Bioreactors~~ - Process options that are screened out from further evaluation are grayed and struck-through.

TABLE 6
SCREENING OF REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS
FOCUSED FEASIBILITY STUDY REPORT
Main Installation - Defense Depot Memphis, Tennessee

General Response Action	Remedial Technology	Process Option	Description	Screening Comments
Treatment (Cont'd)	Ex Situ Physical/Chemical Treatment (Aqueous Phase)	Adsorption	Contaminants are adsorbed onto treatment media, reducing their concentrations in the aqueous phase.	Adsorption is a viable technology for VOC treatment of extracted groundwater.
		~~Advanced Oxidation Processes~~	Ultraviolet (UV) radiation, ozone, and/or hydrogen peroxide are used to destroy organic contaminants as impacted water is pumped into a treatment vessel.	Not practicable, due to high energy requirement with no increase in effectiveness.
		Ex Situ Air Stripping	Mass transfer of volatile contaminants from water to air.	Ex situ air stripping is a well-established technology that can be effective in reducing contaminant toxicity, mobility, and concentration through the use of treatment equipment that is readily available.
	Ex Situ Physical/Chemical Treatment (Vapor Phase)	Adsorption	Contaminants are adsorbed onto treatment media, reducing their concentrations in the vapor phase.	Adsorption is a viable technology for VOC treatment of extracted vapor.
Discharge / Disposal	On-Site Discharge (Aqueous Phase)	Surface Water	Extracted water treated and/or discharged to surface water.	Discharge to surface water can be an effective and implementable discharge method where surface water standards can be met.
		~~Groundwater~~	Extracted water treated and/or discharged into injection well(s) or an infiltration basin.	Not practicable, due to federal and state permit requirements being very restrictive due to the MAQ being the sole-source aquifer.
	On-Site Discharge (Vapor Phase)	Atmosphere	Extracted soil vapor discharged to atmosphere	Discharge to atmosphere can be an effective and implementable discharge method, where air emission limit can be met.
	Off-Site Discharge (Aqueous Phase)	~~POTW~~	Extracted water pre-treated and/or discharged to POTW.	Discharge to POTW can be an effective and implementable discharge method, however, the City of Memphis POTW's permit is not in federal regulatory complaince, therefore screened out.

Legend/Notes

~~POTW~~ - Process options that are screened out from further evaluation are grayed and struck-through.

TABLE 7
SECONDARY SCREENING OF REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS EVALUATION
FOCUSED FEASIBILITY STUDY REPORT
Main Installation - Defense Depot Memphis, Tennessee

General Response Action	Remedial Technology	Process Option	Effectiveness	Implementability	Cost
No Action	None	None	Does not achieve remedial action objectives.	Not acceptable to local community or state government.	None.
Institutional Controls	Access and Use Restrictions	Deed Restrictions & Permits	Will be considered for all remedial alternatives. Existing institutional controls providing some level of protection until the site meets unlimited use and unrestricted exposure (UU/UE) cleanup level.	Legal and administrative requirements.	Variable.
Containment/Ex-situ Physical/Chemical Treatment	Hydraulic Barrier / Ex-Situ Treatment	~~Groundwater Pump & Treat~~	Provides hydraulic barrier and effective in removing CVOCs by ex-situ treatments such as air stripping and liquid GAC; Well esablished technology.	Difficult to implement due to given the large size of the plume and hydrogeologic conditions, which will require a relatively large treatment plant. Requires a long period of operation over the course of the remedy as well as has substaintial volume of discharge requirement. Required disposal of liquid GAC.	High capital and O & M Cost for treating low-concentration contaminant plumes with large areal footprints, O&M (discharge/disposal), and overall costs.
Treatment	In Situ Physical/Chemical Treatment	Air Sparging	Effective in rapidly remediating CVOCs in high permeablity aquifer. Combined with Soil Vapor Extraction (SVE) which involves in removing CVOCs from effluent soil vapor using GAC.	Readily implementable technology. Very effective for high permeability FDAQ found at the Site. Successful implementation in nearby area, Dunn Field; Advantageous for MI with lowpermeablity surficial soil to mitigate soil vapor migration. SVE will also help remove soil contamination from suspected small releases in the unsaturated zone within the MI.	Medium capital, Medium O&M and overall cost. Requires vapor phase GAC disposal.
	Ex Situ Physical/Chemical Treatment (Aqueous Phase)	~~Adsorption~~	Effective and reliable.	Readily implementable; however, it is implementable with groundwater extraction and treatment process option.	High O&M due to liquid GAC replacement/regeration costs.
		~~Ex Situ Air Stripping~~	Effective and reliable.	Readily implementable; however, it is implementable with groundwater extraction and treatment process option.	High O&M due to energy costs.
	Ex Situ Physical/Chemical Treatment (Vapor Phase)	Adsorption	Effective and reliable.	Readily implementable technology	Low O&M due to less frequent GAC replacement/regeneration because of low-concentration contaminant plume.
Discharge	On-Site Discharge (Aquaeous Phase)	~~Surface Water~~	Effective and reliable.	Difficult to implement as substaintial large volume of treated water will require dischage	High capital, O&M, and overall costs if treatment is required to meet surface water discharge requirements for large quantity.
	On-Site Discharge (Vapor Phase)	Atmosphere	Effective and reliable.	Easy to implement; Discharge to atmosphere without off-gas treatment is possbily as it has not been required for the existing AS/SVE system at the Dunn Field or SVE in TTA-2 as the operations are in compliance with the local emission criterion	None

Legend/Notes

~~Groundwater~~ - Process options that are screened out from further evaluation are grayed and struck-through.

TABLE 8
SELECTED PROCESS OPTIONS
FOCUSED FEASIBILITY STUDY REPORT
Main Installation - Defense Depot Memphis, Tennessee

General Response Action			Preliminary Alternatives					
			Alternative 1	Alternatives 2, 3 & 4				Alternatives 3 & 4
Media	Technology Type	Area or Volume	No Action	Soil Vapor Extraction (SVE)	Adsorption	Deed Restrictions and Permits	Long Term Monitoring (LTM)	Air Sparging (AS)
Groundwater	Institutional Controls (ICs)	Groundwater Contamination Area				* - Access and Restrictions		
	Long Term Monitoring (LTM)	All Monitoring Wells Sampled					*	
	In-situ Physical Treatment	Groundwater Contamination Area at Site Boundary						M
Vapor	Removal	Subsurface Soil VOC Source Areas with Concentrations greater than soil vapor screening levels		M				
	Ex-situ Physical Treatment	Collected Vapor			*			
	Discharge	Treated or Un-Treated Vapor Discharge to Atmosphere				*		

Notes:
M - Meets effectiveness, implementability, and cost screening criteria
* - To be used in conjunction with other remedial options, not as stand alone alternative

TABLE 9
SITE CONDITIONS AT TREATMENT AREAS, ALTERNATIVE 2
FOCUSED FEASIBILITY STUDY REPORT
Main Installation - Defense Depot Memphis, Tennessee

Well	Date Completed	Northing	Easting	Aquifer	Area	Top of Casing Elevation (ft, NAVD)	Ground Elevation (ft, NAVD)	Top of Sand Depth[1] (ft, bgs)	Top of Clay Depth[2] (ft, bgs)	Total Boring Depth (ft, bgs)	Depth to Groundwater[3] (ft, btoc)	Riser Length (ft)	Total Well Depth (ft, btoc)	Top of Vadose Zone (ft bgs)	Vadose Zone Thickness (ft)	Saturated Thickness (ft)	Sparge Well Depth (ft bgs)
AS/SVE Transects																	
TTA-1N																	
MW-21	3/28/1989	276473	800603	Fluvial	TTA-1N	295.03	295.4	30	NE	109.5	78.82	92.1	107.1	30	49	NA	NE
MW-219	4/22/2007	276429	800461	Fluvial	TTA-1N	295.13	295.0	30	110	126	78.45	98.0	113.0	30	48	31.6	110
PMW21-01	5/15/2006	276533	800600	Fluvial	TTA-1N	294.76	295.0	31	110	111	78.54	88.4	108.4	31	48	31.5	110
North-Central																	
MW-263	5/13/2015	278945	805817	Fluvial	N-C	291.40	291.8	27	79	93	53.82	69.1	79.3	27	27	25.2	79
Window																	
MW-107	10/18/2001	278419	803010	Upper Claiborne	Window	304.92	305.2	37	158	167	91.36	128.0	143.0	37	54	66.6	158
MW-286	6/15/2018	278427	803027	Fluvial	Window	305.04	305.4	33	NE	115	89.69	101.1	111.3	33	57	NA	NE
MW-305	9/13/19	278490	802793	Fluvial	Window	305.07	305.2	39	NE	119	91.04	108.2	118.4	39	52	NA	NE
SVE System																	
TTA-2																	
DR2-1	6/14/2004	276772	806498	Fluvial	TTA-2	304.90	305.1	33	94	106.0	83.27	73.7	94.3	33	50	10.7	94

Notes:
1) Top of sand is the depth to the uppermost sand in the lower fluvial deposits.
2) Top of clay is the depth to the uppermost dark gray clay in the upper Claiborne.
3) Depth to groundwater is from the April 2021 LTM event.
4) Vadose zone thickness is groundwater depth minus top of sand depth.
5) Saturated thickness is top of clay depth minus groundwater depth.
6) Sparge well depth is top of clay depth.

ft: feet
ft, NAVD: feet above North American Vertical Datum of 1988
ft, bgs: feet below ground surface
ft, btoc: feet below top of casing
NA: Not applicable
NE: Not encountered

TABLE 10
TRAVEL TIMES, ALTERNATIVE 2
FOCUSED FEASIBILITY STUDY REPORT
Main Installation - Defense Depot Memphis, Tennessee

Travel Time Calculation

Area	CVOCs > 40 µg/L	Upgradient Well	Downgradient Well	Distance (ft)	Hydraulic Conductivity (ft/d)	Porosity	Gradient	Pore velocity (ft/d)	Travel Time (days)	Travel Time (years)
TTA-1N	PCE, TCE	MW-219	PMW21-03	316	100	0.2	0.0040	2.0	158	0.4
		PMW21-03	DR1-7	732	100	0.2	0.0020	1.0	732	2.0
								Total	890	**2.4**
NC	TCE	MW-263	MW-291	1028	100	0.2	0.0050	2.5	411	1.1
		MW-291	MW-281	868	100	0.2	0.0062	3.1	280	0.8
		MW-281	MW-318B	1136	100	0.2	0.0131	6.6	173	0.5
								Total	865	**2.4**
Window	PCE	MW-305	MW-256	1749	40	0.2	0.0183	3.7	478	**1.3**

Gradient Calculation

Area	Well	Northing	Easting	Aquifer	Top of Casing Elevation (ft, NAVD)	Depth to Groundwater[1] (ft, btoc)	Groundwater Elevation (ft NAVD)	Distance (ft)	Gradient (ft/ft)
TTA-1N	MW-219	276429	800461	Fluvial	295.13	78.45	216.68		
	PMW21-03	276573	800743	Fluvial	292.11	76.70	215.41	316	0.0040
	DR1-7	276791	801441	Fluvial	289.15	75.21	213.94	732	0.0020
N-C	MW-263	278945	805817	Fluvial	291.40	53.82	237.58		
	MW-291	278371	804963	Fluvial	303.59	71.12	232.47	1028	0.0050
	MW-281	278155	804123	Fluvial	304.56	77.46	227.10	868	0.0062
	MW-318B	277363	803309	Fluvial	304.45	92.27	212.18	1136	0.0131
Window	MW-305	278490	802793	Fluvial	305.07	91.04	214.03		
	MW-256	279302	801244	Intermediat	292.68	110.61	182.07	1749	0.0183

Notes:
1) Water levels measured during April 2021 LTM event
ft: Feet
NAVD: North American Vertical Datum of 1988
bgs: below ground surface
btoc: below top of casing

TABLE 11
SITE CONDITIONS AT TREATMENT AREAS, ALTERNATIVE 3
FOCUSED FEASIBILITY STUDY REPORT
Main Installation - Defense Depot Memphis, Tennessee

Well	Date Completed	Northing	Easting	Aquifer	Area	Top of Casing Elevation (ft, NAVD)	Ground Elevation (ft, NAVD)	Top of Sand Depth[1] (ft, bgs)	Top of Clay Depth[2] (ft, bgs)	Total Boring Depth (ft, bgs)	Depth to Groundwater[3] (ft, btoc)	Riser Length (ft)	Total Well Depth (ft, btoc)	Top of Vadose Zone (ft bgs)	Thickness of Vadose Zone (ft)	Saturated Thickness (ft)	Sparge Well Depth (ft bgs)
Portable Systems																	
TTA-1N																	
MW-100B	11/15/2001	276601	800854	Fluvial	TTA-1N	290.92	291.5	25	127.5	133	75.58	107.4	127.4	25	51	51.9	128
PMW21-03	5/17/2006	276573	800743	Fluvial	TTA-1N	292.11	292.7	38	109	116	76.70	90.3	110.3	38	39	32.3	109
PMW21-04	5/16/2006	276602	800772	Fluvial	TTA-1N	291.87	292.2	39	109	116	76.53	89.0	109.0	39	38	32.5	109
TTA-1S																	
PMW101-07A	6/7/2006	276143	801172	Fluvial	TTA-1S	292.20	292.5	34	138	146	77.17	117.9	137.9	34	43	60.8	138
TTA-2 NW-1																	
MW-217	4/21/2007	276671	805214	Fluvial	TTA-2	304.65	304.5	40	116	126	92.52	101.8	116.8	40	53	23.5	116
MW-218	3/7/2007	276937	805628	Fluvial	TTA-2	306.07	306.0	43	114	126	90.53	98.9	114.2	43	48	23.5	114
TTA-2 NW-2																	
MW-267	5/3/2015	277161	806001	Fluvial	TTA-2	303.84	304.3	32	90	95	71.63	71.9	82.1	32	40	18.4	90
MW-294	6/27/2018	277351	805966	Fluvial	TTA-2	304.38	304.8	33	82	90	70.64	69.6	79.8	33	38	11.4	82
North-Central 1																	
MW-258	3/29/2012	278126	804427	Fluvial	N-C	304.37	304.8	40	100	115	75.40	79.3	99.3	40	35	24.6	100
North-Central 2																	
MW-207A	3/15/2007	277653	803192	Claiborne	N-C	304.05	304.5	51	167	176	91.89	149.9	164.9	51	41	75.1	167
South-Central																	
MW-97	10/3/2001	276074	802139	Fluvial	S-C	297.44	297.7	27	118	123	NA	97.5	117.5	27	-	NA	118
MW-330	6/9/2021	276076	802123	Fluvial	S-C	300.59	297.5	28	NE	100	86.23	92.3	102.3	28	58	31.8	NE
Building 835																	
MW-62	10/14/1998	278290	801858	Fluvial	B-835	293.71	293.9	NA	97	107	79.18	86.0	96.0	-	-	17.8	97
MW-212	4/5/2007	278028	802225	Fluvial	B-835	295.74	295.7	41	100	107	82.69	85.3	100.3	41	42	17.3	100
MW-213	4/6/2007	278427	801669	Fluvial	B-835	294.22	294.2	33	92	106	79.06	77.3	92.3	33	46	12.9	92

Notes:
1) Top of sand is the depth to the uppermost sand in the lower fluvial deposits.
2) Top of clay is the depth to the uppermost dark gray clay in the upper Claiborne.
3) Depth to groundwater is from the April 2021 LTM event.
4) Vadose zone thickness is groundwater depth minus top of sand depth.
5) Saturated thickness is top of clay depth minus groundwater depth.
6) Sparge well depth is top of clay depth.

ft: feet
ft, NAVD: feet above North American Vertical Datum of 1988
ft, bgs: feet below ground surface
ft, btoc: feet below top of casing
NA: Not applicable
NE: Not encountered

TABLE 12
TRAVEL TIMES, ALTERNATIVE 3
FOCUSED FEASIBILITY STUDY REPORT
Main Installation - Defense Depot Memphis, Tennessee

Travel Time Calculation

Area	CVOCs > 40 µg/L	Upgradient Well	Downgradient Well	Distance (ft)	Hydraulic Conductivity (ft/d)	Porosity	Gradient	Pore velocity (ft/d)	Travel Time (days)	Travel Time (years)
AS/SVE Transects										
TTA-1N	PCE, TCE	MW-219	PMW21-03	316	100	0.2	0.0040	2.0	158	**0.4**
NC	TCE	MW-263	MW-291	1028	100	0.2	0.0050	2.5	411	**1.1**
Window	PCE	MW-305	MW-256	1749	40	0.2	0.0183	3.7	478	**1.3**
Portable Systems										
TTA-1N	PCE, TCE	PMW21-03	DR1-7	732	100	0.2	0.002	1.0	732	**2.0**
TTA-1S	TCE	PMW101-07	DR1-3	453	100	0.2	0.0017	0.9	533	**1.5**
TTA-2-NW	CT	MW-217	MW-259	857	100	0.2	0.0033	1.7	519	**1.4**
TTA-2-NW	PCE	MW-294	MW-218	534	100	0.2	0.0341	17.1	31	**0.1**
		MW-218	MW-259	1349	100	0.2	0.0046	2.3	587	**1.6**
									618	**1.7**
NC	TCE	MW-258	MW-288	567	100	0.2	0.0125	6.3	91	**0.2**
NC	PCE	MW-207B	MW-318A	323	100	0.2	0.0009	0.5	718	**2.0**
SC	TCE	MW-330	MW-297	777	100	0.2	0.0034	1.7	457	**1.3**
B-835	TCE	MW-62	MW-199B	897	100	0.2	0.0023	1.2	780	**2.1**

Gradient Calculation

Area	Well	Northing	Easting	Aquifer	Top of Casing Elevation (ft, NAVD)	Depth to Groundwater[1] (ft, btoc)	Groundwater Elevation (ft NAVD)	Distance (ft)	Gradient (ft/ft)
TTA-1N	PMW21-03	276573	800743	Fluvial	292.11	76.70	215.41		
TTA-1N	DR1-7	276791	801441	Fluvial	289.15	75.21	213.94	732.0	0.0020
TTA-1S	PMW101-07B	276142	801177	Fluvial	292.36	77.32	215.04		
TTA-1S	DR1-3	276527	801415	Fluvial	291.09	76.82	214.27	452.7	0.0017
TTA-2	MW-217	276671	805214	Fluvial	304.65	92.52	212.13		
TTA-2	MW-259	276279	804451	Fluvial	290.77	81.43	209.34	857.4	0.0033

TABLE 12
TRAVEL TIMES, ALTERNATIVE 3
FOCUSED FEASIBILITY STUDY REPORT
Main Installation - Defense Depot Memphis, Tennessee

Area	Well	Northing	Easting	Aquifer	Top of Casing Elevation (ft, NAVD)	Depth to Groundwater[1] (ft, btoc)	Groundwater Elevation (ft NAVD)	Distance (ft)	Gradient (ft/ft)
TTA-2	MW-294	277351	805966	Fluvial	304.38	70.64	233.74		
TTA-2	MW-218	276937	805628	Fluvial	306.07	90.53	215.54	534.0	0.0341
TTA-2	MW-259	276279	804451	Fluvial	290.77	81.43	209.34	1348.7	0.0046
N-C	MW-258	278126	804427	Fluvial	304.37	75.40	228.97		
N-C	MW-288	277932	803895	Fluvial	304.69	82.81	221.88	566.5	0.0125
N-C	MW-207B	277665	803193	Fluvial	304.06	91.59	212.47		
N-C	MW-318B	277363	803309	Fluvial	304.45	92.27	212.18	322.9	0.0009
S-C	MW-330	276076	802123	Fluvial	300.59	86.28	214.31		
S-C	MW-297	276351	802850	Fluvial	297.91	86.24	211.67	777.2	0.0034
B-835	MW-62	278290	801858	Fluvial	293.71	79.18	214.53		
B-836	MW-199B	277752	802576	Fluvial	302.06	89.63	212.43	896.9	0.0023

Notes:
1) Water levels measured during April 2021 LTM event
ft: Feet
NAVD: North American Vertical Datum of 1988
bgs: below ground surface
btoc: below top of casing

TABLE 13
SUMMARY OF DETAILED ANALYSIS OF ALTERNATIVES
FOCUSED FEASIBILITY STUDY REPORT
Main Installation - Defense Depot Memphis, Tennessee

Criteria	Alternative 1 No Action	Alternative 2 AS/SVE and SVE	Alternative 3 Expanded AS/SVE and SVE
	No action.	**Alternative 2 includes three AS/SVE systems for preventing contaminated groundwater migration and SVE for treating source area contamination in TTA-2, TTA-1N, and Building 720 with reliance on existing ICs modified to address vapor intrusion and on-going LTM for protection of human health and the environment over the long term.**	**Alternative 3 includes three AS/SVE systems for preventing contaminated groundwater migration, SVE for treating source area contamination in TTA-2, TTA-1N, and Building 720 and portable SVE and AS/SVE systems for reducing contaminant concentrations in isolated CVOC groundwater plumes with reliance on existing ICs modified to address vapor intrusion and on-going LTM for protection of human health and the environment over the long term.**
OVERALL PROTECTIVENESS			
Human Health Protection - Direct Contact/Ingestion	There are no users of groundwater from the fluvial aquifer beneath the MI. There are controls established by the Shelby County Health Department (SCHD) that prohibit the installation of water wells within 0.5 mile of the designated boundaries of a listed NPL site. This alternative does not require continuation of ICs or LTM and relies solely on SCHD groundwater use controls and zoning regulations which are not considered permanent. Concentrations of CVOCs will slowly naturally attenuate over time. However, this alternative provides no mechanism for monitoring the attenuation process or potential off-site migration through deeper aquifers.	There are no users of groundwater from the fluvial aquifer beneath the MI and controls established by SCHD prohibit the installation of water wells within 0.5 mile of the designated boundaries of a listed NPL site. This alternative reduces risk by limiting CVOC migration onto the MI and into deeper aquifers as well as removing residual VOC contamination in soil vapor from subsurface soil and preventing further impacts to groundwater at TTA-2, TTA-1N, and Building 720. It allows natural attenuation to slowly reduce CVOC concentrations to MCLs within plumes downgradient of the active treatment zones and elsewhere on the MI. This alternative will continue LTM as CVOCs within the on-site area attenuate over time. It relies on existing ICs modified to address potential vapor intrusion issues and existing groundwater use controls until the site meets UU/UE cleanup level.	There are no users of groundwater from the fluvial aquifer beneath the MI and controls established by SCHD prohibit the installation of water wells within 0.5 mile of the designated boundaries of a listed NPL site. This alternative reduces risk by limiting CVOC migration onto the MI and into deeper aquifers, removing residual VOC contamination in soil vapor from subsurface soil and preventing further impacts to groundwater at TTA-2, TTA-1N, and Building 720 and reducing CVOC contamination in isolated on-site plumes treatment areas. It allows natural attenuation to slowly reduce CVOC concentrations to MCLs within plumes downgradient of the active treatment zones and elsewhere on the MI. This alternative will continue LTM as CVOCs within the on-site area attenuate over time; the expanded treatment areas will reduce the time required to meet RAOs. It relies on existing ICs modified to address potential vapor intrusion issues and existing groundwater use controls until the site meets UU/UE cleanup level.
Human Health Protection - Inhalation	Risk increases due to halting implementation of existing institutional controls and monitoring.	Reduces risk by preventing CVOC migration onto the MI and into deeper aquifers and by removing residual soil contamination and preventing further impacts to on-site groundwater. Potential vapor intrusion risk is mitigated further by modifying existing institutional controls to address vapor intrusion.	Reduces risk by preventing CVOC migration onto the MI and into deeper aquifers and by removing soil and groundwater contamination and preventing further impacts to on-site groundwater with expanded treatment areas. Potential vapor intrusion risk is mitigated further by modifying existing institutional controls to address vapor intrusion.
Environmental Protection	Allows contaminant migration onto the MI and offers no restoration of the resource.	Limits further impacts to groundwater from on-site subsurface soil VOC source areas and from contaminant migration onto the MI and to deeper aquifers; provides restoration of the resource.	Limits further impacts with expanded on-site treatment areas of subsurface soil and groundwater and preventing contaminant migration onto the MI and to deeper aquifers; provides restoration of the resource.
COMPLIANCE WITH ARARS			
Chemical Specific ARARs	May comply with Federal groundwater maximum contaminant levels (MCLs) over time through natural attenuation of CVOCs. However, there is no groundwater monitoring to indicate if or when MCLs are met.	Would comply with MCLs at the completion of implementation.	Would comply with MCLs at the completion of implementation with reduced treatment time.
Location Specific ARARs	Offers no restoration of the resource. SCHD prohibits the installation of water wells within 0.5 mile of the NPL site, but this restriction is not considered permanent.	Deed restrictions prohibit groundwater use on the MI; restrictions would not be removed until the site meets unlimited use and unrestricted exposure (UU/UE) criteria. SCHD prohibits the installation of water wells within 0.5 mile of the NPL site, but this restriction is not considered permanent.	Deed restrictions prohibit groundwater use on the MI; restrictions would not be removed until the site meets unlimited use and unrestricted exposure (UU/UE) criteria. SCHD prohibits the installation of water wells within 0.5 mile of the NPL site, but this restriction is not considered permanent.
Action Specific ARARs	Not applicable, as no action is taken.	Must comply with - SCHD rules for installation/abandonment of wells for AS/SVE and PDI - Clean Air Act and Tennessee Rule 1200- 3-1 for VOCs emissions to the air during treatment if it doesn't need SCHD emission criteria - RCRA for the disposal of the waste generated during well installation and groundwater monitoring - OSHA for worker protection during well installation, AS/SVE and SVE operations, and groundwater monitoring.	Must comply with - SCHD rules for installation/abandonment of wells for AS/SVE, SVE and PDI - Clean Air Act and Tennessee Rule 1200- 3-1 for VOCs emissions to the air during treatment if it doesn't need SCHD emission criteria - RCRA for the disposal of the waste generated during well installation m and groundwater monitoring - OSHA for worker protection during well installation, AS/SVE and SVE operations, and groundwater monitoring.
Other Criteria and Guidance	Allows continued contamination of groundwater and offers no restoration of the resource.	None	None

TABLE 13
SUMMARY OF DETAILED ANALYSIS OF ALTERNATIVES
FOCUSED FEASIBILITY STUDY REPORT
Main Installation - Defense Depot Memphis, Tennessee

Criteria	Alternative 1 No Action	Alternative 2 AS/SVE and SVE	Alternative 3 Expanded AS/SVE and SVE
LONG TERM EFFECTIVENESS AND PERMANENCE			
Magnitude of residual risk			
Direct Contact/Ingestion	There are no known users of groundwater beneath the MI; well installation restrictions are in place with the SCHD. Natural attenuation may decrease the risk after more than 30 years. There will be no monitoring to confirm natural attenuation or potential migration of the plumes off-site into deeper aquifers. Contamination resulting in potential risk will not be removed.	Increased risk reduction by active treatment of contaminated groundwater migrating onto the MI and to deeper aquifers, and treatment in TTA-2, TTA-1N, and Building 720 by SVE to remove VOCs in subsurface soil and limit further groundwater impacts. Deed restrictions will continue to prevent exposure to contaminants. Risk would remain to unauthorized users until active RA is complete (estimated 10 years). LTM will assess the reduction of the CVOC plumes and migration to deeper aquifers.	Greater risk reduction by active treatment of contaminated groundwater migrating onto the MI and to deeper aquifers, by expanded on-site active treatment of sursurface soil and groundwater in eight isolated areas. Deed restrictions will continue to prevent exposure to contaminants. Risk would remain to unauthorized users until active RA is complete (estimated 5 years). LTM will assess the reduction of the CVOC plumes and migration to deeper aquifers.
Inhalation	Contamination resulting in potential risk will not be removed.	Greater risk reduction by limiting contaminant migration onto the MI and to deeper aquifers and reducing soil vapor concentrations in subsurface soil VOC source areas and limiting impacts to groundwater. Reduction in on-site groundwater contamination over longer timeframe (estimated 20 years) through natural attenuation.	Greater risk reduction by limiting contaminant migration onto MI and to deeper aquifers and reducing subsurface soil and groundwater contamination with active remediation in expanded on-site treatment areas (estimated 5 years). Reduction in on-site groundwater contamination over longer timeframe (estimated 10 years) through natural attenuation.
Impact to Groundwater			
Adequacy and Reliability of Controls	No controls are provided other than SCHD well restrictions and zoning regulations.	AS/SVE and SVE with LTM and institutional controls are expected to be effective and reliable technology in the active treatment zones (up to 10 years). LTM will monitor groundwater contamination reduction b over the long term (up to 20 years). Existing institutional controls modified to include VI are expected to be effective.	AS/SVE and SVE with LTM and institutional controls are expected to be effective and reliable technology in the active treatment zones (up to 5 years). LTM will monitor groundwater contamination reduction b over the long term (up to 15 years). Existing institutional controls modified to include VI are expected to be effective.
Need for 5-Year Review	Review would be required although there are no actions to ensure adequate protection of human health and the environment for future groundwater users.	Review would be required to confirm that institutional controls (ICs) are being enforced and that plume reduction is occurring. Review will also ensure that adequate plume controls are in place if unacceptable risks are indicated during monitoring.	Review would be required to confirm that institutional controls (ICs) are being enforced and that plume reduction is occurring. Review will also ensure that adequate plume controls are in place if unacceptable risks are indicated during monitoring.
REDUCTION AND TOXICITY, MOBILITY OR VOLUME THROUGH TREATMENT			
Treatment Processes Used	None.	SVE will extract CVOCs from soil and AS/SVE will extract CVOCs from soil and groundwater.Extracted vapor will be treated by chemical processes (GAC for CVOCs in vapor), if required, to remove CVOCs from extracted vapor prior to discharge.	SVE will extract CVOCs from soil and AS/SVE will extract CVOCs from soil and groundwater.Extracted vapor will be treated by chemical processes (GAC for CVOCs in vapor), if required, to remove CVOCs from extracted vapor prior to discharge.
Amount Destroyed or Treated	Only that from natural attenuation, because no contaminants are treated or destroyed under this alternative and no monitoring occurs.	VOCs extracted from vadose zone from groundwater sparging or volatilization from soil and, if required, treated through GAC system; eventually destroyed/disposed of when carbon is regenerated.	VOCs extracted from vadose zone from groundwater sparging or volatilization from soil and, if required, treated through GAC system; eventually destroyed/disposed of when carbon is regenerated.
Reduction of Toxicity, Mobility, or Volume	Only that from natural attenuation; because no monitoring occurs, assumes there is no reduction in toxicity, mobility, or volume through treatment under this alternative.	AS/SVE and SVE will reduce volume of CVOCs in soil and groundwater. Flow of groundwater with reduced contaminant volume will result in reduction of volume in downgradient area through natural attenuation .	AS/SVE and SVE will reduce volume of CVOCs in soil and groundwater. Flow of groundwater with reduced contaminant volume will result in reduction of volume in downgradient area through natural attenuation .
Irreversible Treatment	None, because no treatment occurs under this alternative.	In-situ volatilization and extraction by AS/SVE, carbon adsorption, and regeneration of carbon.	In-situ volatilization and extraction by AS/SVE, carbon adsorption, and regeneration of carbon.
Type and Quantity of Residuals Remaining After Treatment	Natural attenuation may generate residuals. Because there is no monitoring, these residuals may increase risk to the human health and environment.	Carbon requires regeneration/disposal.	Carbon requires regeneration/disposal.
Statutory Preference for Treatment	Does not satisfy.	Would satisfy.	Would satisfy.

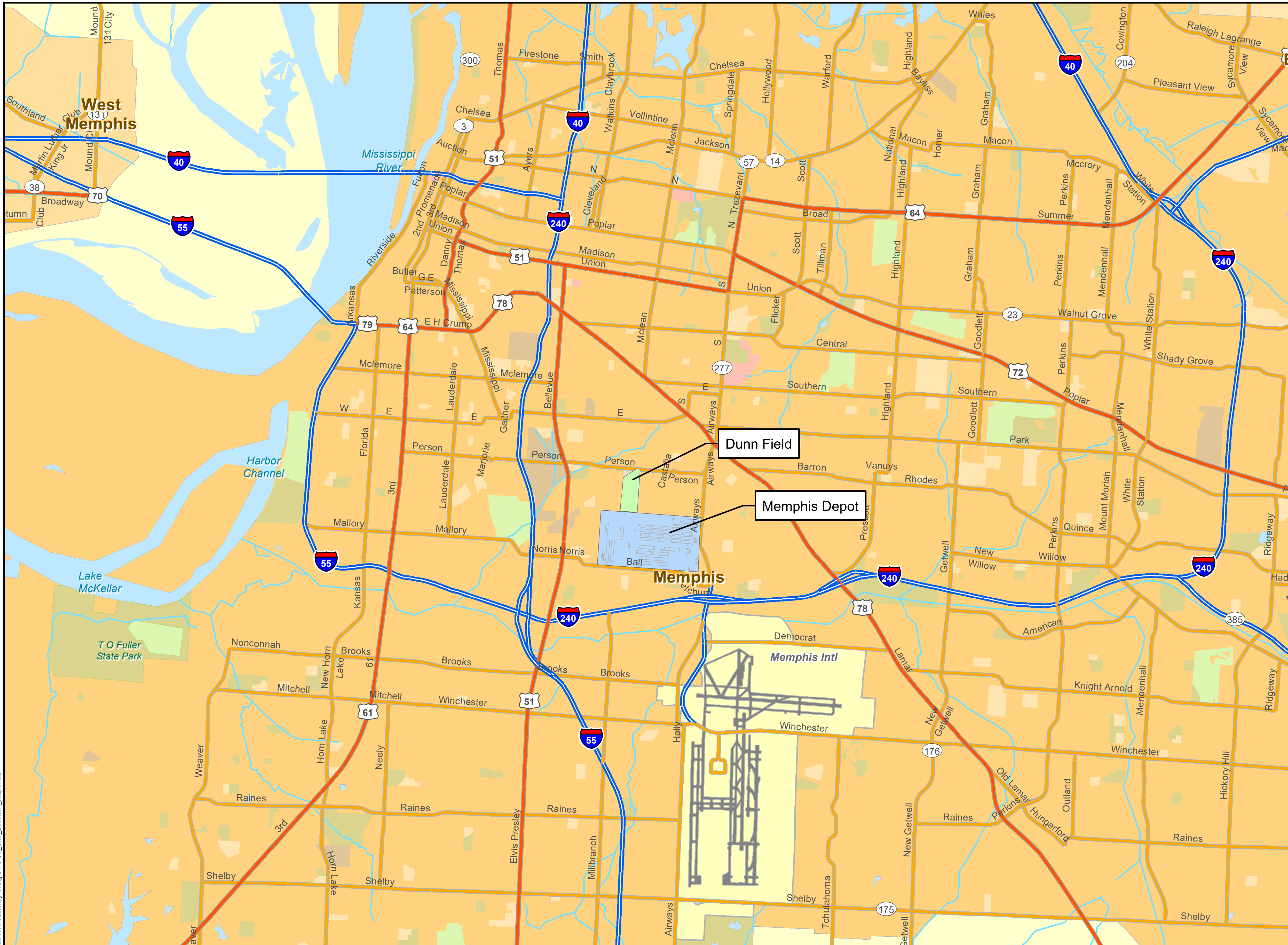
TABLE 13
SUMMARY OF DETAILED ANALYSIS OF ALTERNATIVES
FOCUSED FEASIBILITY STUDY REPORT
Main Installation - Defense Depot Memphis, Tennessee

Criteria	Alternative 1 No Action	Alternative 2 AS/SVE and SVE	Alternative 3 Expanded AS/SVE and SVE
SHORT TERM IMPACTS AND EFFECTIVENESS			
Community Protection	Existing risks increases due to halting implementation of existing institutional controls and monitoring.	Risk to the community is not increased by AS/SVE and SVE. A pilot study will determine whether air emissions would require vapor treatment before discharge to the atmosphere.	Risk to the community is not increased by AS/SVE and SVE. A pilot study will determine whether air emissions would require vapor treatment before discharge to the atmosphere.
Worker Protection	Existing risks increase due to halting implementation of institutional controls and LTM.	Worker exposure is expected to be minimal during construction and operations. Contaminated groundwater will remain underground and VOC vapor emissions would be treated using GAC, if required. Minimal short-term risks to the workers from this alternative would be due to activities associated with borings and installation of AS, SVE and monitoring wells, equipment operations, and groundwater sampling; all can be mitigated by implementation of Site Safety and Health Plan (SSHP).	Worker exposure is expected to be minimal during construction and operations. Contaminated groundwater will remain underground and VOC vapor emissions would be treated using GAC, if required. Minimal short-term risks to the workers from this alternative would be due to activities associated with borings and installation of AS, SVE and monitoring wells, equipment operations, and groundwater sampling; all can be mitigated by implementation of Site Safety and Health Plan (SSHP).
Environmental Impacts	Environmental impacts continue from existing conditions.	The environment would be protected through the use of engineering controls during well installation, AS/SVE operations, groundwater monitoring, and disposal of generated waste. Fugitive VOC emissions would be managed by engineering controls, if required to prevent environmental impacts.	The environment would be protected through the use of engineering controls during well installation, AS/SVE operations, groundwater monitoring, and disposal of generated waste. Fugitive VOC emissions would be managed by engineering controls, if required to prevent environmental impacts.
Time Until Action is Complete	Not applicable.	Deed restrictions will continue to be implemented until UU/UE criteria are met. The PDI and pilot study for each AS/SVE area would be performed and a Remedial Design document prepared over 12 months. Remedial actions would operate concurrently: SVE in TTA-2 would be operated for 2 years and AS/SVE treatment would begin to be effective at system startup, and would be completed in approximately 10 years. LTM would continue for an additional 10 years for a total of 20 years.	Deed restrictions will continue to be implemented until UU/UE criteria are met. The PDI and pilot study for each AS/SVE area would be performed and a Remedial Design document prepared over 12 months. Remedial actions would operate concurrently: SVE in TTA-2 would be operated for 2 years; AS/SVE treatment would begin to be effective at system startup, and would be completed in approximately 5 years; and portable SVE and AS/SVE systems would be implemented over 4 years. LTM would continue for an additional 10 years for a total of 15 years.
IMPLEMENTABILITY			
Ability to Construct and Operate	No construction or operation.	Preliminary investigation and pilot test necessary to complete system designs are straightforward. Installation of AS/SVE wells and injection/extraction system is straightforward. Construction estimated at 2-3 months. Routine O & M activities would be required. Nuisance noise and inconvenience to the surrounding building occupants will be limited. There are no nearby residences.	Preliminary investigation and pilot test necessary to complete system designs are straight forward. Installation of AS/SVE wells and injection/extraction system is straightforward. Construction activities estimated at 2-3 months. Portable SVE and AS/SVE systems would be implemented over 4 years and moved annually; construction activities over 2-3 weeks for each move. Routine O&M activities would be required. Nuisance noise and inconvenience to the surrounding building occupants will be limited. There are no nearby residences.
Ease of Doing More Action if Needed	No action taken.	AS and SVE wells and VMPs could be added easily. Air injection/ extraction flow rates can be modified as necessary based on performance monitoring data. Flexibility in operations can handle varying soil vapor concentrations. Capture and treatment of vapors to meet air emissions limits is easy to implement, if required.	AS and SVE wells and VMPs could be added easily. Air injection/extraction flow rates can be modified as necessary based on performance monitoring data. Flexibility in operations can handle varying soil vapor concentrations. Capture and treatment of vapors to meet air emissions limits is easy to implement, if required.
Ability to Monitor Effectiveness	No monitoring.	Effectiveness of the treatment systems is easily monitored through effluent vapor analyses to confirm that contaminants are being removed through AS/SVE or SVE. Groundwater samples from performance monitoring wells will confirm that contaminant removal from AS/SVE or SVE is reducing groundwater contamination. LTM will confirm reduction in plume extent over time.	Effectiveness of the treatment systems is easily monitored through effluent vapor analyses to confirm that contaminants are being removed through AS/SVE or SVE. Groundwater samples from performance monitoring wells will confirm that contaminant removal from AS/SVE or SVE is reducing groundwater contamination. LTM will confirm reduction in plume extent over time.
Ability to Obtain Approvals and Coordinate with Other Agencies	No approvals necessary.	DDMT has a good relationship with SCHD and has obtained well and air permits previously. Required reports have been submitted without issue.	DDMT has a good relationship with SCHD and has obtained well and air permits previously. Required reports have been submitted without issue.
Ability of Services and Capacities	No services or capacities required.	The planned activities have been conducted previously at DDMT. LTM has been conducted since 2004, an SVE system was operated from 2007 to 2012 and AS/SVE has been conducted since 2009.	The planned activities have been conducted previously at DDMT. LTM has been conducted since 2004, an SVE system was operated from 2007 to 2012 and AS/SVE has been conducted since 2009.
Availability of Equipment, Specialties, and Materials	None required.	No special equipment or specialists are required to continue LTM or ICs. Equipment and materials are readily available to construct and maintain AS/SVE treatment. Requires utility company support for installation of electrical service.	No special equipment or specialists are required to continue LTM or ICs. Equipment and materials are readily available to construct and maintain AS/SVE treatment. Requires utility company support for installation of electrical service.
Availability of Technologies	None required.	Readily available.	Readily available.

TABLE 13
SUMMARY OF DETAILED ANALYSIS OF ALTERNATIVES
FOCUSED FEASIBILITY STUDY REPORT
Main Installation - Defense Depot Memphis, Tennessee

Criteria	Alternative 1 No Action	Alternative 2 AS/SVE and SVE	Alternative 3 Expanded AS/SVE and SVE
COST			
Capital Cost Present Value	$0	$2,293,000	$2,955,000
Total O&M Cost Present Value	$0	$3,427,000	$3,481,000
Total Periodic Cost Present Value	$0	$221,000	$304,000
Total Present Value	$0	$5,941,000	$6,740,000
Time to achieve RAOs		Assumes 20 years	Assumes 15 years
Average Annual O&M Cost	$0	$171,350	$232,067

Figures



Path: W:\Feasibility Study\FFS01_Site_Location_Map.mxd

Figure 1

Site Location Map

Focused Feasibility Study Report

Main Installation
Defense Depot
Memphis, Tennessee

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Date: 12/22/2021
Edition: Rev 0

Figure 2

Aerial Site Photograph

Focused Feasibility Study Report

Main Installation
Defense Depot
Memphis, Tennessee

Legend

- Main Installation Perimeter
- Dunn Field Perimeter

Notes:
1. Aerial date: 2019.
2. Source: Shelby County TN Regional GIS Department.

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0 500 1,000
Feet

Projection: NAD 1927 StatePlane Tennessee
Units: Feet, Elevation Units: Feet, NAVD88

Date: 12/22/2021
Edition: Rev 0

Path: W:\Feasibility Study\FFS\02_Site Aerial.mxd

Figure 3

Ownership and Land Use

Focused Feasibility Study Report

Main Installation Defense Depot Memphis, Tennessee

Legend

- Property Boundary
- Buildings — *490 - DDMT Assigned Number*
- Roads
- Alpha Omega Veterans' Housing
- Barnhart Crane Administrative Area
- Barnhart Crane Operations Area
- MDIP-Undeveloped
- Detention Basin
- Golf Course
- Memphis Depot Industrial Park (MDIP)
- Memphis PD Airport Precinct
- Supply Chain Solutions

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0 500 1,000

Feet

Projection: NAD 1927 StatePlane Tennessee
Units: Feet, Elevation Units: Feet, NAVD88

Date: 6/16/2022
Edition: Rev 0

Document Path: W:\Feasibility Study\FFS\03_Ownership_Land_use.mxd

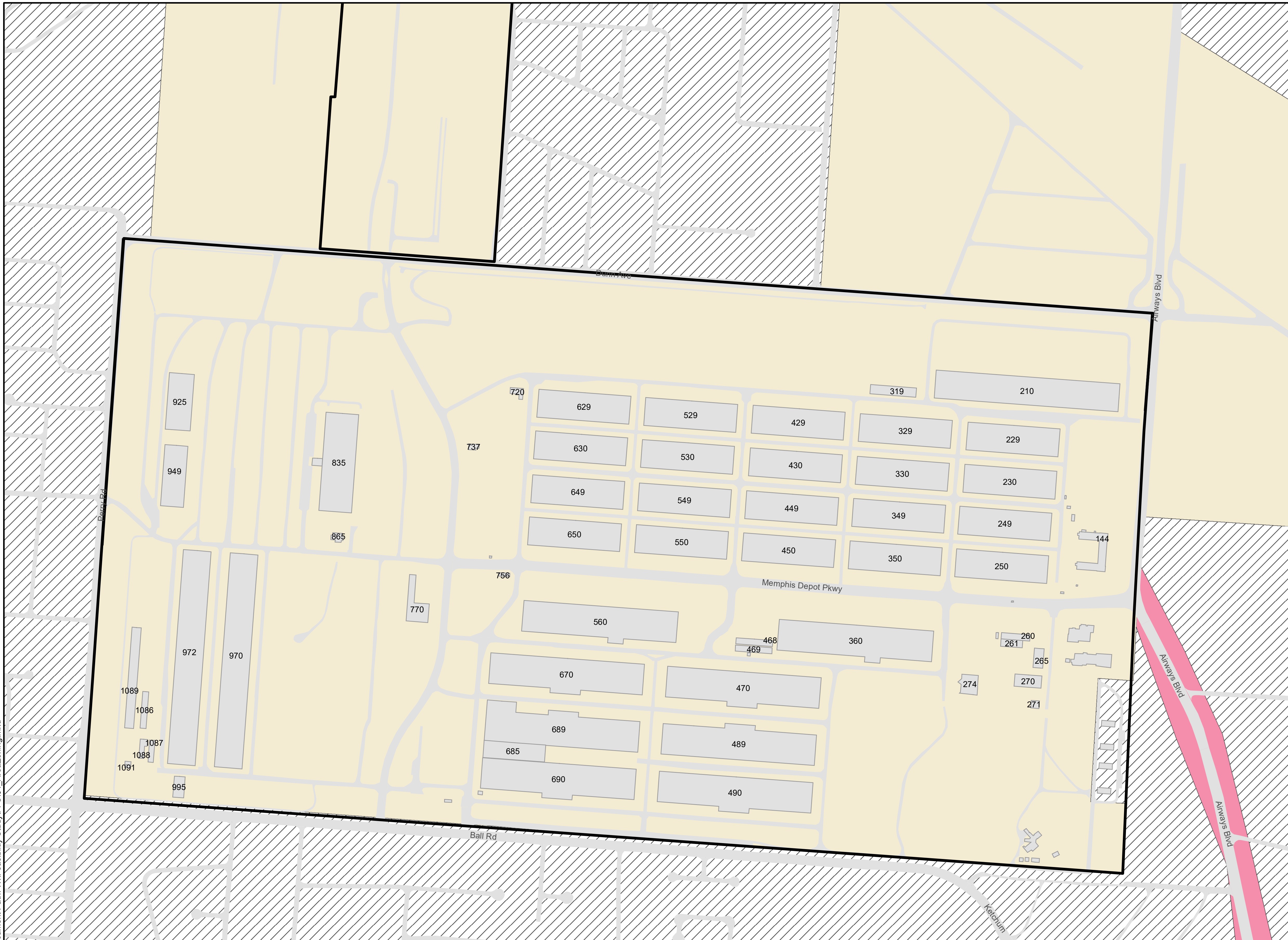

Figure 4

Area Zoning Map

Focused Feasibility
Study Report

Main Installation
Defense Depot
Memphis, Tennessee

Legend

EMP: Commercial/Industrial
CMU: Commercial
R: Residential
Buildings
Roads
Property Boundary

Source: Shelby County Zoning Atlas
https://gis.shelbycountytn.gov/zoning/

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0 500 1,000
Feet

Projection: NAD 1927 StatePlane Tennessee
Units: Feet, Elevation Units: Feet, NAVD88

Date: 6/16/2022
Edition: Rev 0

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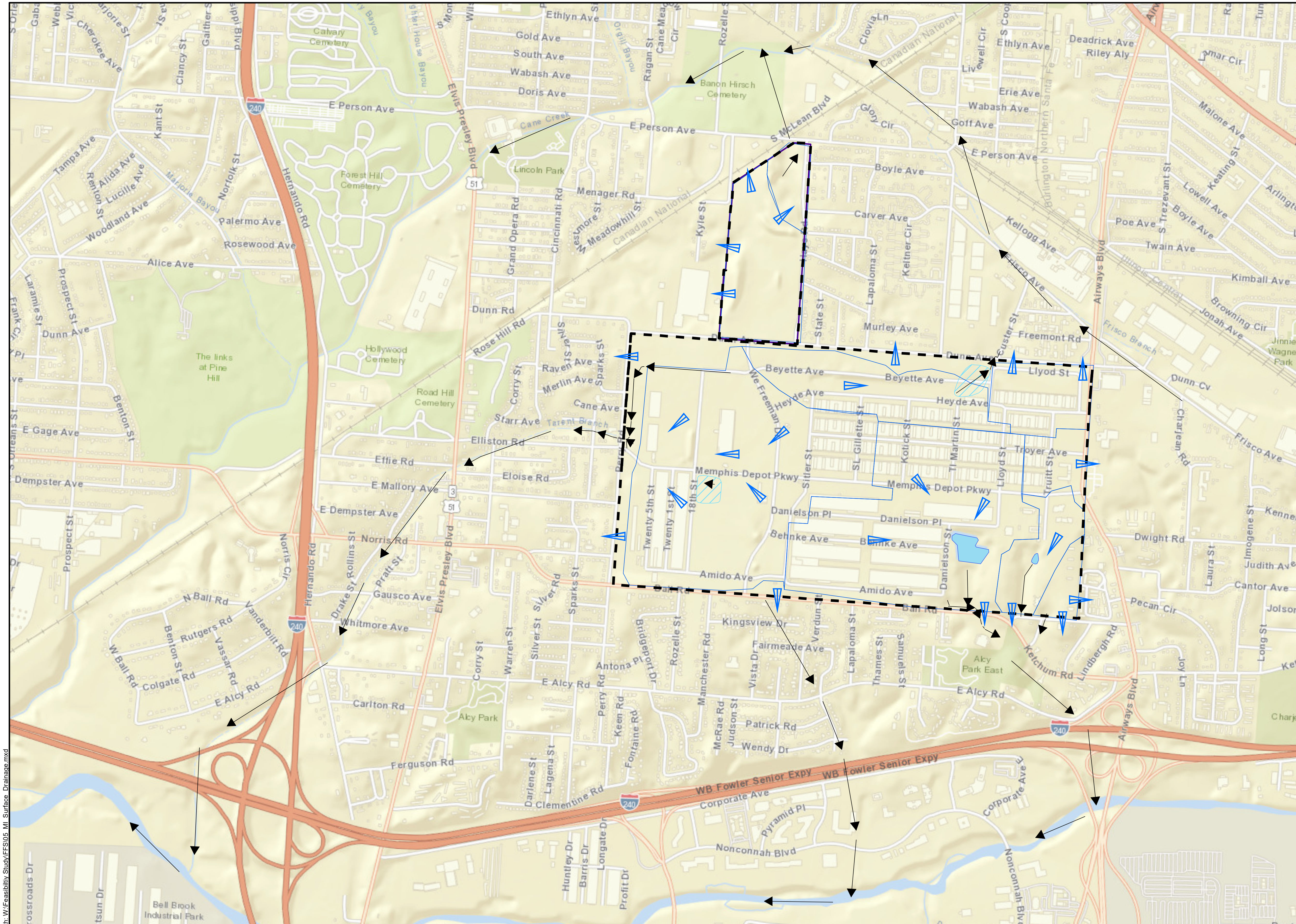

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Figure 5

Surface Drainage

Focused Feasibility Study Report

Main Installation
Defense Depot
Memphis, Tennessee

Legend

- Surface Water Flow Direction
- Stream/Drainage Flow Line
- Property Boundary
- Surface Drainage Boundary
- Surface Water
- Retention Basin

N
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0 1,000 2,000
Feet

Projection: NAD 1927 StatePlane Tennessee
Units: Feet, Elevation Units: Feet , mean sea level

Date: 6/16/2022
Edition: Rev 1

HDR

Erosional Window
MW-58 230.99
MW-55 223.14
MW-19 217.34
MW-300 216.10
MW-143 215.67
MW-213 215.16
MW-299 215.14
MW-62 214.53
MW-142 214.03
MW-212 213.05
MW-198 212.95
MW-99 214.23
MW-305 214.03
MW-286 215.35
MW-317A 215.83
MW-317B 215.80
MW-285 215.77
MW-63B 216.94
MW-63A 216.82
MW-308 218.15
MW-282 229.03
MW-287 226.00
MW-281 227.10
MW-258 228.97
MW-288 221.88
MW-304 214.95
MW-289 229.13
MW-199B 212.43
MW-209B 212.38
MW-207B 212.47
MW-208B 211.97
MW-39 210.17
MW-206A 212.09
MW-206B 212.00
MW-205B 212.54
MW-318A 212.30
MW-318B 212.18
MW-215B 212.24
MW-284 211.44
MW-200 211.60
MW-98 212.21
MW-197B 212.77
MW-203B 213.41
MW-204A 212.74
MW-204B 212.82
MW-94A 211.60
MW-307 210.89
MW-261 212.00
MW-297 211.80
MW-296 211.17
MW-271 210.48
MW-259 209.34
MW-298 212.66
MW-216 214.46
MW-23 215.07
MW-272 210.14
MW-24 211.26
MW-277 210.90
MW-93 210.44
MW-276 210.53
MW-270 211.46
MW-301 211.82
MW-312 211.41
MW-275 212.01
MW-313 212.74
MW-52 213.12
MW-25A 212.73
MW-274 216.66
MW-53 234.76
MW-263 237.58
MW-16 246.24
MW-310 244.87
MW-103 233.84
MW-104 234.98
MW-260 231.18
MW-291 232.47
MW-306 234.08
MW-265 230.62
MW-283 236.12
MW-303 236.31
MW-294 233.74
MW-280 235.43
MW-295 227.15
MW-267 232.21
MW-266 233.17
MW-292 230.73
MW-64 211.83
MW-218 215.54
MW-88 229.47
DR2-5 218.16
DR2-1 221.63
PMW85-01 216.73
DR2-2 232.07
MW-217 212.13
MW-85 216.56
PMW92-03 217.42
DR2-6 215.74
MW-92 218.08
PMW92-02 217.90
MW-26 216.07
DR2-3 216.84
MW-50 221.96
PMW85-05 217.16
DR2-4 218.76
MW-113 217.22
MW-96 217.32
PMW21-04 215.34
PMW21-03 215.41
PMW21-02 215.54
PMW21-01 216.22
MW-66A 218.17
MW-315 217.66
MW-269 217.48
MW-219 216.68
MW-21 216.21
MW-278 218.11
MW-316 217.57
MW-279 216.50
MW-22 216.19
MW-314 217.49
MW-102B 216.52
DR1-8 215.37
MW-100B 215.34
DR1-1A 215.55
DR1-1 215.47
DR1-5A 215.65
DR1-5 215.63
PMW21-05 214.43
DR1-2 214.94
DR1-3 214.27
DR1-7 213.94
PMW101-03B 214.81
PMW101-04B 214.71
DR1-4 215.09
MW-101T 215.51
DR1-6 215.56
DR1-6A 215.54
PMW101-02B 215.30
PMW101-06B 214.99
PMW101-07B 215.04
Legend
Fluvial Aquifer Well
Intermediate/Upper Claiborne Well
Potentiometric surface of the Fluvial Aquifer 1-ft. contour
Potentiometric surface of the Fluvial Aquifer 5-ft. contour
Potentiometric surface extrapolation
Groundwater Flow Direction
Property Boundary
Roads
Buildings
Clay Elevation Exceeds Fluvial Aquifer Groundwater Elevation
MW-03 233.37 Fluvial Aquifer, used for groundwater contours
Water level measurements made in April 2021. Groundwater elevations are in ft, NAVD.
Figure 6
Fluvial Deposits Aquifer Groundwater Elevations, April 2021
Focused Feasibility Study Report
Main Installation Defense Depot Memphis, Tennessee
0 250 500
Feet
FDS

Figure 7

Intermediate Aquifer Groundwater Elevations, April 2021

Focused Feasibility Study Report

Main Installation
Defense Depot
Memphis, Tennessee

Figure 8

Memphis Aquifer Groundwater Elevations, April 2021

Focused Feasibility Study Report

Main Installation
Defense Depot
Memphis, Tennessee

Legend

- Groundwater Elevations (Fluvail)
- Potentiometric surface of the Fluvial Aquifer 1-ft. contour
- Potentiometric surface of the Fluvial Aquifer 5-ft. contour
- Divide for flow into the window (north of line) or into the sink (south of line).
- Flow Direction
- Property Boundary
- Buildings *490 - DDMT Assigned Number*
- Roads
- Clay Elevation Exceeds Groundwater Elevation

Note: Water levels measured during October 2021 LTM Event

Figure 9

Fluvial Deposits Aquifer Flow Vectors

Focused Feasibility Study Report

Main Installation
Defense Depot
Memphis, Tennessee

0 250 500
Feet

Projection: NAD 1927 StatePlane Tennessee
Units: Feet, Elevation Units: Feet, NAVD88

Date: 6/16/2022
Edition: Rev 0

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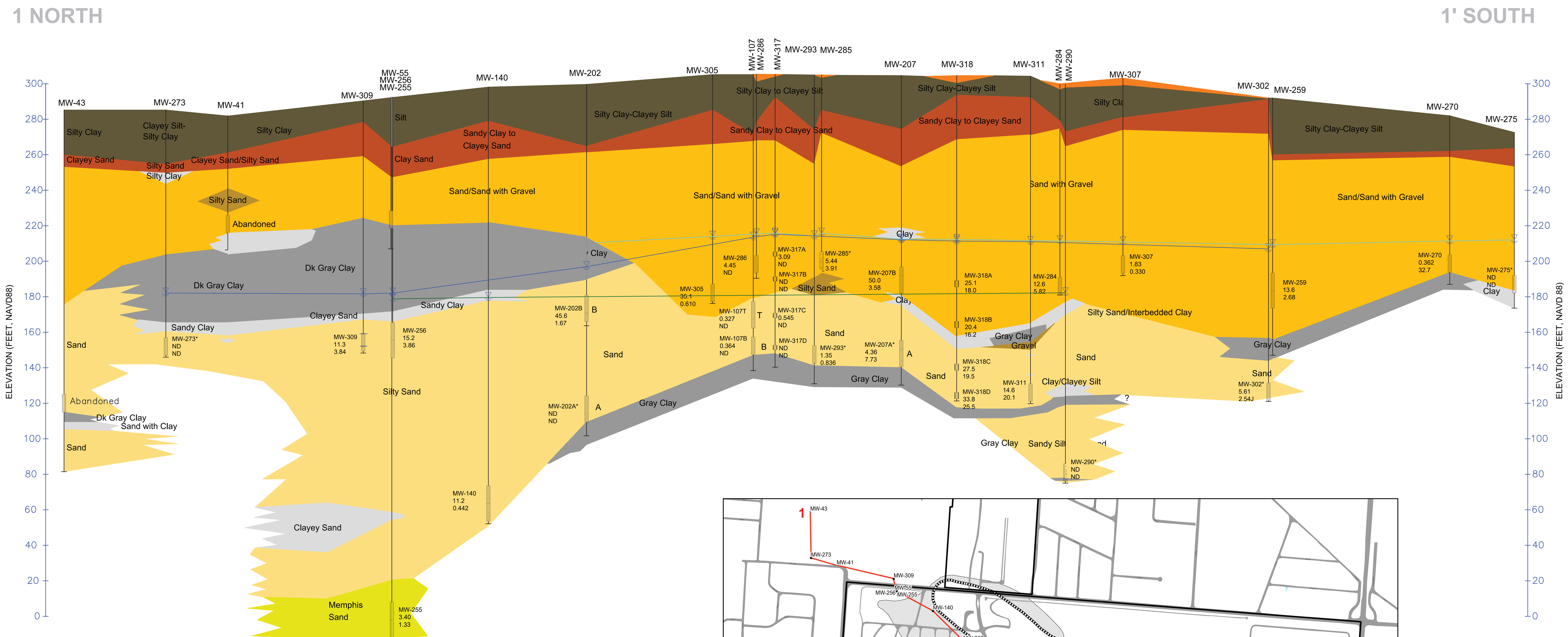
Figure 10

Cross Section 1, MW-43 to MW-275

Focused Feasibility Study Report

Main Installation Defense Depot Memphis, Tennessee



- Fill
- Silty Clay to Clayey Silt
- Sandy Clay to Clayey Sand
- Fluvial Sand or Sand with Gravel
- Clayey Sand to Silty Clay
- Silty Sand-Sandy Silt
- Intermediate Sand
- Clay
- Memphis Sand

Groundwater Elevation

Fluvial Aquifer Groundwater Elevation

Intermediate Aquifer Groundwater Elevation

Memphis Aquifer Groundwater Elevation

Well Screen Interval

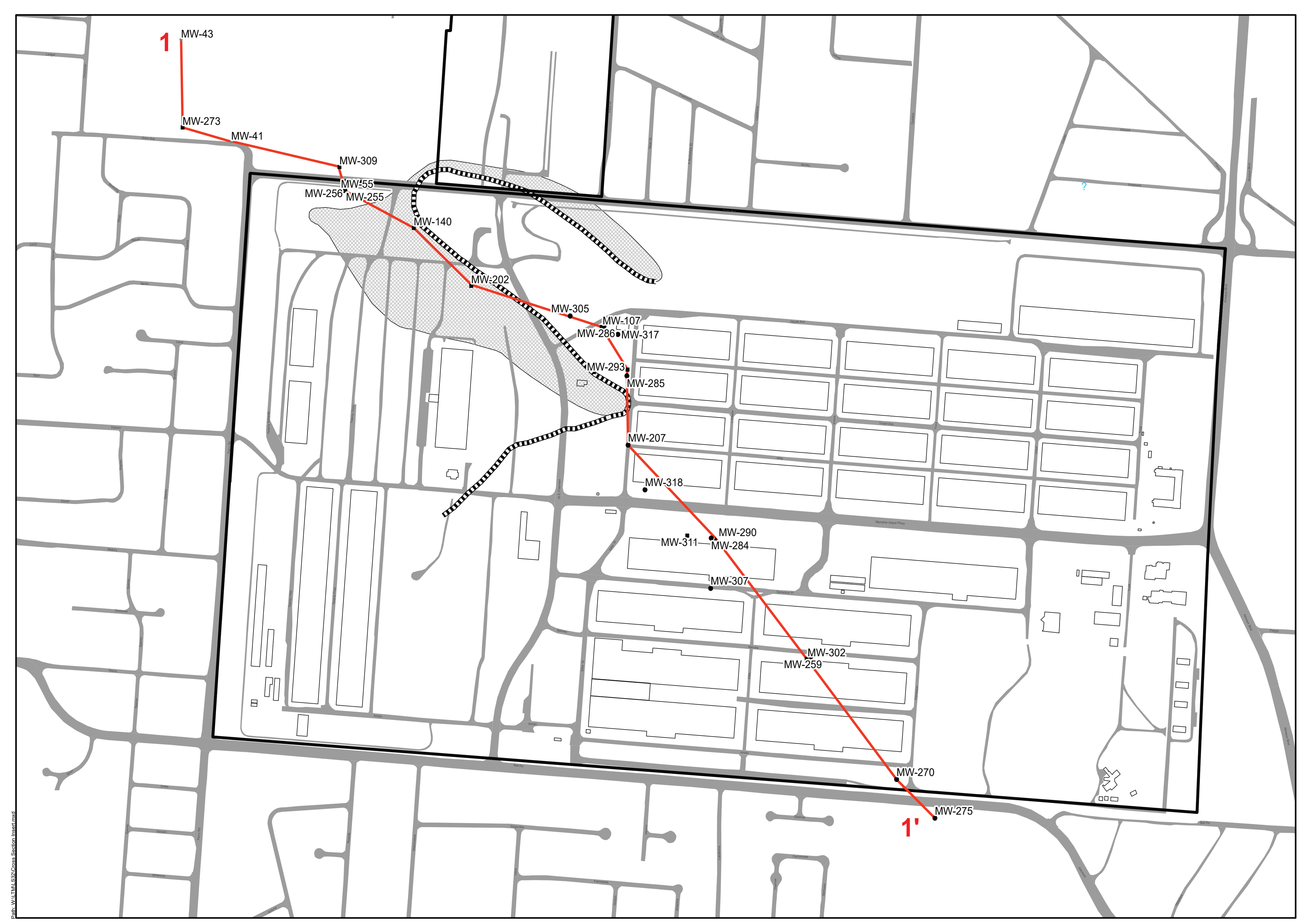
PCE 5 ug/L

PCE 10 ug/L

TCE 50 ug/L

TCE 5 ug/L

TCE 10 ug/L



Cross-Section Location

Well ID
PCE Result ug/L
TCE Result ug/L

Results from April 2021
* Results from October 2020

Note: Water levels measured during LTM in April 2021.

20
0
200

Date: December 2021
Edition: Rev 0

FDR

Figure 11

LTM Well Locations and Plume Designations

Focused Feasibility Study Report

Main Installation
Defense Depot
Memphis, Tennessee

Document Path: W:\Feasibility Study\FFS\11_LTM Well Plume Locations.mxd

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Document Path: W:\Feasibiltiy Study\FFS\13_TCE_FAQ_Apr2021.mxd

Notes:
1. Color-coded well symbols are based on the most recent analytical results at each well. Results are from the October 2020 and the April 2021 LTM events. Only concentrations from the April 2021 LTM event are shown below the well ID.
2. Groundwater contours are from the April 2021 LTM event.

TCE Range

Well Symbol (µg/L)	Contour Shading (µg/L)
0 - 5	5-10
5-10	10-50
10-50	50-100
50-100	>100
>100	

Legend

- Potentiometric surface of the Fluvial Aquifer 1-ft. contour
- Potentiometric surface of the Fluvial Aquifer 5-ft. contour
- Potentiometric surface extrapolation
- Intermediate Aquifer Contours
- Groundwater Flow Direction
- Groundwater Flow Direction (Intermediate)
- Property Boundary
- Buildings
- Roads
- Clay Elevation Exceeds Fluvial Aquifer Groundwater Elevation

Figure 13

Fluvial Deposits Aquifer Trichloroethene Concentrations, April 2021

Focused Feasibility Study Report

Main Installation
Defense Depot
Memphis, Tennessee

0 250 500
Feet

Projection: NAD 1927 StatePlane Tennessee
Units: Feet, Elevation Units: Feet, NAVD88

Date: 6/29/2022
Edition: Rev 0

HDR

Figure 14

Fluvial Deposits Aquifer Carbon Tetrachloride Concentrations, April 2021

Focused Feasibility Study Report

Main Installation
Defense Depot
Memphis, Tennessee

Document Path: W:\Feasibiltiy Study\FFS\14_CT_FAQ_Apr2021.mxd

Figure 15

Fluvial Deposits Aquifer Vinyl Chloride Concentrations, April 2021

Focused Feasibility Study Report

Main Installation
Defense Depot
Memphis, Tennessee

Figure 16
Intermediate Aquifer Tetrachloroethene Concentrations, April 2021
Focused Feasibility Study Report
Main Installation
Defense Depot
Memphis, Tennessee

Notes:
1. Color-coded well symbols are based on the most recent analytical results at each well. Results are from the October 2020 and the April 2021 LTM events. Only concentrations from the April 2021 LTM event are shown below the well ID.
2. Groundwater contours are from the April 2021 LTM event.

Legend

TCE Range

Well Symbol (µg/L)	Contour Shading (µg/L)
0-5	5-10
5-10	>10
10-50	

- Intermediate Aquifer Contours
- Groundwater Flow Direction (Intermediate)
- Property Boundary
- Buildings
- Roads
- Clay Elevation Exceeds Fluvial Aquifer Groundwater Elevation

Figure 17

Intermediate Aquifer Trichloroethene Concentrations, April 2021

Focused Feasibility Study Report

Main Installation
Defense Depot
Memphis, Tennessee

N W E S

0 250 500
Feet

Projection: NAD 1927 StatePlane Tennessee
Units: Feet, Elevation Units: Feet, NAVD88

Date: 6/16/2022
Edition: Rev 0

HDR

Document Path: W:\Feasibility Study\FFS\17_TCE_IUC_Apr2021.mxd

Document Path: W:\Feasibility Study\FFS18_MAQ_CVOC_Apr2021.mxd

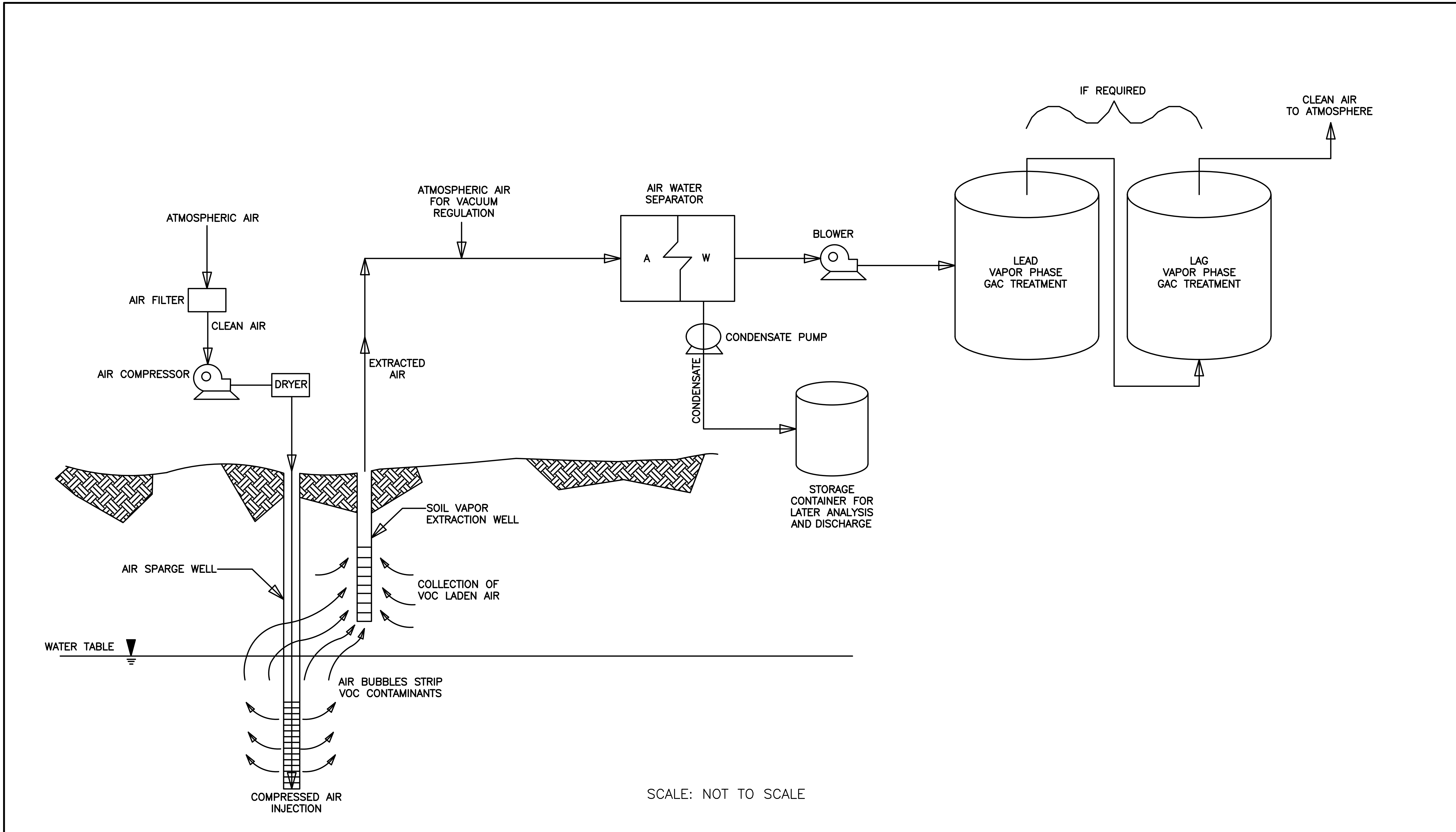
HDR

PROPOSED EXTENT OF ACTIVE TREATMENT ZONES

DEFENSE DEPOT MEMPHIS, TENNESSEE
USEPA ID NO.: TN421002057

DATE 06/2022

FIGURE 19

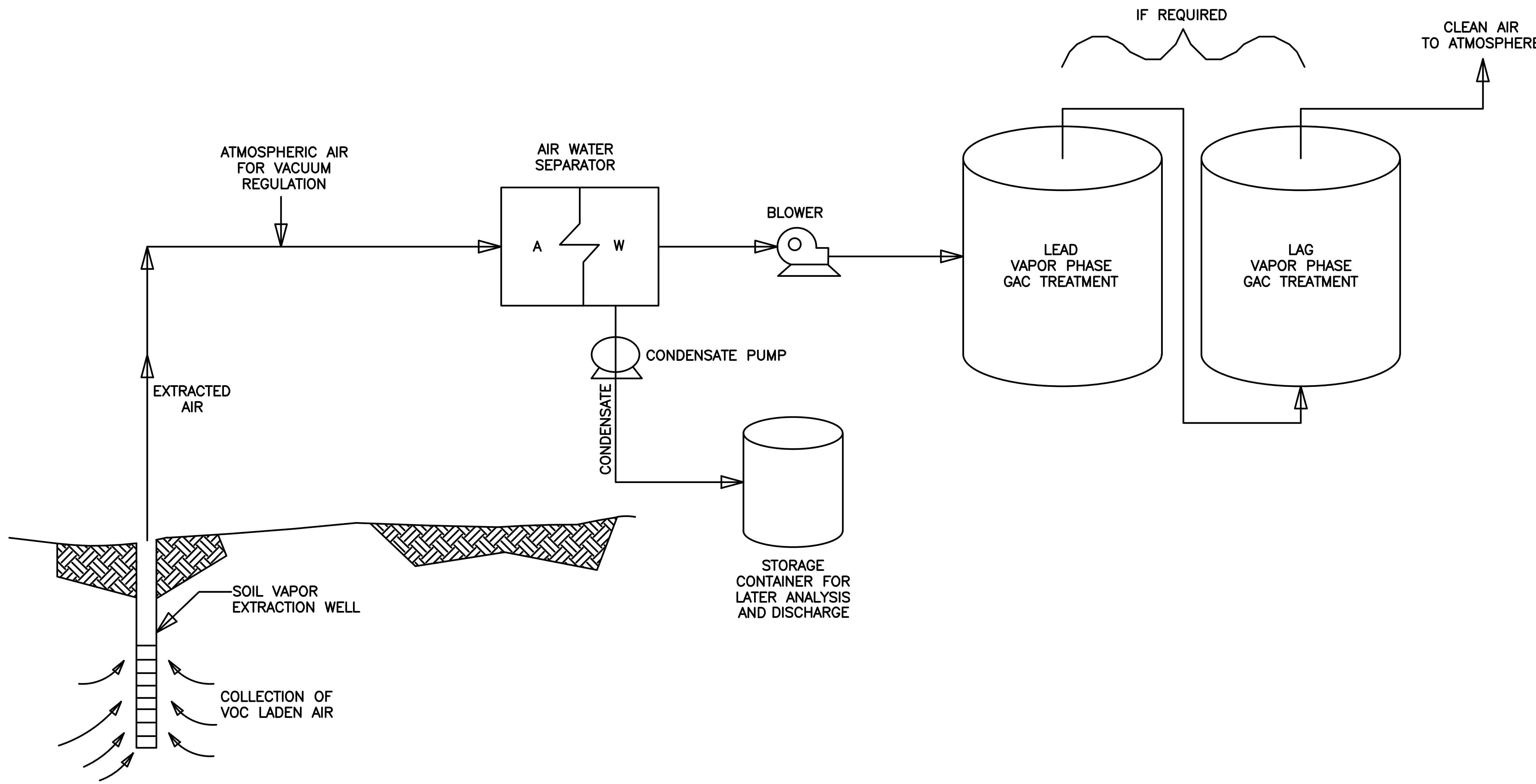


AIR SPARGING/SOIL VAPOR EXTRACTION SCHEMATIC

DEFENSE DEPOT MEMPHIS, TENNESSEE
USEPA ID NO.: TN421002057

DATE 06/2022

FIGURE 20



SCALE: NOT TO SCALE

SOIL VAPOR
EXTRACTION SCHEMATIC

DEFENSE DEPOT MEMPHIS, TENNESSEE
USEPA ID NO.: TN421002057

DATE
06/2022

FIGURE
21

HDR

ALTERNATIVE 2
AS/SVE AND SVE

DEFENSE DEPOT MEMPHIS, TENNESSEE
USEPA ID NO.: TN421002057

DATE 06/2022

FIGURE 22

ALTERNATIVE 3
EXPANDED AS/SVE AND SVE

DEFENSE DEPOT MEMPHIS, TENNESSEE
USEPA ID NO.: TN421002057

DATE 06/2022

FIGURE 23

A

Appendix A

Cost Estimate Backup

Table A-1 - Cost Estimate for Alternative 2 - AS/SVE and SVE

Site: Former Defense Depot Memphis, Tennessee (DDMT) - Main Installation (MI)
Location: Southeastern Memphis, Shelby County, Tennessee
Phase: Focused Feasibility Study
Base Year: 2022
Date: January 17, 2022

Description: Alternative 2 includes three permanent AS/SVE systems for preventing contaminated groundwater migration and SVE for treating source area contamination in TTA-2, with the assumption that there will be additional reliance on existing ICs and on-going LTM for protection of human health and the environment over the long term.

Item No.	Description	Quantity	Unit	Unit Cost	Total	Notes
CAPITAL COSTS:						
1	**Pre-Design Investigation**					
1.1	Investigation Work Plan	1	LS	$ 12,000	$ 12,000	Work Plan, HASP
1.2	Mobe/Demobe	1	LS	$ 13,400	$ 13,400	Two mob/demob for driller, three for HDR
1.3	Monitoring Well Installation	9	EA	$ 12,200	$ 109,800	Drilling, construction, and development + IDW + per diem & oversight (2-inch diameter, ~110 ft depth); 9 between TTA-1 N, N-C and Window
1.4	Groundwater Sampling	32	EA	$ 550	$ 17,600	Assumes 3 upgradient, 3 in-plume and 3 downgradient wells per area, sampling 27 wells for VOCs analysis + 5 QC samples.
1.5	Site Survey	1	LS	$ 2,500	$ 2,500	One day per area
1.6	Data Evaluation/Reporting	1	LS	$ 20,000	$ 20,000	
	Sub-Total				**$ 175,300**	
2	**Pilot Test - AS/SVE Systems**					
2.1	Pilot Test Work Plan	1	LS	$ 12,000	$ 12,000	Work Plan, HASP
2.2	Mobe/Demobe	1	LS	$ 13,200	$ 13,200	One mob/demob for driller, four for HDR
2.3	Air Sparging Wells - TTA 1 North, N-C Area, Window	6	EA	$ 12,800	$ 76,800	Drilling, construction and development of 2 wells per area. 2-inch diameter; 120, 95 and 140 ft depths. Oversight.
2.4	Soil Vapor Extraction Well and Vapor Monitoring Point - TTA 1 North, N-C Area, Window	3	EA	$ 11,500	$ 34,500	Drilling, construction and development of one SVE well and one VMP per area. SVE: 2-inch diameter; 45 ft depth, 75 ft and 75 ft. VMP: 2-inch diameter; 40 ft depth.
2.5	Site Survey	1	LS	$ 3,000	$ 3,000	
2.6	Temporary Surface Piping	3	LS	$ 1,500	$ 4,500	Connect AS well to compressor and SVE wells to blower
2.7	Air Sparging Equipment	1	EA	$ 18,000	$ 18,000	Equipment, mobilization and start up, technical assistance and consulting, and material and expenses.
2.8	Vapor Phase GAC Vessels	2	EA	$ 800	$ 1,600	Two 55-gallon GAC Drums in Series
2.9	AS/SVE System Tests	15	DAY	$ 1,800	$ 27,000	Assumes 5-day pilot test per area, for one person oversight for 10 hours/day.
2.10	Air Sampling and Analysis (TO-15 Analysis)	18	EA	$ 550	$ 9,900	Samples: 3 effluent, two VMP and one QC at each site.
2.11	Data Evaluation/Reporting	1	LS	$ 30,000	$ 30,000	
	Sub-Total				**$ 230,500**	

Table A-1 - Cost Estimate for Alternative 2 - AS/SVE and SVE

Site:	Former Defense Depot Memphis, Tennessee (DDMT) - Main Installation (MI)	**Description:**	Alternative 2 includes three permanent AS/SVE systems for preventing contaminated groundwater migration and SVE for treating source area contamination in TTA-2, with the assumption that there will be additional reliance on existing ICs and on-going LTM for protection of human health and the environment over the long term.
Location:	Southeastern Memphis, Shelby County, Tennessee		
Phase:	Focused Feasibility Study		
Base Year:	2022		
Date:	January 17, 2022		

Item No.	Description	Quantity	Unit	Unit Cost	Total	Notes
3	**TTA-1 North Boundary AS/SVE System Installation**					
3.1	Equipment and Personnel Mob/Demob	1	EA	$ 10,000	$ 10,000	
3.2	Electrical Power Set Up	1	LS	$ 30,000	$ 30,000	
3.3	AS well installation (120 ft deep)	6	EA	$ 13,000	$ 78,000	
3.4	SVE well installation (75 ft deep)	3	EA	$ 9,900	$ 29,700	
3.5	VMP installation (40 ft deep)	2	EA	$ 6,200	$ 12,400	
3.6	Trenching	250	LF	$ 40	$ 10,000	Excavation, piping, and bedding.
3.7	Site Survey	1	LS	$ 3,300	$ 3,300	AS, SVE, VMPs and trench
3.8	Surface Repair	60	SY	$ 40	$ 2,400	Site restoration (road repair)
3.9	Drilling Liquid Storage and Disposal	1	LS	$ 5,000	$ 5,000	
3.10	Treatment system trailer purchase and delivery	1	LS	$ 74,400	$ 74,400	
3.11	System startup	1	LS	$ 10,000	$ 10,000	
3.12	Vapor Phase GAC Vessels	2	EA	$ 800	$ 1,600	Two 55-gallon GAC Drums in Series
	Sub-Total				**$ 266,800**	
4	**N-C Plume Area Boundary AS/SVE System Installation**					
4.1	Equipment and Personnel Mob/Demob	1	EA	$ 10,000	$ 10,000	
4.2	Electrical Power Set Up	1	LS	$ 30,000	$ 30,000	
4.3	AS well installation (95 feet deep)	6	EA	$ 10,300	$ 61,800	
4.4	SVE well installation (45 ft deep)	3	EA	$ 7,700	$ 23,100	
4.5	VMP installation (40 ft deep)	2	EA	$ 6,200	$ 12,400	
4.6	Trenching	250	LF	$ 40	$ 10,000	Excavation, piping, and bedding.
4.7	Site Survey	1	LS	$ 3,300	$ 3,300	AS, SVE, VMPs and trench
4.8	Surface Repair	60	SY	$ 40	$ 2,400	Site restoration (road repair)
4.9	Drilling Liquid Storage and Disposal	1	LS	$ 5,000	$ 5,000	
4.1	Treatment system trailer purchase and delivery	1	LS	$ 74,400	$ 74,400	
4.11	System startup	1	LS	$ 10,000	$ 10,000	
4.12	Vapor Phase GAC Vessels	2	EA	$ 800	$ 1,600	Two 55-gallon GAC Drums in Series
	Sub-Total				**$ 244,000**	
5	**Window Boundary AS/SVE System Installation**					
5.1	Equipment and Personnel Mob/Demob	1	EA	$ 10,000	$ 10,000	
5.2	Electrical Power Set Up	1	LS	$ 30,000	$ 30,000	
5.3	Deep AS well installation (140 ft deep)	6	EA	$ 15,100	$ 90,600	
5.4	SVE well installation (75 ft deep)	3	EA	$ 9,900	$ 29,700	
5.5	VMP installation (40 ft deep)	2	EA	$ 6,200	$ 12,400	
5.6	Trenching	250	LF	$ 40	$ 10,000	Excavation, piping, and bedding.
5.7	Site Survey	1	LS	$ 3,300	$ 3,300	AS, SVE, VMPs and trench
5.8	Surface Repair	60	SY	$ 40	$ 2,400	Site restoration (road repair)
5.9	Drilling Liquid Storage and Disposal	1	LS	$ 5,000	$ 5,000	
5.10	Treatment system trailer purchase and delivery	1	LS	$ 96,800	$ 96,800	

Table A-1 - Cost Estimate for Alternative 2 - AS/SVE and SVE

Site:	Former Defense Depot Memphis, Tennessee (DDMT) - Main Installation (MI)	**Description:**	Alternative 2 includes three permanent AS/SVE systems for preventing contaminated groundwater migration and SVE for treating source area contamination in TTA-2, with the assumption that there will be additional reliance on existing ICs and on-going LTM for protection of human health and the environment over the long term.
Location:	Southeastern Memphis, Shelby County, Tennessee		
Phase:	Focused Feasibility Study		
Base Year:	2022		
Date:	January 17, 2022		

Item No.		Description	Quantity	Unit	Unit Cost	Total	Notes
	5.11	System startup	1	LS	$ 10,000	$ 10,000	
	5.12	Vapor Phase GAC Vessels	2	EA	$ 800	$ 1,600	Two 55-gallon GAC Drums in Series
		Sub-Total				**$ 301,800**	
6	**Operation & Maintenance of AS/SVE Systems (Year 1)**						
	6.1	Electrical Usage	523,100	KW-Hr	$ 0.12	$ 62,772	Three AS/SVE Systems for 12 months
	6.2	Bi-weekly Inspections	26	EA	$ 720	$ 18,720	6 hours every 2 weeks
	6.3	Maintenance - Repair/Replacement of Equipment	3	LS	$ 2,000	$ 6,000	
	6.4	Air Sampling and Analysis (TO-15 Analysis)	120	EA	$ 550	$ 66,000	4 SVE wells, 2 effluent, 3 VMPs and 1 QC at each area per qtr
	6.5	GAC and Liquid Disposal	12	EA	$ 1,050	$ 12,600	
	6.6	Data Evaluation/Reporting	1	LS	$ 30,000	$ 40,000	Annual Report to include Performance Monitroing Results
		Sub-Total				**$ 206,092**	
7	**Performance Monitoring (Year 1)**						
	7.1	Groundwater Sampling and Analysis (Baseline plus Quarterly)	160	EA	$ 550	$ 88,000	27 wells for VOCs analysis + 5 QC samples.
	7.2	Data Evaluation/Reporting	5	LS	$ 5,000	$ 25,000	Brief Data Report for each event
		Sub-Total				**$ 113,000**	
8	**TTA-2 Source Area SVE (Year 1)**						
	8.1	Re-install system, connect power and start-up	1	LS	$ 1,000	$ 1,000	SVE System compressor/blower for one year
	8.2	Electrical Usage	65,400	KW-Hr	$ 0.12	$ 7,848	SVE System compressor/blower for one year
	8.3	Monthly Inspections	12	EA	$ 960	$ 11,520	8 hours/month
	8.4	Quarterly Inspection, Maintenance and Repair	4	EA	$ 500	$ 2,000	
	8.5	Performance Sampling and Analysis	24	EA	$ 550	$ 13,200	Quarterly samples of 4 performance wells + 2 QC samples
	8.6	Vapor Sampling and Analysis (TO-15 Analysis)	32	EA	$ 550	$ 17,600	Quarterly SVE Well and System Influent/Effluent (3), Semiannual VMPs (7) and QC (1). VOCs analysis only
	8.7	Quarterly Data Evaluation/Reporting	3	LS	$ 2,000	$ 6,000	Quarters 1 to 3.
	8.8	Annual Data Evaluation/Reporting	1	LS	$ 12,000	$ 12,000	Annual Report
		Sub-Total				**$ 71,168**	
9	**ICs and LTM (Year 1)**						
	9.1	Annual Site Inspection (LUC) and Report	1	LS	$ 12,500	$ 12,500	
	9.2	Groundwater Sampling and Analysis - Semiannual	247	EA	$ 550	$ 135,850	103 semiannual and 20% QC samples
	9.3	Groundwater Sampling and Analysis - Annual	105	EA	$ 550	$ 57,750	87 annual and 20% QC samples
	9.4	Semiannual and Annual Data Evaluation/Reporting	1	LS	$ 75,000	$ 75,000	
		Sub-Total				**$ 281,100**	

Table A-1 - Cost Estimate for Alternative 2 - AS/SVE and SVE

Site: Former Defense Depot Memphis, Tennessee (DDMT) - Main Installation (MI)
Location: Southeastern Memphis, Shelby County, Tennessee
Phase: Focused Feasibility Study
Base Year: 2022
Date: January 17, 2022

Description: Alternative 2 includes three permanent AS/SVE systems for preventing contaminated groundwater migration and SVE for treating source area contamination in TTA-2, with the assumption that there will be additional reliance on existing ICs and on-going LTM for protection of human health and the environment over the long term.

Item No.	Description	Quantity	Unit	Unit Cost	Total	Notes
	Sub-Total				**$ 1,889,760**	Sub-Total All Construction Costs.
	Contingency	15%			$ 283,000	5% scope + 10% bid.
	Sub-Total				**$ 2,172,760**	
	Project Management				$ 20,000	
	Construction Management and Oversight				$ 30,000	
	Remedial Design				$ 40,000	
	Remedial Action Work Plan				$ 30,000	
	TOTAL CAPITAL COST				**$ 2,293,000**	

TTA-2 SVE O&M (Year 2)

O&M COST:

Item No.	Description	Quantity	Unit	Unit Cost	Total	Notes
1	**Annual O&M of TTA-2 SVE (Year 2)**					
1.1	Electrical Usage	65,400	KW-Hr	$ 0.12	$ 7,848	TTA-2 SVE
1.2	Monthly Inspections	12	EA	$ 960	$ 11,520	
1.3	Maintenance - Repair/Replacement of Equipment	4	LS	$ 500	$ 2,000	Quarterly Maintenance Review
1.4	Performance Sampling and Analysis	12	EA	$ 550	$ 6,600	Semiannual samples of 4 performance wells + 2 QC samples
1.5	Air Sampling and Analysis (TO-15 Analysis)	16	EA	$ 550	$ 8,800	Semiannual sampling; assumes 8 samples
1.6	Semiannual Data Evaluation/Reporting	1	LS	$ 3,000	$ 3,000	
1.7	Annual Data Evaluation/Reporting	1	LS	$ 13,000	$ 13,000	
	Sub-Total				**$ 52,768**	
	Sub-Total				**$ 52,768**	
	Contingency	5%			$ 3,000	
	Sub-Total				**$ 55,768**	
	Project Management				$ 1,500	
	Technical Support				$ 1,500	
	TOTAL ANNUAL O&M COST				**$ 59,000**	

Table A-1 - Cost Estimate for Alternative 2 - AS/SVE and SVE

Site:	Former Defense Depot Memphis, Tennessee (DDMT) - Main Installation (MI)	**Description:**	Alternative 2 includes three permanent AS/SVE systems for preventing contaminated groundwater migration and SVE for treating source area contamination in TTA-2, with the assumption that there will be additional reliance on existing ICs and on-going LTM for protection of human health and the environment over the long term.
Location:	Southeastern Memphis, Shelby County, Tennessee		
Phase:	Focused Feasibility Study		
Base Year:	2022		
Date:	January 17, 2022		

Item No.		Description	Quantity	Unit	Unit Cost	Total	Notes
AS/SVE Systems O&M, ICs and LTM (Years 2-5)							
O&M COST:							
Item No.		**Description**	**Quantity**	**Unit**	**Unit Cost**	**Total**	**Notes**
1	**Annual O&M of Three AS/SVE Systems (Years 2-5)**						
	1.1	Electrical Usage	523,100	KW-Hr	$ 0.12	$ 62,772	Three AS/SVE Systems operation for 12 months
	1.2	Monthly Inspections	12	EA	$ 1,440	$ 17,280	12 hours/month
	1.3	Maintenance - Repair/Replacement of Equipment	3	LS	$ 2,000	$ 6,000	Quarterly Maintenance Review
	1.4	Air Sampling and Analysis (TO-15 Analysis)	120	EA	$ 550	$ 66,000	Quarterly sampling; assumes 10 samples/system
	1.5	GAC and Liquid Disposal	12	EA	$ 1,050	$ 12,600	
	1.6	Quarterly Data Evaluation/Reporting	3	LS	$ 3,000	$ 9,000	
	1.7	Annual Data Evaluation/Reporting	1	LS	$ 21,000	$ 35,000	With Performance Monitoring results
		Sub-Total				**$ 208,652**	
2	**Performance Monitoring (Years 2-5)**						
	2.1	Groundwater Sampling and Analysis (Semiannual)	64	EA	$ 550	$ 35,200	27 wells for VOCs analysis + 5 QC samples.
	2.2	Data Evaluation/Reporting	2	LS	$ 5,000	$ 10,000	Brief Data Report for each event
		Sub-Total				**$ 45,200**	
3	**ICs and LTM (Years 2-5)**						
	3.1	Annual Site Inspection (LUC) and Report	1	LS	$ 12,500	$ 12,500	ICs/Inspection/Reporting
	3.2	Groundwater Sampling - Semiannual	247	EA	$ 550	$ 135,850	103 semiannual and 20% QC samples
	3.3	Groundwater Sampling - Annual	105	EA	$ 550	$ 57,750	87 annual and 20% QC samples
	3.4	Semiannual and Annual Data Evaluation/Reporting	1	LS	$ 75,000	$ 75,000	
		Sub-Total				**$ 281,100**	
	Sub-Total					**$ 534,952**	
		Contingency	5%			$ 27,000	
	Sub-Total					**$ 561,952**	
	Project Management					$ 13,000	
	Technical Support					$ 13,000	
	TOTAL ANNUAL O&M COST					**$ 588,000**	

Table A-1 - Cost Estimate for Alternative 2 - AS/SVE and SVE

Site:	Former Defense Depot Memphis, Tennessee (DDMT) - Main Installation (MI)
Location:	Southeastern Memphis, Shelby County, Tennessee
Phase:	Focused Feasibility Study
Base Year:	2022
Date:	January 17, 2022

Description: Alternative 2 includes three permanent AS/SVE systems for preventing contaminated groundwater migration and SVE for treating source area contamination in TTA-2, with the assumption that there will be additional reliance on existing ICs and on-going LTM for protection of human health and the environment over the long term.

Item No.		Description	Quantity	Unit	Unit Cost	Total	Notes
AS/SVE Systems O&M, ICs and LTM (Years 6-10)							
O&M COST:							
Item No.		**Description**	**Quantity**	**Unit**	**Unit Cost**	**Total**	**Notes**
1	**Annual O&M of Two AS/SVE Systems (Years 6-10)**						
	1.1	Electrical Usage	348,385	KW-Hr	$ 0.12	$ 41,806	Three AS/SVE Systems operation for 12 months
	1.2	Monthly Inspections	12	EA	$ 960	$ 11,520	8 hours/month
	1.3	Maintenance - Repair/Replacement of Equipment	2	LS	$ 2,000	$ 4,000	Quarterly Maintenance Review
	1.4	Air Sampling and Analysis (TO-15 Analysis)	80	EA	$ 550	$ 44,000	Quarterly sampling; assumes 10 samples/system
	1.5	GAC and Liquid Disposal	12	EA	$ 700	$ 8,400	
	1.6	Quarterly Data Evaluation/Reporting	3	LS	$ 2,000	$ 6,000	
	1.7	Annual Data Evaluation/Reporting	1	LS	$ 15,000	$ 15,000	With Performance Monitoring results
		Sub-Total				**$ 130,726**	
2	**Performance Monitoring (Years 6-10)**						
	2.1	Groundwater Sampling and Analysis (Semiannual)	42	EA	$ 550	$ 23,100	18 wells for VOCs analysis + 3 QC samples.
	2.2	Data Evaluation/Reporting	2	LS	$ 3,500	$ 7,000	Brief Data Report for each event
		Sub-Total				**$ 30,100**	
3	**ICs and LTM (Years 6-10)**						
	3.1	Annual Site Inspection (LUC) and Report	1	LS	$ 12,500	$ 12,500	ICs/Inspections/Reporting
	3.2	Groundwater Sampling - Annual	60	EA	$ 550	$ 33,000	Total VOCs analysis + 20% QC samples.
	3.3	Data Evaluation/Reporting	1	LS	$ 15,400	$ 15,400	
		Sub-Total				**$ 60,900**	
	Sub-Total					**$ 221,726**	
		Contingency	5%			$ 11,000	
	Sub-Total					**$ 232,726**	
	Project Management					$ 6,000	
	Technical Support					$ 6,000	
	TOTAL ANNUAL O&M COST					**$ 245,000**	

Table A-1 - Cost Estimate for Alternative 2 - AS/SVE and SVE

Site: Former Defense Depot Memphis, Tennessee (DDMT) - Main Installation (MI)
Location: Southeastern Memphis, Shelby County, Tennessee
Phase: Focused Feasibility Study
Base Year: 2022
Date: January 17, 2022

Description: Alternative 2 includes three permanent AS/SVE systems for preventing contaminated groundwater migration and SVE for treating source area contamination in TTA-2, with the assumption that there will be additional reliance on existing ICs and on-going LTM for protection of human health and the environment over the long term.

Item No.	Description	Quantity	Unit	Unit Cost	Total	Notes
ICs and LTM (Years 11-20)						
O&M COST:						
Item No.	**Description**	**Quantity**	**Unit**	**Unit Cost**	**Total**	**Notes**
1	**ICs and LTM (Years 11-20) - Assumes 30 wells**					
1.1	Annual Site Inspection (LUC) and Report	1	LS	$ 12,500	$ 12,500	ICs/Inspections/Reporting
1.2	Groundwater Sampling - Annual	36	EA	$ 550	$ 19,800	Once a year
1.3	Data Evaluation/Reporting	1	LS	$ 12,700	$ 12,700	
	Sub-Total				**$ 45,000**	
	Sub-Total				**$ 45,000**	
	Contingency	5%			$ 2,000	
	Sub-Total				**$ 47,000**	
	Project Management				$ 1,500	
	Technical Support				$ 1,500	
	TOTAL ANNUAL O&M COST				**$ 50,000**	

PERIODIC COSTS:

Item No.	Description	Year	Quantity	Unit	Unit Cost	Total	Notes
1	**LTM - Periodic Maintenance (Every 5 Years)**						
1.1	Well Maintenance (Assumes 20% of Total LTM Wells)	5	40	EA	$ 300	$ 12,000	Equipment Replacement/Repair
1.2	Reporting	5	1	LS	$ 4,000	$ 4,000	
	Sub-Total					**$ 16,000**	
2	**Decommissioning TTA-2 SVE System (Year 20)**						
2.1	SVE/VMP Well Abandonment	20	8	EA	$ 1,500	$ 12,000	Drilling subcontractor, abandonment of wells
2.2	Reporting	20	1	LS	$ 3,000	$ 3,000	
	Sub-Total					**$ 15,000**	
3	**Decommissioning AS/SVE Transect Systems (Year 20)**						
3.1	AS/SVE/VMP Abandonment	20	42	EA	$ 1,500	$ 63,000	Drilling subcontractor, abandonment of wells
3.2	Reporting	20	1	LS	$ 5,000	$ 5,000	
	Sub-Total					**$ 68,000**	
4	**Site Close Out**						
4.1	Monitoring Well Abandonment	21	197	EA	$ 1,500	$ 295,500	Drilling subcontractor, abandonment of monitoring wells and performance wells.
4.2	Remedial Action Completion Report	21	1	LS	$ 40,000	$ 40,000	
	Sub-Total					**$ 296,000**	

Table A-1 - Cost Estimate for Alternative 2 - AS/SVE and SVE

Site: Former Defense Depot Memphis, Tennessee (DDMT) - Main Installation (MI)
Location: Southeastern Memphis, Shelby County, Tennessee
Phase: Focused Feasibility Study
Base Year: 2022
Date: January 17, 2022

Description: Alternative 2 includes three permanent AS/SVE systems for preventing contaminated groundwater migration and SVE for treating source area contamination in TTA-2, with the assumption that there will be additional reliance on existing ICs and on-going LTM for protection of human health and the environment over the long term.

Item No.	Description	Quantity	Unit	Unit Cost	Total	Notes

PRESENT VALUE ANALYSIS: Rate of Return: 7% Inflation Rate: 3%

Item No.		Year	Total Cost	Present Value	Notes
1	**Capital Cost**	1		**$ 2,293,000**	
2	**O&M Costs**				
2.1	TTA-2 SVE O&M (Year 2)	2	$ 59,000	$ 56,794	
2.3	AS/SVE Systems O&M, ICs and LTM (Years 2-5)	2-5	$ 588,000	$ 2,140,252	
2.5	AS/SVE Systems O&M, ICs and LTM (Years 6-10)	6-10	$ 245,000	$ 939,594	
2.6	ICs and LTM (Years 11-20)	11-20	$ 50,000	$ 289,496	
	Sub-Total			**$ 3,427,000**	
3	**Periodic Costs**				
3.5	LTM - Periodic Maintenance (Every 5 Years)	5,10,15,20	$ 16,000	$ 42,237	
3.6	Decommissioning TTA-2 SVE System (Year 20)	20	$ 15,000	$ 7,273	
3.7	Decommissioning AS/SVE Transect Systems (Year 20)	20	$ 68,000	$ 32,970	
3.8	Site Close Out	21	$ 296,000	$ 138,153	
	Sub-Total			**$ 221,000**	
	TOTAL PRESENT VALUE OF ALTERNATIVE			**$ 5,941,000**	

Table A-2 - Cost Estimate for Alternative 3 - Expanded AS/SVE and SVE

Site: Former Defense Depot Memphis, Tennessee (DDMT) - Main Installation (MI)
Location: Southeastern Memphis, Shelby County, Tennessee
Phase: Focused Feasibility Study
Base Year: 2022
Date: 1/17/2022

Description: Alternative 3 includes three permanent AS/SVE systems for preventing contaminated groundwater migration, SVE for treating source area contamination in TTA-2, and portable SVE and AS/SVE for reducing contaminant concentrations in isolated CVOC groundwater plumes in the active treatment zones, with the assumption that there will be additional reliance on existing ICs and on-going LTM for protection of human health and the environment over the long term.

Item No.	Description	Quantity	Unit	Unit Cost	Total	Notes
CAPITAL COSTS:						
1	**Pre-Design Investigation - Site Wide**					
1.1	Investigation Work Plan	1	LS	$ 14,000	$ 14,000	Work Plan, HASP
1.2	Mobe/Demobe	1	LS	$ 24,200	$ 24,200	Four mob/demob for driller, five for HDR
1.3	Monitoring Well Installation - Transects	9	EA	$ 12,200	$ 109,800	Drilling, construction, and development, IDW, per diem & oversight (2-inch diameter, ~110 ft depth); 9 between TTA-1 N, N-C and Window
1.4	Groundwater Sampling - Transects	32	EA	$ 550	$ 17,600	Assumes 3 upgradient, 3 in-plume and 3 downgradient wells per area, sampling 27 wells for VOCs analysis + 5 QC samples.
1.5	Monitoring Well Installation - On-site Sources	8	EA	$ 12,200	$ 97,600	Drilling, construction, and development, IDW, per diem & oversight (2-inch diameter, ~110 ft depth); 8 wells at on-site source areas
1.6	Groundwater Sampling - On-site Sources	29	EA	$ 550	$ 15,950	Sample at 3 wells per on-site area, 24 wells for VOCs analysis + 5 QC samples.
1.7	VMP Installation - On-site Sources	12	EA	$ 6,400	$ 76,800	Drilling and VMP construction, avg 42 ft depth at on-site source areas
1.8	Vapor Sampling - On-site Sources	14	EA	$ 550	$ 7,700	Sample in 1-L Summa canisters VOCs analysis, 2 duplicate samples.
1.9	Site Survey	1	LS	$ 6,000	$ 6,000	17 wells and 12 VMPs
1.10	Data Evaluation/Reporting	1	LS	$ 26,000	$ 26,000	
	Sub-Total				**$ 395,650**	
2	**Pre-Design Investigation - Pilot Test - AS/SVE Systems**					
2.1	Pilot Test Work Plan	1	LS	$ 12,000	$ 12,000	Work Plan, HASP
2.2	Mobe/Demobe	1	LS	$ 13,200	$ 13,200	One mob/demob for driller, four for HDR
2.3	Air Sparging Wells - TTA 1 North, N-C Area, Window	6	EA	$ 12,800	$ 76,800	Drilling, construction and development of 2 wells per area. 2-inch diameter; 120, 95 and 140 ft depths. Oversight.
2.4	Soil Vapor Extraction Well and Vapor Monitoring Point - TTA 1 North, N-C Area, Window	3	EA	$ 11,500	$ 34,500	Drilling, construction and development of one SVE well and one VMP per area. SVE: 2-inch diameter; 45 ft depth, 75 ft and 75 ft. VMP: 2-inch diameter; 40 ft depth.
2.5	Site Survey	1	LS	$ 3,000	$ 3,000	
2.6	Temporary Surface Piping	3	LS	$ 1,500	$ 4,500	Connect AS well to compressor and SVE wells to blower
2.7	Air Sparging Equipment	1	EA	$ 18,000	$ 18,000	Equipment, mobilization and start up, technical assistance and consulting, and material and expenses.
2.8	Vapor Phase GAC Vessels	2	EA	$ 800	$ 1,600	Two 55-gallon GAC Drums in Series
2.9	AS/SVE System Tests	15	DAY	$ 1,800	$ 27,000	Assumes 5-day pilot test per area, for one person oversight for 10 hours/day.
2.10	Air Sampling and Analysis (TO-15 Analysis)	18	EA	$ 550	$ 9,900	Samples: 3 effluent, two VMP and one QC at each site.
2.11	Data Evaluation/Reporting	1	LS	$ 30,000	$ 30,000	
	Sub-Total				**$ 230,500**	

Table A-2 - Cost Estimate for Alternative 3 - Expanded AS/SVE and SVE

Site: Former Defense Depot Memphis, Tennessee (DDMT) - Main Installation (MI)
Location: Southeastern Memphis, Shelby County, Tennessee
Phase: Focused Feasibility Study
Base Year: 2022
Date: 1/17/2022

Description: Alternative 3 includes three permanent AS/SVE systems for preventing contaminated groundwater migration, SVE for treating source area contamination in TTA-2, and portable SVE and AS/SVE for reducing contaminant concentrations in isolated CVOC groundwater plumes in the active treatment zones, with the assumption that there will be additional reliance on existing ICs and on-going LTM for protection of human health and the environment over the long term.

Item No.	Description	Quantity	Unit	Unit Cost	Total	Notes
3	**TTA-1 North Boundary AS/SVE Installation-Startup**					
3.1	Equipment and Personnel Mob/Demob	1	EA	$ 10,000	$ 10,000	
3.2	Electrical Power Set Up	1	LS	$ 30,000	$ 30,000	
3.3	AS well installation (120 ft deep)	6	EA	$ 13,000	$ 78,000	
3.4	SVE well installation (75 ft deep)	3	EA	$ 9,900	$ 29,700	
3.5	VMP installation (35 ft deep)	2	EA	$ 6,200	$ 12,400	
3.6	Trenching	250	LF	$ 40	$ 10,000	Excavation, piping, and bedding.
3.7	Site Survey	1	LS	$ 3,300	$ 3,300	AS, SVE, VMPs and trench
3.8	Surface Repair	60	SY	$ 40	$ 2,400	Site restoration (road repair)
3.9	Drilling Liquid Storage and Disposal	1	LS	$ 5,000	$ 5,000	
3.10	Treatment system trailer	1	LS	$ 74,400	$ 74,400	
3.11	System startup	1	LS	$ 10,000	$ 10,000	
3.12	Vapor Phase GAC Vessels	2	EA	$ 800	$ 1,600	Two 55-gallon GAC Drums in Series
	Sub-Total				**$ 266,800**	
4	**N-C Plume Area Boundary AS/SVE Installation-Startup**					
4.1	Equipment and Personnel Mob/Demob	1	EA	$ 10,000	$ 10,000	
4.2	Electrical Power Set Up	1	LS	$ 30,000	$ 30,000	
4.3	AS well installation (95 feet deep)	6	EA	$ 10,300	$ 61,800	
4.4	SVE well installation (45 ft deep)	3	EA	$ 7,700	$ 23,100	
4.5	VMP installation (40 ft deep)	2	EA	$ 6,200	$ 12,400	
4.6	Trenching	250	LF	$ 40	$ 10,000	Excavation, piping, and bedding.
4.7	Site Survey	1	LS	$ 3,300	$ 3,300	AS, SVE, VMPs and trench
4.8	Surface Repair	60	SY	$ 40	$ 2,400	Site restoration (road repair)
4.9	Drilling Liquid Storage and Disposal	1	LS	$ 5,000	$ 5,000	
4.1	Treatment system trailer	1	LS	$ 74,400	$ 74,400	
4.11	System startup	1	LS	$ 10,000	$ 10,000	
4.12	Vapor Phase GAC Vessels	2	EA	$ 800	$ 1,600	Two 55-gallon GAC Drums in Series
	Sub-Total				**$ 244,000**	
5	**Window Boundary AS/SVE Installation-Startup**					
5.1	Equipment and Personnel Mob/Demob	1	EA	$ 10,000	$ 10,000	
5.2	Electrical Power Set Up	1	LS	$ 30,000	$ 30,000	
5.3	Deep AS well installation (140 ft deep)	6	EA	$ 15,100	$ 90,600	
5.4	SVE well installation (75 ft deep)	3	EA	$ 9,900	$ 29,700	
5.5	VMP installation (40 ft deep)	2	EA	$ 6,200	$ 12,400	
5.6	Trenching	250	LF	$ 40	$ 10,000	Excavation, piping, and bedding.
5.7	Site Survey	1	LS	$ 3,300	$ 3,300	AS, SVE, VMPs and trench
5.8	Surface Repair	60	SY	$ 40	$ 2,400	Site restoration (road repair)
5.9	Drilling Liquid Storage and Disposal	1	LS	$ 5,000	$ 5,000	
5.10	Treatment system trailer	1	LS	$ 96,800	$ 96,800	
5.11	System startup	1	LS	$ 10,000	$ 10,000	
5.12	Vapor Phase GAC Vessels	2	EA	$ 800	$ 1,600	Two 55-gallon GAC Drums in Series
	Sub-Total				**$ 301,800**	

Table A-2 - Cost Estimate for Alternative 3 - Expanded AS/SVE and SVE

Site: Former Defense Depot Memphis, Tennessee (DDMT) - Main Installation (MI)
Location: Southeastern Memphis, Shelby County, Tennessee
Phase: Focused Feasibility Study
Base Year: 2022
Date: 1/17/2022

Description: Alternative 3 includes three permanent AS/SVE systems for preventing contaminated groundwater migration, SVE for treating source area contamination in TTA-2, and portable SVE and AS/SVE for reducing contaminant concentrations in isolated CVOC groundwater plumes in the active treatment zones, with the assumption that there will be additional reliance on existing ICs and on-going LTM for protection of human health and the environment over the long term.

Item No.	Description	Quantity	Unit	Unit Cost	Total	Notes
6	**Operation & Maintenance of AS/SVE Systems (Year 1)**					
6.1	Electrical Usage	523,100	KW-Hr	$ 0.12	$ 62,772	Three AS/SVE Systems for 12 months
6.2	Bi-weekly Inspections	26	EA	$ 720	$ 18,720	6 hours every 2 weeks
6.3	Maintenance - Repair/Replacement of Equipment	3	LS	$ 2,000	$ 6,000	
6.4	Air Sampling and Analysis (TO-15 Analysis)	120	EA	$ 550	$ 66,000	4 SVE wells, 2 effluent, 3 VMPs and 1 QC at each area per qtr
6.5	GAC and Liquid Disposal	12	EA	$ 1,050	$ 12,600	
6.6	Data Evaluation/Reporting	1	LS	$ 30,000	$ 40,000	Annual Report to include Performance Monitroing Results
	Sub-Total				**$ 206,092**	
7	**Performance Monitoring (Year 1)**					
7.1	Groundwater Sampling and Analysis (Baseline plus Quarterly)	160	EA	$ 550	$ 88,000	27 wells for VOCs analysis + 5 QC
7.2	Data Evaluation/Reporting	5	LS	$ 5,000	$ 25,000	Brief Data Report for each event
	Sub-Total				**$ 113,000**	
8	**On-site Source Areas 1 & 2 Installation-Startup-O&M (Year 1)**					
8.1	Equipment and Personnel Mob/Demob	1	EA	$ 5,000	$ 5,000	
8.2	Electrical Power Set Up	2	LS	$ 30,000	$ 60,000	For two systems
8.3	AS well installation (120 ft deep)	3	EA	$ 13,000	$ 39,000	Three for AS/SVE
8.4	SVE well installation (75 ft deep)	2	EA	$ 9,900	$ 19,800	One each for AS/SVE and SVE locations
8.5	VMP installation (42 ft deep)	2	EA	$ 6,400	$ 12,800	One each for AS/SVE and SVE locations
8.6	Trenching	150	LF	$ 40	$ 6,000	
8.7	Site Survey	1	LS	$ 2,600	$ 2,600	AS, SVE, VMPs and trench
8.8	Surface Repair	60	SY	$ 40	$ 2,400	
8.9	Drilling Liquid Storage and Disposal	1	LS	$ 2,500	$ 2,500	
8.10	AS/SVE Treatment system trailer	1	LS	$ 38,500	$ 38,500	
8.11	SVE Treatment system trailer	1	LS	$ 28,500	$ 28,500	
8.12	System startup	1	LS	$ 5,000	$ 5,000	
8.13	Electrical Usage	228,900	KW-Hr	$ 0.12	$ 27,468	One AS and two SVE systems
8.14	Bi-weekly Inspections	12	EA	$ 960	$ 11,520	6 hours every 2 weeks
8.15	Maintenance - Repair/Replacement of Equipment	2	LS	$ 2,000	$ 3,000	Includes quarterly maintenance reviews
8.16	Vapor Sampling and Analysis (TO-15 Analysis)	28	EA	$ 550	$ 15,400	Quarterly samples for two systems. 4 VMP, 2 SVE Effluent and 1 QC. VOCs analysis - 7 Samples/event
8.17	Groundwater Sampling and Analysis (Baseline plus Quarterly)	28	EA	$ 550	$ 15,400	6 wells for VOCs analysis + 1 QC
8.18	Quarterly Data Evaluation/Reporting	4	LS	$ 3,000	$ 12,000	Brief Data Reports
8.19	Annual Data Evaluation/Reporting	1	EA	$ 18,000	$ 18,000	Annual Reporting
	Sub-Total				**$ 324,888**	

Table A-2 - Cost Estimate for Alternative 3 - Expanded AS/SVE and SVE

Site:	Former Defense Depot Memphis, Tennessee (DDMT) - Main Installation (MI)
Location:	Southeastern Memphis, Shelby County, Tennessee
Phase:	Focused Feasibility Study
Base Year:	2022
Date:	1/17/2022

Description: Alternative 3 includes three permanent AS/SVE systems for preventing contaminated groundwater migration, SVE for treating source area contamination in TTA-2, and portable SVE and AS/SVE for reducing contaminant concentrations in isolated CVOC groundwater plumes in the active treatment zones, with the assumption that there will be additional reliance on existing ICs and on-going LTM for protection of human health and the environment over the long term.

Item No.		Description	Quantity	Unit	Unit Cost	Total	Notes
9		**TTA-2 Source Area SVE (Year 1)**					
	9.1	Re-install system, connect power and start-up	1	LS	$ 1,000	$ 1,000	SVE System compressor/blower for one year
	9.2	Electrical Usage	65,400	KW-Hr	$ 0.12	$ 7,848	SVE System compressor/blower for one year
	9.3	Monthly Inspections	12	EA	$ 960	$ 11,520	8 hours/month
	9.4	Quarterly Inspection, Maintenance and Repair	4	EA	$ 500	$ 2,000	
	9.5	Performance Groundwater Sampling and Analysis	24	EA	$ 550	$ 13,200	Quarterly samples of 4 performance wells + 2 QC samples
	9.6	Vapor Sampling and Analysis (TO-15 Analysis)	32	EA	$ 550	$ 17,600	Quarterly SVE Well and System Influent/Effluent (3), Semiannual VMPs (7) and QC (1). VOCs analysis only
	9.7	Quarterly Data Evaluation/Reporting	3	LS	$ 2,000	$ 6,000	Brief Data Reports
	9.8	Annual Data Evaluation/Reporting	1	LS	$ 12,000	$ 12,000	Annual Report
		Sub-Total				**$ 71,168**	
10		**ICs and LTM (Year 1)**					
	10.1	Annual Site Inspection (LUC) and Report	1	LS	$ 12,500	$ 12,500	
	10.2	Groundwater Sampling and Analysis - Semiannual	247	EA	$ 550	$ 135,850	103 semiannual and 20% QC samples
	10.3	Groundwater Sampling and Analysis - Annual	105	EA	$ 550	$ 57,750	87 annual and 20% QC samples
	10.4	Semiannual and Annual Data Evaluation/Reporting	1	LS	$ 75,000	$ 75,000	
		Sub-Total				**$ 281,100**	
		Sub-Total				**$ 2,434,998**	Sub-Total All Construction Costs.
		Contingency	15%			$ 365,000	5% scope + 10% bid.
		Sub-Total				**$ 2,799,998**	
		Project Management				$ 30,000	
		Construction Management and Oversight				$ 35,000	
		Remedial Design				$ 50,000	
		Remedial Action Work Plan				$ 40,000	
		TOTAL CAPITAL COST				**$ 2,955,000**	

Table A-2 - Cost Estimate for Alternative 3 - Expanded AS/SVE and SVE

Site: Former Defense Depot Memphis, Tennessee (DDMT) - Main Installation (MI)
Location: Southeastern Memphis, Shelby County, Tennessee
Phase: Focused Feasibility Study
Base Year: 2022
Date: 1/17/2022

Description: Alternative 3 includes three permanent AS/SVE systems for preventing contaminated groundwater migration, SVE for treating source area contamination in TTA-2, and portable SVE and AS/SVE for reducing contaminant concentrations in isolated CVOC groundwater plumes in the active treatment zones, with the assumption that there will be additional reliance on existing ICs and on-going LTM for protection of human health and the environment over the long term.

Item No.	Description	Quantity	Unit	Unit Cost	Total	Notes
TTA-2 SVE and On-site Source Areas 3 & 4 (Year 2)						
O&M COST:						
Item No.	**Description**	**Quantity**	**Unit**	**Unit Cost**	**Total**	**Notes**
1	**Annual O&M of TTA-2 SVE (Year 2)**					
1.1	Electrical Usage	65,400	KW-Hr	$ 0.12	$ 7,848	TTA-2 SVE
1.2	Monthly Inspections	12	EA	$ 960	$ 11,520	
1.3	Maintenance - Repair/Replacement of Equipment	4	LS	$ 500	$ 2,000	Quarterly Maintenance Review
1.4	Performance Sampling and Analysis	12	EA	$ 550	$ 6,600	Semiannual samples of 4 performance wells + 2 QC samples
1.5	Air Sampling and Analysis (TO-15 Analysis)	16	EA	$ 550	$ 8,800	Semiannual sampling; assumes 8 samples
1.6	Semiannual Data Evaluation/Reporting	1	LS	$ 3,000	$ 3,000	
1.7	Annual Data Evaluation/Reporting	1	LS	$ 13,000	$ 13,000	
	Sub-Total				**$ 52,768**	
2	**On-site Source Areas 3 & 4 Installation-Startup-Year 2 O&M**					
2.1	Electrical Power Set Up	2	LS	$ 30,000	$ 60,000	For two systems
2.2	AS well installation (120 ft deep)	3	EA	$ 13,000	$ 39,000	Three for AS/SVE
2.3	SVE well installation (75 ft deep)	2	EA	$ 9,900	$ 19,800	One each for AS/SVE and SVE locations
2.4	VMP installation (42 ft deep)	2	EA	$ 6,400	$ 12,800	One each for AS/SVE and SVE locations
2.5	Trenching	150	LF	$ 40	$ 6,000	
2.6	Site Survey	1	LS	$ 2,600	$ 2,600	AS, SVE, VMPs and trench
2.7	Surface Repair	60	SY	$ 40	$ 2,400	
2.8	Drilling Liquid Storage and Disposal	1	LS	$ 2,500	$ 2,500	
2.10	Move SVE and AS/SVE systems, connect power and start-up	2	LS	$ 2,000	$ 4,000	
2.10	Electrical Usage	228,900	KW-Hr	$ 0.12	$ 27,468	One AS and two SVE systems
2.11	Bi-weekly Inspections	12	EA	$ 960	$ 11,520	6 hours every 2 weeks
2.12	Maintenance - Repair/Replacement of Equipment	2	LS	$ 2,000	$ 4,000	Includes quarterly maintenance reviews
2.13	Vapor Sampling and Analysis (TO-15 Analysis)	28	EA	$ 550	$ 15,400	Quarterly samples for two systems. 4 VMP, 2 SVE Effluent and 1 QC. VOCs analysis - 7 Samples/event
2.14	Groundwater Sampling and Analysis (Baseline plus Quarterly)	28	EA	$ 550	$ 15,400	6 wells for VOCs analysis + 1 QC
2.15	Quarterly Data Evaluation/Reporting	4	LS	$ 3,000	$ 12,000	Brief Data Reports
2.16	Annual Data Evaluation/Reporting	1	EA	$ 18,000	$ 18,000	Annual Reporting
	Sub-Total				**$ 252,888**	
	Sub-Total				**$ 305,656**	
	Contingency	5%			$ 15,000	
	Sub-Total				**$ 320,656**	
	Project Management				$ 8,000	
	Technical Support				$ 8,000	
	TOTAL ANNUAL O&M COST				**$ 390,000**	

Table A-2 - Cost Estimate for Alternative 3 - Expanded AS/SVE and SVE

Site:	Former Defense Depot Memphis, Tennessee (DDMT) - Main Installation (MI)
Location:	Southeastern Memphis, Shelby County, Tennessee
Phase:	Focused Feasibility Study
Base Year:	2022
Date:	1/17/2022

Description: Alternative 3 includes three permanent AS/SVE systems for preventing contaminated groundwater migration, SVE for treating source area contamination in TTA-2, and portable SVE and AS/SVE for reducing contaminant concentrations in isolated CVOC groundwater plumes in the active treatment zones, with the assumption that there will be additional reliance on existing ICs and on-going LTM for protection of human health and the environment over the long term.

Item No.	Description	Quantity	Unit	Unit Cost	Total	Notes
AS/SVE Systems O&M, ICs and LTM (Years 2-5)						
O&M COST:						
Item No.	**Description**	**Quantity**	**Unit**	**Unit Cost**	**Total**	**Notes**
1	**Annual O&M of Three AS/SVE Systems (Years 2-5)**					
1.1	Electrical Usage	523,100	KW-Hr	$ 0.12	$ 62,772	Three AS/SVE Systems operation for 12 months
1.2	Monthly Inspections	12	EA	$ 1,440	$ 17,280	12 hours/month
1.3	Maintenance - Repair/Replacement of Equipment	3	LS	$ 2,000	$ 6,000	Quarterly Maintenance Review
1.4	Air Sampling and Analysis (TO-15 Analysis)	120	EA	$ 550	$ 66,000	Quarterly sampling; assumes 10 samples/system
1.5	GAC and Liquid Disposal	12	EA	$ 1,050	$ 12,600	
1.6	Quarterly Data Evaluation/Reporting	3	LS	$ 3,000	$ 9,000	
1.7	Annual Data Evaluation/Reporting	1	LS	$ 21,000	$ 35,000	With Performance Monitoring results
	Sub-Total				**$ 208,652**	
2	**Performance Monitoring (Years 2-5)**					
2.1	Groundwater Sampling and Analysis (Semiannual)	64	EA	$ 550	$ 35,200	27 wells for VOCs analysis + 5 QC samples.
2.2	Data Evaluation/Reporting	2	LS	$ 5,000	$ 10,000	Brief Data Report for each event
	Sub-Total				**$ 45,200**	
3	**ICs and LTM (Years 2-5)**					
3.1	Annual Site Inspection (LUC) and Report	1	LS	$ 12,500	$ 12,500	ICs/Inspection/Reporting
3.2	Groundwater Sampling - Semiannual	247	EA	$ 550	$ 135,850	103 semiannual and 20% QC samples
3.3	Groundwater Sampling - Annual	105	EA	$ 550	$ 57,750	87 annual and 20% QC samples
3.4	Semiannual and Annual Data Evaluation/Reporting	1	LS	$ 75,000	$ 75,000	
	Sub-Total				**$ 281,100**	
	Sub-Total				**$ 534,952**	
	Contingency	5%			$ 27,000	
	Sub-Total				**$ 561,952**	
	Project Management				$ 13,000	
	Technical Support				$ 13,000	
	TOTAL ANNUAL O&M COST				**$ 588,000**	

Table A-2 - Cost Estimate for Alternative 3 - Expanded AS/SVE and SVE

Site: Former Defense Depot Memphis, Tennessee (DDMT) - Main Installation (MI)
Location: Southeastern Memphis, Shelby County, Tennessee
Phase: Focused Feasibility Study
Base Year: 2022
Date: 1/17/2022

Description: Alternative 3 includes three permanent AS/SVE systems for preventing contaminated groundwater migration, SVE for treating source area contamination in TTA-2, and portable SVE and AS/SVE for reducing contaminant concentrations in isolated CVOC groundwater plumes in the active treatment zones, with the assumption that there will be additional reliance on existing ICs and on-going LTM for protection of human health and the environment over the long term.

Item No.	Description		Quantity	Unit	Unit Cost	Total	Notes
On-site Source Areas 5 & 6 Installation-Startup-O&M (Year 3)							
1	**On-site Source Areas 5 & 6 Installation-Startup-O&M (Year 3)**						
1.1	Electrical Power Set Up	3	2	LS	$ 30,000	$ 60,000	For two systems
1.2	AS well installation (120 ft deep)	3	3	EA	$ 13,000	$ 39,000	Three for AS/SVE
1.3	SVE well installation (75 ft deep)	3	2	EA	$ 9,900	$ 19,800	One each for AS/SVE and SVE locations
1.4	VMP installation (42 ft deep)	3	2	EA	$ 6,400	$ 12,800	One each for AS/SVE and SVE locations
1.5	Trenching	3	150	LF	$ 40	$ 6,000	
1.6	Site Survey	3	1	LS	$ 2,600	$ 2,600	AS, SVE, VMPs and trench
1.7	Surface Repair	3	60	SY	$ 40	$ 2,400	
1.8	Drilling Liquid Storage and Disposal	3	1	LS	$ 2,500	$ 2,500	
1.9	Move SVE and AS/SVE systems, connect power and start-up	3	2	LS	$ 2,000	$ 4,000	
1.10	Electrical Usage	3	228,900	KW-Hr	$ 0.12	$ 27,468	One AS and two SVE systems
1.11	Bi-weekly Inspections	3	12	EA	$ 960	$ 11,520	6 hours every 2 weeks
1.12	Maintenance - Repair/Replacement of Equipment	3	2	LS	$ 2,000	$ 4,000	Includes quarterly maintenance reviews
1.13	Vapor Sampling and Analysis (TO-15 Analysis)	3	28	EA	$ 550	$ 15,400	Quarterly for two systems. 4 VMP, 2 SVE Effluent and 1 QC. VOCs analysis - 7 samples/event
1.14	Groundwater Sampling and Analysis (Baseline plus Quarterly)	3	28	EA	$ 550	$ 15,400	6 wells for VOCs analysis + 1 QC
1.15	Quarterly Data Evaluation/Reporting	3	4	LS	$ 3,000	$ 12,000	Brief Data Reports
1.16	Annual Data Evaluation/Reporting	3	1	EA	$ 18,000	$ 18,000	Annual Reporting
	Sub-Total					**$ 252,888**	
Sub-Total						**$ 252,888**	
	Contingency		10%			$ 25,000	5% scope + 5% bid.
Sub-Total						**$ 277,888**	
Project Management						$ 12,000	
Technical Support						$ 12,000	
TOTAL PERIODIC COST						**$ 302,000**	

Table A-2 - Cost Estimate for Alternative 3 - Expanded AS/SVE and SVE

Site: Former Defense Depot Memphis, Tennessee (DDMT) - Main Installation (MI)
Location: Southeastern Memphis, Shelby County, Tennessee
Phase: Focused Feasibility Study
Base Year: 2022
Date: 1/17/2022

Description: Alternative 3 includes three permanent AS/SVE systems for preventing contaminated groundwater migration, SVE for treating source area contamination in TTA-2, and portable SVE and AS/SVE for reducing contaminant concentrations in isolated CVOC groundwater plumes in the active treatment zones, with the assumption that there will be additional reliance on existing ICs and on-going LTM for protection of human health and the environment over the long term.

Item No.	Description		Quantity	Unit	Unit Cost	Total	Notes
On-site Source Areas 5 & 6 Installation-Startup-O&M (Year 4)							
1	**On-site Source Areas 7 & 8 Installation-Startup-O&M (Year 4)**						
1.1	Electrical Power Set Up	4	2	LS	$ 30,000	$ 60,000	For two systems
1.2	AS well installation (120 ft deep)	4	3	EA	$ 13,000	$ 39,000	Three for AS/SVE
1.3	SVE well installation (75 ft deep)	4	2	EA	$ 9,900	$ 19,800	One each for AS/SVE and SVE locations
1.4	VMP installation (42 ft deep)	4	2	EA	$ 6,400	$ 12,800	One each for AS/SVE and SVE locations
1.5	Trenching	4	150	LF	$ 40	$ 6,000	
1.6	Site Survey	4	1	LS	$ 2,600	$ 2,600	AS, SVE, VMPs and trench
1.7	Surface Repair	4	60	SY	$ 40	$ 2,400	
1.8	Drilling Liquid Storage and Disposal	4	1	LS	$ 2,500	$ 2,500	
1.9	Move SVE and AS/SVE systems, connect power and start-up	4	2	LS	$ 2,000	$ 4,000	
1.10	Electrical Usage	4	228,900	KW-Hr	$ 0.12	$ 27,468	One AS and two SVE systems
1.11	Bi-weekly Inspections	4	12	EA	$ 960	$ 11,520	6 hours every 2 weeks
1.12	Maintenance - Repair/Replacement of Equipment	4	2	LS	$ 2,000	$ 4,000	Includes quarterly maintenance reviews
1.13	Vapor Sampling and Analysis (TO-15 Analysis)	4	28	EA	$ 550	$ 15,400	Quarterly samples for two systems. 4 VMP, 2 SVE Effluent and 1 QC. VOCs analysis - 7 Samples/event
1.14	Groundwater Sampling and Analysis (Baseline plus Quarterly)	4	28	EA	$ 550	$ 15,400	6 wells for VOCs analysis + 1 QC
1.15	Quarterly Data Evaluation/Reporting	4	4	LS	$ 3,000	$ 12,000	Brief Data Reports
1.16	Annual Data Evaluation/Reporting	4	1	EA	$ 18,000	$ 18,000	Annual Reporting
	Sub-Total					**$ 252,888**	
	Sub-Total					**$ 252,888**	
	Contingency		10%			$ 25,000	5% scope + 5% bid.
	Sub-Total					**$ 277,888**	
	Project Management					$ 12,000	
	Technical Support					$ 12,000	
	TOTAL PERIODIC COST					**$ 302,000**	

Table A-2 - Cost Estimate for Alternative 3 - Expanded AS/SVE and SVE

Site:	Former Defense Depot Memphis, Tennessee (DDMT) - Main Installation (MI)
Location:	Southeastern Memphis, Shelby County, Tennessee
Phase:	Focused Feasibility Study
Base Year:	2022
Date:	1/17/2022

Description: Alternative 3 includes three permanent AS/SVE systems for preventing contaminated groundwater migration, SVE for treating source area contamination in TTA-2, and portable SVE and AS/SVE for reducing contaminant concentrations in isolated CVOC groundwater plumes in the active treatment zones, with the assumption that there will be additional reliance on existing ICs and on-going LTM for protection of human health and the environment over the long term.

Item No.	Description	Quantity	Unit	Unit Cost	Total	Notes
ICs and LTM (Years 6-10)						
O&M COST:						
Item No.	**Description**	**Quantity**	**Unit**	**Unit Cost**	**Total**	**Notes**
1	**ICs and LTM - Assumes 50 wells (Years 6-10)**					
	1.1 Annual Site Inspection (LUC) and Report	1	LS	$ 12,500	$ 12,500	ICs/Inspections/Reporting
	1.2 Groundwater Sampling - Annual	60	EA	$ 550	$ 33,000	Annual 50 wells+ 20% QC samples., VOCs analysis
	1.3 Data Evaluation/Reporting	1	LS	$ 15,400	$ 15,400	
	Sub-Total				**$ 60,900**	
	Sub-Total				**$ 60,900**	
	Contingency	5%			$ 3,000	
	Sub-Total				**$ 63,900**	
	Project Management				$ 1,500	
	Technical Support				$ 1,500	
	TOTAL ANNUAL O&M COST				**$ 67,000**	
ICs and LTM (Years 11-15)						
O&M COST:						
Item No.	**Description**	**Quantity**	**Unit**	**Unit Cost**	**Total**	**Notes**
1	**ICs and LTM (Years 11-15) - Assumes 30 wells**					
	1.1 Annual Site Inspection (LUC) and Report	1	LS	$ 12,500	$ 12,500	ICs/Inspections/Reporting
	1.2 Groundwater Sampling - Annual	36	EA	$ 550	$ 19,800	Annual 30 wells+ 20% QC samples., VOCs analysis
	1.3 Data Evaluation/Reporting	1	LS	$ 12,700	$ 12,700	
	Sub-Total				**$ 45,000**	
	Sub-Total				**$ 45,000**	
	Contingency	5%			$ 2,000	
	Sub-Total				**$ 47,000**	
	Project Management				$ 1,500	
	Technical Support				$ 1,500	
	TOTAL ANNUAL O&M COST				**$ 50,000**	

Table A-2 - Cost Estimate for Alternative 3 - Expanded AS/SVE and SVE

Site:	Former Defense Depot Memphis, Tennessee (DDMT) - Main Installation (MI)
Location:	Southeastern Memphis, Shelby County, Tennessee
Phase:	Focused Feasibility Study
Base Year:	2022
Date:	1/17/2022

Description: Alternative 3 includes three permanent AS/SVE systems for preventing contaminated groundwater migration, SVE for treating source area contamination in TTA-2, and portable SVE and AS/SVE for reducing contaminant concentrations in isolated CVOC groundwater plumes in the active treatment zones, with the assumption that there will be additional reliance on existing ICs and on-going LTM for protection of human health and the environment over the long term.

Item No.	Description		Quantity	Unit	Unit Cost	Total	Notes
PERIODIC COSTS:							
1	**LTM - Periodic Maintenance (Every 5 Years)**						
1.1	Well Maintenance (Assumes 20% of Total LTM Wells)	5	41	EA	$ 300	$ 12,300	Equipment Replacement/Repair
1.2	Reporting	5	1	LS	$ 4,000	$ 4,000	Documentations
	Sub-Total					**$ 17,000**	
2	**Decommissioning TTA-2 SVE System (Year 15)**						
2.1	SVE/VMP Well Abandonment	15	8	EA	$ 1,500	$ 12,000	Drilling subcontractor, abandonment of wells
2.2	Reporting	15	1	LS	$ 3,000	$ 3,000	
	Sub-Total					**$ 15,000**	
3	**Decommissioning Permanent and Portable AS/SVE Systems (Year 15)**						
3.1	AS/SVE Wells Abandonment	15	60	EA	$ 1,500	$ 90,000	Drilling subcontractor, abandonment of wells
3.2	Reporting	15	1	LS	$ 5,000	$ 5,000	
	Sub-Total					**$ 95,000**	
4	**Site Close Out**						
4.1	Monitoring Well Abandonment	16	205	EA	$ 1,500	$ 307,500	Drilling subcontractor, abandonment of monitoring wells and performance wells.
4.2	Final Closure Report	16	1	LS	$ 50,000	$ 50,000	
	Sub-Total					**$ 358,000**	

PRESENT VALUE ANALYSIS: Rate of Return: 7% Inflation Rate: 3%

Item No.		Year	Total Cost	Present Value	Notes
1	**Capital Cost**	1		**$ 2,955,000**	
2	**O&M Costs**				
2.1	TTA-2 SVE and On-site Source Areas 3 & 4 (Year 2)	2	$ 390,000	$ 375,421	
2.2	AS/SVE Systems O&M, ICs and LTM (Years 2-5)	2-5	$ 588,000	$ 2,140,252	
2.3	On-site Source Areas 5 & 6 Installation-Startup-O&M (Year 3)	3	$ 302,000	$ 279,843	
2.4	On-site Source Areas 7 & 8 Installation-Startup-O&M (Year 4)	4	$ 302,000	$ 269,381	
2.5	ICs and LTM (Years 6-10)	6-10	$ 67,000	$ 256,950	
2.6	ICs and LTM (Years 11-15)	11-15	$ 50,000	$ 158,494	
	Sub-Total			**$ 3,481,000**	
3	**Periodic Costs**				
3.1	LTM - Periodic Maintenance (Every 5 Years)	5,10,15	$ 17,000	$ 36,634	
3.2	Decommissioning TTA-2 SVE System (Year 15)	15	$ 15,000	$ 8,799	
3.3	Decommissioning Permanent and Portable AS/SVE Systems (Year 15)	15	$ 95,000	$ 55,728	
3.4	Site Close Out	16	$ 358,000	$ 202,155	
	Sub-Total			**$ 304,000**	
	TOTAL PRESENT VALUE OF ALTERNATIVE			**$ 6,740,000**	

B

Appendix B

Supplemental Information

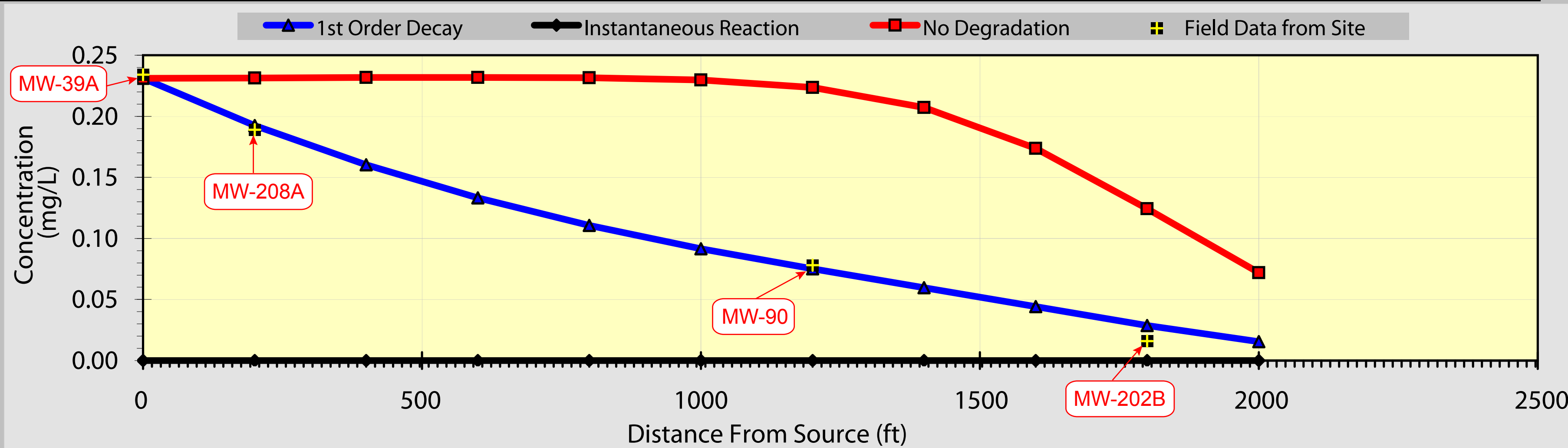
Table 1
BIOSCREEN Input Data – Intermediate Aquifer Site Characterization

Input	PCE	TCE
Seepage Velocity	1159 ft/yr	1159 ft/yr
Hydraulic Conductivity	40 ft/d	40 ft/d
Hydraulic Gradient	0.012 ft/ft	0.012 ft/ft
Effective Porosity	0.15	0.15
Retardation Factor	2.2	1.7
Plume Length	1800 ft	1500 ft
Longitudinal Dispersivity	30 ft	30 ft
Transverse Dispersivity	3.0 ft	3.0 ft
* 1st Order Attenuation Rate	0.5 per yr	0.8 per yr

Source: Contaminant Plume Modeling at the Main Installation of the Former Memphis Depot, CH2MHILL, February 13, 2009
Appendix F, Main Installation Source Areas Investigation, e2M, February 2009

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

	Distance from Source (ft)										
TYPE OF MODEL	0	200	400	600	800	1000	1200	1400	1600	1800	2000
No Degradation	0.231	0.231	0.232	0.232	0.232	0.230	0.224	0.207	0.174	0.124	0.072
1st Order Decay	0.231	0.192	0.160	0.133	0.111	0.092	0.075	0.060	0.044	0.029	0.016
Inst. Reaction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site	0.234	0.189					0.078			0.016	



Replay Animation

Next Timestep

Prev Timestep

Time:

3.5 Years

Return to Input

Recalculate This Sheet

FIGURE 11
Attenuation Rate Calibration with Field Data for PCE
Contaminant Plume Modeling Report, January 2009
Main Installation Defense Depot, Memphis, Tennessee

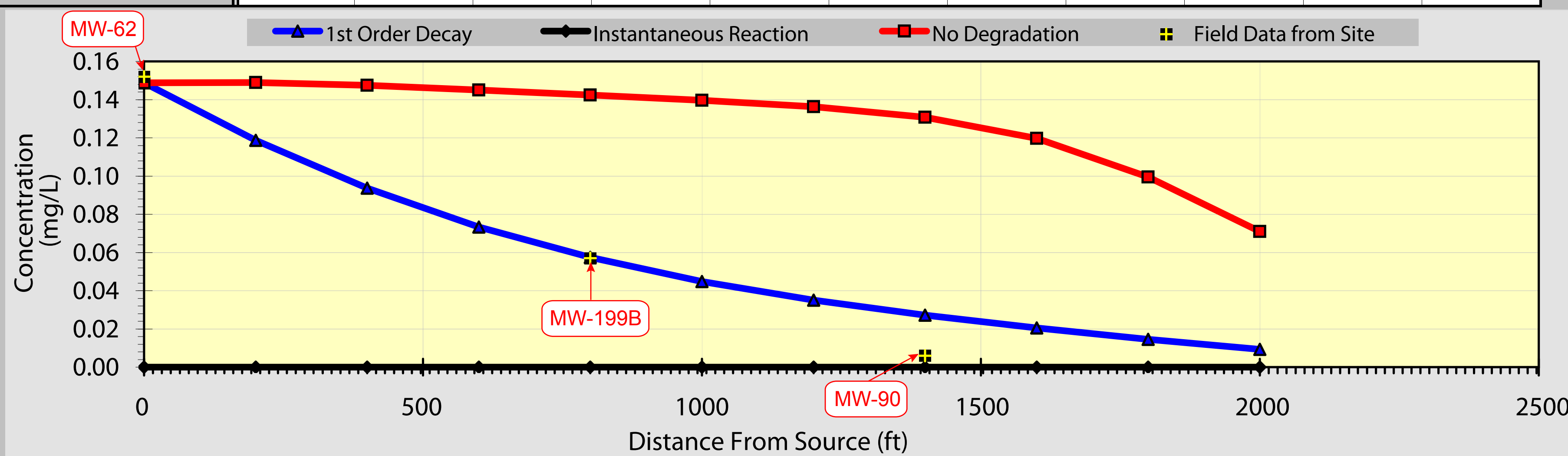
CH2MHILL

ES022009001ATL Fig11.ai

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	200	400	600	800	1000	1200	1400	1600	1800	2000
No Degradation	0.149	0.149	0.148	0.145	0.142	0.140	0.136	0.131	0.120	0.099	0.071
1st Order Decay	0.149	0.119	0.094	0.073	0.057	0.045	0.035	0.027	0.021	0.015	0.009
Inst. Reaction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site	0.152				0.057			0.006			



Replay Animation

Next Timestep

Prev Timestep

Time:

3.0 Years

Return to Input

Recalculate This Sheet

FIGURE 12
Attenuation Rate Calibration with Field Data for TCE
Contaminant Plume Modeling Report, January 2009
Main Installation Defense Depot, Memphis, Tennessee

CH2MHILL

ES022009001ATL Fig12.ai

Technical Memorandum

Date: Monday, March 20, 2023

Project: Defense Depot Memphis, Tennessee

To: Thomas Holmes, P.G.

From: Joseph Cattafe, P.G.

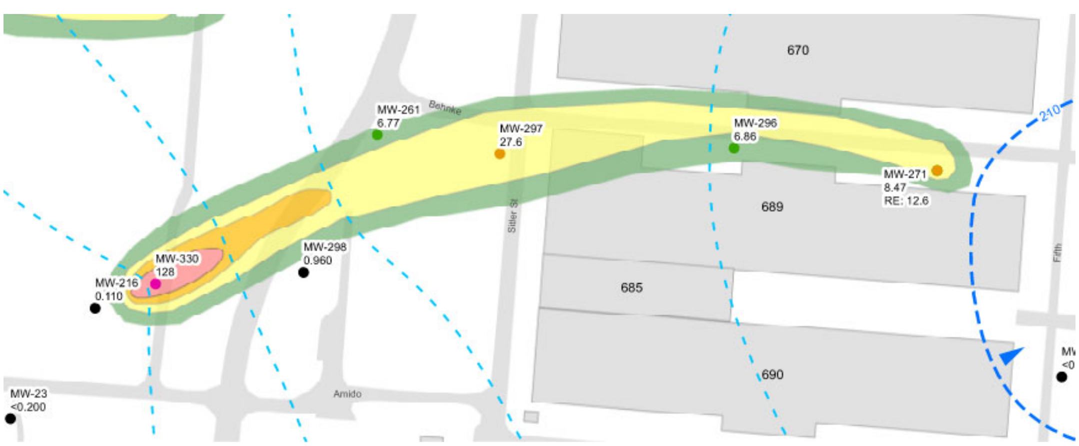
Subject: Attenuation of TCE

1.0 Introduction

This memorandum presents an evaluation of the fate and transport of trichloroethene (TCE) in the Fluvial Deposits Aquifer (FDAQ) at the Main Installation (MI) area of the Defense Depot Memphis, Tennessee (DDMT). The evaluation included a review of the geochemical and hydrogeological characteristics of the FDAQ that impact the fate and transport of TCE, approximation of attenuation rates assuming a continuous source and a decaying source using EPA's BIOCHLOR Natural Attenuation Decision Support System, and estimates of the time to meet regulatory limits under these conditions.

2.0 Background Information

The evaluation was performed using the South-Central TCE plume located in the southern portion of the MI where source remediation has not been initiated. The plume is migrating within the FDAQ. The TCE plume is approximately 1900 feet in length and 250 feet in width. TCE concentrations currently range from 6.77 to 128 micrograms per liter (µg/L) based on an October 2022 round of water quality monitoring as shown in the image below.



The observed data from monitoring wells MW-330, MW-297 and MW-271, located along the approximate centerline of the plume, were used for comparison to predicted values in the model. Data from wells MW-261,MW-296 and MW-298 were not used because they are not along the centerline and therefore, not consistent with the assumptions of the model. Historical concentration vs. time data indicate that TCE concentrations are stable throughout the plume. Time-trend plots are provided in Attachment A. MW-330 was installed in June 2021 as a replacement for MW-97; plots for both wells are included.

The fluvial deposits consist of an upper silty, sandy clay to clayey sand unit that ranges in thickness from 0 to 30 feet (ft) and a lower sand and gravel unit that ranges in thickness from 30 to 100 ft. The upper unit is unsaturated at the MI, while the more permeable lower unit is partially saturated and comprises the FDAQ, the water table aquifer at the MI. The uppermost clay bed of the Upper Claiborne Formation establishes the base of the FDAQ.

Horizontal hydraulic conductivity of the saturated portion of the FDAQ has been determined through aquifer performance tests to range from approximately 45 to 193 feet per day (ft/d) (CH2MHILL, 2004). The hydraulic gradient along the centerline of the plume was calculated from October 2022 water level measurements to be approximately 0.002 ft/ft. Aquifer porosity is 26 percent (%), based on published literature (Robinson, et. al., 1997). Previous studies at the MI indicate that the FDAQ is under aerobic conditions.

BIOCHLOR is an analytical screening model that simulates the fate and transport of chlorinated solvents developed by researchers at the Battelle Pacific Northwest National Laboratory. The software is programmed in the Microsoft© Excel and is based on the Domenico analytical solute transport model. BIOCHLOR combines the processes of advection, dispersion, linear adsorption and degradation (based on sequential first-order decay). Each model run compares contaminant migration with degradation to migration without degradation.

3.0 Fate and Transport Evaluation

The fate and transport of organic compounds such as TCE in groundwater is largely controlled by a combination of advective movement, dispersion, adsorption and degradation. Based on the hydrogeological and geochemical conditions in the FDAQ, the major mechanisms controlling TCE migration at the MI are expected to be advection, dispersion and adsorption. The primary mechanism for TCE degradation is anaerobic reductive dechlorination. The aerobic geochemical conditions in the FDAQ are not favorable for the reductive dechlorination process. TCE is also subject to aerobic degradation through co-metabolic processes and abiotic degradation, such as hydrolysis and dehydrohalogenation. However, these processes are much more limited and result in lower degradation rates.

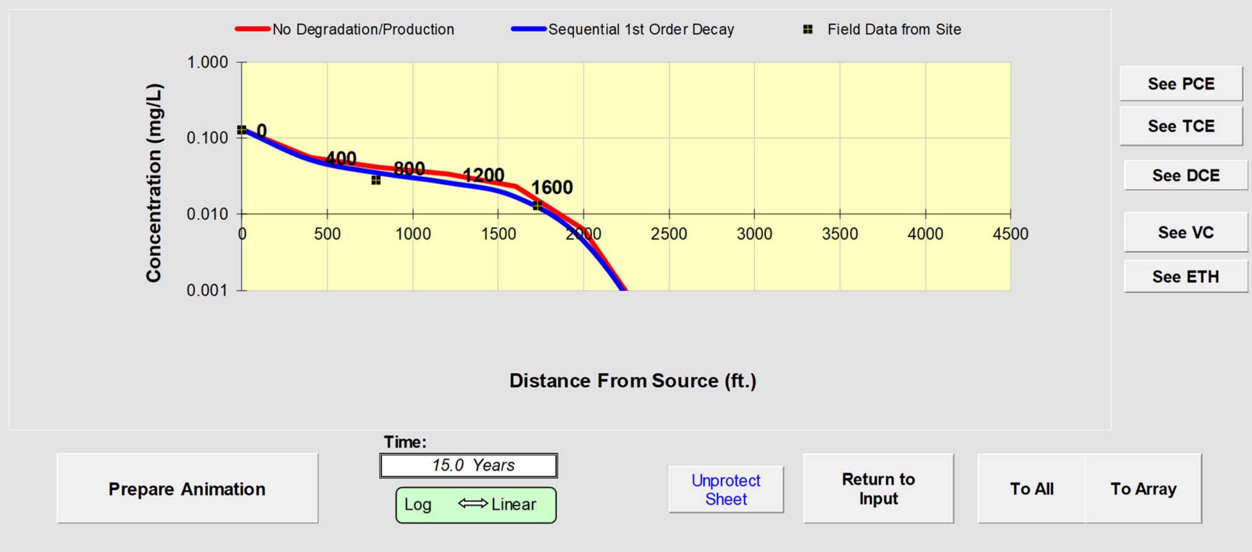
Based on the geochemical conditions in the FDAQ, TCE attenuation rates were expected to be low. To estimate a value for the attenuation rate, EPA's BIOCHLOR model was run to approximate the current distribution of the TCE plume.

Input to the model was based on a combination of site-specific data and default values from BIOCHLOR for parameters that were not specifically characterized at the site. The model requires input to the source, advection, dispersion, adsorption and degradation terms. To approximate current conditions an active or "continuous" source was assumed with a distribution that matches the plume cross section at MW-330. Input to the advection term consisted of a hydraulic conductivity of 0.0281 cm/sec or approximately 80 ft/day, a hydraulic gradient of 0.002 and an effective porosity of 0.26 (dimensionless). The average linear velocity is calculated to be approximately 0.6 ft/day (225 ft/yr) .

Input to the dispersion term was based on guidance from the BIOCHLOR Users Manual and then adjusted so that the predicted concentrations approximated observed concentrations. The final input was a longitudinal dispersity of 20 ft (approximately 10% of the estimated plume length), a horizontal transverse dispersity of 2 ft and a negligible vertical transverse dispersity. Input to the adsorption term was also based on default values from the BIOCHLOR Users Manual and included a soil bulk density of 1.7 kg/L, a f_{oc} of 0.001 and a TCE K_{oc} of 130 L/kg. Input to the decay term began at the lower end of the typical range reported in the BIOCHLOR Users Manual and was adjusted until a reasonable approximation of current observed concentrations was achieved as shown in the image below:

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

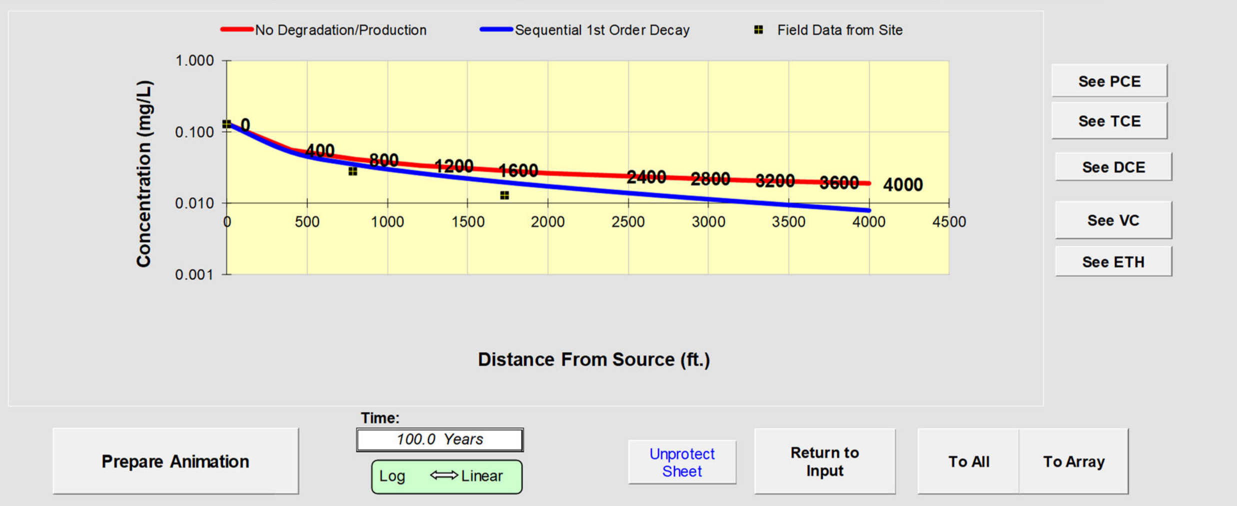
	Distance from Source (ft)										
TCE	0	400	800	1200	1600	2000	2400	2800	3200	3600	4000
No Degradation	0.130	0.057	0.041	0.034	0.024	0.006	0.000	0.000	0.000	0.000	0.000
Biotransformation	0.1300	0.052	0.035	0.026	0.017	0.004	0.000	0.000	0.000	0.000	0.000
	Monitoring Well Locations (ft)										
	0	785		1730							
Field Data from Site	0.128	0.028		0.013							



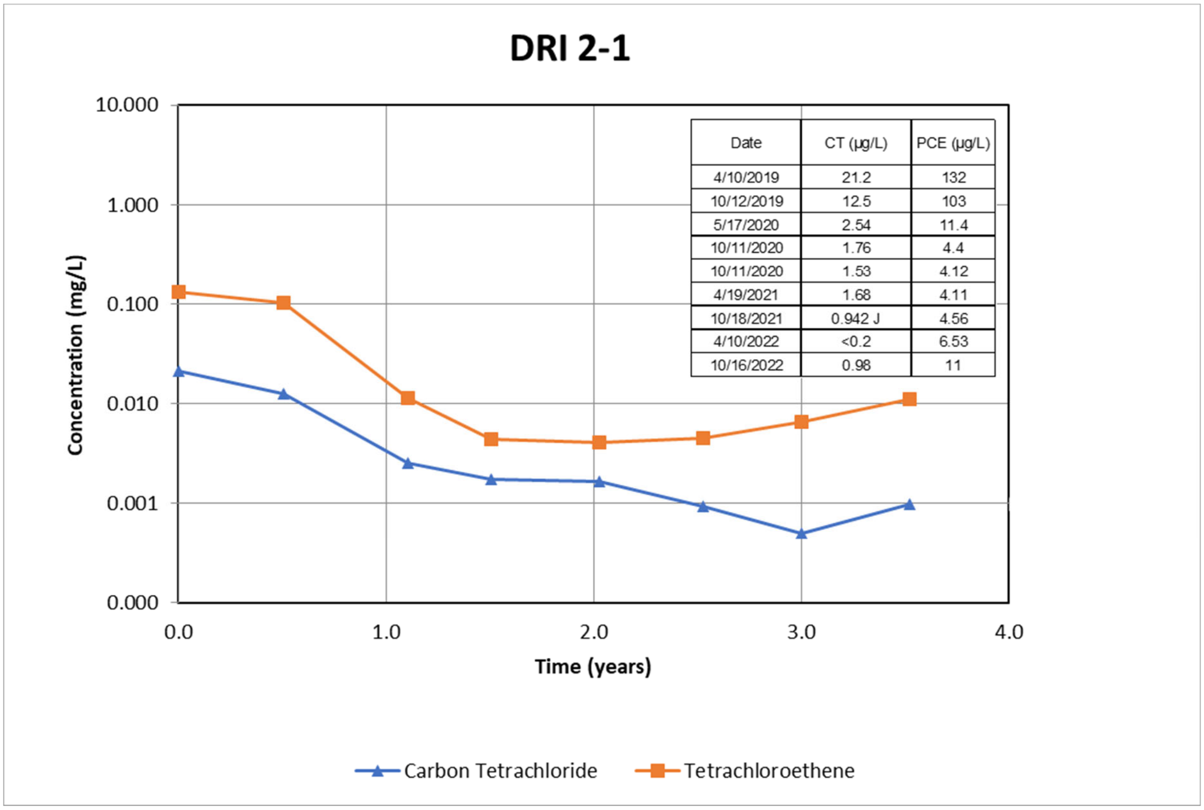
Input to the decay term for this run was a 1st order decay coefficient of 0.05 1/yr and a half-life of 14 years. This attenuation rate is low and is reflective of the geochemical conditions that limit anerobic biodegradation at the site. To estimate the length of time it would take TCE to meet an MCL of 5 µg/L under these limited natural attenuation conditions, the final input parameters were held constant and the time period was sequentially increased until the MCL was met. Under the assumptions of a continuous source, the model predicted that the MCL would not be met in 100 years as shown in the image below.

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

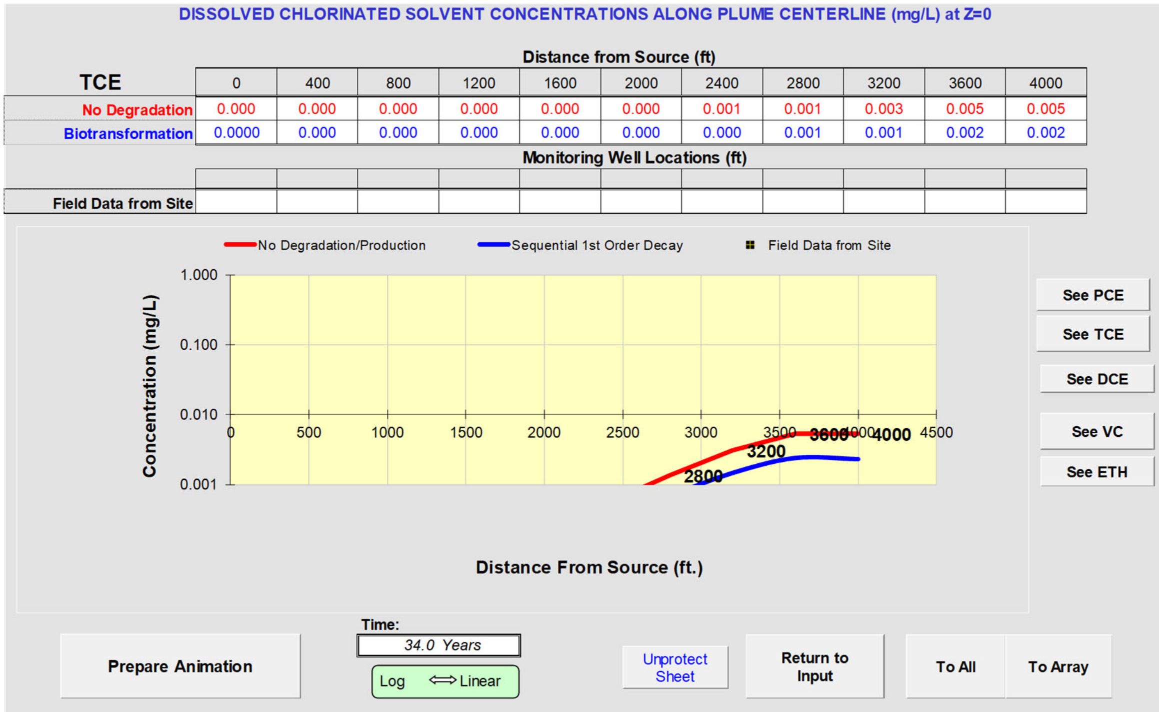
	Distance from Source (ft)										
TCE	0	400	800	1200	1600	2000	2400	2800	3200	3600	4000
No Degradation	0.130	0.057	0.041	0.034	0.030	0.027	0.024	0.023	0.021	0.020	0.019
Biotransformation	0.1300	0.052	0.035	0.026	0.021	0.017	0.014	0.012	0.010	0.009	0.008
	Monitoring Well Locations (ft)										
	0	785		1730							
Field Data from Site	0.128	0.028		0.013							



The model was then run using the same input parameters but changing the source term to a decaying source to reflect source reduction through remedial action. The source decay term was approximated using concentration vs time data from other source remediation projects at the DDMT. The trend plot below for DR2-1 shows concentrations spanning the SVE pilot test (August 2019 to October 2021); only tetrachloroethene (132 µg/L) and carbon tetrachloride (21.2 µg/L) concentrations, which exceeded MCLs prior to the start of the test, are shown. Concentrations decreased below the MCL in May 2020 (CT) and October 2020 (PCE). PCE then rebounded above the MCL in October 2022 indicating residual contamination was still present.

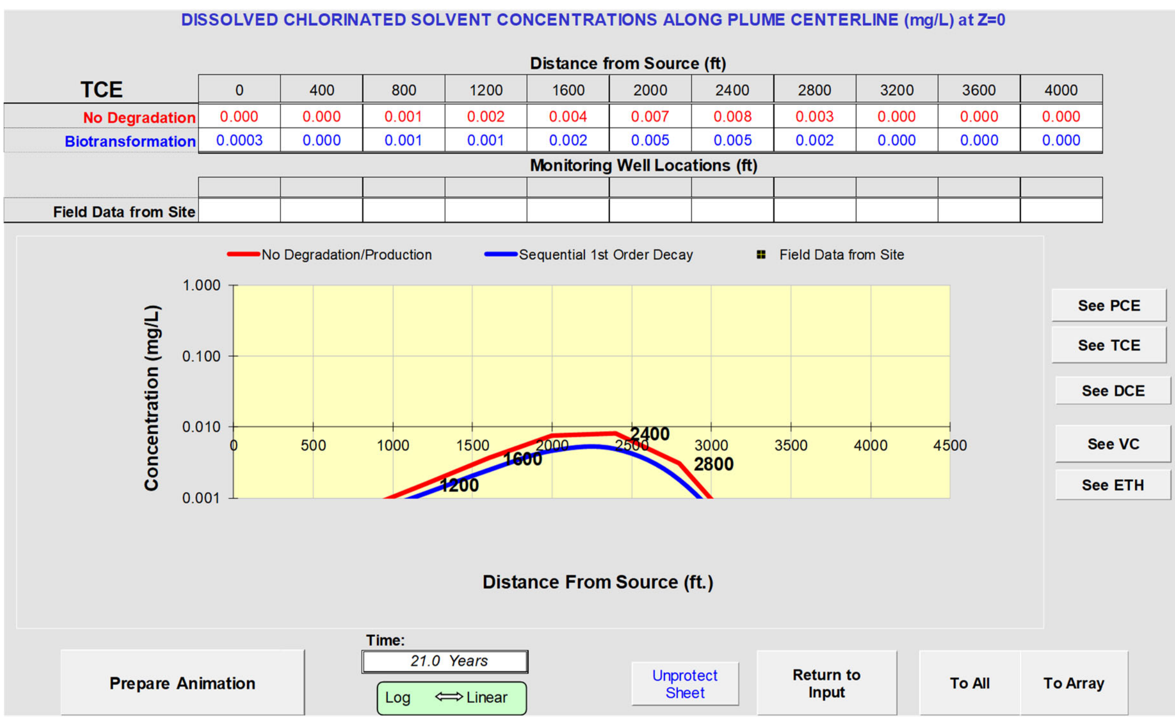


With source remediation, the TCE concentrations are predicted to meet the MCL of 5 µg/L in approximately 34 years, through the processes of dispersion and adsorption alone as shown in the image below:



TCE	0	400	800	1200	1600	2000	2400	2800	3200	3600	4000
No Degradation	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.003	0.005	0.005
Biotransformation	0.0000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.002	0.002
Field Data from Site											

With the addition of the limited amount of decay that also matches current conditions, TCE concentrations are predicted to meet the 5 µg/L in approximately 21 years.



TCE	0	400	800	1200	1600	2000	2400	2800	3200	3600	4000
No Degradation	0.000	0.000	0.001	0.002	0.004	0.007	0.008	0.003	0.000	0.000	0.000
Biotransformation	0.0003	0.000	0.001	0.001	0.002	0.005	0.005	0.002	0.000	0.000	0.000
Field Data from Site											

4.0 Summary and Conclusions

EPA's BIOCHLOR natural attenuation model was used to evaluate the fate and transport of TCE at the MI area of the DDMT. Input parameters were initially based on a combination of existing data from facility investigations and default values from the model and then calibrated to a plume in the south-central portion of the MI where no source remediation has been performed.

The model was then used to approximate the length of time for TCE to meet it's MCL under two scenarios; through natural attenuation alone, and through a combination of source remediation and natural attenuation.

The evaluation concluded that under the geochemical conditions present in the FDAQ at the MI, TCE concentrations in the plume would not meet its MCL in a reasonable time (> 100 years) through natural attenuation alone. However, with a combination of active source remediation (e.g. air sparging) and natural attenuation, TCE concentrations would meet it's MCL in a reasonable period of time, estimated to range from 21 to 34 years.

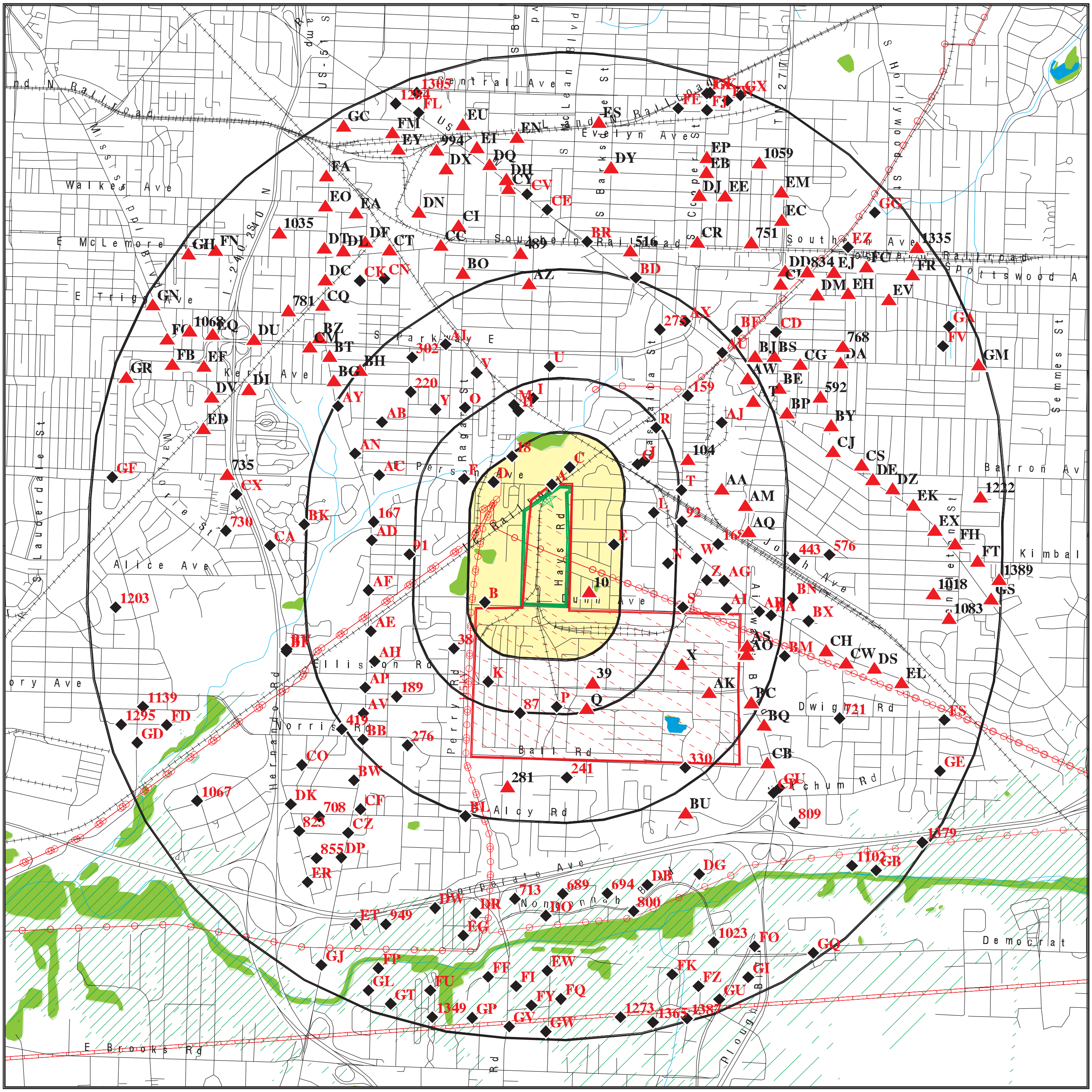
Memphis DDMT
1763 E Person Ave
Memphis, TN 38106

Inquiry Number: 5052485.2s
September 18, 2017

The EDR Radius Map™ Report with GeoCheck®

6 Armstrong Road, 4th floor
Shelton, CT 06484
Toll Free: 800.352.0050
www.edrnet.com

OVERVIEW MAP - 5052485.2S



Target Property

Sites at elevations higher than or equal to the target property

Sites at elevations lower than the target property

Manufactured Gas Plants

National Priority List Sites

Dept. Defense Sites

0 1/2 1 2 Miles

Indian Reservations BIA

Power transmission lines

Pipelines

100-year flood zone

500-year flood zone

National Wetland Inventory

State Wetlands

Upgradient Area

This report includes Interactive Map Layers to display and/or hide map information. The legend includes only those icons for the default map view.

SITE NAME:	Memphis DDMT	CLIENT:	HDR Engineering, Inc.
ADDRESS:	1763 E Person Ave Memphis TN 38106	CONTACT:	Taylor Redmond
		INQUIRY #:	5052485.2s
LAT/LONG:	35.099114 / 90.003712	DATE:	September 18, 2017 1:09 pm

Appendix B-4 – Supplemental Information

Selected Trend Plots for MI Plumes

Trend plots for designated plumes on the MI are provided to shows contaminant concentrations over time at monitoring wells within the core of the plumes. Trend plots for all MI LTM wells with concentrations above the MCL in at least one sample are provided in Appendix G of the Annual Long-Term Monitoring Report – 2022 (HDR, 2023). A brief statement of site conditions is provided below for each well with an attached trend plot.

TTA-1N

MW-219, located up-gradient of the treatment area, was installed less than one year after start of EBT-2. Concentrations show no response to EBT-1 or EBT-2. The low PCE and TCE concentrations in 2011 are not considered due to EBT because cDCE also concentrations decrease. Increased concentrations for PCE, TCE and cDCE after 2012 are consistent with trends in off-site, up-gradient wells MW-269 and MW-278.

MW-21 is located in the up-gradient section of the treatment area. CVOC concentrations show limited response to EBT-1, but the well was an injection well (IW) during EBT-2. PCE and TCE decreased below the limit of detection (LOD) and cDCE increased. PCE and TCE concentrations rebounded from 2017 to 2020. PCE, TCE and cDCE have decreasing trends in 2021 and 2022.

PMW21-04 is located in the down-gradient section of the treatment area near a suspected source area between Buildings 1089 and 972. Concentrations responded to both EBT events, but PCE and TCE concentrations rebounded quickly after each event. PCE, TCE and cDCE concentrations have decreasing trends since 2019.

DR1-7 is located down-gradient of the treatment area. PCE, TCE and cDCE concentrations had decreasing trends from 2005 to 2014, which was probably due to impact of up-gradient EBT; trends have been increasing since 2015.

TTA-1S

DR1-6A is located in the up-gradient section of the treatment area. No apparent response to EBT-1 is seen, but the well was used as an IW during EBT-2. PCE and TCE decreased below the LOD and cDCE and VC increased. PCE and TCE concentrations have been non-detect since 2019. cDCE and VC concentrations remain elevated.

PMW101-02B is located in the central section of the treatment area. Concentrations responded to both EBT events with increased cDCE concentrations and increased VC concentrations after EBT-2; PCE and TCE concentrations rebounded above the MCL after EBT-1 but have remained below the MCL since EBT-2.

DR1-3 is located down-gradient of the treatment area. Concentrations responded to both EBT events with decreased PCE and TCE and increased cDCE. PCE and TCE concentrations rebounded to pre-treatment levels after EBT-2 but have had a general decreasing trend since 2019.

TTA-2

DR2-1 is located in the up-gradient section of the treatment area. Limited response to EBT-1 was seen with decreased PCE and CT concentrations and increased cDCE concentrations. PCE concentrations rebounded quickly, and no response was seen to EBT-2. A significant response to the SVE Pilot test is seen in all CVOC concentrations after May 2020 with rebound after completion of the test.

MW-92 is located in the central section of the treatment area. A significant response to EBT-1 is seen, but PCE and TCE concentrations rebounded in 2011; no response to EBT-2 is seen. All CVOCs have a deceasing trend after 2018.

DR2-3 is located down-gradient of the treatment area. A clear response is not seen for EBT-1 or EBT-2 but concentrations of all CVOCs have been decreasing since 2012.

MW-267 was installed north of the treatment area in 2015. It would have had no response to the EBT events based on its location up-gradient and side-gradient to the TTA-2 treatment area. Residual contamination is suspected in that area based on CVOC concentrations in surrounding wells.

MW-218 is located down-gradient of MW-267 and side-gradient to the TTA-2 treatment area. CVOC concentrations have a stable to slightly decreasing trend since well installation in 2007.

North-Central

MW-263 is located near the northern boundary of DDMT where a groundwater plume, primarily TCE, is migrating on to the MI. TCE and PCE concentration trends are slightly decreasing. EBT was not conducted in the North-Central plume.

MW-104 is located down-gradient of MW-263. TCE concentrations are stable; PCE concentrations are below 1 µg/L.

MW-258 is located down-gradient of MW-104. PCE concentrations above the MCL begin at this well and TCE concentrations are higher than in upgradient wells. TCE and PCE concentration trends are slightly decreasing.

MW-207B is located down-gradient of MW-258. PCE and TCE concentrations are more variable, which may be due to intermingling with the Bldg 835 plume.

West-Central

MW-203B is located in the up-gradient portion of the West-Central plume but is down-gradient of the TTA1-N and TTA-1S plumes. The CVOC concentrations show the impact of EBT-1 in TTA-1. MW-203B was an IW during EBT-2.

MW-205B is located down-gradient of MW-203B and also shows the impact of EBT-1, with cDCE concentration increasing approximately one year after injections began in TTA-1. PCE concentrations have a general decreasing trend, while the TCE trend is stable.

Building 835

MW-62 is located in the up-gradient portion of the Building 835 plume and was an IW during EBT-2.

MW-212 is located down-gradient of MW-62. The TCE concentration trend has a decreasing trend from 2007 to 2014 and an increasing trend after 2014. The increased cDCE concentration in 2014 may be due to EBT-2.

South-Central

MW-97 is located in the suspected source area of the South-Central TCE plume. The well was damaged in 2019; it was abandoned and replacement well MW-330 was installed within approximately 15 ft in 2021. The trend plot shows the TCE concentration in samples from both wells; the concentration has an increasing trend.

MW-297 is located down-gradient of MW-97/330. The TCE concentration trend has an increasing trend.

Window

MW-286 is an FDAQ well located in the up-gradient area of the window west of Bldg 720. EBT was not performed in the Window plume, which is primarily PCE. The PCE concentration has a decreasing trend.

MW-305 is an FDAQ well located approximately 250 ft down-gradient of MW-286 and has higher PCE concentrations.

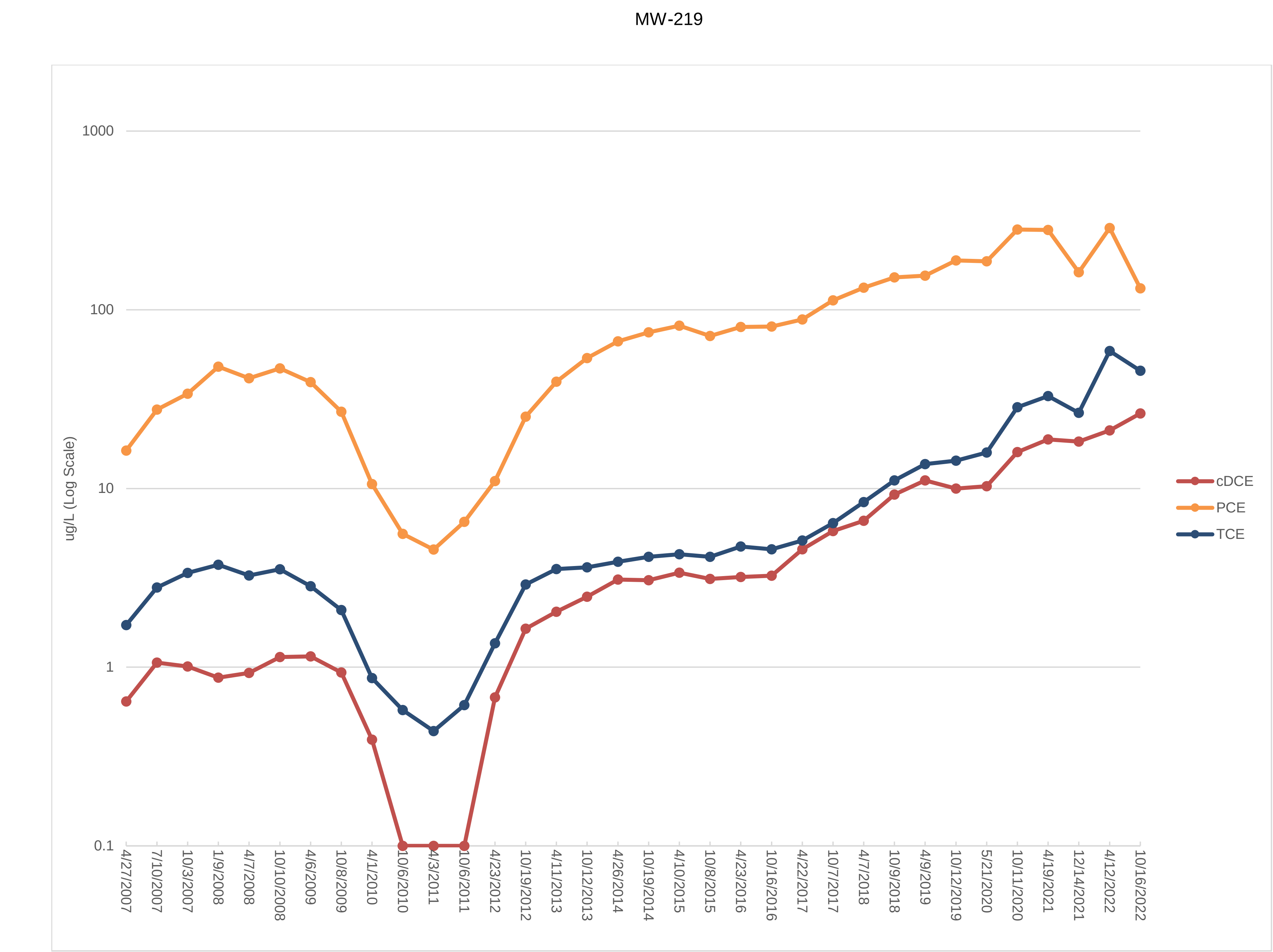
MW-90 is in the upper portion of the IAQ and located side-gradient (south) of MW-305. PCE and TCE concentrations have decreasing trends.

MW-202B is in the upper portion of the IAQ downgradient of MW-90. The PCE concentration has a generally increasing trend.

MW-256 is in the upper portion of the IAQ downgradient of MW-202B and near the northwest corner of the MI. PCE and TCE concentrations increased from installation in 2010 to 2013 but have decreased since 2015.

MW-140 is in the lower portion of the IAQ midway between MW-202 and MW256; the groundwater elevation is consistent with MAQ wells MW-254 and MW-255. The PCE concentration increased from installation in 2004 to 2017 but has had a decreasing trend since 2018; the TCE concentration has been near 1 µg/L.

MW-254 is in the MAQ down-gradient of MW-140 and near the northwest corner of the MI. The PCE concentration has been increasing since 2015 and TCE since 2019; both concentrations were slightly below 10 µg/L in October 2022.



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ug/L (Log Scale)
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0.1
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10/3/2007
1/9/2008
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10/10/2008
4/6/2009
10/8/2009
4/1/2010
10/6/2010
4/3/2011
10/6/2011
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4/9/2019
10/12/2019
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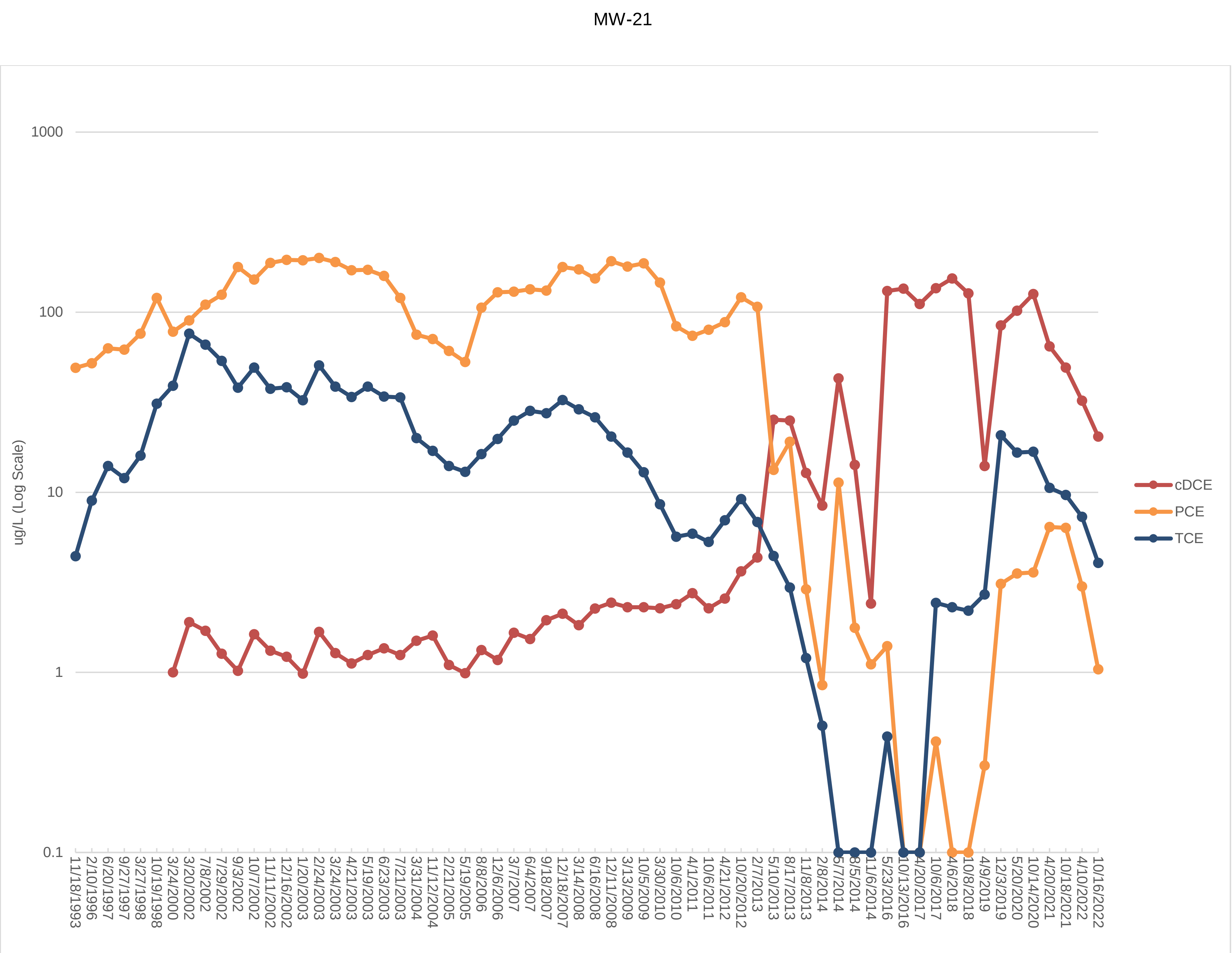
cDCE
PCE
TCE



MW-21
ug/L (Log Scale)
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100
10
1
0.1
cDCE
PCE
TCE
11/18/1993
2/10/1996
6/20/1997
9/27/1997
3/27/1998
10/19/1998
3/24/2000
3/20/2002
7/8/2002
7/29/2002
9/3/2002
10/7/2002
11/11/2002
12/16/2002
1/20/2003
2/24/2003
3/24/2003
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6/23/2003
7/21/2003
3/31/2004
11/12/2004
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3/7/2007
6/4/2007
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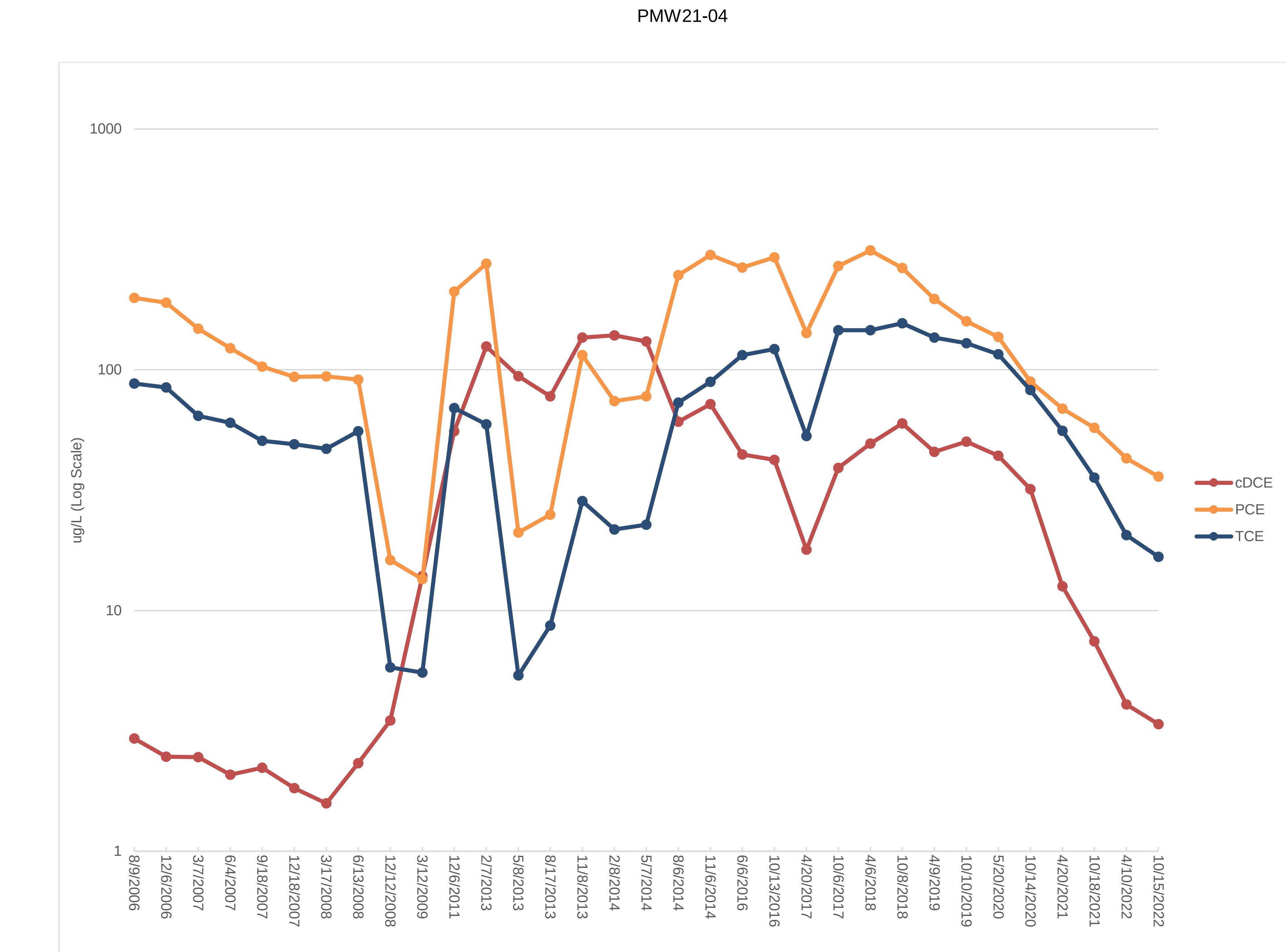
4/20/2021
10/18/2021
4/10/2022
10/16/2022



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ug/L (Log Scale)
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4/9/2019
10/10/2019
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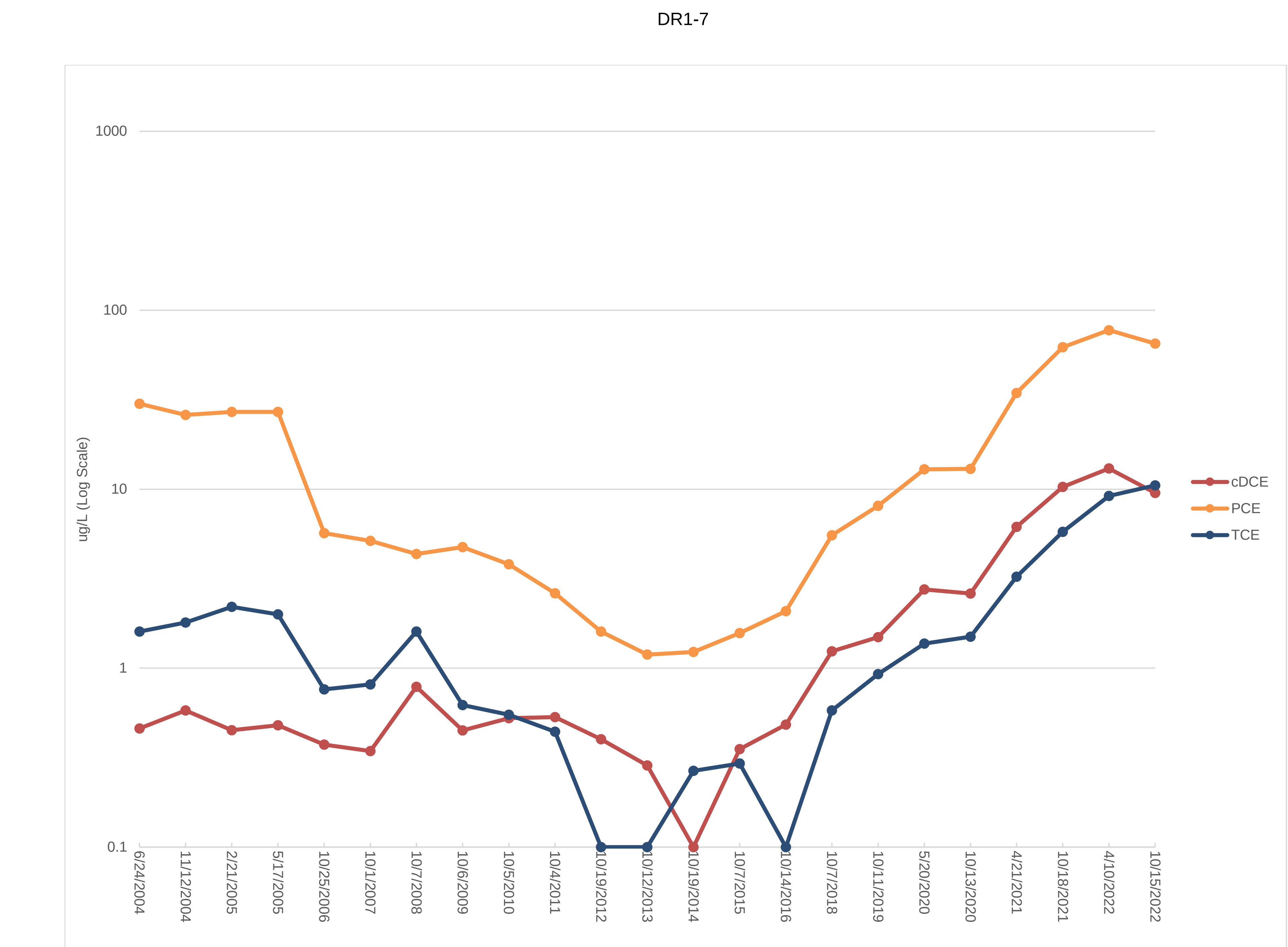
cDCE
PCE
TCE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10/7/2018
10/11/2019
5/20/2020
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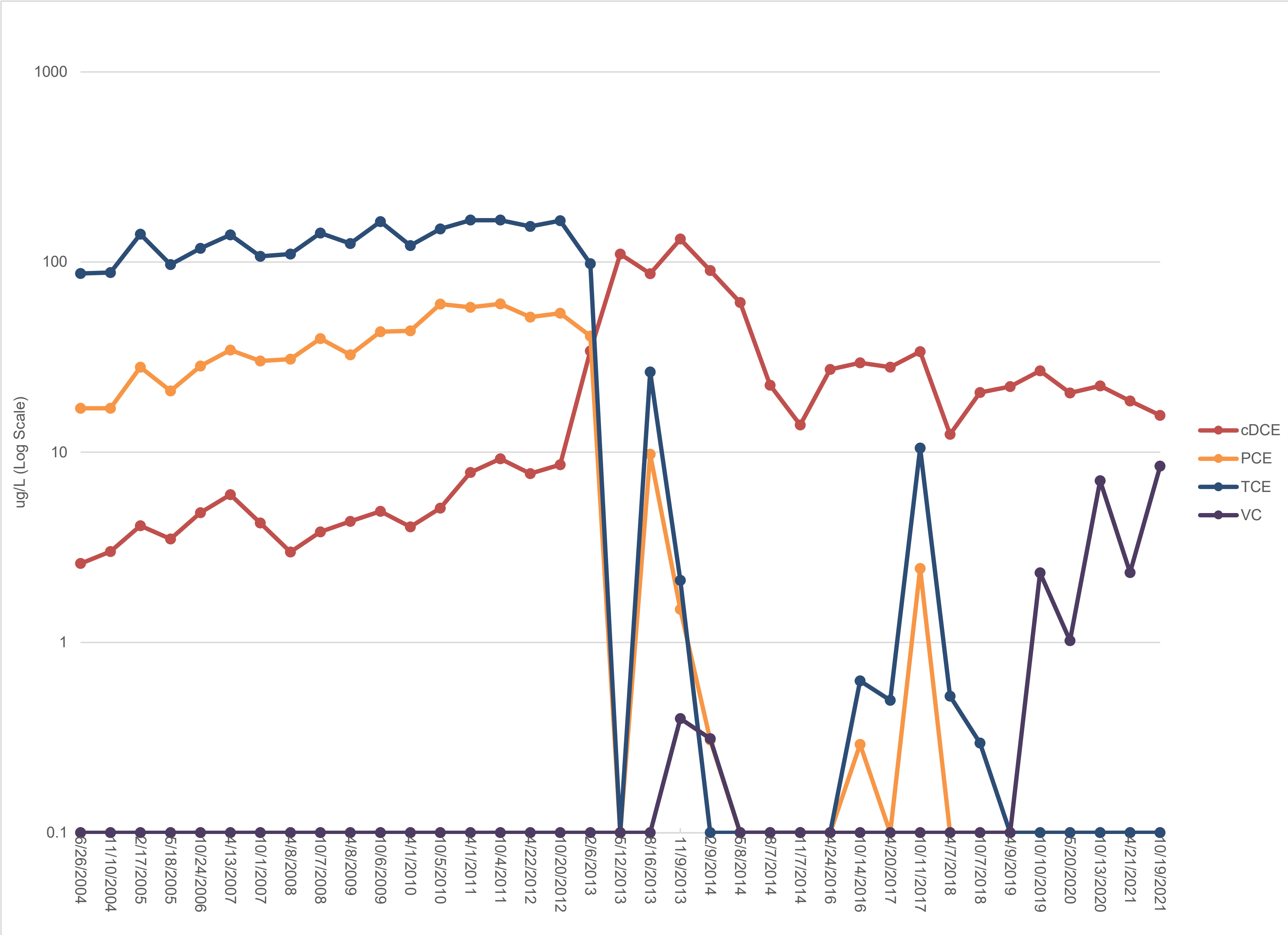
10/18/2021
4/10/2022
10/15/2022
cDCE
PCE
TCE

DR1-6A



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4/20/2017
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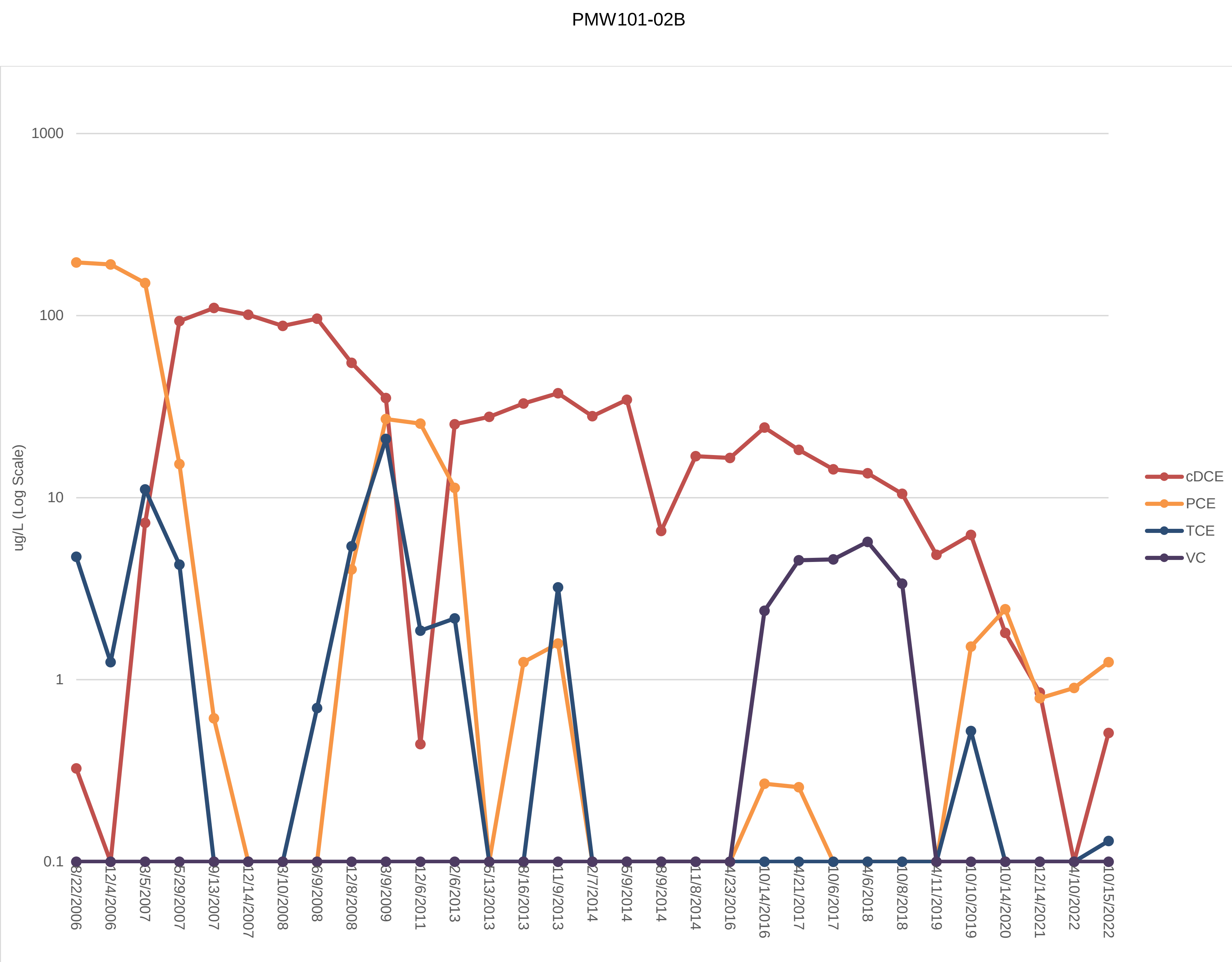
10/19/2021
cDCE
PCE
TCE
VC



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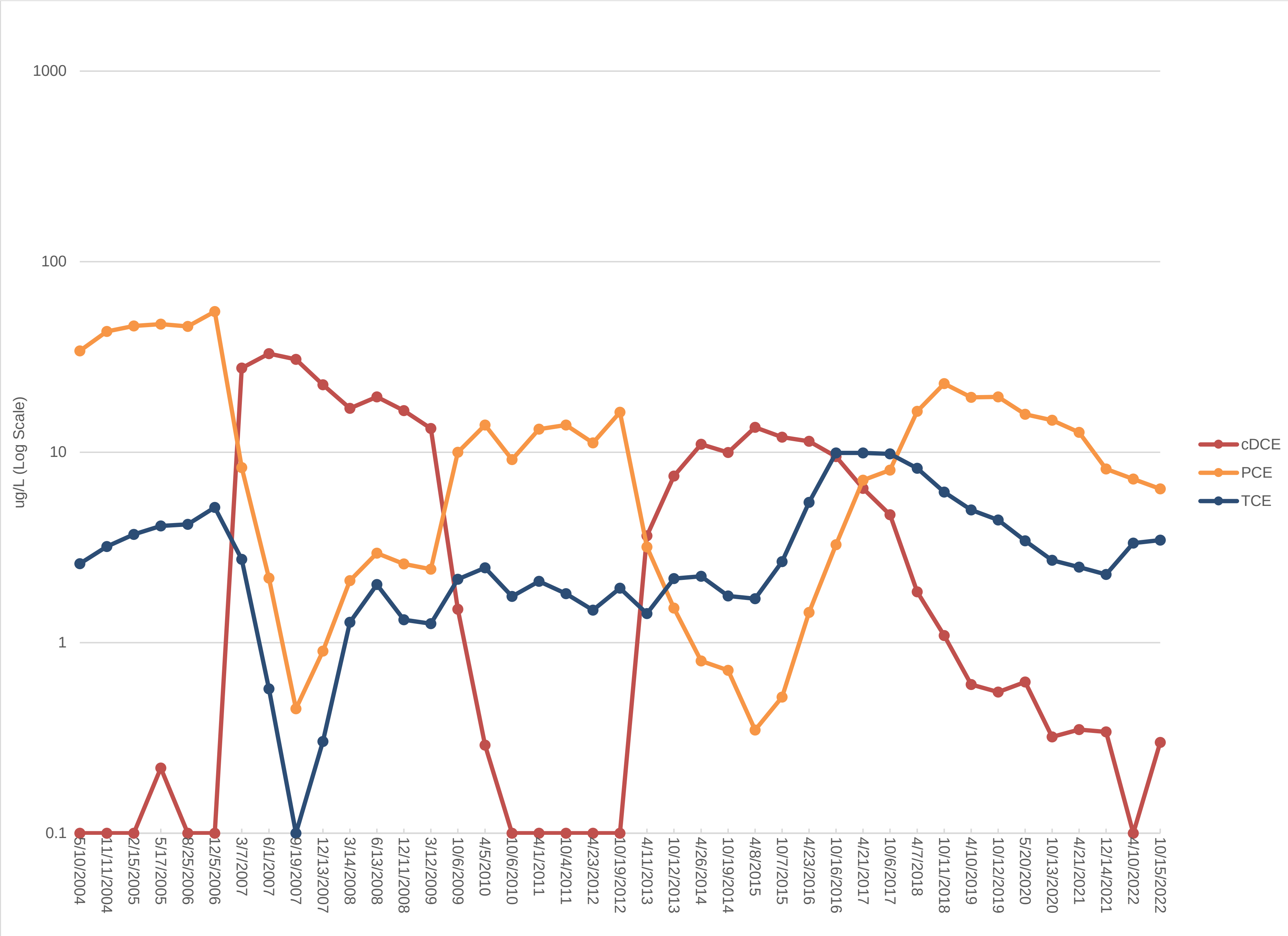
cDCE
PCE
TCE
VC

DR1-3



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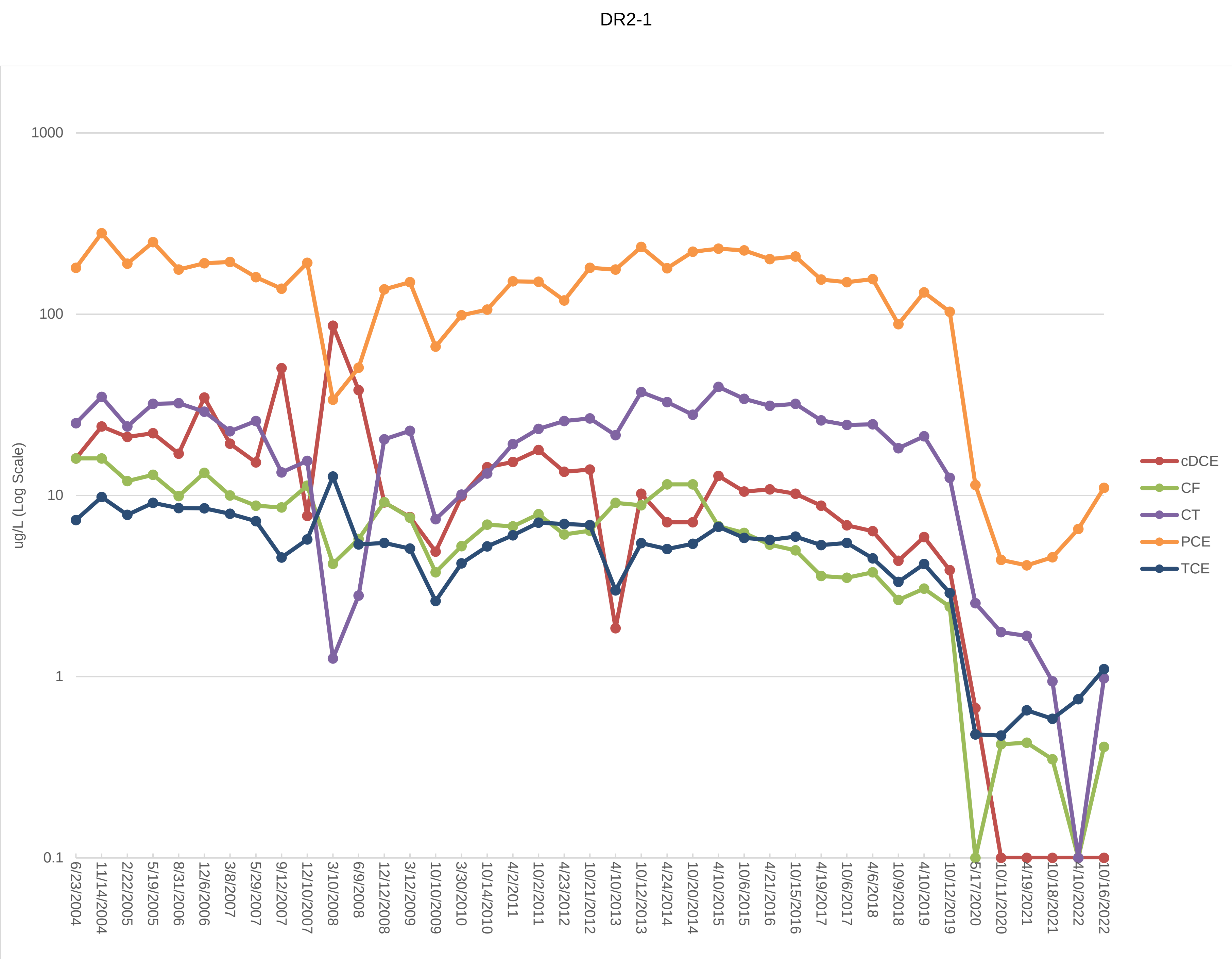
TCE



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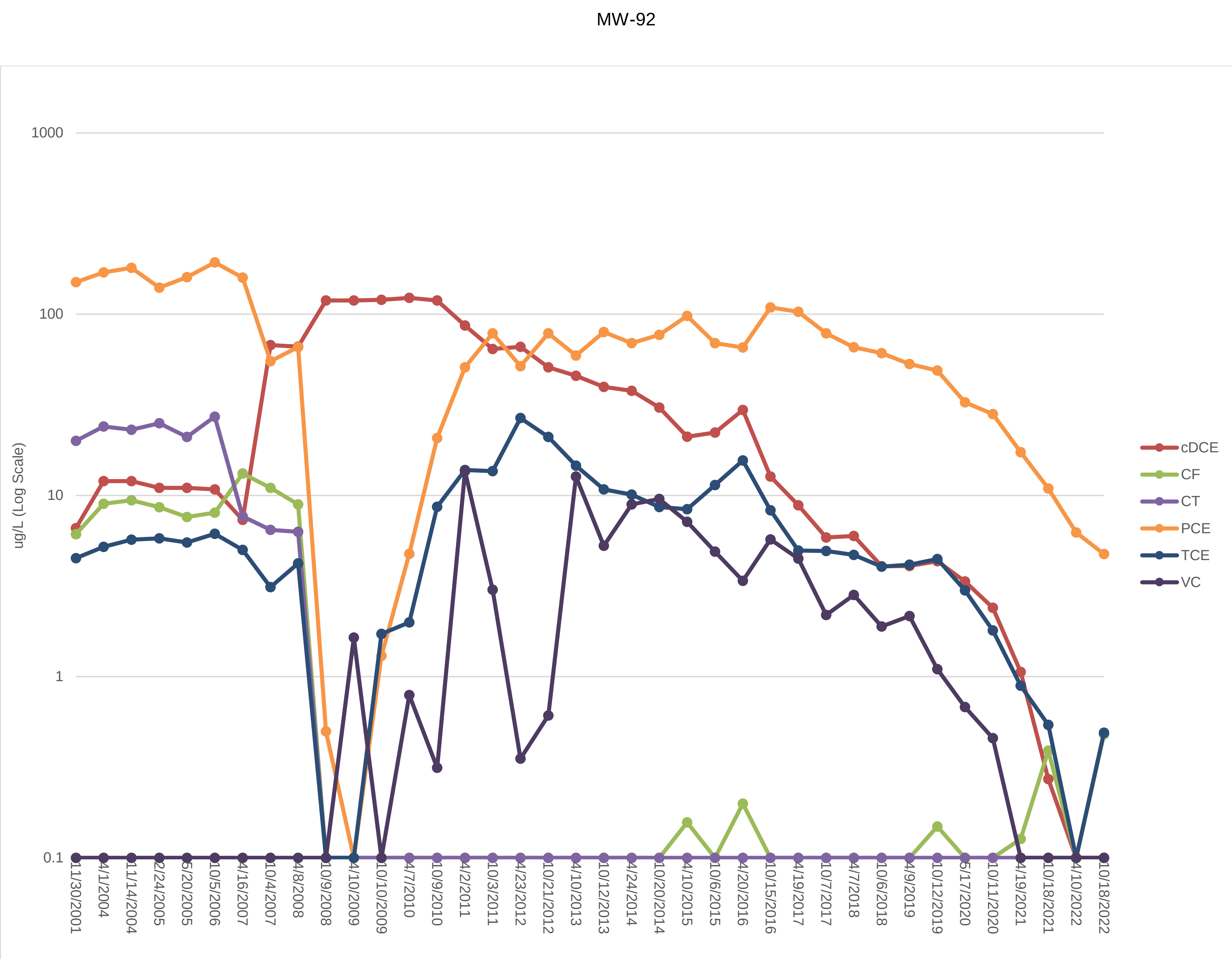
PCE
TCE



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CF
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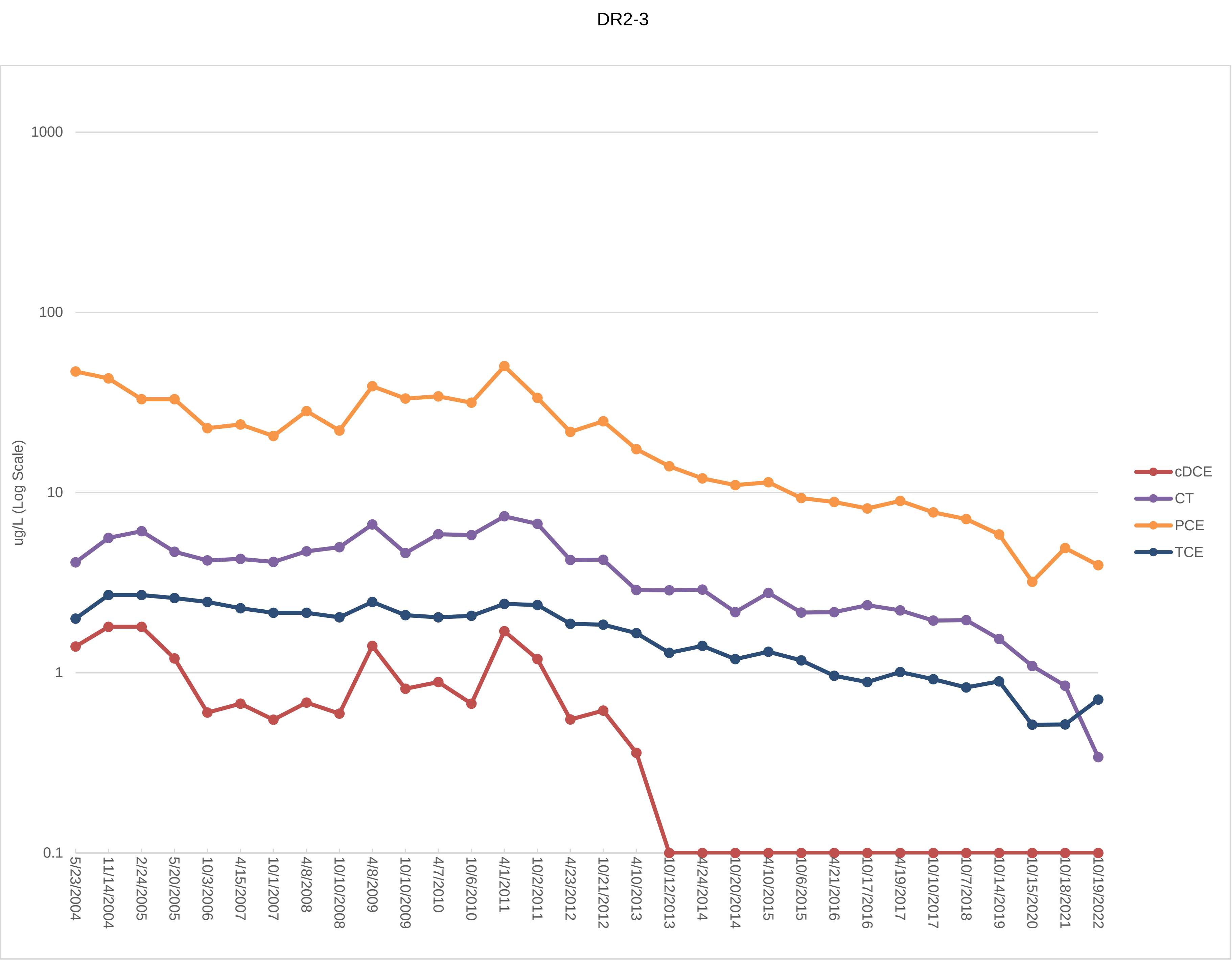
PCE
TCE
VC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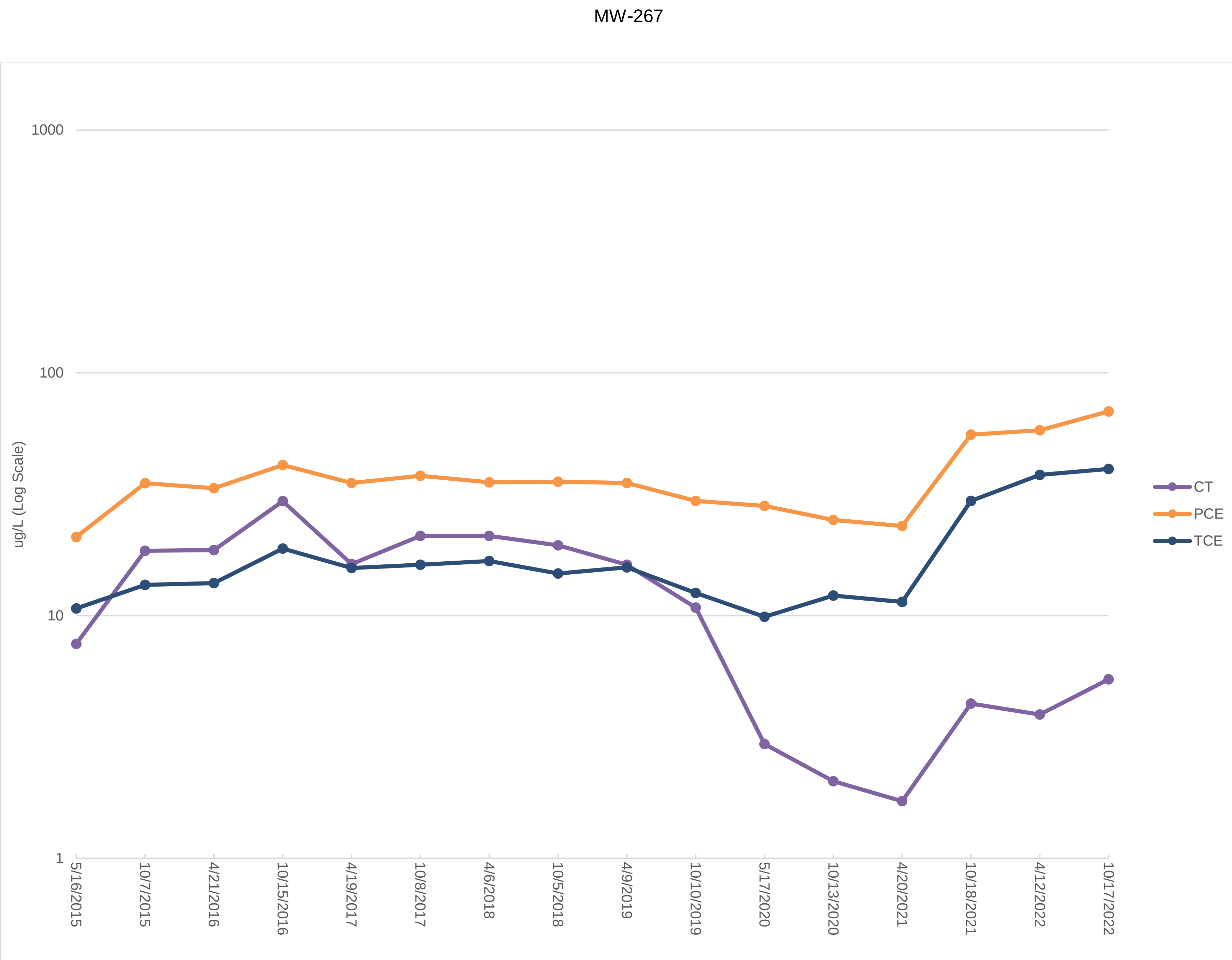
CT
PCE
TCE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10/10/2019
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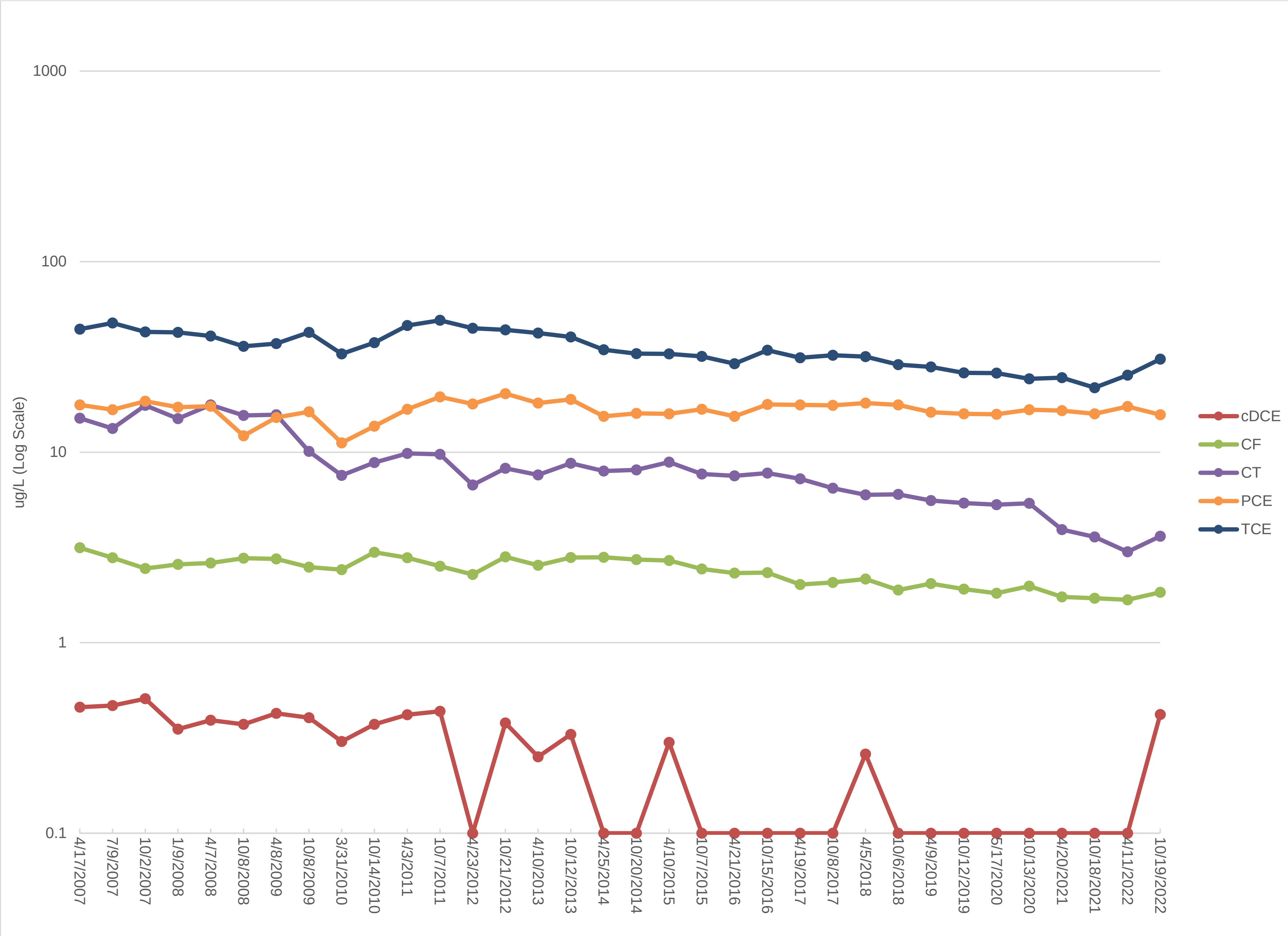
10/17/2022
CT
PCE
TCE

MW-218



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100
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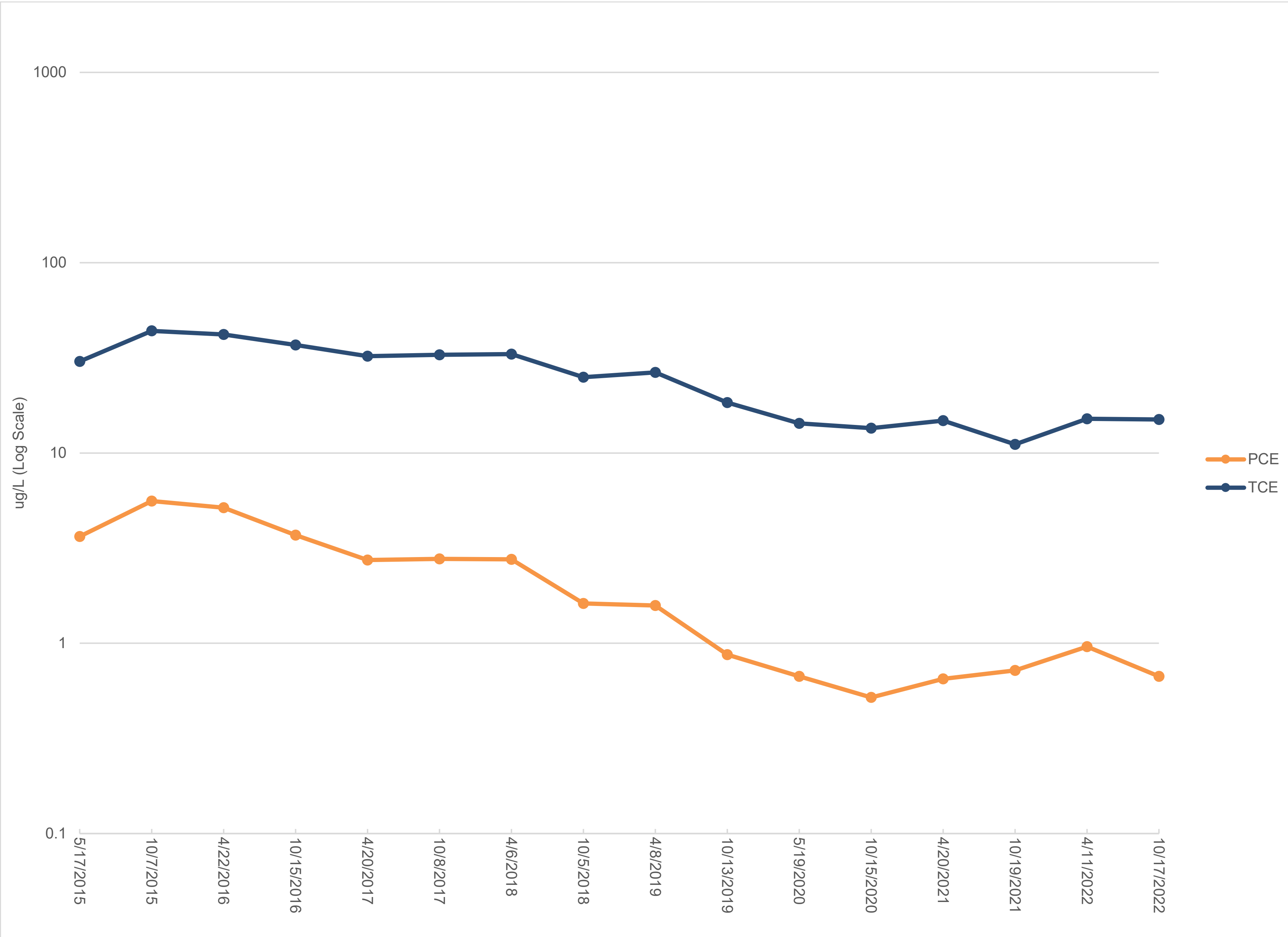
cDCE
CF
CT
PCE
TCE

MW-263



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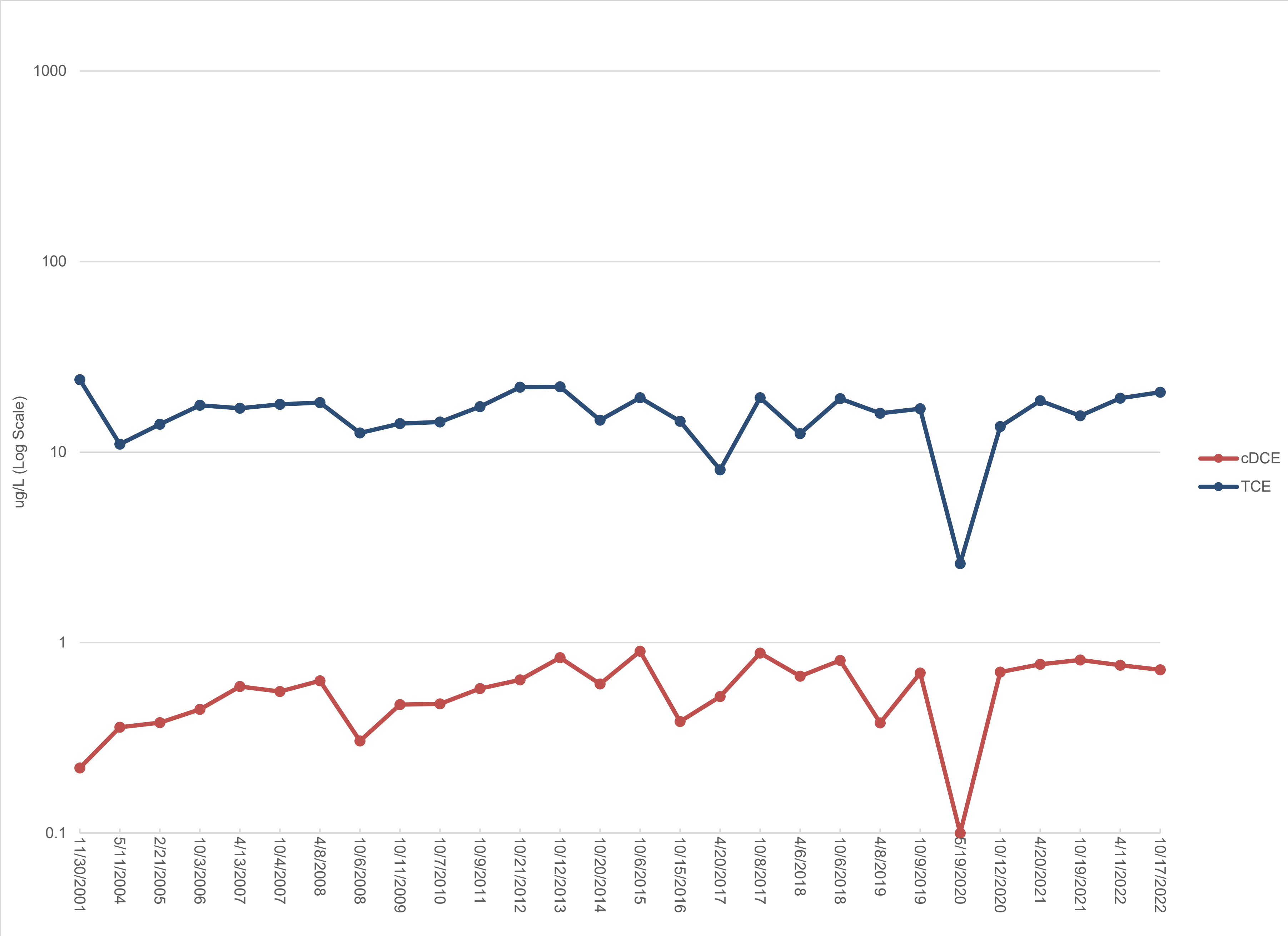
PCE
TCE

MW-104



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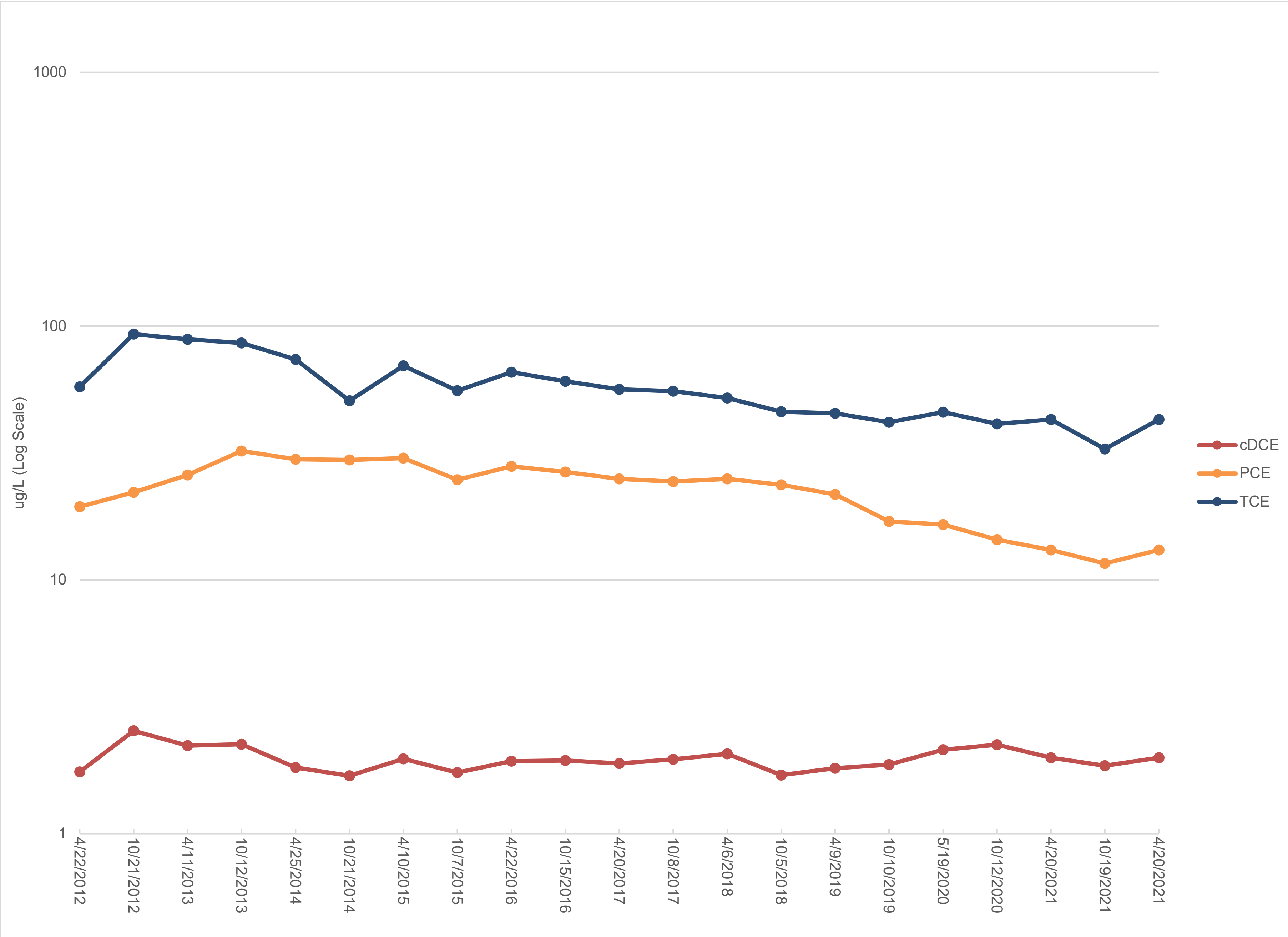
cDCE
TCE

MW-258



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4/9/2019
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4/20/2021
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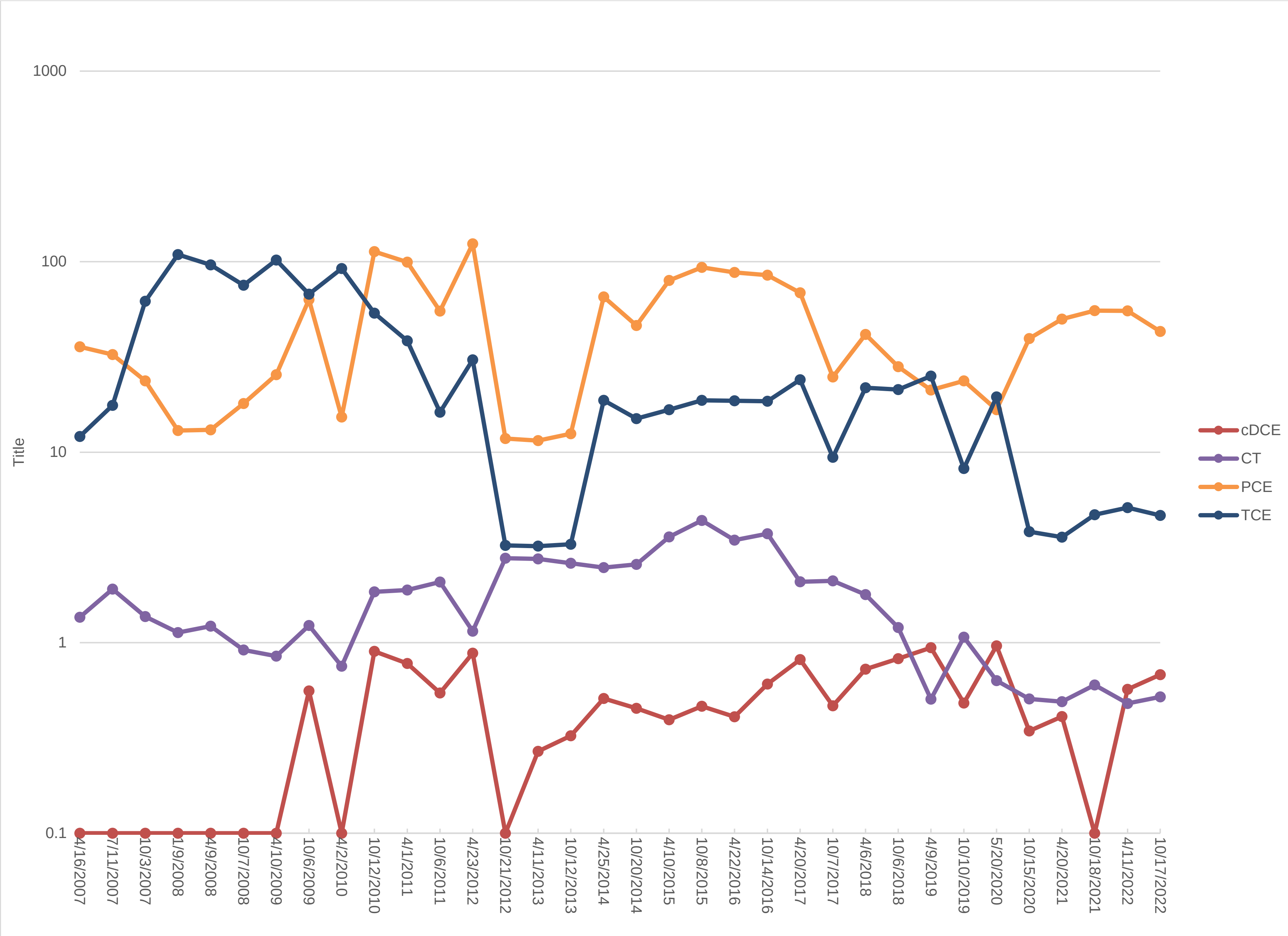
4/20/2021
cDCE
PCE
TCE

MW-207B



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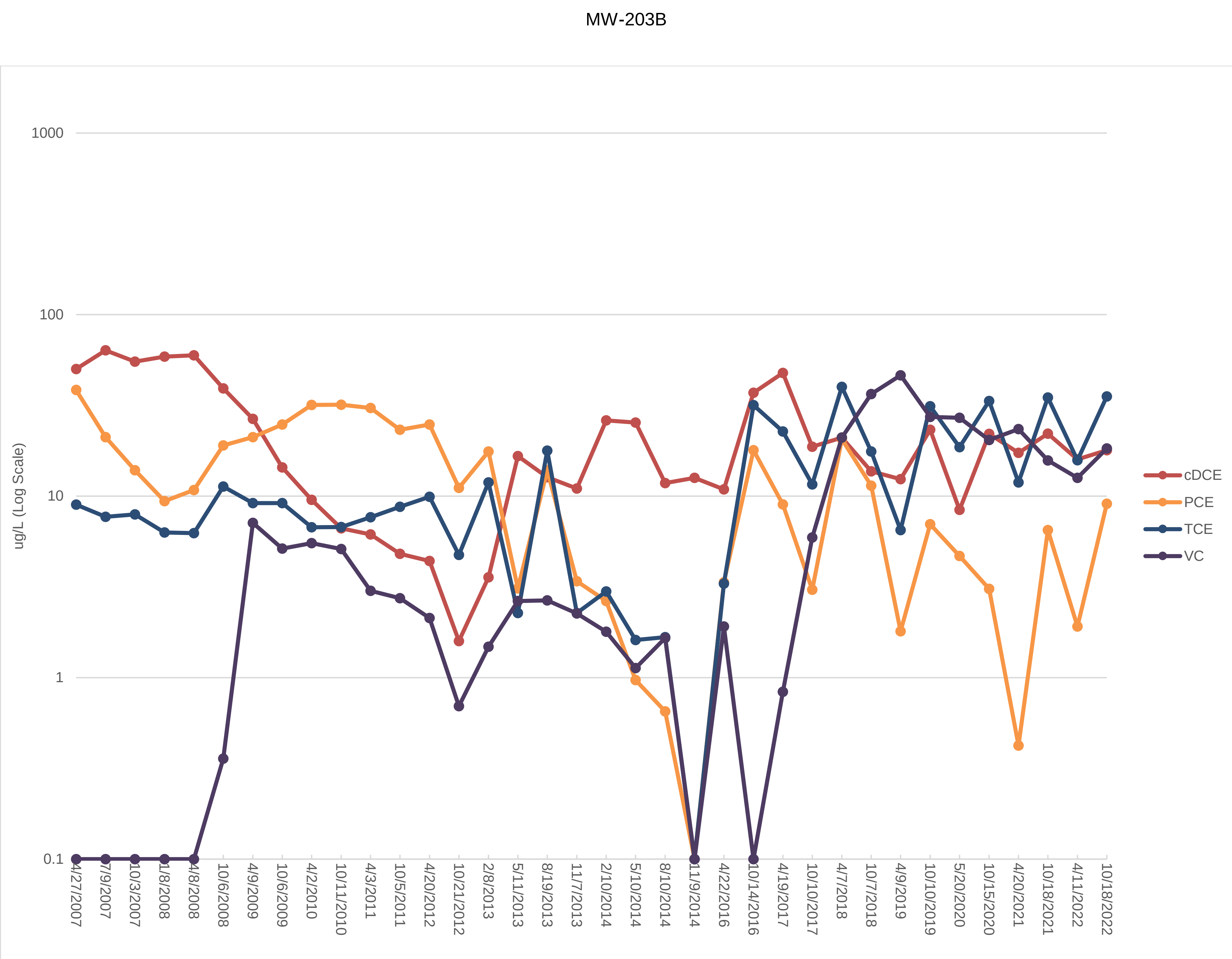
PCE
TCE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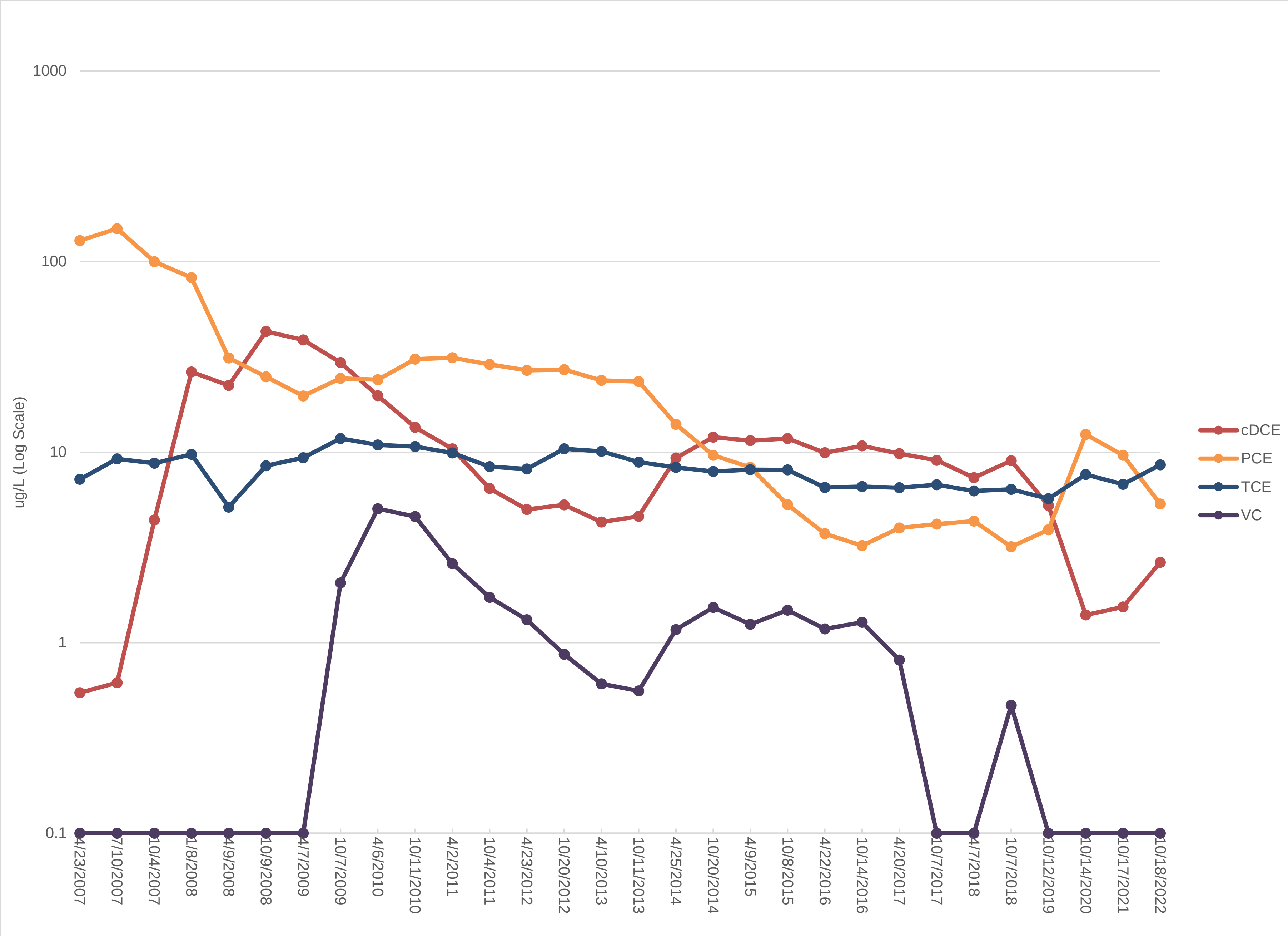
cDCE
PCE
TCE
VC

MW-205B



ug/L (Log Scale)
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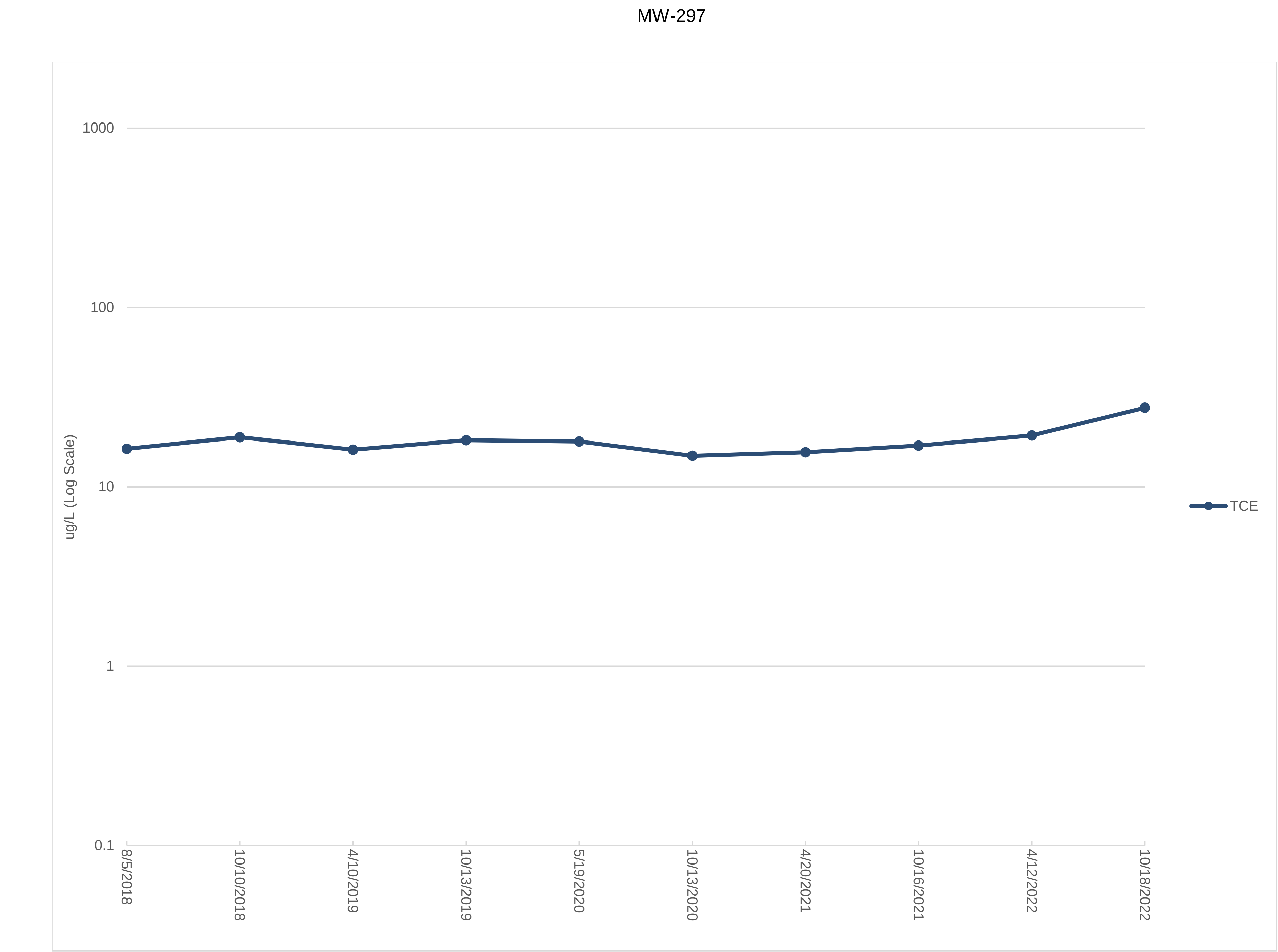

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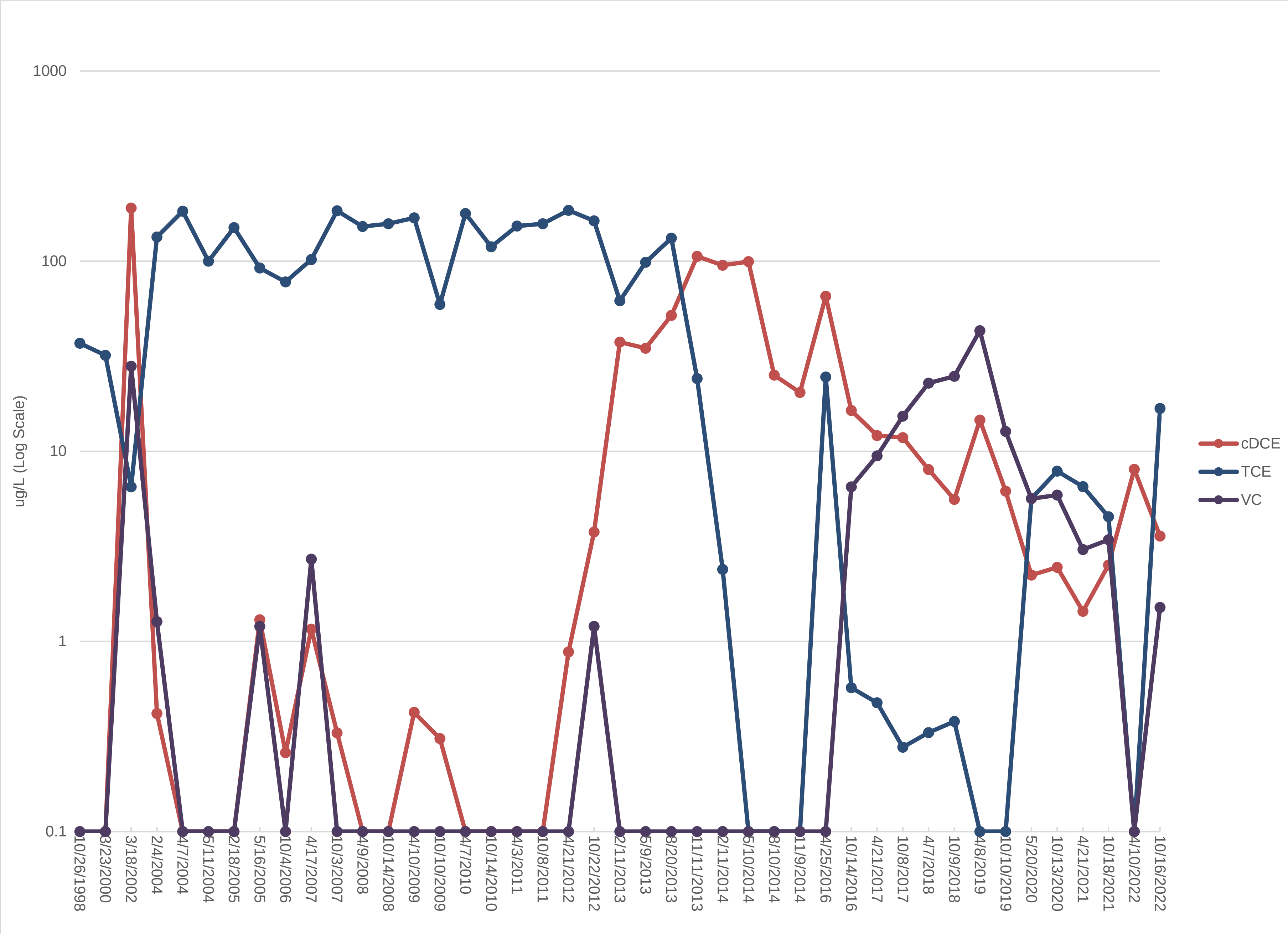
MW-62



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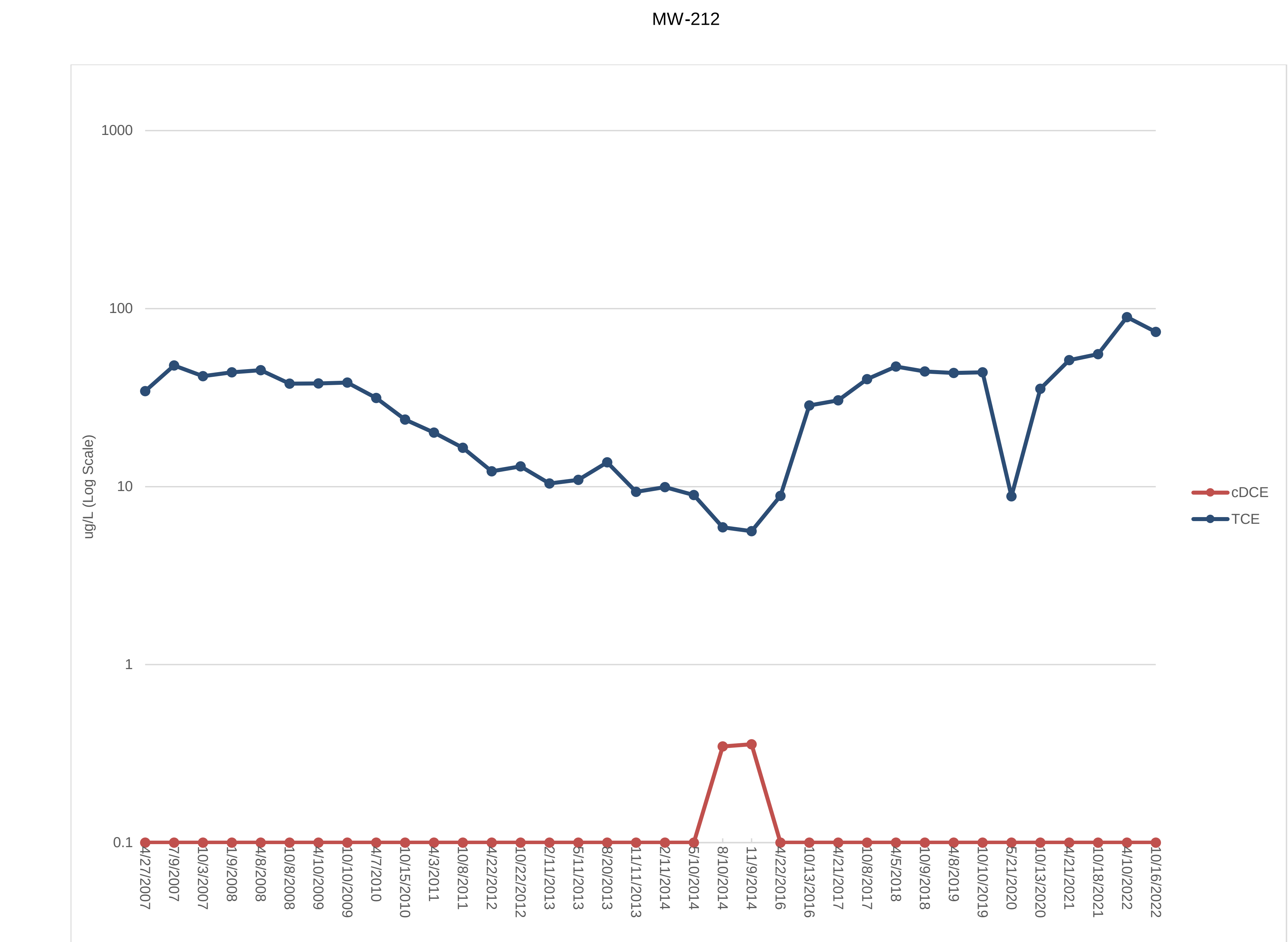
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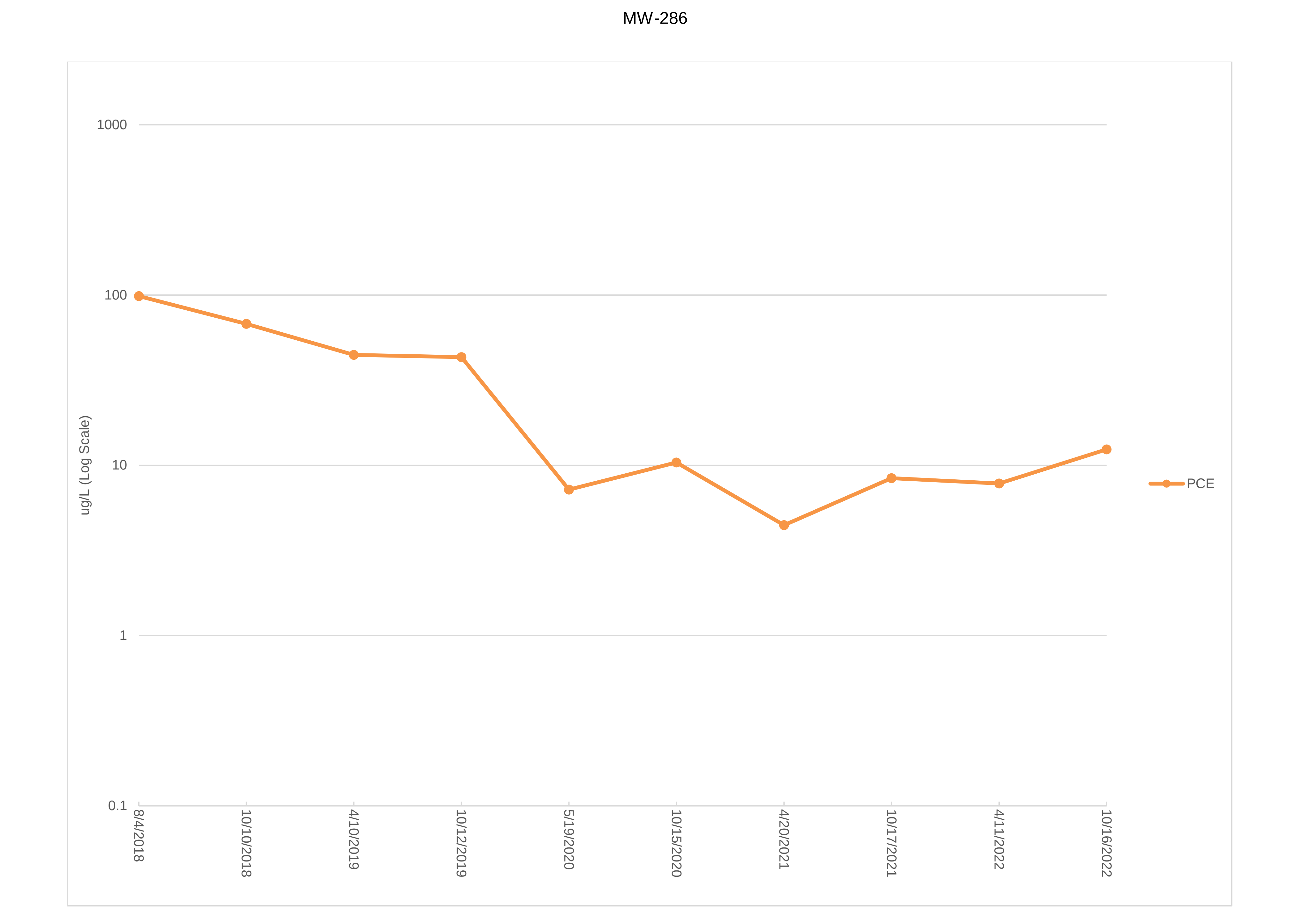

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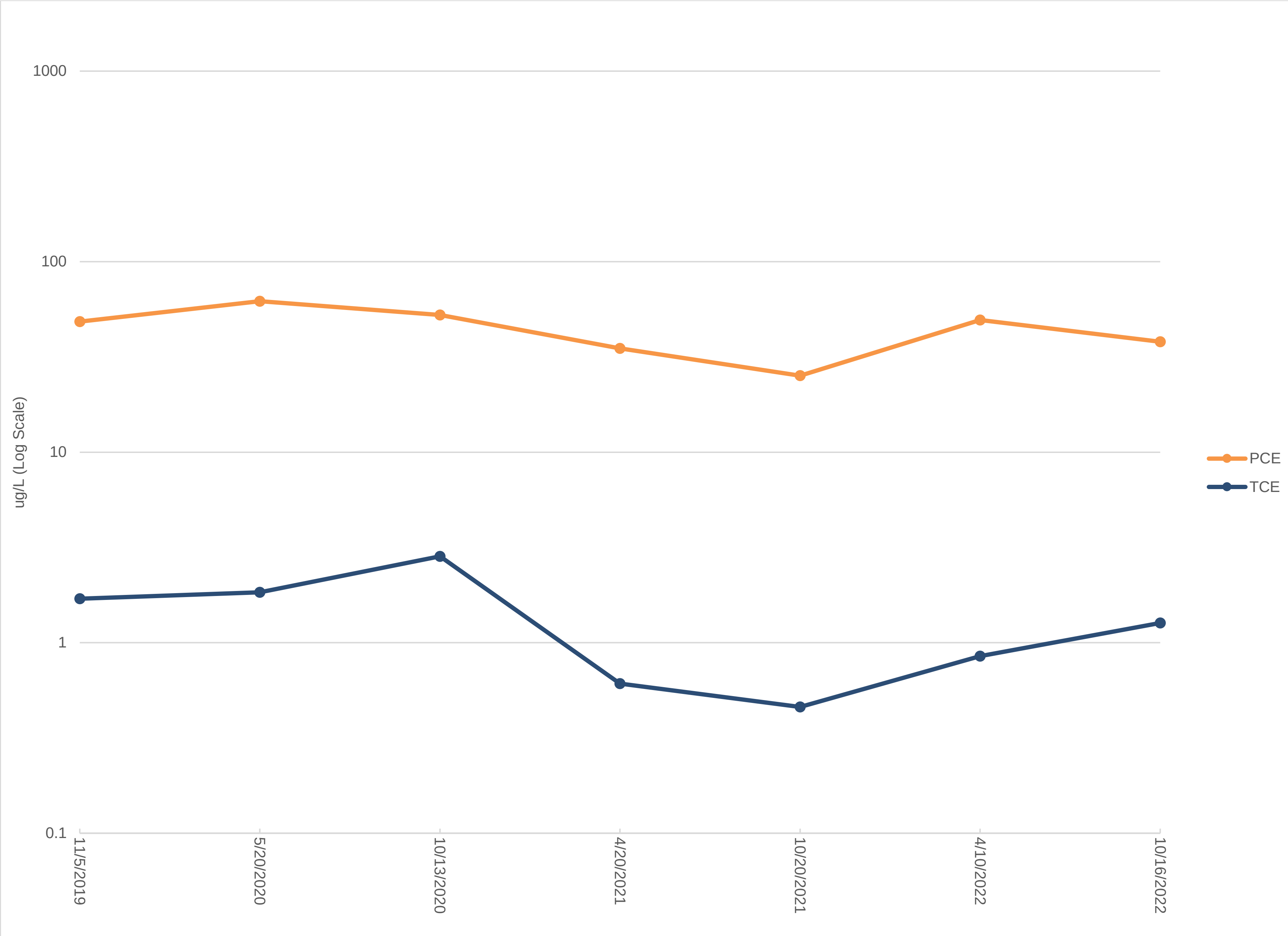
MW-305



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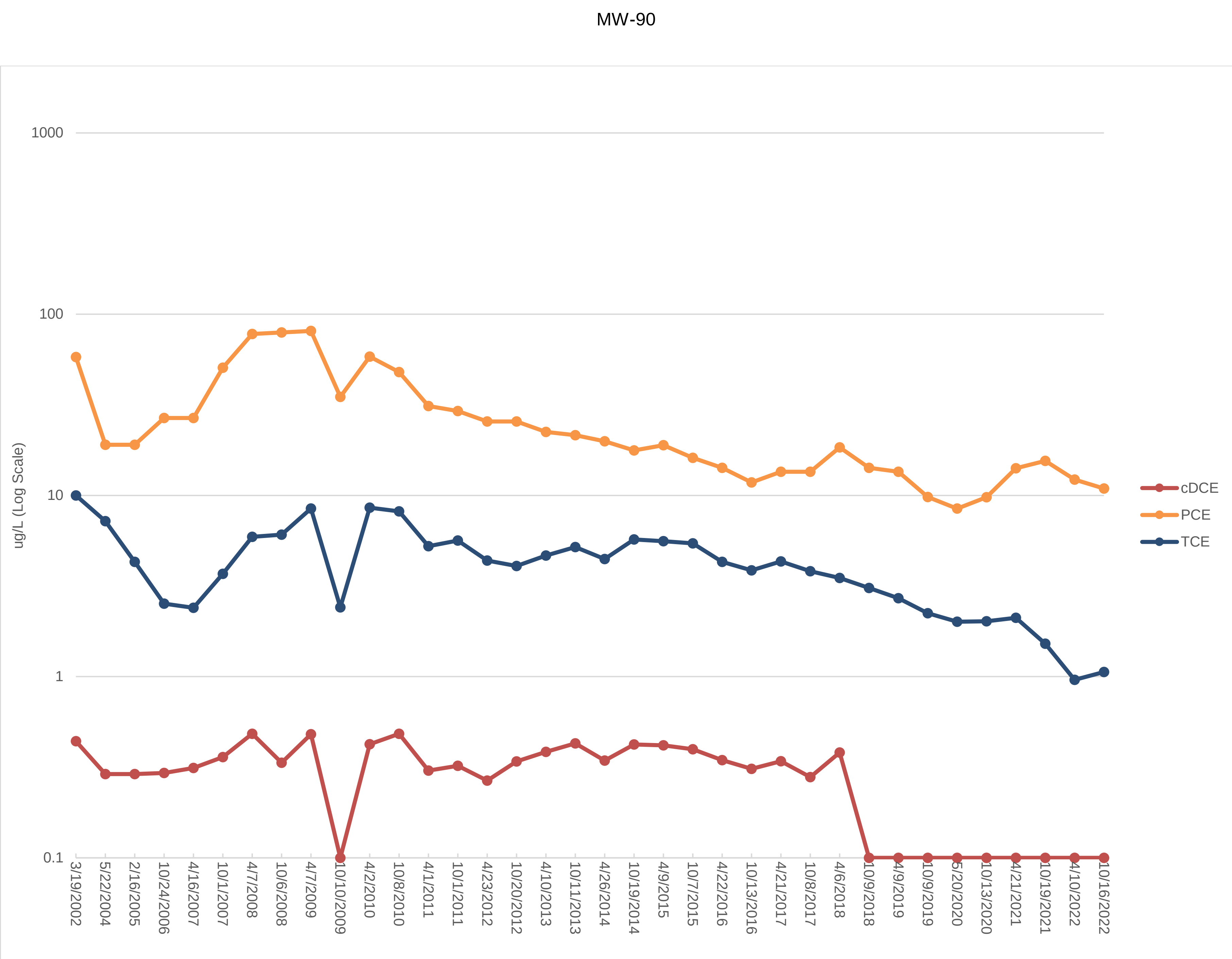

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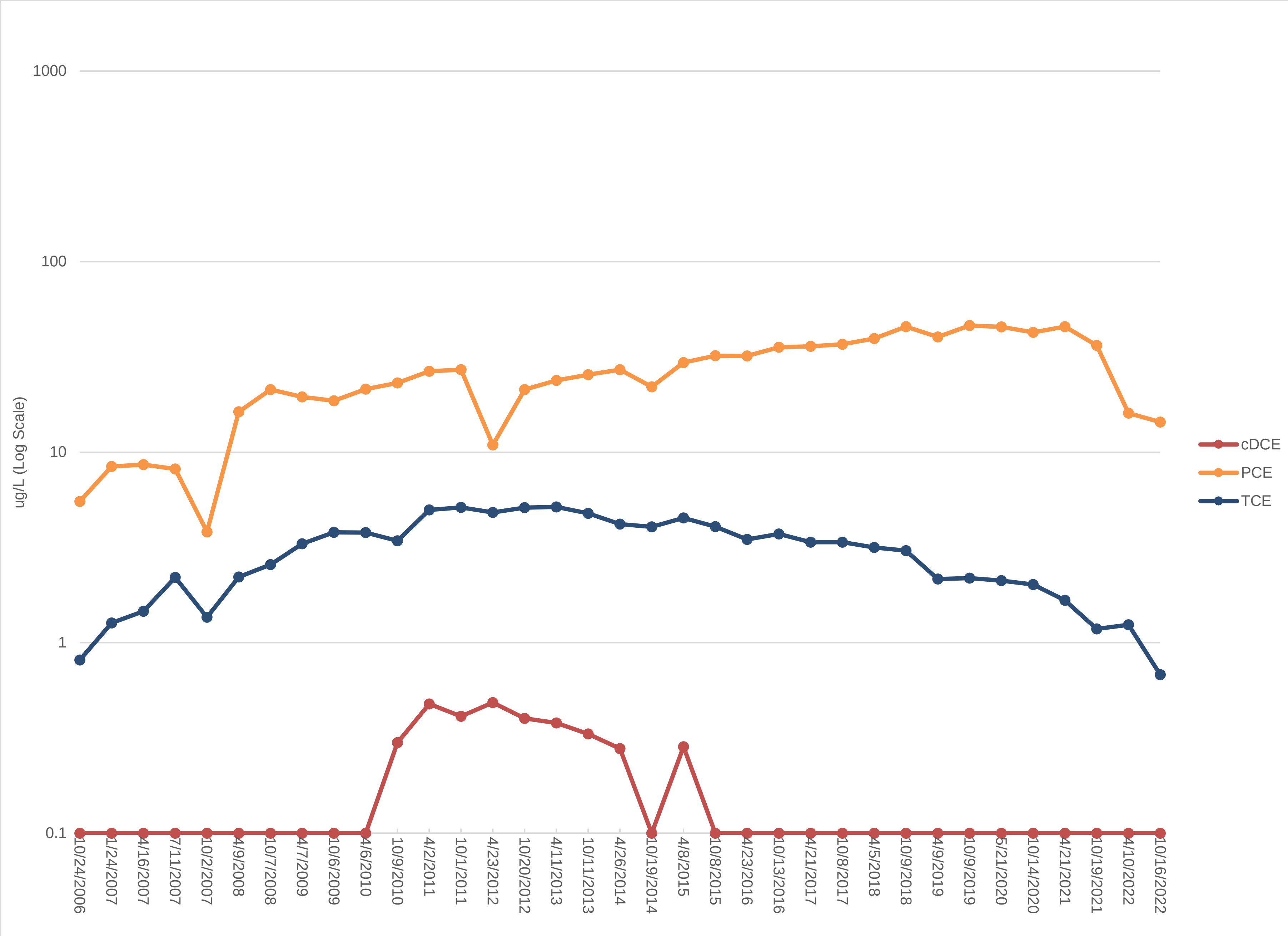

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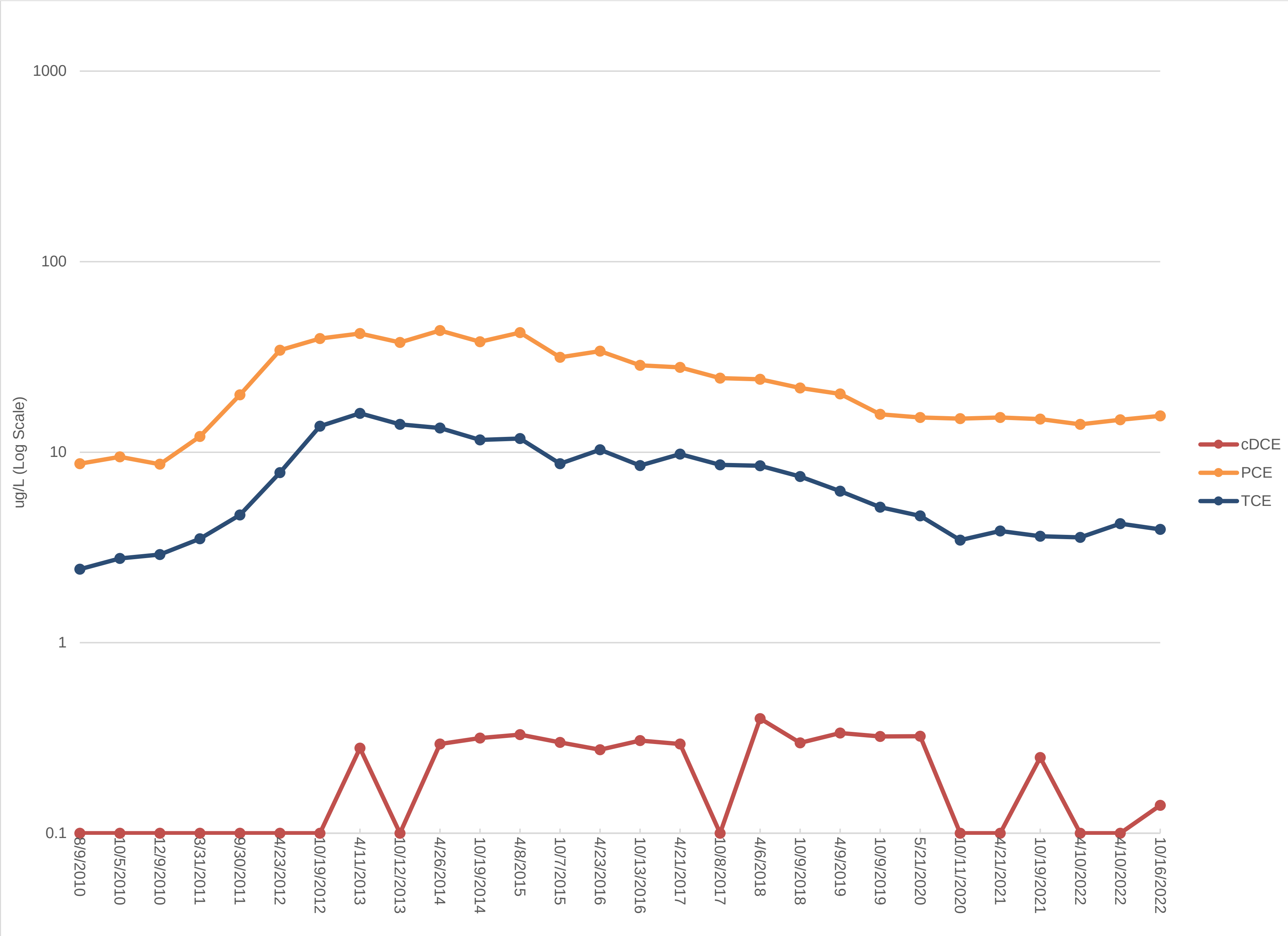
MW-256



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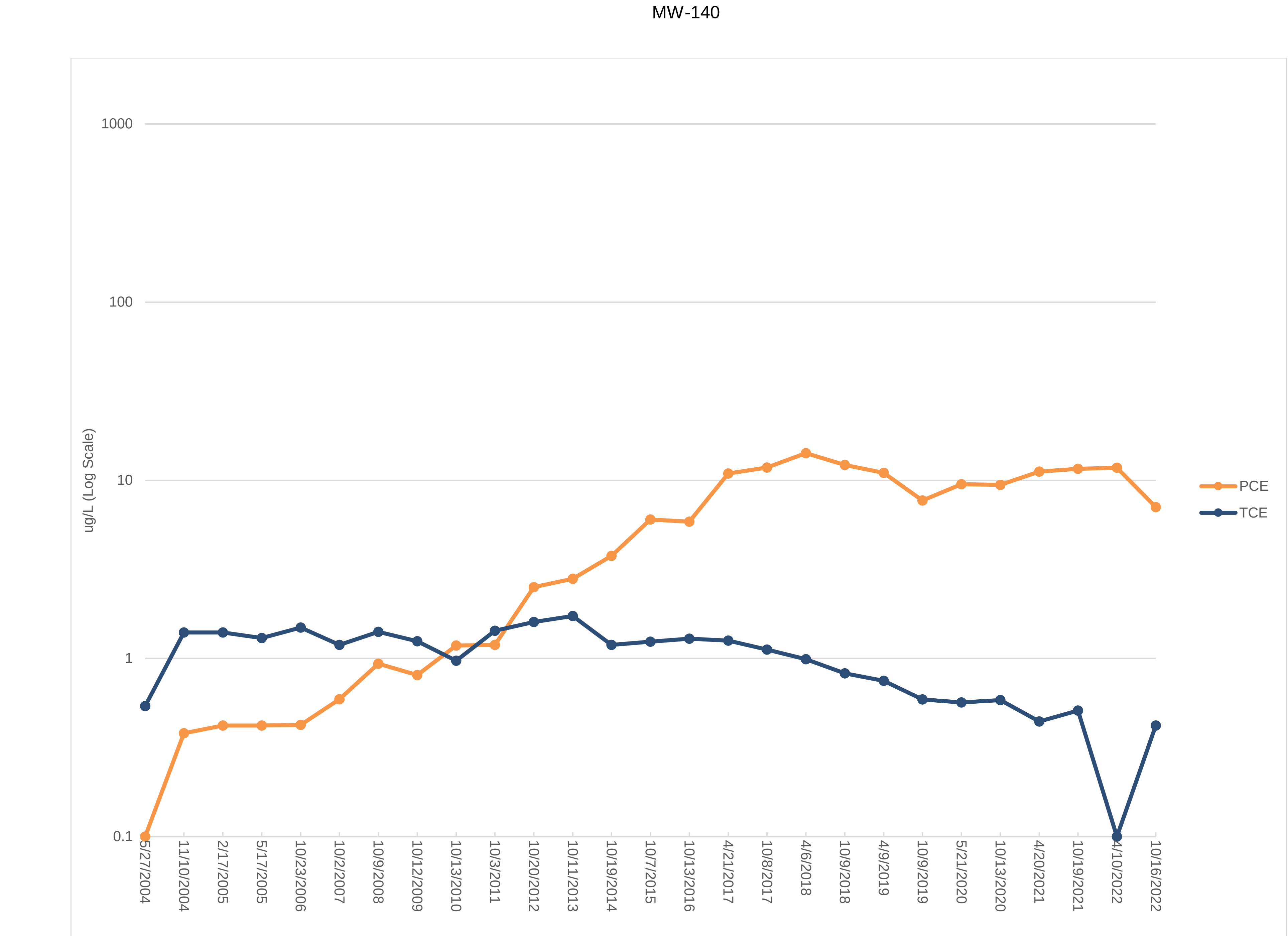
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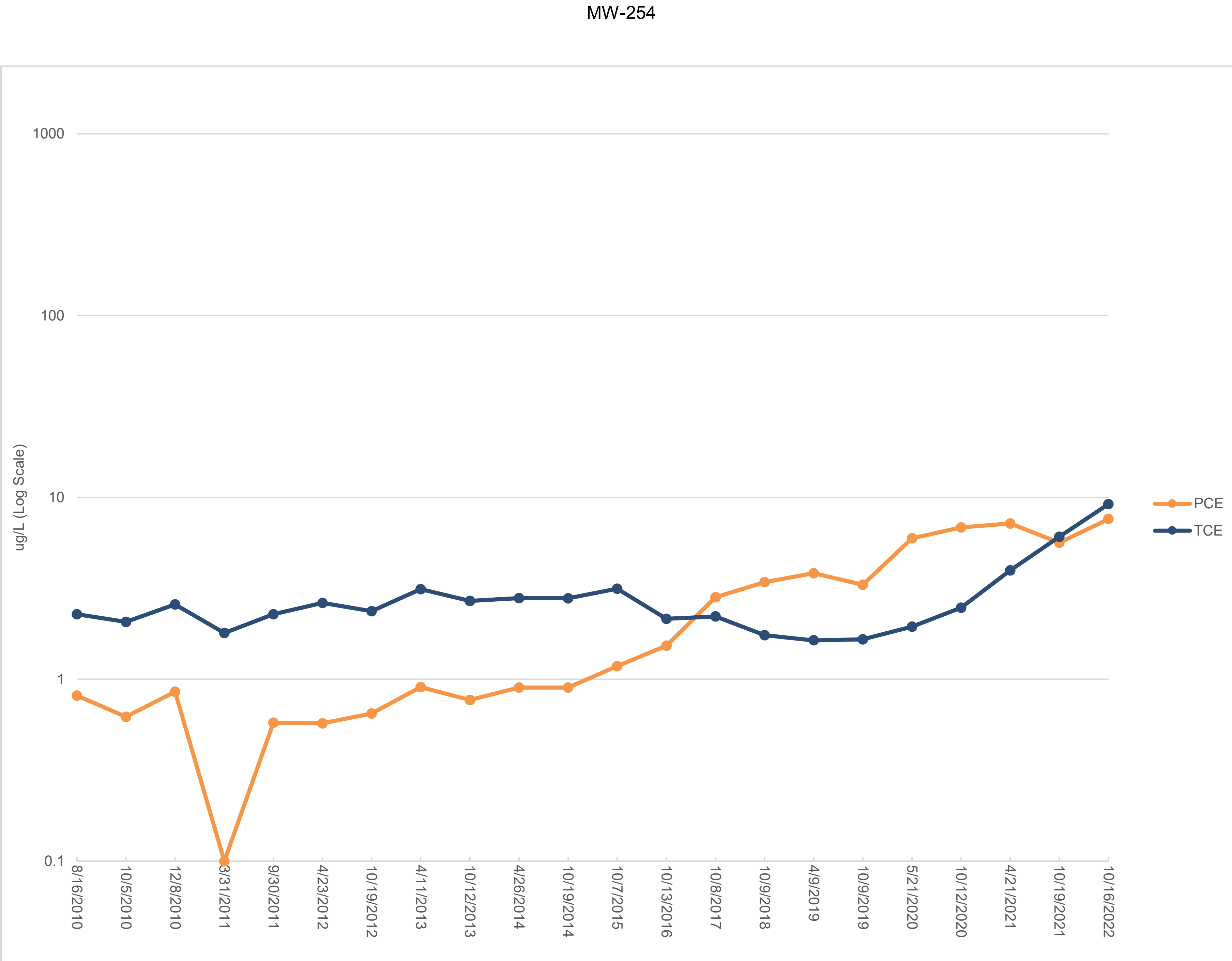

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PCE
TCE

C

Appendix C

Agency Correspondence and Responses to Comments

STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
Division of Remediation
Memphis Environmental Field Office
8383 Wolf Lake Drive
Bartlett, TN 38133-4119

January 17, 2023

James C. Foster
BRAC Program Manager
Headquarters Department of the Army,
Assistant Chief of Staff for
Installation Management (DAIM-ODB)
Army Pentagon,
2530 Crystal Drive,
Arlington, VA 22202-3934

Subject: **2022 Main Installation Focused Feasibility Report, Rev 0**
Defense Depot Memphis, Tennessee
TDoR ID # 79-736
TN4210020570

Mr. Foster,

TDEC-DoR has reviewed the **2022 Main Installation Focused Feasibility Report (Rev 0)** and has no comments regarding the document's contents. If there are questions regarding the approval, please contact me at (901) 371-3041 or at jamie.woods@tn.gov .

Regards,

Jamie A. Woods, P.G.
Project Manager
Division of Remediation
Memphis Environmental Field Office

cc: Bill Millar (CALIBRE)
T. Holmes (HDR Inc)
F. Martinez-Torres (EPA-PM)

TDoR NCO: file 79-736
TDoR MEFO: file 79-736

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION 4
SAM NUNN ATLANTA FEDERAL CENTER
61 FORSYTH STREET, S.W. ATLANTA, GEORGIA 30303

12/18/2022

Mr. James Foster
Base Realignment and Closure Division (ACSIM-ODB)
2530 Crystal Drive (Taylor Building), Room 5000
Arlington, VA 22202-3940

Subject: Unites States Environmental Protection Agency Review of the Defense Depot Memphis Tennessee, 2022 Main Installation Focused Feasibility Study Report, Revision 0

Dear Mr. Foster

The Unites States Environmental Protection (EPA/Agency) has completed its regulatory review over the review of the 2022 Main Installation Focused Feasibility Study Report, Revision 0, dated September 2022 for the Defense Depot Memphis, Tennessee (the FFSR/ Report).

This will be a review of the previously mentioned FFSR. DDMT is a large facility with eight proposed treatment areas. Except for a couple of wells in Target Treatment Area 1 (TTA-1) North, all the Volatile Organic Compound (VOC) concentrations are less than 100 ug/L, and the highest concentrations are in the shallowest aquifer, the Fluvial. There are erosional features in the subsurface and clay layers that make hydrogeology somewhat complicated. There have been some small detections of Tetrachloroethene (PCE) and Trichloroethene (TCE) in the Memphis Sand Aquifer.

Moreover, Figure 18 shows chlorinated VOC detections in the Memphis Sand Aquifer. As part of the monitoring plan, downgradient monitoring locations will need to be installed.

Additionally, the Agency noted that it is unclear why groundwater contamination located west of the TTA-1 North area is attributed to an off-site source. One general comment was generated further highlighting this concern. The EPA also noted it is unclear how the treatment target concentration of 40 micrograms per liter (µg/L) in groundwater was derived. One general comment was generated further highlighting this issue.

Last, 20 specific comments were generated to further enhance the clarity and overall completeness of the Report.

The USEPA commends the USARMY for its efforts on further investigating the DDMT environmental conditions. If you have any questions about this letter, please contact me via email at martinez-torres.fernando@epa.gov or at 404-695- 4991.

Sincerely,

FERNANDO MARTINEZ-TORRES

Digitally signed by FERNANDO MARTINEZ-TORRES
Date: 2022.12.18 15:48:44 -05'00'

Fernando Martinez Torres
Remedial Project Manager
Restoration and DOD Coordination Section
Superfund & Emergency Management Division
United States Environmental Protection Agency

cc: Jaime A. Woods, TDEC
cc: William Millar, CALIBRE
cc: Laura Roebuck, USACE, Mobile
cc: Melissa Shirley, USACE, Mobile
cc: Ben Bentkowski, USEPA, R4
cc: Kevin Koporec, USEPA, R4

Unites States Environmental Protection Agency
Review of the Defense Depot Memphis Tennessee,
2022 Main Installation Focused Feasibility Study Report,
Revision 0

GENERAL COMMENTS

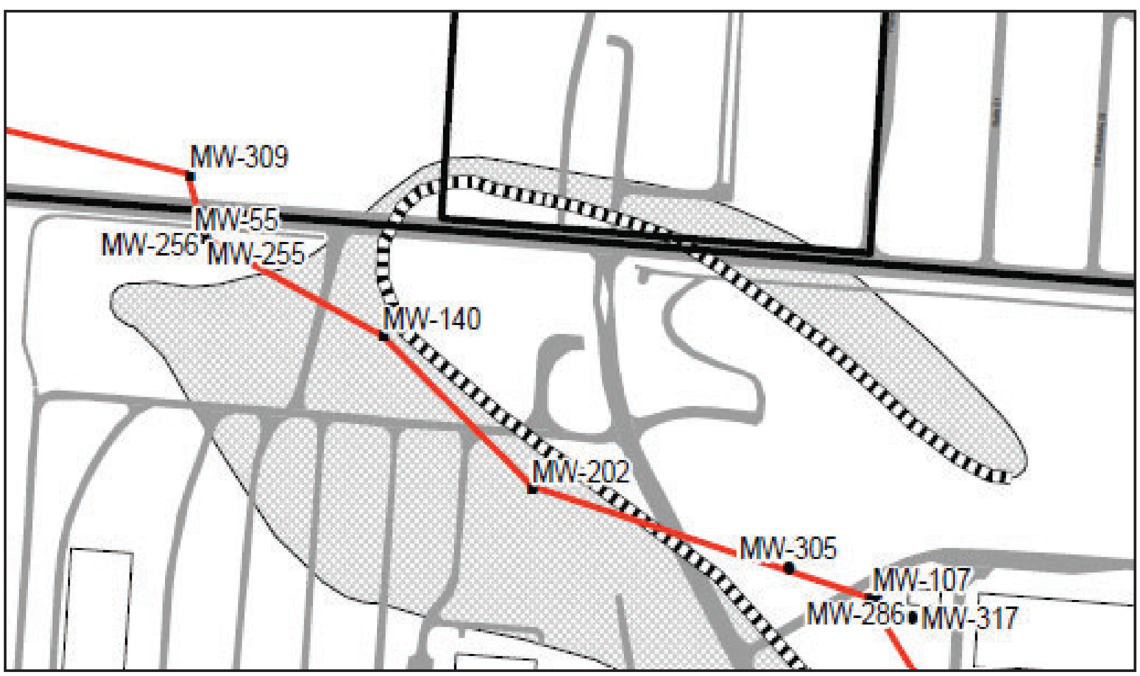
1. In several sections of the FFSR, groundwater contamination located to the west of the TTA-1 North (N) area is partially attributed to an off-site source. It is acknowledged that based on groundwater flow, it appears there may be an off-site source area. However, since the area west of TTA-1 is currently, and has historically been primarily used for residential purposes, it is unlikely that chlorinated solvents were stored, handled, and released into the subsurface. Additionally, due to continued pumping of the Allen Wellfield since the 1950s, groundwater sinks located at MW-39 and MW-259, respectively, and the erosional window located to the east of the TTA-1N area have influenced groundwater flow. Therefore, prior to the 1950s, natural groundwater flow in the TTA-1N area may have been towards the west. Based on this reversal of groundwater flow, off-site contamination east of TTA-1N may have originated on the Main Installation (MI), which is more likely, since chlorinated solvents were handled and stored at the MI. Please provide additional lines of evidence to support the assertion that an off-site source exists west of TTA-1N or consider the off-site contamination west of the TTA-1N area to have originated from the MI.

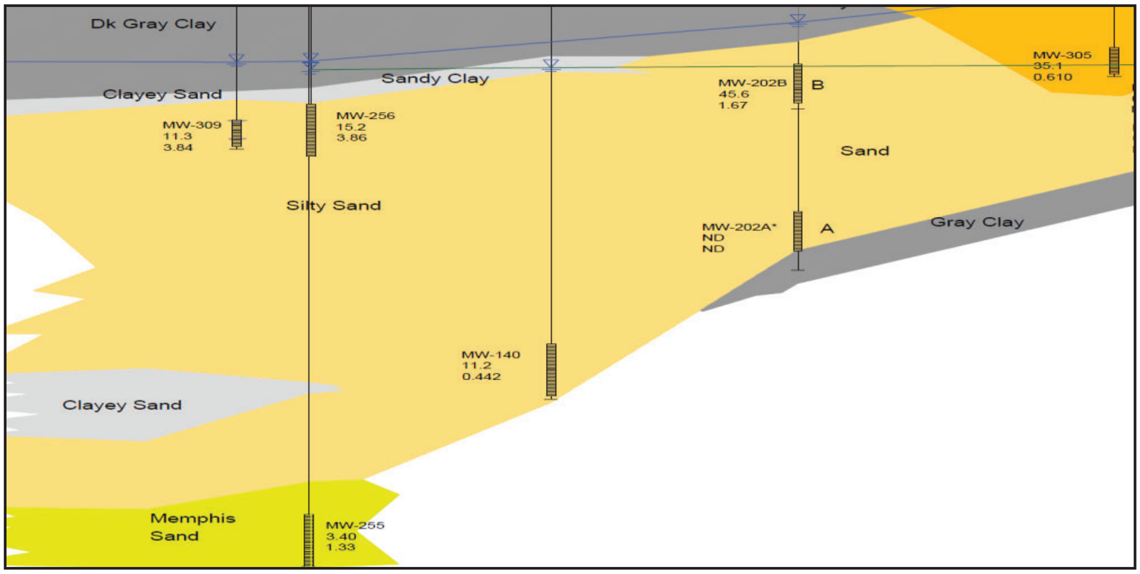
2. The FFSR identifies a treatment target concentration of 40 micrograms per liter (µg/L) for total chlorinated volatile organic compounds (CVOCs) in groundwater at the MI. However, there is no basis or supporting information for selection and/or derivation of this treatment target concentration and it is unclear whether 40 µg/L is a sufficient target concertation for measuring weather monitored natural attenuation (MNA) will occur within a reasonable timeframe. Please include additional background information for the selection of the 40 µg/L treatment target concentration.

3. Monitored Natural Attenuation (MNA) is a major component of all the proposed remedies under consideration in this document. As per EPA's 1999 MNA Guidance1, one of the primary lines of evidence requires is "Historical groundwater and/or soil chemistry data that demonstrate a clear and meaningful trend of decreasing contaminant mass and/or concentration over time at appropriate monitoring or sampling points. (In the case of a groundwater plume, decreasing concentrations should not be solely the result of plume migration.", as identified on page 16. No trend graphs were included in this document. One can assume that with concentrations so low and after a plume has been treated, that the concentrations will have to go down. But that is not how the Guidance is written. MNA must be demonstrated as a viable part of a remedy before it is chosen. Alternatively, an Interim ROD is an acceptable alternative allowing the implementation of the AS/SVE actions while the attenuation data is collected. EPA can accept that dilution of the plume that remains after treatment will likely be attenuation mechanism at play, especially considering the low VOC concentrations. Please revise this document to include trend graphs for representative monitoring wells for each of the eight proposed treatment areas as well as the three aquifer units.

4. The Army and their contractor should review the referenced MNA guidance document for the expected level of information, data and evaluation that will be required during the MNA phase of the remedial action at this site, for these eight plumes.

5. In looking at Figure 11 that identifies the eight plumes and Figure 19, The Proposed Treatment Zones, there appears to be an area that is not covered. What remedy is proposed for the Intermediate Aquifer beyond the 'Window' treatment system? It does say on page 3-4 that the trigger for the implementation of the MNA phase is 20 ug/L. MW-202A appears to be beyond the Window boundaries and has a PCE concentration of 45.6 ug/L. From Table 13, the suggested travel time from MW-305, the location of the proposed treatment unit, to MW-256 is 1.3 years. This reviewer is not confident that the contamination beyond the treatment zone at MW-305 will attenuate the contamination that is seen in the portion of the cross section below as it exits the site boundaries approximately 1,900 feet away from the proposed treatment location and 180' deeper. This contamination is likely being drawn to the pumping wells for the Memphis municipal water supply to the west, <1 mile away. Supporting that need for deeper treatment is the trend graphs from the 2020 Supplemental Remedial Investigation Report, Appendix C, that shows increasing trends for Chlorinated Volatile Organic Compound (CVOC) in the deeper wells on site, including MWs-34, 202B, 254 and 255. Additional provisions for treating this deeper portion of the aquifer need to be presented in the revisions of this document.





6. DDMT is a large facility comprising 567 acres for the Main Installation. Nearly all the environmental work has been performed before the advent of high-resolution site characterization. The intent of this comment is not to cause a systemic reworking of the investigative approach, especially at this point. A more useful approach is to include some feedback loops and regular assessment of remedial progress to document the remediation of the groundwater. Part of that remedial management process would be to assess the progress of the remedy/remedies and provide clear decision criteria about when additional treatment would be needed. For example, the carbon tetrachloride plume is 2,000 feet long, about 1.25 acres and is defined by 8 wells. This plume is proposed to be treated with two portable air sparge units, one to the northeast and one to the southwest. Each location is proposed to have three air sparge wells with an assumed ROI of 20 ft and 5 ft of overlap, covering a distance of 45 to 60 feet. The plume ranges between 120 and 235' wide. Will this limited treatment system be able to treat this 1.25-acre plume? In the opinion of this author, that is not clearly obvious. Whether it is in the next version of this document but certainly in the Proposed Plan and the Record of Decision, the decision logic for the management of meeting the remedial goals needs to be formulated and formally included as part of these documents.

SPECIFIC COMMENTS

1. **Section 1.1, Purpose and Organization of the Report, Page 1-1:** The text states that the purpose of the FFSR is to assess the effectiveness of the current remedy; however, based on the most recent Five-Year Review (FYR), it has been established that the current remedy at the MI is not effective, and the purpose of the FFSR is to evaluate potential remedial alternatives. Therefore, please revise the text to state the actual purpose of the FFS.

2. **Section 1.2.3.1, Physiographic Setting, Page 1-3:** This section states that groundwater at the MI is at a depth of 80 feet below ground surface (bgs); however, according to Table 10 (Site Conditions at Treatment Areas, Alternative 3) of the FFSR, groundwater levels in monitoring well MW-263 during the April 2021 long term monitoring (LTM) event was measured at a depth of 53.83 feet (ft) below top of casing (btoc). Please revise this statement to accurately reflect groundwater level variations at the MI.

3. **Section 1.2.3.2.4, Memphis Sand, Page 1-4:** This section states that three monitoring wells (MW-67, MW-254 and MW-255) have been installed in the Memphis Sand (i.e., Memphis Aquifer [MAQ]) hydrogeologic unit at the DDMT; however, according to Table 1 (PCE, TCE, and CT Concentrations in Groundwater, April 2021) of the FFSR, five wells are installed in the MAQ (MW-140, MW-229, MW-254, MW-255 and MW-290) and according to Figure 18 (Memphis Aquifer, CVOC Concentrations, April 2021) there are six MAQ wells (MW-67, MW-140, MW-229, MW-254, MW-255 and MW-290). Please revise this statement to accurately reflect the correct number of wells installed in the MAQ.

4. **Section 1.2.3.3.3, Memphis Aquifer, Page 1-5:** This section states that groundwater withdrawal since 1886 have resulted in the decline of water levels in the Memphis area; however, the text should specifically provide greater detail on specific conditions that impact groundwater levels at the MI; specifically, the presence of the Allen Wellfield, that is located approximately one to two miles west of the MI. The FFSR should discuss when the Allen Wellfield became operational and how much water is withdrawn annually. This information will provide greater context regarding the complex groundwater flow patterns at the MI and how the pumping well field influences groundwater gradients and flow direction on the MI.

5. **Section 1.2.4.2.2, Page 1-7:** The verbiage here regarding *Land Use Controls* is somewhat confusing. Please clarify exactly where residences can be constructed based both on the zoning and on the calculated health risks. Also state whether there are any areas where groundwater can be used as residential drinking water (based on the calculated health risks). If there are any restrictions on land use OR groundwater use, it would not seem to be an unlimited use and unlimited exposure (UU/UE) situation.

6. **Section 1.2.4.3.3, Page 1-10:** This section discusses the supporting data for the MNA portion of the remedy. It refers to an agreement between the decay rates of the contaminants in the groundwater, as expressed in the 2009 groundwater model and the recent data. This needs to be expanded further to provide the evidence of that agreement. Perhaps that documentation and discussion should be in an appendix and referenced here.

7. **Section 1.2.5, Risk Assessment Summary, Page 1-11:** The first paragraph states that the risk assessment exposure scenarios considered drinking water ingestion, dermal contact, and inhalation as well as inhalation of indoor air vapor intrusion from groundwater vapors for current/future on-site workers and future on-site resident adult

and child; however, the second bullet of the section states that the vapor intrusion (VI) pathway was not evaluated for a resident. Please discuss why the VI pathway was not evaluated for the residential scenario, especially since the TTA-1N area plume extends off the MI into an adjacent residential area.

8. **Sections 1.2.5, 2.2.1, Table 4 – Risk-Based PRGs for soil vapor:** The risk-based PRGs listed for *Chloroform* are Vapor Intrusion Screening Levels (VISLs) but are not cleanup levels. As I discussed in detail in my comments on the human health risk assessment (HHRA) (April/2020 memo to Diedre Lloyd), Chloroform has been determined by EPA to be a threshold carcinogen for all routes of exposure (IRIS). A "threshold carcinogen" designation means that if the noncancer hazard index does not exceed 1, the cancer risk is zero. It is accepted practice (if a bit confusing) to use the cancer potency values to calculate values by which to screen Chloroform; hence the RSLs and VISLs are calculated as such. In making remedial decisions and setting cleanup levels, however, a HI of 1 (protective of cancer and noncancer endpoints) should be used. Based on indoor air [IA] concentrations set at a HI of 1 (residential IA= 98 $\mu g/m^3$; industrial IA= 430 $\mu g/m^3$) and assuming the default attenuation factor of 0.03, health protective (for cancer and noncancer) concentrations for Chloroform in soil vapor are 3200 $\mu g/m^3$ (residential exposure scenario) and 14,000 $\mu g/m^3$ (industrial exposure scenario).

9. **Sections 1.2.5, Table 5, Risk-Based PRGs for Groundwater:** The risk-based PRGs listed for *Chloroform* are Regional Screening Levels (RSLs) but are not cleanup levels. As discussed in the previous comment, Chloroform has been determined by EPA to be a threshold carcinogen for all routes of exposure (IRIS) which means that to assess health risks, make remedial decisions, and set risk-based cleanup levels, a HI of 1 should be used. The tap water RSL for a HI of 1 is 97 µg/L. This screening RSL is still overly conservative (health protective) as it is based on a child-only exposure and on a high default water-to-air volatilization factor. A Superfund site HHRA, based on appropriate adjustment of these factors, would generate a somewhat higher groundwater Chloroform level as health protective. The MCLG of 70 µg/L established by EPA Office of Water (EPA 2018a) is based only on the noncancer toxicity, consistent with the threshold carcinogen designation. This MCLG is, therefore, a protective level for current and potential drinking water sources.

10. **Section 1.2.6.1, Subsurface Soil Vapor Source Areas, Page 1-12:** The first sentence states that historical sampling did not identify volatile organic compound (VOC) concentrations above soil screening levels; however, according to Section 1.2.4.3.1 (2009 Source Area Investigation and Groundwater Model Update), five of 70 soil samples had VOC concentrations above screening levels. Please revise the text to accurately reflect these soil screening level exceedances.

11. **Sections 1.2.6.1 – Subsurface Soil Vapor Source Areas:** *"…PCE at 14,000 ppbV, CT at 15,000 ppbV, CF at 670 ppb, cDCE at 250 ppbV…"* To be consistent with the text in Section 2.3.1 and with Table 4, all soil vapor concentrations should be in units of $\mu g/m^3$.

12. **Section 1.2.6.2.8, Hydraulic Connections – IAQ and MAQ, Page 1-15:** The final sentence of this section states that there is no plume in the MAQ; however, according to Figure 18 (Memphis Aquifer CVOC Concentrations, April 2021) tetrachloroethylene (PCE) was detected above the USEPA Maximum Contaminant Level (MCL) of 5 µg/L in monitoring wells MW-254 and MW-140, which are in the northeast portion of the MI. It should be noted there is no MAQ well to the southwest to bound these PCE exceedances. Based on the proximity of MW-254 and MW-140, a potential undefined PCE plume appears to be present in the MAQ in the northwest portion of the MI. Please revise the text to discuss this potential PCE plume in the MAQ.

13. **Section 2.2.1, Subsurface Soil Vapor Source Areas, Page 2-3:** The final sentence of this section states that the USEPA vapor intrusion screening level (VISL) for a residential scenario at a target risk (TR) of $1x10^{-4}$ and target hazard quotient (THQ) of 1 can be applied to the unlimited use and unrestricted exposure (UU/UE) area at the MI; however, it is unclear what VISL scenario will be used to evaluate soil gas data that may be collected at the off-site residential area located to the west of the TTA-1N area. Please consider using the VISLs for a residential scenario at a TR of $1x10^{-4}$ and THQ of 1 for off-site residential areas since the commercial VISLs are not protective of human health for the residential scenario.

14. **Section 2.3.1, Subsurface Soil Vapor Source Areas, Pages 2-3 and 2-4:** This section presents commercial screening levels as remedial action objectives (RAOs) that will be added to the MI Record of Decision (ROD); however, since contamination from the MI extends off-site into residential areas and some areas of the MI are zoned for residential use, these commercial RAOs are not applicable for the entire MI. Please consider using a combination of commercial and residential screening levels as RAOs, depending on the land use of the impacted area.

15. **Section 2.6.1, Technologies and Process Options for Subsurface Soil Vapor Source Areas, Page 2-6:** This section states that VOCs were detected in soil vapor at concentrations above vapor screening levels and references Section 1.2.4.4 (Soil Vapor Extraction Pilot Test) for discussion; however, there is no comparison of soil vapor results to screening levels in Section 1.2.4.4. Please include a discussion of soil vapor results with respect to screening levels in Section 1.2.4.4 or include this information in Section 2.6.1.

16. **Section 2.6.1.2, Vapor Intrusion Institutional Controls, Pages 2-6 and 2-7:** The last sentence states that additional notification Institutional Controls (ICs) will be included in the MI Land Use Control Implementation Plan (LUCIP) and Notice of Land Use Restrictions (NLUR) to notify landowners of potential VI issues; however, it is unclear if these ICs will be in place for off-site properties. Please discuss if the ICs for VI issues will include properties outside the boundaries of the MI.

17. **Section 2.6.2.4.2, Hydraulic Barriers, Pages 2-8 and 2-9:** This section states that groundwater reinjection of treated groundwater is not a viable option at the MI; however, no explanation is provided for why this option is not viable. Please revise the text to explain why reinjection of treated groundwater is not a viable option.

18. **Section 3, Development and Screening of Remedial Alternatives, Page 3-1:** The source area for TTA-1N and Building 720 are both estimated to be 100 feet by 100 feet, which is the same dimension as the TTA-2 source area. While the Building 720 plume area appears to be similar in size to TTA-2, the TTA-1N plume is much more extensive; therefore, it is not clear why the source area extent of TTA-1N is reported as like the Building 720 and TTA-2 areas. Please provide additional lines of evidence to support the estimated source area of TTA-1N or revise the estimated source area extent as appropriate.

19. **Section 3.3.3, Description, Page 3-4:** The proposed location of the soil vapor extraction (SVE) system for TTA-1N is situated on the eastern side of the plume, west of monitoring well MW-100B, with a large portion of the radius of influence overlapping uncontaminated areas. The area east and to the north of MW-219 appears to be a more suitable location since groundwater contamination is more extensive. Please consider moving the SVE system to the west or adding a second SVE location in the area of MW-219 to capture additional contamination.

20. **Section 3.3.3, Description, Page 3-4:** According to Alternative 2, SVE systems are proposed at the TTA-1N, TTA-2 and Building 720 areas, and the text states that the exiting VMP networks will be utilized to evaluate the radius of influence; however, the existing VMPs associated with the Building 720 area are located to the east of the proposed SVE point, and mostly outside the theoretical radius of influence. Please consider revising the text to include the installation of additional VMPs in the area of the proposed Building 720 SVE system to adequately monitor the area of influence.

U.S. ENVIRONMENTAL PROTECTION AGENCY
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1/18/2023

Mr. James Foster
Base Realignment and Closure Division (ACSIM-ODB)
2530 Crystal Drive (Taylor Building), Room 5000
Arlington, VA 22202-3940

Subject: United States Environmental Protection Agency Supplementary Comments for the Revision 0 of the 2022 Main Installation Focused Feasibility Study Report, Defense Depot of Memphis Tennessee

The United States Environmental Protection Agency (EPA) is supplementing its regulatory review (EPA's review) of the Revision 0, 2022 Main Installation (MI) Focused Feasibility Study Report (FFS/report), for the Defense Depot of Memphis Tennessee (DDMT/Site) dated December 18, 2022 (EPA's letter).

These comments complement the existing EPA review, which was generally concerned with the technical aspects of the FFS. Additionally, the comments in this letter were generated in accordance with Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the National Contingency Plan (NCP), and relevant EPA guidelines, and they are provided to improve the overall clarity and completeness of the report.

Specifically, the EPA requests that the Army (USARMY/Lead Agency) revise and make the necessary changes to the report, keeping in mind that any missing Applicable or Relevant and Appropriate Requirements (ARARs) associated to this Site should be approved by the EPA and included in the FFS prior to its approval.

The EPA commends the Army for its efforts on further investigating the DDMT environmental conditions. If you have any questions about this letter, please contact me via email at martinez-torres.fernando@epa.gov or at 404-695- 4991.

Sincerely,

FERNANDO MARTINEZ-TORRES

Digitally signed by FERNANDO MARTINEZ-TORRES
Date: 2023.02.01 00:45:02 -05'00'

Fernando Martinez Torres
Remedial Project Manager
Restoration and DOD Coordination Section
Superfund & Emergency Management Division
United States Environmental Protection Agency

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
SUPPLEMENTARY COMMENTS FOR THE REVISION 0 OF THE 2022 MAIN INSTALLATION FOCUSED FEASIBILITY STUDY REPORT
DEFENSE DEPOT OF MEMPHIS TENNESSEE

Enclosure

cc: Jamie A. Woods, TDEC
William Millar, CALIBRE
Laura Roebuck, USACE, Mobile
Melissa Shirley, USACE, Mobile
Ben Bentkowski, USEPA, R4
Kevin Koporec, USEPA, R4

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
SUPPLEMENTARY COMMENTS FOR THE REVISION 0 OF THE 2022 MAIN INSTALLATION FOCUSED FEASIBILITY STUDY REPORT
DEFENSE DEPOT OF MEMPHIS TENNESSEE

ENCLOSURE

General Comment:

1. The FFS does not appear to contain a discussion of whether monitored natural attenuation (MNA) will achieve Maximum Contaminant Levels (MCLs) in a reasonable timeframe, consistent with EPA guidance, *Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites*, OSWER Directive 9200.4-17P, April 1999. This is a significant deficiency, and the Army should include such discussion in the FFS. Moreover, without including supporting data that demonstrate that MNA is a viable alternative, then any alternative relying on MNA will be unsupported. Please refer to the EPA comments 3 and 4 of the EPA's letter and update the report to incorporate the requested information.

Specific Comments

1. **Section 1.2.4.2.1, Soil Excavation, page 1-7.** The first sentence describes excavation completed *"prior to execution."* This phrase appears to mean prior to remedy selection in the Record of Decision (ROD). If this is the case, please revise this sentence for clarity, to read, *"ET&D for lead contamination adjacent to Building 949 was completed prior to selection of the remedy in an approved ROD and was noted as a significant change in the MI ROD; the early completion eliminated it as part of the selected remedy."* However, if this was not the intended meaning, please clarify the meaning of *"prior to execution."*

   Furthermore, a recommendation of removing the word *"effectively"* is suggested because it seems to add nothing to the denotation of the statement and instead raised questions about its meaning. However, if *"effectively"* meant to convey some limitations on removing the excavation as part of the selected remedy, please clarify it in the report.

2. **Section 1.2.4.2.2, Land Use Controls, page 1-7**. If there are restrictions on groundwater use or access to groundwater in this area, it should not be noted as unlimited use and unrestricted exposure (UU/UE), although the acceptable risk from direct exposure makes it safe for residential use. If that is the claim, please replace "UU/UE" with *"residential use."* Please refer to requested information on EPA comments 5 of the EPA's letter.

3. **Section 1.2.4.2.4, Enhanced Bioremediation Treatment, page 1-8.** The first sentence notes a concentration of 100 ug/L for trichloroethylene (TCE) and perchloroethylene (PCE) to delineate treatment areas. Since this is 20 times higher than the MCL, it might be helpful to note in this section that the treatment area concentration was not used as a substitute for the MCL and that the MCL of 5 ug/L is still the Remedial Goal (RG) for those contaminants.

4. **Sections 3.4.3 and 3.5.3, Description, pages 3-10 and 3-15.** Each section (Alternatives 3 and 4) state *that "Vapor extraction piping will be sloped to allow moisture and condensate to drain into the SVE wells. Condensate will be collected in a knockout tank and periodically*

disposed at an approved off-site facility or stored in the existing condensate tank on Dunn Field for testing and disposal in accordance with TDEC requirements." Please note that prior to approving an off-site facility for dispositioning any CERCLA waste waters, the facility must be evaluated to determine whether the waste waters will be dispositioned protectively.

Likewise, *"in accordance with TDEC requirements"* must ensure that the waste waters will be dispositioned protectively. Please clarify whether these facilities will discharge to surface water.

5. **Section 4.2.2.2, Compliance with ARARs, page 4-4.** The first paragraph states, *"This alternative will not comply with MCLs at the southwest and north site boundaries where migration of off-site contaminants onto the MI are occurring. This ongoing source will limit MNA's ability to meet MCLs throughout the plume in a reasonable timeframe."* Please clarify whether not meeting MCLs occurs throughout the plume or just upgradient from the treatment locations.

   In a case where MCLs will not be met, that is, an ARAR will not be met, the ARAR must be waived, using one of the bases in the NCP at 40 CFR 300.430(f)(1)(ii)(C). The Lead Agency needs to clarify with more specificity where it is anticipated that the ARAR will not be met and to provide justification for a waiver. Moreover, if there is no ARAR waiver available, this alternative is not viable and should be removed.

   Please discuss and address this issue in the report for clarity and completeness, as this has an impact on determining the preferable alternative.

6. **Section 4.2.2.2, Compliance with ARARs.** In addition, please note that because this plume is impacting a Class I drinking water source *(i.e., impacting the Memphis Aquifer via migration downward through the "window")*, EPA's policy is to address the contamination via "rapid" restoration. Since the Memphis Aquifer provides 95% of the municipal and commercial water supplies in the Memphis area, it is likely that even a "very rapid" (one to five years) restoration should take place. *See EPA groundwater policy at 55 Fed. Reg 8732.*

   Please discuss and address this issue in the report, particularly in *Section 4.3.2, Compliance with ARARs*, as this has an impact on determining the preferable alternative.

7. **Section 4.2.2.4, Reduction of Toxicity, Mobility, or Volume of Contamination Through Treatment, page 4-5.** In the first sentence, please add *"through treatment"* after *"contamination"* to mirror the text in the NCP.

8. **Section 4.2.3.4, Reduction of Toxicity, Mobility, or Volume of Contamination Through Treatment, page 4-8.** In the first sentence, please add *"through treatment"* after "*contamination"* to mirror the text in the NCP.

9. **Section 4.3.2, Compliance with ARARs, page 4-13.** Regarding the first sentence in this section and the statement in *Section 4.2.2., Section 4.2.2.2* states that *"This alternative will not comply with MCLs at the southwest and north site boundaries where migration of off-site contaminants onto the MI are occurring. This ongoing source will limit MNA's ability to meet MCLs throughout the plume in a reasonable timeframe."* In contrast, the first sentence in Section 4.3.2 states *"Alternative 2 will comply with ARARs for subsurface soil remediation activities but the groundwater remedy (MNA) will not comply with groundwater MCLs for a long period of time."* As noted in the prior comments, if an alternative will not comply with ARARs and has no basis for an ARAR waiver under 40 CFR 300.430(f)(1)(ii)(C), then the alternative is not viable and should be removed from the FFS.

10. **Table 2, Chemical- specific ARARs.** Please add the additional ARARs to Table 2. However, adding columns identifying a website referring to these ARARs, as well as the alternatives to which the requirements apply or are relevant and appropriate, is also acceptable.

    In addition, for clarity, the EPA recommends removing the "Title" column.

    DDMT Main Installation FFS – additional CAA ARARs

Operation of a Groundwater Treatment System – Air Quality			
General standards for process vents used in treatment of VOC-contaminated groundwater	Select and meet the requirements under one of the options specified below: • Control HAP emissions from the affected process vents according to the applicable standards specified in §§ 63.7890 through 63.7893. • Determine for the remediation material treated or managed by the process vented through the affected process vents that the average total volatile organic hazardous air pollutant (VOHAP) concentration, as defined in § 63.7957, of this material is less than 10 (ppm). Determination of VOHAP concentration will be made using procedures specified in § 63.7943. • Control HAP emissions from affected process vents subject to another subpart under 40 CFR part 61 or 40 CFR part 63, in compliance with the standards specified in the applicable subpart.	Process vents as defined in 40 CFR § 63.7957 used in site remediation of media (e.g., soil and groundwater) that could emit HAPs listed in Table 1 of Subpart GGGGG of Part 63 and vent stream flow exceeds the rate in 40 CFR 63.7885(c)(1) – **Relevant and Appropriate**	40 CFR § 63.7885(b)
Emission limitations for process vents used in treatment of VOC contaminated groundwater	Meet the requirements under one of the options specified below: • Reduce from all affected process vents the total emissions of the HAP to a level less than 1.4 kilograms per hour (kg/hr) and 2.8 Mg/yr (3.0 pounds per hour (lb/hr) and 3.1 tpy); • Reduce from all affected process vents the emissions of total organic compounds (TOC) (minus methane and ethane) to a level below 1.4 kg/hr and 2.8 Mg/yr (3.0 lb/hr and 3.1 tpy); • Reduce from all affected process vents the total emissions of the HAP by 95 percent by weight or more; or • Reduce from all affected process vents the emissions of TOC (minus methane and ethane) by 95 percent by weight or more.	Process vents as defined in 40 CFR § 63.7957 used in site remediation of media (e.g., soil and groundwater) that could emit hazardous air pollutants (HAP) listed in Table 1 of Subpart GGGGG of Part 63 and vent stream flow exceeds the rate in 40 CFR § 63.7885(c)(1) – **Relevant and Appropriate**	40 CFR § 63.7890(b)(1)-(4)

**UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
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DEFENSE DEPOT OF MEMPHIS TENNESSEE**

DDMT Main Installation FFS – additional CAA ARARs – Continue

Standards for closed vent systems and control devices used in treatment of VOC contaminated groundwater	For each closed vent system and control device you use to comply with the requirements above, you must meet the operating limit requirements and work practice standards in Sec. 63.7925(d) through (j) that apply to the closed vent system and control device. *NOTE: EPA approval to use alternate work practices under paragraph (j) in 40 CFR § 63.7925 will be obtained in a CERCLA document.*	*Closed vent system* and control devices as defined in 40 CFR § 63.7957 that are used to comply with § 63.7890(b) – **Relevant and Appropriate**	40 CFR § 63.7890(c)
Monitoring of closed vent systems and control devices used in treatment of VOC contaminated groundwater	Must monitor and inspect the closed vent system and control device according to the requirements in 40 CFR § 63.7927 that apply to the affected source. *NOTE: Monitoring program will be developed as part of the CERCLA process and included in an appropriate CERCLA document*	*Closed vent system* and control devices as defined in 40 CFR § 63.7957 that are used to comply with § 63.7890(b) – **Relevant and Appropriate**	40 CFR § 63.7892

Media/Location/Action	Requirements	Prerequisite	Citation
Remediation of contaminated groundwater	Except for naturally occurring levels, General Use Ground Water: • shall not contain constituents that exceed those levels specified in TDEC 0400-40-03-.03 subparagraphs j [*levels equivalent to SDWA MCLs*] and k [*quantities detrimental to public health or that impair use of the water as domestic water supply*]; and • shall contain no other constituents at levels and conditions which pose an unreasonable risk to the public health or the environment.	Presence of contaminants in groundwater of the State designated as General Use Groundwater as defined in TDEC 0400-40-03-.07(4)(b)—**applicable**	TDEC 0400-40-03-.08(2)(a) and (b)
	MCLs are promulgated concentration levels for organic and inorganic contaminants in public drinking water supplies. Must not exceed the MCLs listed in TDEC 0400-45-1-.06 and 0400-45-1-.25 in public community water systems, as measured at the consumer's tap. Under CERCLA § 121(d)(2)(A) and the NCP, MCLs are relevant and appropriate for groundwater response actions where the groundwater aquifer is used or classified for use as drinking water.	Release of contaminants to groundwater or actions potentially impacting groundwater—**relevant and appropriate**	TDEC 0400-45-01-.06 and TDEC 0400-45-01-.25 40 *CFR* 300.430(e)(2)(i)(B) and (C)

11. **Table 3, Action-specific ARARs**. Please add the following ARARs to Table 3. However, if the Lead Agency believes that any of the ARARs on this list are neither applicable nor relevant and appropriate, the EPA should be notified before the FFS approval.

Media/Location/Action	Requirements	Prerequisite	Citation
	Action-specific ARARs		
	Site preparation, construction, and excavation activities		
Activities causing fugitive dust emissions	Shall take reasonable precautions to prevent particulate matter from becoming airborne; reasonable precautions shall include, but are not limited to, the following:	Use, construction, alteration, repair or demolition of a building, or appurtenances or a road or the handling transport or storage of material—**applicable**	TDEC 1200-3-8-.01(1)
	• use, where possible, of water or chemicals for control of dust, and		TDEC 1200-3-8-.01(1)(a)
	• application of asphalt, water, or suitable chemicals on dirt roads, materials stock piles, and other surfaces, which can create airborne dusts.		TDEC 1200-3-8-.01(1)(b)
	Shall not cause or allow fugitive dust to be emitted in such a manner as to exceed 5 min/h or 20 min/day beyond property boundary lines on which emission originates.		TDEC 1200-3-8-.01(2)

Activities causing storm water runoff (e.g., clearing, grading, excavation)	Implement good construction management techniques (including sediment and erosion controls, vegetative controls, and structural controls) in accordance with the substantive requirements of *General Permit No. TNR10-0000* ("General Permit for Stormwater Discharges Associated with Construction Activities") to ensure that storm water discharge:	Dewatering or storm water runoff discharges from land disturbed by construction activity—disturbance of ≥ 1 acre total—**applicable**	T.C.A. 69-3-108(l) TDEC 0400-40-10-.03(2)(a) *General Permit No. TNR10-0000* (effective October 1, 2016) (**TBC**)
	• does not violate water quality criteria as stated in TDEC 0400-40-03-.03, including, but not limited to, prevention of discharges that cause a condition in which visible solids, bottom deposits, or turbidity impairs the usefulness of waters of the state for any of the designated uses for that water body by TDEC 0400-40-04;	Storm water discharges from construction activities—**TBC**	*General Permit No. TNR10-0000*, Sect. 5.3.2
	• does not contain distinctly visible floating scum, oil, or other matter; • does not cause an objectionable color contrast in the receiving stream; and		
	• results in no materials in concentrations sufficient to be hazardous or otherwise detrimental to humans, livestock, wildlife, plant life, or fish and aquatic life in the receiving stream.		

12. **<u>Table 3, Action-specific ARARs</u>**. The table incorrectly refers to some RCRA regulations as TBCs. Furthermore, requirements for waste management and groundwater monitoring ARARs are missing. Moreover, it also appears that there will be no CERCLA waste waters discharged to surface water as alternatives involving discharge screened from the final alternatives. As a result, the following requirements apply to solid waste generated during a CERCLA response action. Please make the necessary changes, keeping in mind that the EPA frequently provides parallel state and federal citations where they are substantially similar/the same. Finally, if it is understood that any missing ARARs related to this type of discharge exist, they should be provided to the ARMY prior to FFS approval. Please clarify.

Characterization of solid waste	Must determine if solid waste is hazardous or is excluded under 40 *CFR* 261.4; and	Generation of solid waste as defined in 40 *CFR* 261.2—**applicable**	40 *CFR* 262.11(a) TDEC 0400-12-01-.03(1)(b)1
	Must determine if waste is listed as a hazardous waste in 40 *CFR* Part 261; or	Generation of solid waste which is not excluded under 40 *CFR* 261.4—**applicable**	40 *CFR* 262.11(b) TDEC 0400-12-01-.03(1)(b)2
	Must determine whether the waste is identified in subpart C of 40 *CFR* 261, characterizing the waste by using prescribed testing methods or applying generator knowledge based on information regarding material or processes used.	Generation of solid waste that is not listed in subpart D of 40 *CFR* 261 and not excluded under 40 *CFR* 261.4—**applicable**	40 *CFR* 262.11(c) TDEC 0400-12-01-.03(1)(b)3
	Must refer to Parts 261, 262, 264, 265, 266, 268, and 273 of Chap. 40 for possible exclusions or restrictions pertaining to management of the specific waste.	Generation of solid waste that is determined to be hazardous—**applicable**	40 *CFR* 262.11(d) TDEC 0400-12-01-.03(1)(b)4
Characterization of remediation hazardous waste	Must obtain a detailed chemical and physical analysis of a representative sample of the waste(s) which at a minimum contains all the information which must be known to treat, store, or dispose of the waste in accordance with 40 *CFR* 264 and 268.	Generation of RCRA hazardous waste for storage, treatment, or disposal—**applicable**	40 *CFR* 264.13(a)(1) TDEC 0400-12-01-.06(2)(d)1 40 *CFR* 264.1(j)(2) TDEC 0400-12-01-.06(1)(b)9(ii)
	Must determine if the waste meets the treatment standards in 40 *CFR* 268.40, 268.45, or 268.49 by testing in accordance with prescribed methods or use of generator knowledge of waste.		40 *CFR* 268.7(a) TDEC 0400-12-01-.10(1)(g)1(i)
	Must determine each EPA Hazardous Waste Number (Waste Code) to determine the applicable treatment standards under 40 *CFR* 268.40 *et seq*.	Generation of RCRA hazardous waste for storage, treatment, or disposal—**applicable**	40 *CFR* 268.9(a) TDEC 0400-12-01-.10(1)(i)1
	Must determine the underlying hazardous constituents [as defined in 40 *CFR* 268.2(i)] in the waste.	Generation of RCRA characteristically hazardous waste (and is not D001 non-wastewaters treated by CMBST, RORGS, or POLYM of Sect. 268.42 Table 1) for storage, treatment, or disposal—**applicable**	40 *CFR* 268.9(a) TDEC 0400-12-01-.10(1)(i)1
Management of hazardous waste on-site	A generator who treats, stores, or disposes of hazardous waste on-site must comply with the applicable substantive standards and requirements set forth in 40 *CFR* Parts 264, 265, 266, 268, and 270.	Generation of RCRA hazardous waste for storage, treatment, or disposal on-site—**applicable**	40 *CFR* 262.10, Note 2 TDEC 0400-12-01-.03(1)(a)3

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY SUPPLEMENTARY COMMENTS FOR THE REVISION 0 OF THE 2022 MAIN INSTALLATION FOCUSED FEASIBILITY STUDY REPORT DEFENSE DEPOT OF MEMPHIS TENNESSEE

	Groundwater monitoring activities		
Placement of extraction and monitoring wells	Well(s) shall be designed, constructed, and operated in such a manner that their use does not cause any underground source of drinking water to contain any substances that are toxic, carcinogenic, mutagenic, or teratogenic, other than those of natural origin, at levels and conditions that violate primary drinking water standards or adversely affect the health of persons and does not cause a violation of water quality standards.	Class V injection systems—**relevant and appropriate** to placement of extraction or monitoring wells	TDEC 0400-45-06-.14(1)(b) TDEC 0400-45-06-.14(7)(b) and (8)(a)
Construction and abandonment of monitoring wells	Establishes quality and workmanship requirements for well drilling, installation, and abandonment, and for sampling, borehole geophysical logging, and hydrologic testing. The substantive requirements of this procedure are TBC for construction and abandonment of monitoring wells.	Construction and abandonment of monitoring wells—**TBC**	*Standard Specifications for Installation, Well Drilling, and Abandonment*, SPG-00000-A005/Rev 2, 10/14/11
Closure of monitoring wells	Before abandonment, clean well of obstructions and disinfect using bleach or hypochlorite granules to produce free chlorine residual concentrations of 25 ppm.	Plugging and closure of a water production well—**relevant and appropriate**	TDEC 0400-45-09-.16(1)(a) – (c)
	Use one of several different methods to close well depending on depth of well, construction details, whether it is cased or uncased, and whether or not it intercepts multiple aquifers.		TDEC 0400-45-09-.16(2)(a) – (c)
	Backfill must be placed so that there are no gaps or bridging. Backfill top must be level with land surface.		TDEC 0400-45-09-.16(2)(d)
	Wells extending into more than one aquifer shall be filled and sealed in such a way that exchange of water from one aquifer to another is prevented.		TDEC 0400-45-09-.16(3)
	Flowing wells must be treated to reduce flow to zero before sealing.		TDEC 0400-45-09-.16(4)
	An alternate method of closure may be approved by TDEC.		TDEC 0400-45-09-.16(5)
	Storage		
Storage of hazardous wastes restricted from land disposal	Prohibits storage of hazardous waste restricted from land disposal unless the generator stores such waste in tanks, containers, or containment buildings on-site solely for the purpose of accumulating such quantities as necessary to facilitate proper recovery, treatment, or disposal. Must comply with the pertinent substantive requirements in 40 *CFR* 262.34 and 40 *CFR* Part 264.	Accumulation of hazardous wastes restricted from land disposal solely for purpose of accumulation of quantities as necessary to facilitate proper recovery, treatment, or disposal—**applicable**	40 *CFR* 268.50 TDEC 0400-12-01-.10(4)(a)
Temporary storage of hazardous waste in containers on-site – "Satellite Accumulation Area"	A generator may accumulate as much as 55 gal of hazardous waste at or near any point of generation where wastes initially accumulate which is under the control of the operator of the process generating the waste provided: • If a container holding hazardous waste is not in good condition, or if it begins to leak, the generator must immediately transfer the hazardous waste from this container to a container that is in good condition and does not leak, or immediately transfer and manage the waste in a central accumulation area operated in compliance with part (g)2 or (h)1 of this paragraph. • The generator must use a container made of or lined with materials that will not react with, and are otherwise compatible with, the hazardous waste to be accumulated, so that the ability of the container to contain the waste is not impaired. • A container holding hazardous waste must be closed at all times during accumulation, except when adding, removing, or consolidating waste: or, when temporary venting of a container is necessary for the proper operation of equipment or to prevent dangerous situations, such as build-up of extreme pressure. • Container must be marked or labeled with the words "Hazardous Waste" and an indication of the hazards of the contents.	Accumulation of 55 gal or less of RCRA hazardous waste at or near any point of generation—**applicable**	40 *CFR* 262.15(a)(1), (2), (4), and (5) TDEC 0400-12-01-.03(1)(f)(1)(i), (ii), (iv), and (v)

Temporary storage of hazardous waste in containers on-site – "90-Day Storage Area"	A generator may accumulate hazardous waste at the facility provided that: • The waste is placed in containers that comply with the air emission standards TDEC 0400-12-01-.05((27), (28), and (29); • If a container holding hazardous waste is not in good condition, or if it begins to leak, the generator must immediately transfer the hazardous waste from this container to a container that is in good condition, or immediately manage the waste in some other way that complies with the conditions for exemption of this part; • The generator must use a container made of or lined with materials that will not react with, and are otherwise compatible with, the hazardous waste to be stored, so that the ability of the container to contain the waste is not impaired; • A container holding hazardous waste must always be closed during accumulation, except when it is necessary to add or remove waste. A container holding hazardous waste must not be opened, handled, or stored in a manner that may rupture the container or cause it to leak.	Accumulation of RCRA hazardous waste on-site as defined in TDEC 0400-12-01-.01(2)(a)—**applicable**	40 *CFR* 262.17(a)(1)(i) through (iv) TDEC 0400-12-01-.03(1)(h)(1)(i)(I) through (IV)
	• Container must be marked or labeled with the words "Hazardous Waste," an indication of the hazards of the contents, and the date upon which each period of accumulation begins clearly visible for inspection on each container.		40 *CFR* 262.17(a)(5)(i) TDEC 0400-12-01-.03(1)(h)(1)(v)(I)
	The generator must close the waste accumulation unit in a manner that: • Minimizes the need for further maintenance by controlling, minimizing, or eliminating, to the extent necessary to protect human health and the environment, the post-closure escape of hazardous waste, hazardous constituents, leachate, contaminated run-off, or hazardous waste decomposition products to the ground or surface waters or to the atmosphere, • Removes or decontaminates all contaminated equipment, structures and soil and any remaining hazardous waste residues from waste accumulation units • Any hazardous waste generated in the process of closing either the generator's facility or unit(s) accumulating hazardous waste must be managed in accordance with all applicable standards of parts 262, 263, 265 and 268 of this chapter.		40 *CFR* 262.17(a)(8)(iii)(1)-(3) TDEC 0400-12-01-.03(1)(h)(1)(viii)(III)I and II
Management of hazardous waste stored in containers	If container is not in good condition (e.g., severe rusting, structural defects) or if it begins to leak, must transfer waste into container in good condition.	Storage of RCRA hazardous waste in containers—**applicable**	40 *CFR* 264.171 TDEC 0400-12-01-.06(9)(b)
	Use container made or lined with materials compatible with waste to be stored so that the ability of the container is not impaired.		40 *CFR* 264.172 TDEC 0400-12-01-.06(9)(c)
	Keep containers closed during storage, except to add/remove waste.		40 *CFR* 264.173(a) TDEC 0400-12-01-.06(9)(d)
	Open, handle, and store containers in a manner that will not cause containers to rupture or leak.		40 *CFR* 264.173(b) TDEC 0400-12-01-.06(9)(d)
Storage of incompatible waste in containers	Must not place incompatible wastes in same container unless comply with 40 *CFR* 264.17(b).	Storage of "incompatible" RCRA hazardous wastes in containers—**applicable**	40 *CFR* 264.177(a) TDEC 0400-12-01-.06(9)(h)1
	Waste shall not be placed in an unwashed container that previously held an incompatible waste or material.		40 *CFR* 264.177(b) TDEC 0400-12-01-.06(9)(h)2
	A container holding incompatible wastes must be separated from any waste or nearby materials or must protect them from one another by using a dike, berm, wall, or other device.		40 *CFR* 264.177(c) TDEC 0400-12-01-.06(9)(h)3

	Treatment/disposal		
Disposal of RCRA-prohibited hazardous waste in a land-based unit	May be land disposed only if it meets the requirements in the table "Treatment Standards for Hazardous Waste" at 40 *CFR* 268.40 before land disposal. The table lists either "total waste" standards, "waste-extract" standards, or "technology-specific" standards (as detailed further in 40 *CFR* 268.42).	Land disposal, as defined in 40 *CFR* 268.2, of RCRA-restricted waste—**applicable**	40 *CFR* 268.40(a) TDEC 0400-12-01-.10(3)(a)1
	For characteristic wastes (D001 – D043) that are subject to the treatment standards, all underlying hazardous constituents must meet the UTSs specified in 40 *CFR* 268.48.	Land disposal of restricted RCRA characteristic wastes (D001 – D043) that are not managed in a wastewater treatment unit that is regulated under the CWA, that is CWA equivalent, or that is injected into a Class I nonhazardous injection well—**applicable**	40 *CFR* 268.40(e) TDEC 0400-12-01-.10(3)(a)5
	To determine whether a hazardous waste identified in this section exceeds the applicable treatment standards of 40 *CFR* 268.40, the initial generator must test a sample of the waste extract or the entire waste, depending on whether the treatment standards are expressed as concentration in the waste extract or waste, or the generator may use knowledge of the waste.	Land disposal of RCRA toxicity characteristic wastes (D004 – D011) that are newly identified (i.e., wastes, soil, or debris identified by the TCLP but not the Extraction Procedure)—**applicable**	40 *CFR* 268.34(f)
	If the waste contains constituents (including UHCs in the characteristic wastes) in excess of the applicable UTS levels in 40 *CFR* 268.48, the waste is prohibited from land disposal, and all requirements of Part 268 are applicable, except as otherwise specified.		
	Are not prohibited if the wastes no longer exhibit a characteristic at the point of land disposal, unless the wastes are subject to a specified method of treatment other than DEACT in 40 *CFR* 628.40, or are D003 reactive cyanide.	Land disposal of RCRA-restricted characteristic wastes—**applicable**	40 *CFR* 268.1(c)(4)(iv) TDEC 0400-12-01-.10(1)(a)3(iv)
Prohibition of dilution to meet LDRs	Except as provided under 40 *CFR* 268.3(b), must not in any way dilute a restricted waste or the residual from treatment of a restricted waste as a substitute for adequate treatment to achieve compliance with land disposal restriction levels.	Land disposal, as defined in 40 *CFR* 268.2, of RCRA-restricted hazardous soils—**applicable**	40 *CFR* 268.3(a) TDEC 0400-12-01-.10(1)(c)1
	Closure		
Closure performance standard for RCRA hazardous waste management units	Must close the facility in a manner that: • Minimizes the need for further maintenance; and	Closure of a RCRA hazardous waste management unit—**applicable**	40 *CFR* 264.111(a) TDEC 0400-12-01-.06(7)(b)1
	• Controls, minimizes, or eliminates, to the extent necessary to protect human health and environment, post-closure escape of hazardous waste or its decomposition products, hazardous constituents, contaminated runoff to ground or surface waters, or to the atmosphere.		40 *CFR* 264.111(b) TDEC 0400-12-01-.06(7)(b)2
	• Complies with the substantive closure requirements of 40 *CFR* 264 for the particular type of facility, including but not limited to the requirements of Sects. 264.178 (container storage area), 264.197 (tanks), 264.310 (landfills), and 264.554 (remediation waste piles).		40 *CFR* 264.111(c) TDEC 0400-12-01-.06(7)(b)3
	During closure periods, all contaminated equipment, structures, and soils must be properly disposed or decontaminated.		40 *CFR* 264.114 TDEC 0400-12-01-.06(7)(e)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
SUPPLEMENTARY COMMENTS FOR THE REVISION 0 OF THE 2022 MAIN INSTALLATION FOCUSED FEASIBILITY STUDY REPORT
DEFENSE DEPOT OF MEMPHIS TENNESSEE

	Transportation		
Transportation of hazardous waste on-site	The generator manifesting requirements of 40 *CFR* 262.20-262.32(b) do not apply. Generator or transporter must comply with the requirements set forth in 40 *CFR* 263.30 and 263.31 in the event of a discharge of hazardous waste on a private or public right-of-way.	Transportation of hazardous wastes on a public or private right-of-way within or along the border of contiguous property under the control of the same person, even if such contiguous property is divided by a public or private right-of-way—**applicable**	40 *CFR* 262.20(f) TDEC 0400-12-01-.03(3)(a)6
Transportation of hazardous materials off-site	Shall be subject to and must comply with all applicable provisions of the HMTA and HMR at 49 *CFR* 171 – 180.	Any person who, under contract with a department or agency of the federal government, transports "in commerce", or causes to be transported or shipped, a hazardous material—**applicable**	49 *CFR* 171.1(c)
Transportation of hazardous waste off-site	Must comply with the generator requirements of 40 *CFR* 262.20 23 for manifesting, Sect. 262.30 for packaging, Sect. 262.31 for labeling, Sect. 262.32 for marking, Sect. 262.33 for placarding and Sect. 262.40, 262.41(a) for record keeping requirements and Sect. 262.12 to obtain EPA ID number.	Preparation and initiation of shipment of RCRA hazardous waste off-site—**applicable**	40 *CFR* 262.10(h) TDEC 0400-12-01-.03(1)(a)(8)

Responses to Comments from
U.S. Environmental Protection Agency (EPA) Region 4 on:
2022 Main Installation Focused Feasibility Study, Revision 0, September 2022
Defense Depot Memphis, Tennessee
Comments Received: 19 December 2022 and 18 January 2023

General Comments

1. In several sections of the FFSR, groundwater contamination located to the west of the TTA-1 North (N) area is partially attributed to an off-site source. It is acknowledged that based on groundwater flow, it appears there may be an off-site source area. However, since the area west of TTA-1 is currently, and has historically been primarily used for residential purposes, it is unlikely that chlorinated solvents were stored, handled, and released into the subsurface. Additionally, due to continued pumping of the Allen Wellfield since the 1950s, groundwater sinks located at MW-39 and MW-259, respectively, and the erosional window located to the east of the TTA-1N area have influenced groundwater flow. Therefore, prior to the 1950s, natural groundwater flow in the TTA-1N area may have been towards the west. Based on this reversal of groundwater flow, off-site contamination east of TTA-1N may have originated on the Main Installation (MI), which is more likely, since chlorinated solvents were handled and stored at the MI. Please provide additional lines of evidence to support the assertion that an off-site source exists west of TTA-1N or consider the off-site contamination west of the TTA-1N area to have originated from the MI.

Response G1: While the area surrounding the MI to the south and to the west is primarily residential, that does not preclude the use and release of chlorinated solvents. A environmental database search report (EDR) for environmental sites with potential contaminant sources within a 2-mile radius of the Memphis Depot was obtained in 2017 for the off-site groundwater investigation at Dunn Field. Attachment 1 from that report shows numerous sites with potential contaminant sources around DDMT, including sites to the west of the MI.

USGS WRI-76-67, *Historic Water-Level Changes and Pumpage from the Principal Aquifers of the Memphis Area, Tennessee: 1886-1975* and USGS Scientific Investigations Map 3415, *Altitude of the Potentiometric Surface, 2000–15, and Historical Water-Level Changes in the Memphis Aquifer in the Memphis Area, Tennessee* were reviewed for groundwater volume extracted and groundwater elevations in the MAQ. Extraction from the MAQ was over 70 million gallons per day (MGD) in 1940, 100 MGD in 1950, 130 MGD in 1960 and 170 MGD in 1970. WRI-76-67 shows MAQ potentiometric surface maps for 1886, 1960 and 1970; SI Map 3415 shows MAQ potentiometric surface maps for 2000, 2005, 2010 and 2015. Approximate groundwater elevations (ft, msl & NAD 1883) from those maps and LTM FDAQ elevations in 2015 are listed below.

Year	Allen Well Field	DDMT MAQ	DDMT-FDAQ
1886	245	250	-
1960	<130	140-150	-
1970	<110	140-150	-
2015	<160	160-170	199-244

The 2020 SRI Report (HDR, 2021) noted that MAQ groundwater elevations in LTM wells at DDMT were consistent with elevations on Map 3415. The elevations clearly show the FDAQ groundwater flow directions would have been consistent with the current flow, onto the MI from all sides, since at least 1960 and possibly well before. It is unreasonable to assume that a brief period of groundwater flow away from the MI around 1950 could have resulted in the observed off-site CVOC concentrations if the contaminant source was on the MI. Section 1.2.3.3.4 will be revised to include this review.

2. The FFSR identifies a treatment target concentration of 40 micrograms per liter (µg/L) for total chlorinated volatile organic compounds (CVOCs) in groundwater at the MI. However, there is no basis or supporting information for selection and/or derivation of this treatment target concentration and it is unclear whether 40 µg/L is a sufficient target concertation for measuring whether monitored natural attenuation (MNA) will occur within a reasonable timeframe. Please include additional background information for the selection of the 40 µg/L treatment target concentration.

Response G2: The target concentration for treatment (40 µg/L) is used in the FFS to identify areas requiring active treatment (source control). The RAOs in Section 2.3 list the Contaminants of Concern and cleanup levels that will be used to determine if remedial objectives are met; cleanup levels for groundwater are MCLs, where established.

Selection of 40 µg/L as the target concentration for treatment (remedial action) is reasonable in comparison to the historical CVOC treatment targets used at DDMT. The MI ROD selected “Enhanced bioremediation of chlorinated volatile organic compounds (CVOCs) in the most contaminated part of the groundwater plume” and stated “Untreated parts of the plume will degrade under natural attenuation processes.” The MI RD selected “contaminated portions of the MI plumes within the 100 µg/L contour” as the basis for treatment. The Dunn Field ROD Amendment stated “The AS-SVE system will be installed to intercept the majority of the Off-Depot CVOC plume and reduce individual CVOC concentrations to below 50 µg/L.”

The selection of 100 µg/L for treatment on the MI was not considered sufficient and would eliminate most on-site plumes from treatment. Since the selected alternatives and site conditions are similar to Dunn Field, 50 µg/L was considered appropriate and was lowered to 40 µg/L to allow for variability in groundwater concentrations.

3. Monitored Natural Attenuation (MNA) is a major component of all the proposed remedies under consideration in this document. As per EPA’s 1999 MNA Guidance, one of the primary lines of evidence requires is “Historical groundwater and/or soil chemistry data that demonstrate a clear and meaningful trend of decreasing contaminant mass and/or concentration over time at appropriate monitoring or sampling points. (In the case of a groundwater plume, decreasing concentrations should not be solely the result of plume migration.”, as identified on page 16. No trend graphs were included in this document. One can assume that with concentrations so low and after a plume has been treated, that the concentrations will have to go down. But that is not how the Guidance is written. MNA must be demonstrated as a viable part of a remedy before it is chosen.

Alternatively, an Interim ROD is an acceptable alternative allowing the implementation of the AS/SVE actions while the attenuation data is collected. EPA can accept that dilution of the plume that remains after treatment will likely be attenuation mechanism at play, especially considering the low VOC concentrations. Please revise this document to include trend graphs for representative monitoring wells for each of the eight proposed treatment areas as well as the three aquifer units.

Response G3: Trend plots for selected wells in each plume and aquifer will be provided in an appendix. Trend plots for all wells with VOC concentrations above MCLs in recent or historic samples are provided in the annual LTM reports submitted to EPA.

The primary component of the proposed alternative remedy is source control by SVE and AS/SVE. MNA is included to the same extent it was in both the MI ROD and the Dunn Field ROD.

As noted in Response G2, the MI ROD limited active treatment to the most contaminated areas and stated the remainder of the plume would degrade naturally. The MI ROD selected EBT as the active remedy for source control. A second component was long-term groundwater monitoring to document changes in plume concentrations and to detect potential plume migration to off-site areas or into deeper aquifers. The FFS identifies alternative remedies for source control but leaves the long-term monitoring component unchanged.

The 1999 MNA Guidance states source control and long-term performance monitoring will be fundamental components of any MNA remedy; Alternatives 2, 3 and 4 meet that requirement. The guidance notes the MNA remediation approach includes a variety of physical, chemical, or biological processes; the FFS notes that only physical processes will apply on the MI; Section 1.2.4.3.3: “The review found naturally occurring biodegradation of CVOCs was not a significant contributor to natural attenuation in the FDAQ at the MI.”

The guidance also states MNA will only be appropriate for sites that have a low potential for contaminant migration. Groundwater flow in the FDAQ is onto the MI preventing lateral migration off-site. There is vertical migration to the IAQ and MAQ, but at low concentrations that will be reduced further by the source control component and by natural attenuation.

The Dunn Field ROD has the same long-term monitoring component as the MI ROD but lists it as MNA: “Monitored natural attenuation (MNA) and long-term groundwater monitoring (LTM) to document changes in plume concentrations, to detect potential plume migration to off-site areas or into deeper aquifers, and to track progress toward remediation goals.”

The suggestion for an Interim ROD can be discussed by Army, EPA and TDEC.

4. The Army and their contractor should review the referenced MNA guidance document for the expected level of information, data and evaluation that will be required during the MNA phase of the remedial action at this site, for these eight plumes.

Response G4: The guidance has been reviewed as noted in Response G3.

5. In looking at Figure 11 that identifies the eight plumes and Figure 19, The Proposed Treatment Zones, there appears to be an area that is not covered. What remedy is proposed for the Intermediate Aquifer beyond the ‘Window’ treatment system? It does say on page 3-4 that the trigger for the implementation of the MNA phase is 20 µg/L. MW-202A appears to be beyond the Window boundaries and has a PCE concentration of 45.6 µg/L. From Table 13, the suggested travel time from MW-305, the location of the proposed treatment unit, to MW-256 is 1.3 years. This reviewer is not confident that the contamination beyond the treatment zone at MW-305 will attenuate the contamination that is seen in the portion of the cross section below as it exits the site boundaries approximately 1,900 feet away from the proposed treatment location and 180’ deeper. This contamination is likely being drawn to the pumping wells for the Memphis municipal water supply to the west, <1 mile away. Supporting that need for deeper treatment is the trend graphs from the 2020 Supplemental Remedial Investigation Report, Appendix C, that shows increasing trends for Chlorinated Volatile Organic Compound (CVOC) in the deeper wells on site, including MWs-34, 202B, 254 and 255. Additional provisions for treating this deeper portion of the aquifer need to be presented in the revisions of this document.

Response G5: Treatment in the IAQ and MAQ is not considered necessary because contaminant migration from the FDAQ is the source of CVOCs in the IAQ and MAQ. The increasing trends cited are from low concentrations and remain relatively low. October 2022 concentrations in these wells, where MCLs are exceeded, are: IAQ wells MW-34 (TCE 11.9 µg/L), MW-202B (PCE 14.4 µg/L); and MAQ wells MW-254 (PCE 7.62 µg/L and TCE 9.21 µg/L). CVOC concentrations have not exceeded the MCL in MAQ well MW-255 (PCE 3.13 µg/L and TCE 0.89 µg/L).

6. DDMT is a large facility comprising 567 acres for the Main Installation. Nearly all the environmental work has been performed before the advent of high-resolution site characterization. The intent of this comment is not to cause a systemic reworking of the investigative approach, especially at this point. A more useful approach is to include some feedback loops and regular assessment of remedial progress to document the remediation of the groundwater. Part of that remedial management process would be to assess the progress of the remedy/remedies and provide clear decision criteria about when additional treatment would be needed. For example, the carbon tetrachloride plume is 2,000 feet long, about 1.25 acres and is defined by 8 wells. This plume is proposed to be treated with two portable air sparge units, one to the northeast and one to the southwest. Each location is proposed to have three air sparge wells with an assumed ROI of 20 ft and 5 ft of overlap, covering a distance of 45 to 60 feet. The plume ranges between 120 and 235’ wide. Will this limited treatment system be able to treat this 1.25-acre plume? In the opinion of this author, that is not clearly obvious. Whether it is in the next version of this document but certainly in the Proposed Plan and the Record of Decision, the decision logic for the management of meeting the remedial goals needs to be formulated and formally included as part of these documents.

Response G6: The isopleths on Figures 21, 23 and 24, which depict the alternatives are 10, 20 and 40 µg/L. The dimensions cited for the carbon tetrachloride plume appear to be based on the 10 µg/L isopleth. The treatment areas are planned to cover the plume cross-section exceeding 20 µg/L.

The three AS/SVE transects on the north and west boundaries and in the window are planned to have 8 AS wells and 4 SVE wells. With the stated ROI and overlap, the cross-section treatment length would be 140 feet for AS and 185 feet for SVE. The portable systems will employ either 1 SVE well or 1 SVE well and 3 AS wells with cross-section treatment length of 100 feet for SVE and 55 feet for AS.

A preliminary design investigation, prior to the remedial design, is planned to include installation of 17 monitoring wells and 12 vapor monitoring points. Plume width at higher concentrations (<40 µg/L) is not well defined in several areas. The VMPs will also indicate areas where SVE may be appropriate (high CVOC concentrations in soil vapor). Final design in treatment areas, such as the carbon tetrachloride plume, may need to be altered. Vapor and groundwater samples will be collected during performance monitoring and may also indicate the need for modifications.

Specific Comments

1. **Section 1.1, Purpose and Organization of the Report, Page 1-1:** The text states that the purpose of the FFSR is to assess the effectiveness of the current remedy; however, based on the most recent Five-Year Review (FYR), it has been established that the current remedy at the MI is not effective, and the purpose of the FFSR is to evaluate potential remedial alternatives. Therefore, please revise the text to state the actual purpose of the FFS.

Response S1: Text will be revised to state "… identify an appropriate alternative to the remedy selected in *Memphis Depot Main Installation Record of Decision* (CH2M Hill, 2001)."

2. **Section 1.2.3.1, Physiographic Setting, Page 1-3:** This section states that groundwater at the MI is at a depth of 80 feet below ground surface (bgs); however, according to Table 10 (Site Conditions at Treatment Areas, Alternative 3) of the FFSR, groundwater levels in monitoring well MW-263 during the April 2021 long term monitoring (LTM) event was measured at a depth of 53.83 feet (ft) below top of casing (btoc). Please revise this statement to accurately reflect groundwater level variations at the MI.

Response S2: Will revise the statement to "… depth of approximately 54 to 95 ft below ground surface (bgs) in the water-table aquifer on the MI …".

3. **Section 1.2.3.2.4, Memphis Sand, Page 1-4:** This section states that three monitoring wells (MW-67, MW-254 and MW-255) have been installed in the Memphis Sand (i.e., Memphis Aquifer [MAQ]) hydrogeologic unit at the DDMT; however, according to Table

1 (PCE, TCE, and CT Concentrations in Groundwater, April 2021) of the FFSR, five wells are installed in the MAQ (MW-140, MW-229, MW-254, MW-255 and MW- 290) and according to Figure 18 (Memphis Aquifer, CVOC Concentrations, April 2021) there are six MAQ wells (MW-67, MW-140, MW-229, MW-254, MW-255 and MW- 290). Please revise this statement to accurately reflect the correct number of wells installed in the MAQ.

Response S3: Will revise the first paragraph of Section 1.2.3.3.3 to clarify wells used for MAQ water levels. "…the three wells installed in the Memphis Sand (MW-67, MW-254 and MW-255) and from three wells installed in the lower section of the upper Claiborne with groundwater elevations consistent with the wells in the Memphis Sand (MW-140, MW-229 and MW-290)." Figure 10 shows the MAQ water level based on MW-254, MW-140 and MW-290.

4. **Section 1.2.3.3.3, Memphis Aquifer, Page 1-5:** This section states that groundwater withdrawal since 1886 have resulted in the decline of water levels in the Memphis area; however, the text should specifically provide greater detail on specific conditions that impact groundwater levels at the MI; specifically, the presence of the Allen Wellfield, that is located approximately one to two miles west of the MI. The FFSR should discuss when the Allen Wellfield became operational and how much water is withdrawn annually. This information will provide greater context regarding the complex groundwater flow patterns at the MI and how the pumping well field influences groundwater gradients and flow direction on the MI.

Response S4: See Response G1.

5. **Section 1.2.4.2.2, Page 1-7:** The verbiage here regarding *Land Use Controls* is somewhat confusing. Please clarify exactly where residences can be constructed based both on the zoning and on the calculated health risks. Also state whether there are any areas where groundwater can be used as residential drinking water (based on the calculated health risks). If there are any restrictions on land use OR groundwater use, it would not seem to be an unlimited use and unlimited exposure (UU/UE) situation

Response S5: Section 1.2.4.2.2 will be revised for clarity and will summarize the following information.

Residential use on the MI is limited to the former housing area, which is shown on Figure 4. Additional housing within the former housing area would have to be approved by Shelby County, which is unlikely based on current zoning, adjacent land use on the MI and DDMT's inclusion on the NPL.

Deed restrictions for DDMT do not allow construction of wells on Dunn Field, except those installed by Army for environmental restoration activities. In addition, Shelby County Groundwater Quality Control Board Rules apply to DDMT and the surrounding area:

- 4.01C and 5.02E. A water well or production well cannot be cited or placed in service within a half-mile of the designated boundary of a mandated or voluntary remediation site involving groundwater contamination.
- 12.01H. Construction of a well shall not be permitted at a premise where public water is available.
- 12.01I. When a public water system (PWS) is available to a residential premise the potable water shall be obtained from the PWS.

The use of “unlimited use and unrestricted exposure” for the former housing and administrative area is from the MI LUCIP. The MI ROD uses the term “unrestricted use” but it was still restricted. Section 2.4.2: “ Restrict (1) future residential land use (except for the existing Housing Area in FU6) in FUs 1 through 6 …The Housing Area is the only area of the MI that may be used for future residential purposes, according to the DRC’s Memphis Depot Redevelopment Plan. … Figure 2-3b depicts the areas of FU6 (Parcels 1 and 2) available for unrestricted reuse. The remainder of FU6 is safe for industrial use but not suitable for future residential use.”

6. **Section 1.2.4.3.3, Page 1-10:** This section discusses the supporting data for the MNA portion of the remedy. It refers to an agreement between the decay rates of the contaminants in the groundwater, as expressed in the 2009 groundwater model and the recent data. This needs to be expanded further to provide the evidence of that agreement. Perhaps that documentation and discussion should be in an appendix and referenced here.

Response S6: The referenced text does not discuss recent data. The 2009 groundwater model (App. F, MI Source Area Investigation; e2M, 2009) is discussed in the 2020 SRI Report (HDR,2021). Figures in Appendix C of the SRI report show agreement between April 2008 concentrations in LTM wells along the flow path and estimated concentrations from the groundwater model; the first order attenuation rates were 0.5/year for PCE and 0.8/year for TCE.

Determining 1st order decay rates for most of the plumes is no longer possible due to enhanced bioremediation treatment (EBT), contaminant migration onto the MI, the SVE pilot test in TTA-2 and/or potential multiple small sources area within the plumes. The South-Central plume is the only ‘undisturbed location, and attenuation rates will be determined for comparison with those from 2009.

7. **Section 1.2.5, Risk Assessment Summary, Page 1-11:** The first paragraph states that the risk assessment exposure scenarios considered drinking water ingestion, dermal contact, and inhalation as well as inhalation of indoor air vapor intrusion from groundwater vapors for current/future on-site workers and future on-site resident adult and child; however, the second bullet of the section states that the vapor intrusion (VI) pathway was not evaluated for a resident. Please discuss why the VI pathway was not

evaluated for the residential scenario, especially since the TTA-1N area plume extends off the MI into an adjacent residential area.

Response S7: The text will be revised to state that initial work on the VI Study began at about the same time as the HHERA, and, as only limited vapor data had been collected, evaluation of the VI pathway for on-site residents within the former housing area on the MI was delayed until implementation of the VI SAP; The VI SAP was recently reviewed by EPA.

It would be more accurate to state the TTA-1N plume extends on to the MI. VI evaluation of off-site residential areas by Army is not planned because groundwater flow in the uppermost aquifer (FDAQ) is onto the MI from all sides; therefore, groundwater contamination in the FDAQ from on-site sources does not migrate off-site and does not have potential for off-site VI. See Response G1.

8. **Sections 1.2.5, 2.2.1, Table 4 – Risk-Based PRGs for soil vapor:** The risk-based PRGs listed for *Chloroform* are Vapor Intrusion Screening Levels (VISLs) but are not cleanup levels. As I discussed in detail in my comments on the human health risk assessment (HHRA) (April/2020 memo to Diedre Lloyd), Chloroform has been determined by EPA to be a threshold carcinogen for all routes of exposure (IRIS). A "threshold carcinogen" designation means that if the noncancer hazard index does not exceed 1, the cancer risk is zero. It is accepted practice (if a bit confusing) to use the cancer potency values to calculate values by which to screen Chloroform; hence the RSLs and VISLs are calculated as such. In making remedial decisions and setting cleanup levels, however, a HI of 1 (protective of cancer and noncancer endpoints) should be used. Based on indoor air [IA] concentrations set at a HI of 1 (residential IA= 98 µg/m3; industrial IA= 430 µg/m3) and assuming the default attenuation factor of 0.03, health protective (for cancer and noncancer) concentrations for Chloroform in soil vapor are 3200 µg/m3 (residential exposure scenario) and 14,000 µg/m3 (industrial exposure scenario).

Response S8: The above methodology will be used to revise the chloroform soil vapor PRGs and a note explaining the basis will be added to Table 4. To clarify, the noncancer Residential IA Screening Level in the VISL calculator is 102 ug/m^3 and 100 ug/m^3 in the RSL calculator (Nov 2022) and this would result in a noncancer residential soil vapor PRG of 3,333 ug/m^3 (100 / 0.03), which rounds to 3,300 ug/m^3. Please provide the basis for the Residential IA of 98 ug/m3 in the comment, which resulted in a noncancer residential soil vapor PRG of 3,200 ug/m^3.

9. **Sections 1.2.5, Table 5, Risk-Based PRGs for Groundwater:** The risk-based PRGs listed for *Chloroform* are Regional Screening Levels (RSLs) but are not cleanup levels. As discussed in the previous comment, Chloroform has been determined by EPA to be a threshold carcinogen for all routes of exposure (IRIS) which means that to assess health risks, make remedial decisions, and set risk-based cleanup levels, a HI of 1 should be used. The tap water RSL for a HI of 1 is 97 µg/L. This screening RSL is still

overly conservative (health protective) as it is based on a child-only exposure and on a high default water-to-air volatilization factor. A Superfund site HHRA, based on appropriate adjustment of these factors, would generate a somewhat higher groundwater Chloroform level as health protective. The MCLG of 70 µg/L established by EPA Office of Water (EPA 2018a) is based only on the noncancer toxicity, consistent with the threshold carcinogen designation. This MCLG is, therefore, a protective level for current and potential drinking water sources.

Response S9: The groundwater PRG for chloroform will be revised to 70 µg/L and a note explaining the basis will be added to Table 5.

10. **Section 1.2.6.1, Subsurface Soil Vapor Source Areas, Page 1-12:** The first sentence states that historical sampling did not identify volatile organic compound (VOC) concentrations above soil screening levels; however, according to Section 1.2.4.3.1 (2009 Source Area Investigation and Groundwater Model Update), five of 70 soil samples had VOC concentrations above screening levels. Please revise the text to accurately reflect these soil screening level exceedances.

Response S10: 'Historical soil sampling' is referring to the MI RI samples. Will revise the sentence to "Soil sampling in suspected source areas for the MI RI (CH2MHILL, 2000a) did not identify …"

11. **Sections 1.2.6.1 – Subsurface Soil Vapor Source Areas:** *"…PCE at 14,000 ppbV, CT at 15,000 ppbV, CF at 670 ppb, cDCE at 250 ppbV…"* To be consistent with the text in Section 2.3.1 and with Table 4, all soil vapor concentrations should be in units of µg/m3.

Response S11: Will revise the text to list concentrations in µg/m3 and provide the Dunn Field soil vapor remedial goals and VISLs for comparison.

12. **Section 1.2.6.2.8, Hydraulic Connections – IAQ and MAQ, Page 1-15:** The final sentence of this section states that there is no plume in the MAQ; however, according to Figure 18 (Memphis Aquifer CVOC Concentrations, April 2021) tetrachloroethylene (PCE) was detected above the USEPA Maximum Contaminant Level (MCL) of 5 µg/L in monitoring wells MW-254 and MW-140, which are in the northeast portion of the MI. It should be noted there is no MAQ well to the southwest to bound these PCE exceedances. Based on the proximity of MW-254 and MW-140, a potential undefined PCE plume appears to be present in the MAQ in the northwest portion of the MI. Please revise the text to discuss this potential PCE plume in the MAQ

Response S12: Will revise the final sentence in this section to "These exceedances are isolated but indicate a potential undefined plume in the MAQ due to contaminant migration from upgradient IAQ wells. Due to the relatively low concentrations in MW-254 and MW-140, a monitoring well has not been installed downgradient (southwest) of MW-254."

13. **Section 2.2.1, Subsurface Soil Vapor Source Areas, Page 2-3:** The final sentence of this section states that the USEPA vapor intrusion screening level (VISL) for a residential scenario at a target risk (TR) of 1x10-4 and target hazard quotient (THQ) of 1 can be applied to the unlimited use and unrestricted exposure (UU/UE) area at the MI; however, it is unclear what VISL scenario will be used to evaluate soil gas data that may be collected at the off-site residential area located to the west of the TTA-1N area. Please consider using the VISLs for a residential scenario at a TR of 1x10-4 and THQ of 1 for off-site residential areas since the commercial VISLs are not protective of human health for the residential scenario

Response S13: The groundwater flow direction in the FDAQ is onto the MI at the TTA-1N plume and at the North-Central plume. The off-site portion of these plumes, and the on-site portion to an undefined extent, are considered to result from an off-site source. Soil gas data will not be collected and the VI pathway from off-site plumes will not be evaluated by Army.

14. **Section 2.3.1, Subsurface Soil Vapor Source Areas, Pages 2-3 and 2-4:** This section presents commercial screening levels as remedial action objectives (RAOs) that will be added to the MI Record of Decision (ROD); however, since contamination from the MI extends off-site into residential areas and some areas of the MI are zoned for residential use, these commercial RAOs are not applicable for the entire MI. Please consider using a combination of commercial and residential screening levels as RAOs, depending on the land use of the impacted area.

Response S14: Residential screening levels will be considered as RAOs for the former housing area on the MI. Passive screening soil vapor samples, and possibly active soil vapor samples, are planned for that area in the VI SAP.

As stated in preceding responses, it would be more accurate to state contamination from off-site areas extends <u>on to</u> the MI, and evaluation of potential VI in off-site areas is not planned by Army.

15. **Section 2.6.1, Technologies and Process Options for Subsurface Soil Vapor Source Areas, Page 2-6:** This section states that VOCs were detected in soil vapor at concentrations above vapor screening levels and references Section 1.2.4.4 (Soil Vapor Extraction Pilot Test) for discussion; however, there is no comparison of soil vapor results to screening levels in Section 1.2.4.4. Please include a discussion of soil vapor results with respect to screening levels in Section 1.2.4.4 or include this information in Section 2.6.1.

Response S15: The reference in Section 2.6.1 should be to Section 1.2.6.1, not 1.2.4.4. As stated in Response S11, Section 1.2.6.1 will be revised to list concentrations in µg/m3 and provide the Dunn Field soil vapor remedial goals and VISLs for comparison, with a comparison of soil vapor concentrations to screening levels.

16. **Section 2.6.1.2, Vapor Intrusion Institutional Controls, Pages 2-6 and 2-7:** The last sentence states that additional notification Institutional Controls (ICs) will be included in the MI Land Use Control Implementation Plan (LUCIP) and Notice of Land Use Restrictions (NLUR) to notify landowners of potential VI issues; however, it is unclear if these ICs will be in place for off-site properties. Please discuss if the ICs for VI issues will include properties outside the boundaries of the MI

Response S16: As noted in previous comments, off-site groundwater plumes are considered the result of off-site sources based on groundwater flow direction per elevation contours and the relatively high concentrations in off-site wells. Army does not plan further action for potential off-site VI from the off-site plumes. Potential VI impacts from on-site plumes will be evaluated based on soil vapor concentrations near the MI property boundary.

17. **Section 2.6.2.4.2, Hydraulic Barriers, Pages 2-8 and 2-9:** This section states that groundwater reinjection of treated groundwater is not a viable option at the MI; however, no explanation is provided for why this option is not viable. Please revise the text to explain why reinjection of treated groundwater is not a viable option.

Response S17: The second paragraph in 2.6.2.4.2 identifies options for discharge of extracted groundwater but notes that discharge to surface or stormwater drainage is the only viable option and that cost for remediation of extensive plumes as found on the MI can be prohibitive. The option was retained for further analysis. Further evaluation of this option is presented in Section 2.8.4 where it is screened out.

18. **Section 3, Development and Screening of Remedial Alternatives, Page 3-1:** The source area for TTA-1N and Building 720 are both estimated to be 100 feet by 100 feet, which is the same dimension as the TTA-2 source area. While the Building 720 plume area appears to be similar in size to TTA-2, the TTA-1N plume is much more extensive; therefore, it is not clear why the source area extent of TTA-1N is reported as like the Building 720 and TTA-2 areas. Please provide additional lines of evidence to support the estimated source area of TTA-1N or revise the estimated source area extent as appropriate.

Response S18: The TTA-1N plume is more extensive than the TTA-2 and Building 720 plume but the on-site source area is considered to be similar in size. The plume area extending from the access road west of Building 1089 and off-site to the west is considered due to an off-site source. The on-site area west of the access road is not developed and has overhead high-voltage transmission lines which greatly restrict activity in that area. The on-site source is considered to be in the area of wells PMW21-02, PMW21-03 and PMW21-04 which are in the past operations area and have the highest CVOC concentrations east of MW-219.

19. **Section 3.3.3, Description, Page 3-4:** The proposed location of the soil vapor extraction (SVE) system for TTA-1N is situated on the eastern side of the plume, west of monitoring well MW-100B, with a large portion of the radius of influence overlapping uncontaminated areas. The area east and to the north of MW-219 appears to be a more suitable location since groundwater contamination is more extensive. Please consider moving the SVE system to the west or adding a second SVE location in the area of MW-219 to capture additional contamination

Response S19: As stated in Response S18, the area from the access road to the property line has overhead high-voltage transmission lines. An AS/SVE system along the access road is the recommended alternative to address the plume coming on to the MI and is included in Alternatives 3 and 4.

20. **Section 3.3.3, Description, Page 3-4:** According to Alternative 2, SVE systems are proposed at the TTA-1N, TTA-2 and Building 720 areas, and the text states that the exiting VMP networks will be utilized to evaluate the radius of influence; however, the existing VMPs associated with the Building 720 area are located to the east of the proposed SVE point, and mostly outside the theoretical radius of influence. Please consider revising the text to include the installation of additional VMPs in the area of the proposed Building 720 SVE system to adequately monitor the area of influence.

Response S20: Section 2.4.1 states "These suspected source areas and other presumed small release areas on the MI will be further characterized during the preliminary design investigation (PDI) to target areas for subsurface soil vapor remediation efforts."

A PDI will be added in section 3.3.4 to include installation of six VMPs between the three areas. Proposed locations will be included in a work plan.

Supplemental Comments (Received1/18/23)

General Comment

1. The FFS does not appear to contain a discussion of whether monitored natural attenuation (MNA) will achieve Maximum Contaminant Levels (MCLs) in a reasonable timeframe, consistent with EPA guidance, *Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites,* OSWER Directive 9200.4-17P, April 1999. This is a significant deficiency, and the Army should include such discussion in the FFS. Moreover, without including supporting data that demonstrate that MNA is a viable alternative, then any alternative relying on MNA will be unsupported. Please refer to the EPA comments 3 and 4 of the EPA's letter and update the report to incorporate the requested information.

Response GC1: The estimated time to reach MCLs is discussed in Sections 3.4.3 for Alternative 3 and in Section 3.5.3 for Alternative 4. See Response G3 above for selection of MNA.

Specific Comments

1. **Section 1.2.4.2.1, Soil Excavation, page 1-7.** The first sentence describes excavation completed *"prior to execution."* This phrase appears to mean prior to remedy selection in the Record of Decision (ROD). If this is the case, please revise this sentence for clarity, to read, *"ET&D for lead contamination adjacent to Building 949 was completed prior to selection of the remedy in an approved ROD and was noted as a significant change in the MI ROD; the early completion eliminated it as part of the selected remedy."* However, if this was not the intended meaning, please clarify the meaning of *"prior to execution"*.

   Furthermore, a recommendation of removing the word *"effectively"* is suggested because it seems to add nothing to the denotation of the statement and instead raised questions about its meaning. However, if *"effectively"* meant to convey some limitations on removing the excavation as part of the selected remedy, please clarify it in the report.

Response SC1: The initial phrase will be revised to "… was completed prior to final approval of the MI ROD and was noted as a significant change in the ROD; the early …". Other revision is not needed; page 2-53 of the approved MI ROD states: "the early completion of this action effectively eliminates it as part of the remedy".

2. **Section 1.2.4.2.2, Land Use Controls, page 1-7**. If there are restrictions on groundwater use or access to groundwater in this area, it should not be noted as unlimited use and unrestricted exposure (UU/UE), although the acceptable risk from direct exposure makes it safe for residential use. If that is the claim, please replace "UU/UE" with *"residential use."* Please refer to requested information on EPA comments 5 of the EPA's letter.

Response SC2: 1.2.4.2.2 does not refer to UU/UE. The purpose of section 1.2.4.2.2 is to discuss the use restrictions as described in the 2004 MI LUCIP (CH2MHILL, 2004b) approved by EPA. The issue is discussed in Response S5. Further revision is not necessary.

3. **Section 1.2.4.2.4, Enhanced Bioremediation Treatment, page 1-8.** The first sentence notes a concentration of 100 ug/L for trichloroethylene (TCE) and perchloroethylene (PCE) to delineate treatment areas. Since this is 20 times higher than the MCL, it might be helpful to note in this section that the treatment area concentration was not used as a substitute for the MCL and that the MCL of 5 ug/L is still the Remedial Goal (RG) for those contaminants.

Response SC3: Section 1.2 provides background information including the MI ROD and past remedial action. Section 1.2.4.1 identifies MCLs as RAOs in the MI ROD. Table 5 is introduced in Section 2.2 and lists MCLs as PRGs. Revision for this comment is not considered necessary.

4. **Sections 3.4.3 and 3.5.3, Description, pages 3-10 and 3-15.** Each section (Alternatives 3 and 4) state *that "Vapor extraction piping will be sloped to allow moisture and condensate to drain into the SVE wells. Condensate will be collected in a knockout tank and periodically disposed at an approved off-site facility or stored in the existing condensate tank on Dunn Field for testing and disposal in accordance with TDEC requirements."* Please note that prior to approving an off-site facility for dispositioning any CERCLA waste waters, the facility must be evaluated to determine whether the waste waters will be dispositioned protectively. Likewise, *"in accordance with TDEC requirements"* must ensure that the waste waters will be dispositioned protectively. Please clarify whether these facilities will discharge to surface water.

Response SC4: Condensate from the existing AS/SVE system and wastewater from groundwater sampling and sampling equipment decontamination is currently discharged to a storm water drain per agreement with TDEC, when sample analyses meet TDEC criteria. The storm water drain discharges to an ephemeral or intermittent surface water drainage. The sentence will be revised to "… *disposed at an off-site facility approved for receipt of CERCLA waste or stored in the existing condensate tank on Dunn Field for testing and disposal in accordance with requirements of the existing agreement with TDEC.*"

5. **Section 4.2.2.2, Compliance with ARARs, page 4-4.** The first paragraph states, *"This alternative will not comply with MCLs at the southwest and north site boundaries where migration of off-site contaminants onto the MI are occurring. This ongoing source will limit MNA's ability to meet MCLs throughout the plume in a reasonable timeframe."* Please clarify whether not meeting MCLs occurs throughout the plume or just upgradient from the treatment locations. In a case where MCLs will not be met, that is, an ARAR will not be met, the ARAR must be waived, using one of the bases in the NCP at 40 CFR 300.430(f)(1)(ii)(C). The Lead Agency needs to clarify with more specificity where it is anticipated that the ARAR will not be met and to provide justification for a waiver. Moreover, if there is no ARAR waiver available, this alternative is not viable and should be removed. Please discuss and address this issue in the report for clarity and completeness, as this has an impact on determining the preferable alternative.

Response SC5: Alternatives 2 to 4 provide an increasing level of active treatment. Section 4.2.2.2 is for Alternative 2, which includes SVE in TTA-1N, TTA-2 and Bldg 720, and MNA. It does not include treatment at the site boundary where plumes migrate on to the MI, and no reduction in contaminant migration on to the MI will be provided.

For clarity, the referenced sentence will be revised to "… site boundaries due to contaminant migration of off-site contaminants onto the MI until the off-site contaminant sources are remediated. This ongoing source will limit MNA's ability to meet MCLs throughout the site in a reasonable timeframe."

The following will be added after the first paragraph" "SVE in areas with high CVOC concentrations in soil vapor will provide source control. Building 720 is the only identified potential contaminant source within the erosional window; SVE will reduce contaminant impacts to groundwater and will, with MNA, reduce concentrations in downgradient wells, including MAQ wells MW-140 and MW-254, which slightly exceed MCLs at present."

6. **Section 4.2.2.2, Compliance with ARARs.** In addition, please note that because this plume is impacting a Class I drinking water source *(i.e., impacting the Memphis Aquifer via migration downward through the "window")*, EPA's policy is to address the contamination via "rapid" restoration. Since the Memphis Aquifer provides 95% of the municipal and commercial water supplies in the Memphis area, it is likely that even a "very rapid" (one to five years) restoration should take place. *See EPA groundwater policy at 55 Fed. Reg 8732.* Please discuss and address this issue in the report, particularly in *Section 4.3.2, Compliance with ARARs*, as this has an impact on determining the preferable alternative.

Response SC6: The FFS was prepared in accordance with DOD Manual, *Defense Environmental Restoration Program (DERP) Management* (DOD, 2012), which references EPA regulations and guidance, and directs that " If remedial action for groundwater is necessary to protect human health or the environment, the DoD Component should consider the NCP expectation that useable ground waters will be returned to their beneficial uses whenever practicable, within a timeframe that is reasonable given the particular circumstances of the site …".

As stated in Response SC5, contaminant concentrations in the MAQ in the downgradient area of the plume, within the erosional window, are only slightly above the MCL. Concentrations in upgradient wells in the MAQ and lower IAQ are not significantly higher (see Figure 10 of the FFS). Groundwater modeling estimated concentrations would decrease below 1 µg/L within approximately 2,000 ft from the MI. Response SC5 states that active remediation at Building 720, within the window, will "reduce concentrations in downgradient wells including MAQ wells …".

Section 4.2.2.2 already states that achieving drinking water standards (i.e. MCLs) is the intent of the alternative, that the alternative will not achieve the MCLs at the southwest and north site boundaries due to off-site contaminants migrating onto the MI until the off-site source is remediated, and that this limits the ability to meet MCLs in a reasonable time frame. The window in the northwest MI is the only area on the MI where contaminant concentrations migrate off-site in the IAQ, and concentrations in the MAQ slightly exceed MCLs; the planned action will reduce those concentrations. Army considers this action will achieve MCLs in the MAQ within a reasonable timeframe given site conditions.

Finally, while the word "rapid" was used in the Federal Register Vol. 55, No.46, March 8, 1990, page 8732, the word "rapid" was not carried forward to subsequent EPA guidance, and was replaced by "reasonable". In fact, a more thorough reading of page 8732 reveals that EPA goes on to say that the necessity for rapid restoration is reduced where there are other readily available drinking water sources.

7. **Section 4.2.2.4, Reduction of Toxicity, Mobility, or Volume of Contamination Through Treatment, page 4-5.** In the first sentence, please add *"through treatment"* after *"contamination"* to mirror the text in the NCP.

Response SC7: Will revise as suggested.

8. **Section 4.2.3.4, Reduction of Toxicity, Mobility, or Volume of Contamination Through Treatment, page 4-8.** In the first sentence, please add *"through treatment"* after "*contamination"* to mirror the text in the NCP.

Response SC8: Will revise as suggested and will make similar revision in 4.2.4.4.

9. **Section 4.3.2, Compliance with ARARs, page 4-13.** Regarding the first sentence in this section and the statement in *Section 4.2.2., Section 4.2.2.2* states that *"This alternative will not comply with MCLs at the southwest and north site boundaries where migration of off-site contaminants onto the MI are occurring. This ongoing source will limit MNA's ability to meet MCLs throughout the plume in a reasonable timeframe."* In contrast, the first sentence in Section 4.3.2 states *"Alternative 2 will comply with ARARs for subsurface soil remediation activities but the groundwater remedy (MNA) will not comply with groundwater MCLs for a long period of time."* As noted in the prior comments, if an alternative will not comply with ARARs and has no basis for an ARAR waiver under 40 CFR 300.430(f)(1)(ii)(C), then the alternative is not viable and should be removed from the FFS.

Response SC9: See Responses SC5 and SC6. Further revision of the FFS is not considered necessary.

10. **Table 2, Chemical- specific ARARs.** Please add the additional ARARs to Table 2. However, adding columns identifying a website referring to these ARARs, as well as the alternatives to which the requirements apply or are relevant and appropriate, is also acceptable. In addition, for clarity, the EPA recommends removing the "Title" column.

Response SC10: Revision of Table 2 is not necessary for this comment. Four suggested ARARs reference 40 CFR 63 (NESHAP); the nature of releases at the MI are not at all similar to the releases covered by NESHAP nor is the intent of NESHAP to regulate a CERCLA remedial action. The fifth suggested ARAR refers to state standards for groundwater that are not more stringent than the Federal standard.

11. **Table 3, Action-specific ARARs**. Please add the following ARARs to Table 3. However, if the Lead Agency believes that any of the ARARs on this list are neither applicable nor relevant and appropriate, the EPA should be notified before the FFS approval.

Response SC11: Revision of Table 3 is not necessary for this comment. The state standard for activities causing fugitive dust emissions and stormwater runoff are not applicable to the planned remedial activities and are also not ARARs because they are general construction requirements that do not contain standards for the site-related contaminants found at this site.

12. **Table 3, Action-specific ARARs**. The table incorrectly refers to some RCRA regulations as TBCs. Furthermore, requirements for waste management and groundwater monitoring ARARs are missing. Moreover, it also appears that there will be no CERCLA waste waters discharged to surface water as alternatives involving discharge screened from the final alternatives. As a result, the following requirements apply to solid waste generated during a CERCLA response action. Please make the necessary changes, keeping in mind that the EPA frequently provides parallel state and federal citations where they are substantially similar/the same. Finally, if it is understood that any missing ARARs related to this type of discharge exist, they should be provided to the ARMY prior to FFS approval. Please clarify.

Response SC12: Revision of Table 3 is not necessary for this comment. Characterization of solid waste is included as a TBC because 40 CFR 261 does not provide cleanup standards or standards of control to be met and is not an ARAR. Hazardous wastes will not be created by the remedial activities and the related suggested ARARs are not applicable. The other suggested ARARs are not substantive, but administrative or procedural, and thus are not ARARs.

With regard to discharges to surface water, extraction treatment and discharge of groundwater was screened out in Section 2.8.4. However, as stated in Responses SC4, condensate from the existing AS/SVE system and from groundwater sampling and equipment decontamination is currently discharged to a storm water drain per agreement with TDEC. Discharges under that agreement will continue during the proposed remedial action.

U.S. ENVIRONMENTAL PROTECTION AGENCY
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8/11/2023

Mr. James Foster
Base Realignment and Closure Division (ACSIM-ODB)
2530 Crystal Drive (Taylor Building), Room 5000
Arlington, VA 22202-3940

Subject: United States Environmental Protection Agency Review of the Red-Line-Strikeout, Revision 1 Focus Feasibility Study, and the United States Army Responses to EPA Comments of the Main Installation, Defense Depot of Memphis Tennessee

Dear Mr. Foster,

The United States Environmental Protection Agency (EPA/USEPA) has completed its evaluation of the United States Army (ARMY/USARMY) Responses to EPA Comments (RTCs) and the Revision 1 Focus Feasibility Study (FFS), Main Installation, Defense Depot of Memphis Tennessee, dated June 2023. Overall, the EPA has found that several of the responses are unsatisfactory which require the implementation of changes to the FFS before its final version could be approve. Specifically, several of EPA's comments requested that the Army support the identification of Monitored Natural Attenuation (MNA)[1] as part of an alternative by demonstrating how MNA was consistent with EPA's MNA guidance.[2][3] The EPA informs the Army that it is unable to approve the FFS as is because it has not demonstrated that the MNA alternative is consistent with the EPA guidance.

In general, demonstrating that the plume is stable is a critical requirement in establishing MNA as a viable remedial alternative (or as part of an alternative). The facts demonstrated that the plume is migrating both laterally and vertically, rather than being stable. Therefore, the Army should amend the FFS to remove any mention of MNA and replace it with *"monitoring,"* as done in the Main Installation Record of Decision (2002).

Likewise, if the Army demonstrates that treatment will reach maximum contaminant levels (MCLs) within a reasonable time, it can retain the treatment alternatives. On the other hand, if the program does not find sufficient support for the treatment's ability to reach the MCLs in a reasonable time frame, the action should be an interim action.

The comments below were created to convey the EPA position on the Lead Agency Responses and to improve the FFS's overall completeness and clarity. In addition to these comments, the EPA encloses the updated CAA NESHAPS ARARs that the Army should also consider and include it in the FFS.[4]

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[1] Groundwater Technologies | US EPA.
[2] April 1999, OSWER Directive 9200.4-17P, EPA 540/R-99/009.
[3] August 2015, OSWER Directive 9283.1-36.
[4] The updated ARARs that became final in December 2022 were not reflected in the original NESHAPS comments dated January 2023.

General Comments

Response to EPA General Comment 3. Response unsatisfactory. MNA should not be part of the recommended remedial actions.

MNA is currently a major component of all the proposed remedies under consideration in this document. As such, MNA should have been screened out and should not be part of the recommended remedial actions.

As per EPA's MNA Guidance,[5] page 16, one of the primary lines of evidence required is: *"Historical groundwater and/or soil chemistry data that demonstrate a clear and meaningful trend of decreasing contaminant mass and/or concentration over time at appropriate monitoring or sampling points. However, in the case of a groundwater plume, decreasing concentrations should not be solely the result of plume migration."*

In fact, page 1-13 of the FFS states that plume migration is occuring: "*Contamination in the IAQ and MAQ is the result of migration of FDAQ groundwater where clay layers are thin in the sink and absent in the erosional window."* What emerges is a very dynamic hydrogeological setting in which dissolved phase contamination has moved/is moving into new areas and depths, including the Memphis Aquifer; this is in direct conflict with the applicable Guidance citation (above).

Furthermore, this is not to say that attenuation through dilution does not occur or cannot be expected to continue. There is also plenty of evidence of decreasing concentrations along groundwater flow pathways over time, as well as contamination moving past static groundwater monitoring wells. As a result, it is expected that the air sparge and soil vapor extraction remedial actions will readily reduce groundwater contamination to 20 ug/L, where attenuation by dilution will cause the groundwater to be 'restored.'[6]

Response to EPA General Comment 4 - Response unsatisfactory. Please see General Comment 3.

Response to EPA General Comment 5 – Some components of the remedy may require modification.

All the operational details about the air sparge and soil vapor extraction systems provided in Section 3.0 are provisionally agreed to, but this is not the remedial design. Based on actual in-field performance and restoration efficiency, the operation of these components as part of the remedial action may require some changes. Moreover, it could be years before the remedial

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[5] USE OF MONITORED NATURAL ATTENUATION AT SUPERFUND, RCRA CORRECTIVE ACTION, AND UNDERGROUND STORAGE TANK SITES, U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Directive 9200.4-17P, April 1999, pp 35. Emphasis added.
[6] This evaluation was completed using direct, appropriate information from the MNA Guidance and images from three recent groundwater monitoring reports (2016, 2019 and 2022).

action commences and given the dynamic nature of the groundwater at the Main Installation, other areas and depths may need remedial action, while others may not.[7]

Therefore, the areas for the operation of these systems should retain a degree of flexibility.

Specific Comments

Response to EPA Specific Comment 5. Response unsatisfactory.

Part of the EPA comment stated that, *"If there are any restrictions on land use OR groundwater use, it would not seem to be an unlimited use and unlimited exposure (UU/UE) situation."* The Army's response referred to the [DATE] Land Use Control Implementation Plan (LUCIP). Specifically, regardless of the LUCIP, if there is contaminated groundwater beneath or nearby parts of the property that are deemed safe for residential use, the presence of use restrictions preventing access to, or use of the groundwater means that it is not UU/UE. Please revise the text to describe as safe for residential use, not "UU/UE."[8]

Response to EPA Specific Comment 17. Response unsatisfactory.

If the Army is discharging onsite to surface water, an agreement with TDEC is an insufficient way to describe the legal requirements related to discharge to surface water. The FFS states that, *"condensate from the existing AS/SVE system and from groundwater sampling and equipment decontamination is currently discharged to a storm water drain per agreement with TDEC. Discharges under that agreement will continue during the proposed remedial action."*

For the contrary, the FFS should state clearly that the waste waters will be transfer to a named POTW or other named wastewater treatment facility, which facility is designed to treat the waste waters and contaminants in this action. Likewise, depending on the treatment facility discharge limits, the Army may be required to perform pre-treatment.

Supplemental General Comment

Several of EPA's comments requested that the Army support the identification of MNA as part of an alternative by demonstrating how MNA was consistent with EPA's MNA guidance, which the Army has failed to accomplish. For instance, a key factor in identifying MNA as a viable remedial alternative (or part of an alternative) is to show that the plume is stable. The facts show that, rather than being stable, the plume is migrating both laterally and vertically. As a result, unless the Army could demonstrate that treatment will reach MCLs within a reasonable time, and it can retain the treatment alternatives, then the FFS should be revised to change any mention of MNA to monitoring, as was done in the MI ROD (2002). If the program does not find sufficient

[7] The issues raised in this original comment need further discussion.
[8] If the LUCIP should be revised to reflect this distinction, the Army should revise the LUCIP as well.

support for treatment's ability to reach MCLs in a reasonable time frame, the action should be an interim action.

Supplemental Specific Comments

Response to EPA Supplemental Specific Comment 2. Response unsatisfactory. Same as Specific Comment 5.

Response to EPA Supplemental Specific Comment 4. Response unsatisfactory. See reply to Specific Comment 17.

Response to EPA Supplemental Specific Comment 5. Response unsatisfactory.

Discussion with program recommended about ability to meet ARARs or not, with respect to the two "offsite" plumes. If this is an interim action, the Army could utilize that waiver until more is known about the "offsite" plumes. Regarding MNA, since the Army has not demonstrated that MNA is a viable alternative consistent with EPA MNA guidance (for example, the plume is not stable but is, in contrast, migrating both laterally and vertically), for any alternative that includes MNA, the MNA should be revised to monitoring and identified as an interim action. See General Reply above.

Response to EPA Supplemental Specific Comment 6. Response unsatisfactory.

The language regarding "rapid" restoration is taken from the Preamble to the final NCP, which has not been superseded by later EPA guidance. The full text, as noted in the NCP, is that *"[r]easonable restoration time periods may range from very rapid (one to five years) to relatively extended (perhaps several decades). EPA's preference is for rapid restoration, when practicable, of Class I ground waters and contaminated ground waters that are currently, or likely in the near-term to be, the source of a drinking water supply. The most appropriate timeframe must, however, be determined through an analysis of alternatives. The minimum restoration timeframe will be determined by hydrogeological conditions. Specific contaminants at a site, and the size of the contaminant plume. If there are other readily available drinking water sources of sufficient quality and yield that may be used as an alternative water supply, the necessity for rapid restoration of the contaminated ground water may be reduced."* 55 Fed Reg 8732.

Since the Memphis Aquifer, which is being impacted by the surface aquifer, is a Class I drinking water source, the expectation is for rapid restoration, unless the Army justifies a different but still reasonable restoration time frame, using the factors described in the quoted excerpt from the NCP. Please include a discussion of these factors and how that impacts the *"reasonableness"* of the restoration time frame and a deviation from the preference of rapid restoration.

Response to EPA Supplemental Specific Comment 9. Response unsatisfactory. See reply to Specific Comment 17.

Response to EPA Supplemental Specific Comment 10. Response unsatisfactory.

While the Army has characterized this requirement as relating to "*inspection and monitoring requirements*" and are "*administrative only*," these monitoring requirements also have specific control standards referred to in the rule, at 40 CFR 62.7927. This rule should be included.

However, since the NESHAPS requirements were updated in December 2022 but not captured in the supplemental comments submitted in January 2023, the Army should ensure that it includes the ARARs that would be relevant and appropriate to this action. See the enclosed copy of the updated NESHAPS requirements that should be reviewed for inclusion as ARARs for this action, wherever the "Prerequisite" is met.

Monitoring of closed vent systems and control devices used in treatment of VOC contaminated groundwater	Must monitor and inspect the closed vent system and control device according to the requirements in 40 CFR § 63.7927 that apply to the affected source. *NOTE: Monitoring program will be developed as part of the CERCLA process and included in an appropriate CERCLA document.*	*Closed vent system* and control devices as defined in 40 CFR § 63.7957 that are used to comply with § 63.7890(b) – **Relevant and Appropriate**	40 CFR § 63.7892

The Army has rejected these state groundwater ARARs on the basis that the requirements "*list[s] state standards for groundwater that are not more stringent than the Federal standard.*" The Army is correct that where the state standard is no more stringent than the Federal, the state standard need not be cited. In this case, because the state standard is not precisely parallel to the Federal, these state requirements should be cited. If this action is not intended to address inorganic contaminants, the reference to TDEC 0400-45-01-.06 may be removed.

Further, to correct an error in the citation below, please remove the reference to *40 CFR 300.430(e)(2)(i)(B) and (C).* Citations in the NCP are not considered to be ARARs. In addition, please remove the text under *"Requirement"* that states, *"Under CERCLA Section 121(d)(2)(A) and the NCP, MCLs are relevant and appropriate for groundwater response actions where the groundwater aquifer is used or classified for use as drinking water."* While this is an accurate statement, it is unnecessary to provide justification for inclusion as applicable or relevant and appropriate.

Remediation of contaminated groundwater	Except for naturally occurring levels, General Use Ground Water: • shall not contain constituents that exceed those levels specified in TDEC 0400-40-03-.03 subparagraphs j [*levels equivalent to SDWA MCLs*] and k [*quantities detrimental to public health or that impair use of the water as domestic water supply*]; and • shall contain no other constituents at levels and conditions which pose an unreasonable risk to the public health or the environment.	Presence of contaminants in groundwater of the State designated as General Use Groundwater as defined in TDEC 0400-40-03-.07(4)(b)—**applicable**	TDEC 0400-40-03-.08(2)(a) and (b)
	MCLs are promulgated concentration levels for organic and inorganic contaminants in public drinking water supplies. Must not exceed the MCLs listed in TDEC 0400-45-1-.06 and 0400-45-1-.25 in public community water systems, as measured at the consumer's tap. Under CERCLA § 121(d)(2)(A) and the NCP, MCLs are relevant and appropriate for groundwater response actions where the groundwater aquifer is used or classified for use as drinking water.	Release of contaminants to groundwater or actions potentially impacting groundwater—**relevant and appropriate**	TDEC 0400-45-01-.06 and TDEC 0400-45-01-.25 40 *CFR* 300.430(e)(2)(i)(B) and (C)

EPA Supplemental Specific Comment 11. Response unsatisfactory.

The Army has rejected these ARARs on the basis that "*The state standard for activities causing fugitive dust emissions and stormwater runoffs are not applicable to the planned remedial activities and are also not ARARs because they are general construction requirements that do not contain standards for the site-related contaminants found at this site*."

These requirements are triggered by land disturbance and is intended to prevent stormwater runoff from affecting any nearby stream or stormwater drain that flows into nearby creek/river. The requirements should remain on table unless action does not involve land disturbance. It is EPA's understanding that land disturbance will occur during this action. Please include in the ARARs table.

Activities causing fugitive dust emissions	Shall take reasonable precautions to prevent particulate matter from becoming airborne; reasonable precautions shall include, but are not limited to, the following:	Use, construction, alteration, repair or demolition of a building, or appurtenances or a road or the handling transport or storage of material—**applicable**	TDEC 1200-3-8-.01(1)
	• use, where possible, of water or chemicals for control of dust, and		TDEC 1200-3-8-.01(1)(a)
	• application of asphalt, water, or suitable chemicals on dirt roads, materials stock piles, and other surfaces, which can create airborne dusts.		TDEC 1200-3-8-.01(1)(b)
	Shall not cause or allow fugitive dust to be emitted in such a manner as to exceed 5 min/h or 20 min/day beyond property boundary lines on which emission originates.		TDEC 1200-3-8-.01(2)
Activities causing storm water runoff (e.g., clearing, grading, excavation)	Implement good construction management techniques (including sediment and erosion controls, vegetative controls, and structural controls) in accordance with the substantive requirements of *General Permit No. TNR10-0000* ("General Permit for Stormwater Discharges Associated with Construction Activities") to ensure that storm water discharge:	Dewatering or storm water runoff discharges from land disturbed by construction activity—disturbance of ≥ 1 acre total—**applicable**	T.C.A. 69-3-108(l) TDEC 0400-40-10-.03(2)(a) *General Permit No. TNR10-0000* (effective October 1, 2016) (**TBC**)
	• does not violate water quality criteria as stated in TDEC 0400-40-03-.03, including, but not limited to, prevention of discharges that cause a condition in which visible solids, bottom deposits, or turbidity impairs the usefulness of waters of the state for any of the designated uses for that water body by TDEC 0400-40-04;	Storm water discharges from construction activities—**TBC**	*General Permit No. TNR10-0000*, Sect. 5.3.2
	• does not contain distinctly visible floating scum, oil, or other matter;		
	• does not cause an objectionable color contrast in the receiving stream; and		
	• results in no materials in concentrations sufficient to be hazardous or otherwise detrimental to humans, livestock, wildlife, plant life, or fish and aquatic life in the receiving stream.		

EPA Supplemental Specific Comment 12. Response unsatisfactory.

The Army rejected the following solid and hazardous waste management etc ARARs on the following basis: "*Characterization of solid waste was not included as an ARAR because 40 CFR 261 does not provide cleanup standards or standards of control to be met. Based on further* *review, it will be deleted as a TBC, because TBCs only include policy and guidance, not statutes. Hazardous wastes will not be created by the remedial activities and the related suggested ARARs are not applicable. The other suggested ARARs are not substantive, but administrative or procedural, and thus are not ARARs.*"

The actions evaluated in this FFS do involve generation of secondary solid waste and must meet the characterization requirements in 40 CFR Part 262 (not 261), which the FFS acknowledges that it would generate solid waste.

In addition, if upon characterization is determined that the solid waste is not hazardous, then the prerequisite for the hazardous waste requirements would not be triggered and would not need to be met. In the meantime, however, they should be included. Therefore, the Army should ensure that the most current version of these requirements is included, although that could be done as part of the submittal of the Draft ROD.

Please include the following ARARs for the characterization of solid waste and the management of hazardous waste.

Characterization of solid waste	Must determine if solid waste is hazardous or is excluded under 40 *CFR* 261.4; and	Generation of solid waste as defined in 40 *CFR* 261.2—**applicable**	40 *CFR* 262.11(a) TDEC 0400-12-01-.03(1)(b)1
	Must determine if waste is listed as a hazardous waste in 40 *CFR* Part 261; or	Generation of solid waste which is not excluded under 40 *CFR* 261.4—**applicable**	40 *CFR* 262.11(b) TDEC 0400-12-01-.03(1)(b)2
	Must determine whether the waste is identified in subpart C of 40 *CFR* 261, characterizing the waste by using prescribed testing methods or applying generator knowledge based on information regarding material or processes used.	Generation of solid waste that is not listed in subpart D of 40 *CFR* 261 and not excluded under 40 *CFR* 261.4—**applicable**	40 *CFR* 262.11(c) TDEC 0400-12-01-.03(1)(b)3
	Must refer to Parts 261, 262, 264, 265, 266, 268, and 273 of Chap. 40 for possible exclusions or restrictions pertaining to management of the specific waste.	Generation of solid waste that is determined to be hazardous—**applicable**	40 *CFR* 262.11(d) TDEC 0400-12-01-.03(1)(b)4
Characterization of remediation hazardous waste	Must obtain a detailed chemical and physical analysis of a representative sample of the waste(s) which at a minimum contains all the information which must be known to treat, store, or dispose of the waste in accordance with 40 *CFR* 264 and 268.	Generation of RCRA hazardous waste for storage, treatment, or disposal—**applicable**	40 *CFR* 264.13(a)(1) TDEC 0400-12-01-.06(2)(d)1 40 *CFR* 264.1(j)(2) TDEC 0400-12-01-.06(1)(b)9(ii)
	Must determine if the waste meets the treatment standards in 40 *CFR* 268.40, 268.45, or 268.49 by testing in accordance with prescribed methods or use of generator knowledge of waste.		40 *CFR* 268.7(a) TDEC 0400-12-01-.10(1)(g)1(i)
	Must determine each EPA Hazardous Waste Number (Waste Code) to determine the applicable treatment standards under 40 *CFR* 268.40 *et seq.*	Generation of RCRA hazardous waste for storage, treatment, or disposal—**applicable**	40 *CFR* 268.9(a) TDEC 0400-12-01-.10(1)(i)1
	Must determine the underlying hazardous constituents [as defined in 40 *CFR* 268.2(i)] in the waste.	Generation of RCRA characteristically hazardous waste (and is not D001 non-wastewaters treated by CMBST, RORGS, or POLYM of Sect. 268.42 Table 1) for storage, treatment, or disposal—**applicable**	40 *CFR* 268.9(a) TDEC 0400-12-01-.10(1)(i)1
Management of hazardous waste on-site	A generator who treats, stores, or disposes of hazardous waste on-site must comply with the applicable substantive standards and requirements set forth in 40 *CFR* Parts 264, 265, 266, 268, and 270.	Generation of RCRA hazardous waste for storage, treatment, or disposal on-site—**applicable**	40 *CFR* 262.10, Note 2 TDEC 0400-12-01-.03(1)(a)3

Placement of extraction and monitoring wells	Well(s) shall be designed, constructed, and operated in such a manner that their use does not cause any underground source of drinking water to contain any substances that are toxic, carcinogenic, mutagenic, or teratogenic, other than those of natural origin, at levels and conditions that violate primary drinking water standards or adversely affect the health of persons and does not cause a violation of water quality standards.	Class V injection systems—**relevant and appropriate** to placement of extraction or monitoring wells	TDEC 0400-45-06-.14(1)(b) TDEC 0400-45-06-.14(7)(b) and (8)(a)
Construction and abandonment of monitoring wells	Establishes quality and workmanship requirements for well drilling, installation, and abandonment, and for sampling, borehole geophysical logging, and hydrologic testing. The substantive requirements of this procedure are TBC for construction and abandonment of monitoring wells.	Construction and abandonment of monitoring wells—**TBC**	*Standard Specifications for Installation, Well Drilling, and Abandonment*, SPG-00000-A005/Rev 2, 10/14/11
Closure of monitoring wells	Before abandonment, clean well of obstructions and disinfect using bleach or hypochlorite granules to produce free chlorine residual concentrations of 25 ppm.	Plugging and closure of a water production well—**relevant and appropriate**	TDEC 0400-45-09-.16(1)(a) – (c)
	Use one of several different methods to close well depending on depth of well, construction details, whether it is cased or uncased, and whether or not it intercepts multiple aquifers.		TDEC 0400-45-09-.16(2)(a) – (c)
	Backfill must be placed so that there are no gaps or bridging. Backfill top must be level with land surface.		TDEC 0400-45-09-.16(2)(d)
	Wells extending into more than one aquifer shall be filled and sealed in such a way that exchange of water from one aquifer to another is prevented.		TDEC 0400-45-09-.16(3)
	Flowing wells must be treated to reduce flow to zero before sealing.		TDEC 0400-45-09-.16(4)
	An alternate method of closure may be approved by TDEC.		TDEC 0400-45-09-.16(5)
	Storage		
Storage of hazardous wastes restricted from land disposal.	Prohibits storage of hazardous waste restricted from land disposal unless the generator stores such waste in tanks, containers, or containment buildings on-site solely for the purpose of accumulating such quantities as necessary to facilitate proper recovery, treatment, or disposal. Must comply with the pertinent substantive requirements in 40 *CFR* 262.34 and 40 *CFR* Part 264.	Accumulation of hazardous wastes restricted from land disposal solely for purpose of accumulation of quantities as necessary to facilitate proper recovery, treatment, or disposal—**applicable**	40 *CFR* 268.50 TDEC 0400-12-01-.10(4)(a)
Temporary storage of hazardous waste in containers on-site – "Satellite Accumulation Area"	A generator may accumulate as much as 55 gal of hazardous waste at or near any point of generation where wastes initially accumulate which is under the control of the operator of the process generating the waste provided: • If a container holding hazardous waste is not in good condition, or if it begins to leak, the generator must immediately transfer the hazardous waste from this container to a container that is in good condition and does not leak, or immediately transfer and manage the waste in a central accumulation area operated in compliance with part (g)2 or (h)1 of this paragraph. • The generator must use a container made of or lined with materials that will not react with, and are otherwise compatible with, the hazardous waste to be accumulated, so that the ability of the container to contain the waste is not impaired. • A container holding hazardous waste must be closed at all times during accumulation, except when adding, removing, or consolidating waste: or, when temporary venting of a container is necessary for the proper operation of equipment or to prevent dangerous situations, such as build-up of extreme pressure. • Container must be marked or labeled with the words "Hazardous Waste" and an indication of the hazards of the contents.	Accumulation of 55 gal or less of RCRA hazardous waste at or near any point of generation—**applicable**	40 *CFR* 262.15(a)(1), (2), (4), and (5) TDEC 0400-12-01-.03(1)(f)(1)(i), (ii), (iv), and (v)

Temporary storage of hazardous waste in containers on-site – "90-Day Storage Area"	A generator may accumulate hazardous waste at the facility provided that: • The waste is placed in containers that comply with the air emission standards TDEC 0400-12-01-.05((27), (28), and (29); • If a container holding hazardous waste is not in good condition, or if it begins to leak, the generator must immediately transfer the hazardous waste from this container to a container that is in good condition, or immediately manage the waste in some other way that complies with the conditions for exemption of this part; • The generator must use a container made of or lined with materials that will not react with, and are otherwise compatible with, the hazardous waste to be stored, so that the ability of the container to contain the waste is not impaired; • A container holding hazardous waste must always be closed during accumulation, except when it is necessary to add or remove waste. A container holding hazardous waste must not be opened, handled, or stored in a manner that may rupture the container or cause it to leak.	Accumulation of RCRA hazardous waste on-site as defined in TDEC 0400-12-01-.01(2)(a)—**applicable**	40 *CFR* 262.17(a)(1)(i) through (iv) TDEC 0400-12-01-.03(1)(h)(1)(i)(I) through (IV)
	• Container must be marked or labeled with the words "Hazardous Waste," an indication of the hazards of the contents, and the date upon which each period of accumulation begins clearly visible for inspection on each container.		40 *CFR* 262.17(a)(5)(i) TDEC 0400-12-01-.03(1)(h)(1)(v)(I)
	The generator must close the waste accumulation unit in a manner that: • Minimizes the need for further maintenance by controlling, minimizing, or eliminating, to the extent necessary to protect human health and the environment, the post-closure escape of hazardous waste, hazardous constituents, leachate, contaminated run-off, or hazardous waste decomposition products to the ground or surface waters or to the atmosphere. • Removes or decontaminates all contaminated equipment, structures and soil and any remaining hazardous waste residues from waste accumulation units • Any hazardous waste generated in the process of closing either the generator's facility or unit(s) accumulating hazardous waste must be managed in accordance with all applicable standards of parts 262, 263, 265 and 268 of this chapter.		40 *CFR* 262.17(a)(8)(iii)(1)-(3) TDEC 0400-12-01-.03(1)(h)(1)(viii)(III)I and II
Management of hazardous waste stored in containers	If container is not in good condition (e.g., severe rusting, structural defects) or if it begins to leak, must transfer waste into container in good condition.	Storage of RCRA hazardous waste in containers—**applicable**	40 *CFR* 264.171 TDEC 0400-12-01-.06(9)(b)
	Use container made or lined with materials compatible with waste to be stored so that the ability of the container is not impaired.		40 *CFR* 264.172 TDEC 0400-12-01-.06(9)(c)
	Keep containers closed during storage, except to add/remove waste.		40 *CFR* 264.173(a) TDEC 0400-12-01-.06(9)(d)
	Open, handle, and store containers in a manner that will not cause containers to rupture or leak.		40 *CFR* 264.173(b) TDEC 0400-12-01-.06(9)(d)
Storage of incompatible waste in containers	Must not place incompatible wastes in same container unless comply with 40 *CFR* 264.17(b).	Storage of "incompatible" RCRA hazardous wastes in containers—**applicable**	40 *CFR* 264.177(a) TDEC 0400-12-01-.06(9)(h)1
	Waste shall not be placed in an unwashed container that previously held an incompatible waste or material.		40 *CFR* 264.177(b) TDEC 0400-12-01-.06(9)(h)2
	A container holding incompatible wastes must be separated from any waste or nearby materials or must protect them from one another by using a dike, berm, wall, or other device.		40 *CFR* 264.177(c) TDEC 0400-12-01-.06(9)(h)3

Disposal of RCRA-prohibited hazardous waste in a land-based unit	May be land disposed only if it meets the requirements in the table "Treatment Standards for Hazardous Waste" at 40 *CFR* 268.40 before land disposal. The table lists either "total waste" standards, "waste-extract" standards, or "technology-specific" standards (as detailed further in 40 *CFR* 268.42).	Land disposal, as defined in 40 *CFR* 268.2, of RCRA-restricted waste—**applicable**	40 *CFR* 268.40(a) TDEC 0400-12-01-.10(3)(a)1
	For characteristic wastes (D001 – D043) that are subject to the treatment standards, all underlying hazardous constituents must meet the UTSs specified in 40 *CFR* 268.48.	Land disposal of restricted RCRA characteristic wastes (D001 – D043) that are not managed in a wastewater treatment unit that is regulated under the CWA, that is CWA equivalent, or that is injected into a Class I nonhazardous injection well—**applicable**	40 *CFR* 268.40(e) TDEC 0400-12-01-.10(3)(a)5
	To determine whether a hazardous waste identified in this section exceeds the applicable treatment standards of 40 *CFR* 268.40, the initial generator must test a sample of the waste extract or the entire waste, depending on whether the treatment standards are expressed as concentration in the waste extract or waste, or the generator may use knowledge of the waste.	Land disposal of RCRA toxicity characteristic wastes (D004 – D011) that are newly identified (i.e., wastes, soil, or debris identified by the TCLP but not the Extraction Procedure)—**applicable**	40 *CFR* 268.34(f)
	If the waste contains constituents (including UHCs in the characteristic wastes) in excess of the applicable UTS levels in 40 *CFR* 268.48, the waste is prohibited from land disposal, and all requirements of Part 268 are applicable, except as otherwise specified.		
	Are not prohibited if the wastes no longer exhibit a characteristic at the point of land disposal, unless the wastes are subject to a specified method of treatment other than DEACT in 40 *CFR* 628.40, or are D003 reactive cyanide.	Land disposal of RCRA-restricted characteristic wastes—**applicable**	40 *CFR* 268.1(c)(4)(iv) TDEC 0400-12-01-.10(1)(a)3(iv)
Prohibition of dilution to meet LDRs	Except as provided under 40 *CFR* 268.3(b), must not in any way dilute a restricted waste or the residual from treatment of a restricted waste as a substitute for adequate treatment to achieve compliance with land disposal restriction levels.	Land disposal, as defined in 40 *CFR* 268.2, of RCRA-restricted hazardous soils—**applicable**	40 *CFR* 268.3(a) TDEC 0400-12-01-.10(1)(c)1
	Closure		
Closure performance standard for RCRA hazardous waste management units	Must close the facility in a manner that: • Minimizes the need for further maintenance; and	Closure of a RCRA hazardous waste management unit—**applicable**	40 *CFR* 264.111(a) TDEC 0400-12-01-.06(7)(b)1
	• Controls, minimizes, or eliminates, to the extent necessary to protect human health and environment, post-closure escape of hazardous waste or its decomposition products, hazardous constituents, contaminated runoff to ground or surface waters, or to the atmosphere.		40 *CFR* 264.111(b) TDEC 0400-12-01-.06(7)(b)2
	• Complies with the substantive closure requirements of 40 *CFR* 264 for the particular type of facility, including but not limited to the requirements of Sects. 264.178 (container storage area), 264.197 (tanks), 264.310 (landfills), and 264.554 (remediation waste piles).		40 *CFR* 264.111(c) TDEC 0400-12-01-.06(7)(b)3
	During closure periods, all contaminated equipment, structures, and soils must be properly disposed or decontaminated.		40 *CFR* 264.114 TDEC 0400-12-01-.06(7)(e)

Transportation of hazardous waste on-site	The generator manifesting requirements of 40 *CFR* 262.20-262.32(b) do not apply. Generator or transporter must comply with the requirements set forth in 40 *CFR* 263.30 and 263.31 in the event of a discharge of hazardous waste on a private or public right-of-way.	Transportation of hazardous wastes on a public or private right-of-way within or along the border of contiguous property under the control of the same person, even if such contiguous property is divided by a public or private right-of-way—**applicable**	40 *CFR* 262.20(f) TDEC 0400-12-01-.03(3)(a)6
Transportation of hazardous materials off-site	Shall be subject to and must comply with all applicable provisions of the HMTA and HMR at 49 *CFR* 171 – 180.	Any person who, under contract with a department or agency of the federal government, transports "in commerce", or causes to be transported or shipped, a hazardous material—**applicable**	49 *CFR* 171.1(c)
Transportation of hazardous waste off-site	Must comply with the generator requirements of 40 *CFR* 262.20 23 for manifesting, Sect. 262.30 for packaging, Sect. 262.31 for labeling, Sect. 262.32 for marking, Sect. 262.33 for placarding and Sect. 262.40, 262.41(a) for record keeping requirements and Sect. 262.12 to obtain EPA ID number.	Preparation and initiation of shipment of RCRA hazardous waste off-site—**applicable**	40 *CFR* 262.10(h) TDEC 0400-12-01-.03(1)(a)(8)

The USEPA commends the USARMY for its efforts on further investigating the DDMT environmental conditions. If you have any questions about this letter, please contact me via email at martinez-torres.fernando@epa.gov or at 404-695- 4991.

Sincerely,

FERNANDO MARTINEZ-TORRES

Digitally signed by FERNANDO MARTINEZ-TORRES
Date: 2023.08.11 11:46:25 -04'00'

Fernando Martinez Torres
Remedial Project Manager
Department of Defense Section
Superfund & Emergency Management Division
United States Environmental Protection Agency

cc: Jamie A. Woods, TDEC
William Millar, CALIBRE
Ben Bentkowski, USEPA, R4
Kevin Koporec, USEPA, R4

Enclosures:

1. Table - List of Potential ARARs from 40 CFR Part 63 Subpart GGGGG NESHAP for Site Remediation

From: Holmes, Thomas C <Thomas.Holmes@hdrinc.com>
Sent: Friday, November 10, 2023 6:30 AM
To: Martinez-Torres, Fernando <martinez-torres.fernando@epa.gov>; Jamie A. Woods (Jamie.Woods@tn.gov) <Jamie.Woods@tn.gov>; Bentkowski, Ben <Bentkowski.Ben@epa.gov>; Koporec, Kevin <Koporec.Kevin@epa.gov>; McRae, Mac <mac.mcrae@techlawinc.com>
Cc: Millar, William <william.w.millar.ctr@army.mil>; James C. Foster <james.c.foster10.civ@army.mil>; Melissa Shirley (Melissa.L.Shirley@usace.army.mil) <Melissa.L.Shirley@usace.army.mil>; Carter (Chase.E.Carter@usace.army.mil) <Chase.E.Carter@usace.army.mil>; Mokri, Clayton R <clayton.mokri@hdrinc.com>
Subject: RE: DDMT MI FFS RTC to EPA letter 11 August 2023

Fernando,
At the request of Bill Millar, I am submitting the FFS RLSO and revised FFS tables and figures. The attached text, tables and figures were revised in accordance with the Response to Comments submitted by Mr. Millar on October 24. All revisions in the previous FFS RLSO submitted 6/22/23 were accepted prior to making the current revisions. Comments have been added to the attached figures showing the minor changes to be made.

Thomas Holmes, PG
M 404.295.3279

hdrinc.com/follow-us

From: Millar, William W Sr CTR USARMY HQDA DCS G-9 (USA) <william.w.millar.ctr@army.mil>
Sent: Tuesday, October 24, 2023 1:24 PM
To: Fernando Martinez-Torres (martinez-torres.fernando@epa.gov) <martinez-torres.fernando@epa.gov>; Jamie Woods (Jamie.Woods@tn.gov) <jamie.woods@tn.gov>; 'Bentkowski.ben@Epa.gov' <Bentkowski.Ben@epa.gov>; Koporec.Kevin@epa.gov; McRae, Mac <mac.mcrae@techlawinc.com>
Cc: Foster, James C CIV USARMY HQDA DCS G-9 (USA) <james.c.foster10.civ@army.mil>; Shirley, Melissa L CIV USARMY CESAM (USA) <Melissa.L.Shirley@usace.army.mil>; Roebuck, Laura W CIV (USA) <Laura.W.Roebuck@usace.army.mil>; Carter, Chase E CIV (USA) <chase.e.carter@usace.army.mil>; Holmes, Thomas C <Thomas.Holmes@hdrinc.com>; Mokri, Clayton R <clayton.mokri@hdrinc.com>; Larry Pannell <lpannell@komangs.com>
Subject: DDMT MI FFS RTC to EPA letter 11 August 2023

All,

Attached please find the latest Response to Comments to the letter received from EPA on 11 August 2023 on the FFS for the MI. A revision of the RLSO version of the text will be submitted ASAP, probably next week.

Thanks.

Bill Millar
CALIBRE
703-819-0100

EPA's letter dated 8/11/2023, for review of the FFS RLSO and Army responses to EPA comments (RTCs) submitted 6/22/23, identified 14 of the 39 RTCs as unsatisfactory and provided additional comments. The letter content was re-organized to group the additional comments by subject:

1 MNA in Remedy

2 Modifications/Flexibility in Remedial Action

3 UU/UE

4 Wastewater Discharge

5 MNA and Meeting ARAR (MCL) at Site Boundary

6 Rapid Restoration

7 ARARs

The content from EPA's letter has been copied in this response, including the comment number from the June 13 RTCs, the designation as unsatisfactory and the additional comments provided in the letter. Army's responses are provided at the end of each comment subject group.

1 Review Comments Regarding MNA in Remedy

Response to EPA General Comment 3. Response unsatisfactory. MNA should not be part of the recommended remedial actions.

MNA is currently a major component of all the proposed remedies under consideration in this document. As such, MNA should have been screened out and should not be part of the recommended remedial actions.

As per EPA's MNA Guidance,[5] page 16, one of the primary lines of evidence required is: *"Historical groundwater and/or soil chemistry data that demonstrate a clear and meaningful trend of decreasing contaminant mass and/or concentration over time at appropriate monitoring or sampling points. However, in the case of a groundwater plume, decreasing concentrations should not be solely the result of plume migration."*

In fact, page 1-13 of the FFS states that plume migration is occurring: "*Contamination in the IAQ and MAQ is the result of migration of FDAQ groundwater where clay layers are thin in the sink and absent in the erosional window."* What emerges is a very dynamic hydrogeological setting in which dissolved phase contamination has moved/is moving into new areas and depths, including the Memphis Aquifer; this is in direct conflict with the applicable Guidance citation (above).

Furthermore, this is not to say that attenuation through dilution does not occur or cannot be expected to continue. There is also plenty of evidence of decreasing concentrations along groundwater flow pathways over time, as well as contamination moving past static groundwater monitoring wells. As a result, it is expected that the air sparge and soil vapor extraction remedial actions will readily reduce groundwater contamination to 20 ug/L, where attenuation by dilution will cause the groundwater to be 'restored.'

Response to EPA General Comment 4 - Response unsatisfactory. Please see General Comment 3.

Supplemental General Comment

Several of EPA's comments requested that the Army support the identification of MNA as part of an alternative by demonstrating how MNA was consistent with EPA's MNA guidance, which the Army has failed to accomplish. For instance, a key factor in identifying MNA as a viable remedial alternative (or part of an alternative) is to show that the plume is stable. The facts show that, rather than being stable, the plume is migrating both laterally and vertically. As a result, unless the Army could demonstrate that treatment will reach MCLs within a reasonable time, and it can retain the treatment alternatives, then the FFS should be revised to change any mention of MNA to monitoring, as was done in the MI ROD (2002). If the program does not find sufficient support for treatment's ability to reach MCLs in a reasonable time frame, the action should be an interim action.

Army Response

Section 2.6.2.3 will be revised to state site conditions and analytical results from LTM at the MI are not consistent with EPA 1999 MNA Guidance, and MNA has not been retained for further analysis. Later references to MNA will be deleted.

2 Review Comment Regarding Modifications/Flexibility in Remedial Action

Response to EPA General Comment 5 – Some components of the remedy may require modification.

All the operational details about the air sparge and soil vapor extraction systems provided in Section 3.0 are provisionally agreed to, but this is not the remedial design. Based on actual in-field performance and restoration efficiency, the operation of these components as part of the remedial action may require some changes. Moreover, it could be years before the remedial action commences and given the dynamic nature of the groundwater at the Main Installation, other areas and depths may need remedial action, while others may not.

Therefore, the areas for the operation of these systems should retain a degree of flexibility.

Army Response

Flexibility in identifying areas for remedial action is considered in the FFS. The areas will be determined through a preliminary design investigation and described in the remedial design. Trailer-mounted AS/SVE and SVE equipment can be shifted between planned treatment areas, as needed, or to new areas, if identified. No revision to the FFS is required by this comment.

3 Review Comments Regarding UU/UE

Response to EPA Specific Comment 5. Response unsatisfactory.

Part of the EPA comment stated that, "If there are any restrictions on land use or groundwater use, it would not seem to be an unlimited use and unlimited exposure (UU/UE) situation." The Army's response referred to the [DATE] Land Use Control Implementation Plan (LUCIP). Specifically, regardless of the LUCIP, if there is contaminated groundwater beneath or nearby parts of the property that are deemed safe for residential use, the presence of use restrictions preventing access to, or use of the groundwater means that it is not UU/UE. Please revise the text to describe as safe for residential use, not "UU/UE."

Response to EPA Supplemental Specific Comment 2. Response unsatisfactory. Same as Specific Comment 5.

Army Response

Specific Comment 5 refers to discussion in FFS Section 1.2.4.2.2. The final paragraph in the response was provided to explain where the terms “unrestricted use” and “unrestricted use and unlimited exposure” were used in the MI ROD and the MI LUCIP. Section 1.2.4.2.2 was revised to delete use of “UU/UE” in the RLSO text provided to EPA on 6/22/23. Any remaining use of “UU” in reference to the housing area will be deleted per the comment.

4 Review Comments Regarding Wastewater Discharge

Response to EPA Specific Comment 17. Response unsatisfactory.

If the Army is discharging onsite to surface water, an agreement with TDEC is an insufficient way to describe the legal requirements related to discharge to surface water. The FFS states that, “condensate from the existing AS/SVE system and from groundwater sampling and equipment decontamination is currently discharged to a storm water drain per agreement with TDEC. Discharges under that agreement will continue during the proposed remedial action.”

For the contrary, the FFS should state clearly that the waste waters will be transfer to a named POTW or other named wastewater treatment facility, which facility is designed to treat the waste waters and contaminants in this action. Likewise, depending on the treatment facility discharge limits, the Army may be required to perform pre-treatment.

Response to EPA Supplemental Specific Comment 4. Response unsatisfactory. See reply to Specific Comment 17.

Army Response

Specific Comment 17 referred to Section 2.6.2.4.2 and asked why groundwater reinjection was not a viable option. The RTC answered the question.

Supplemental Specific Comment 4 referred to text in FFS Sections 3.4.3 and 3.5.3 regarding disposal of condensate from SVE and AS/SVE operations and noted the current practice of discharge to stormwater when sample analyses meet criteria in the agreement with TDEC. The RLSO text provided to EPA on 6/22/23 listed “disposed at an approved off-site facility approved for receipt of CERCLA waste” or “disposal in accordance with requirements of the existing agreement with TDEC”.

Groundwater from the IRA extraction system was previously discharged to the city sewer system without treatment under Industrial Wastewater Discharge Agreement Permit # S-NN3-092 with the City of Memphis. DDMT was notified in February 2011 that the City of Memphis was no longer authorized to accept wastewater from CERCLA sites. On August 17, 2023, the Plant Manager for the Maynard C. Stiles Wastewater Treatment Plant stated the restriction for POTWs to accept wastewater from a Superfund site remains in effect.

Wastewater consisting of decon water, condensate from the AS/SVE system and groundwater from purging and sampling wells has been discharged to stormwater since a procedure for sampling and analysis of the wastewater with concentration limits specified by TDEC was approved in 2011. In a conversation on 9/12/23, TDEC RPM Jamie Woods stated that TDEC had authority to approve discharges to stormwater and considered the 2011 agreement to be valid.

Discharges occur after approval by Army and reports of each discharge are submitted to EPA and TDEC.

If discharge per the agreement with TDEC is not approved, the wastewater will be disposed at an off-site facility approved for receipt of CERCLA waste, with pre-treatment if required. Further revision of the FFS is not considered necessary for this comment, absent specific guidance from EPA showing the current practice is not allowed.

5 Review Comments Regarding MNA and Meeting ARAR (MCL) at Site Boundary

Response to EPA Supplemental Specific Comment 5. Response unsatisfactory.

Discussion with program recommended about ability to meet ARARs or not, with respect to the two “offsite” plumes. If this is an interim action, the Army could utilize that waiver until more is known about the “offsite” plumes. Regarding MNA, since the Army has not demonstrated that MNA is a viable alternative consistent with EPA MNA guidance (for example, the plume is not stable but is, in contrast, migrating both laterally and vertically), for any alternative that includes MNA, the MNA should be revised to monitoring and identified as an interim action. See General Reply above.

Response to EPA Supplemental Specific Comment 9. Response unsatisfactory. See reply to Specific Comment 17.

Army Response

Supplemental Specific Comment 5 refers to Section 4.2.2.2 and the statement that “This alternative will not comply with MCLs at the southwest and north site boundaries …”

Supplemental Specific Comment 9 refers to Sections 4.2.2 and 4.3.2, Compliance with ARARs for Alternative 2 and should refer to Supplemental Specific Comment 5, not 17.

Alternative 2 is the most limited of the active remediation alternatives with SVE to remove residual soil contamination in subsurface VOC source areas at TTA-2, TTA-1N, and Building 720. It does not include AS/SVE where the two off-site plumes are coming on to the MI.

Alternative 2 will be deleted from the FFS.

6 Review Comment Regarding Rapid Restoration

Response to EPA Supplemental Specific Comment 6. Response unsatisfactory.

The language regarding “rapid” restoration is taken from the Preamble to the final NCP, which has not been superseded by later EPA guidance. The full text, as noted in the NCP, is that “[r]easonable restoration time periods may range from very rapid (one to five years) to relatively extended (perhaps several decades). EPA's preference is for rapid restoration, when practicable, of Class I ground waters and contaminated ground waters that are currently, or likely in the near-term to be, the source of a drinking water supply. The most appropriate timeframe must, however, be determined through an analysis of alternatives. The minimum restoration timeframe will be determined by hydrogeological conditions. Specific contaminants at a site, and the size of the contaminant plume. If there are other readily available drinking water sources of sufficient quality and yield that may be used as an alternative water supply, the necessity for rapid restoration of the contaminated ground water may be reduced.” 55 Fed Reg 8732.

Since the Memphis Aquifer, which is being impacted by the surface aquifer, is a Class I drinking water source, the expectation is for rapid restoration, unless the Army justifies a different but still reasonable restoration time frame, using the factors described in the quoted excerpt from the NCP. Please include a discussion of these factors and how that impacts the “reasonableness” of the restoration time frame and a deviation from the preference of rapid restoration.

Army Response

FFS Sections 3.4.4 and 3.5.4 state the estimated time required to meet RAOs for Alternatives 3 and 4, respectively. The RAOs are based on the current land use continuing: industrial/ commercial use for most of the MI, residential use in the former housing area and recreational use of the golf course.

Alternative 3 is estimated to require 20 years to meet RAOs, 10 years of active remediation and another 10 years of LTM.

Alternative 4 is estimated to require 15 years to meet RAOs, 5 years of active remediation and another 10 years of LTM.

FFS, Table 1 lists concentrations of PCE, TCE and CT for all LTM wells as of April 2021. The only area where groundwater contaminants at concentrations above the MCL are migrating off the MI are in the northwest corner where IAQ well MW-309, across Dunn Road from the MI, has TCE at 11.3 µg/L, and MAQ well MW-254, on the northwestern MI boundary, has PCE at 7.2 µg/L.

Concentrations at these wells from the April 2023 LTM event were TCE at 10.3 µg/L for MW-309 and TCE at 9.72 µg/L and PCE at 6.53 µg/L for MW-254. Concentrations are not much higher in upgradient LTM wells, and the concentrations at MW-309 and MW-254 are not expected to increase significantly. Remedial action in the erosional window under both alternatives will reduce the concentrations, and the estimated time required to meet RAOs is reasonable.

7 Review Comments Regarding ARARs

Response to EPA Supplemental Specific Comment 10. Response unsatisfactory.

While the Army has characterized this requirement as relating to “inspection and monitoring requirements” and are “administrative only,” these monitoring requirements also have specific control standards referred to in the rule, at 40 CFR 62.7927. This rule should be included.

However, since the NESHAPS requirements were updated in December 2022 but not captured in the supplemental comments submitted in January 2023, the Army should ensure that it includes the ARARs that would be relevant and appropriate to this action. See the enclosed copy of the updated NESHAPS requirements that should be reviewed for inclusion as ARARs for this action, wherever the “Prerequisite” is met.

The Army has rejected these state groundwater ARARs on the basis that the requirements “list[s] state standards for groundwater that are not more stringent than the Federal standard.” The Army is correct that where the state standard is no more stringent than the Federal, the state standard need not be cited. In this case, because the state standard is not precisely parallel to the Federal, these state requirements should be cited. If this action is not intended to address inorganic contaminants, the reference to TDEC 0400-45-01-.06 may be removed.

Further, to correct an error in the citation below, please remove the reference to 40 CFR 300.430(e)(2)(i)(B) and (C). Citations in the NCP are not considered to be ARARs. In addition, please remove the text under "Requirement" that states, "Under CERCLA Section 121(d)(2)(A) and the NCP, MCLs are relevant and appropriate for groundwater response actions where the groundwater aquifer is used or classified for use as drinking water." While this is an accurate statement, it is unnecessary to provide justification for inclusion as applicable or relevant and appropriate.

EPA Supplemental Specific Comment 11. Response unsatisfactory.

The Army has rejected these ARARs on the basis that "The state standard for activities causing fugitive dust emissions and stormwater runoffs are not applicable to the planned remedial activities and are also not ARARs because they are general construction requirements that do not contain standards for the site-related contaminants found at this site."

These requirements are triggered by land disturbance and is intended to prevent stormwater runoff from affecting any nearby stream or stormwater drain that flows into nearby creek/river. The requirements should remain on table unless action does not involve land disturbance. It is EPA's understanding that land disturbance will occur during this action. Please include in the ARARs table.

EPA Supplemental Specific Comment 12. Response unsatisfactory.

The Army rejected the following solid and hazardous waste management etc. ARARs on the following basis: "Characterization of solid waste was not included as an ARAR because 40 CFR 261 does not provide cleanup standards or standards of control to be met. Based on further review, it will be deleted as a TBC, because TBCs only include policy and guidance, not statutes. Hazardous wastes will not be created by the remedial activities and the related suggested ARARs are not applicable. The other suggested ARARs are not substantive, but administrative or procedural, and thus are not ARARs."

The actions evaluated in this FFS do involve generation of secondary solid waste and must meet the characterization requirements in 40 CFR Part 262 (not 261), which the FFS acknowledges that it would generate solid waste.

In addition, if upon characterization is determined that the solid waste is not hazardous, then the prerequisite for the hazardous waste requirements would not be triggered and would not need to be met. In the meantime, however, they should be included. Therefore, the Army should ensure that the most current version of these requirements is included, although that could be done as part of the submittal of the Draft ROD.

Please include the following ARARs for the characterization of solid waste and the management of hazardous waste.

<u>Army Response</u>

<u>Supplemental Specific Comment 10</u>: The comments refers to updated NESHAPS requirements and state drinking water criteria for groundwater.

The updated NESHAPS requirements provided with the EPA review letter lists three necessary conditions for applicability. The third condition is being a "major source of HAP", which is defined as "the potential to emit any single HAP at the rate of 10 tons or more per year". The remedial actions on the MI will not meet discharge levels for a "major source of HAP", and Army disagrees that the cited regulations should be included as ARARs.

The total mass of VOCs extracted during past use of SVE and AS/SVE was 4,000 pounds over five years of operation for Dunn Field SVE, 95 pounds over 12 years of operations of the Off Depot AS/SVE system and 200 pounds during 9 months of operations for the initial SVE pilot test. The subsurface soil contamination at Dunn Field was much higher than on the MI.

EPA's comment regarding TN groundwater criteria is "the state standard is not precisely parallel to the Federal, these state requirements should be cited". The state criteria for the groundwater contaminants at DDMT are no more stringent than federal requirements, and Army disagrees that state criteria should be included as ARARs.

<u>Supplemental Specific Comment 11</u>: Land disturbance for implementation of the remedial alternatives will be minor. Disturbance would be limited to installation of air sparge and SVE wells, trenching to connect wells to the equipment trailer and a pad (12 ft x20 ft) with chain link fencing for the trailer with the SVE blower (or SVE blower and AS compressor) and system controls, and ancillary equipment.

The total disturbed area would be less 1 acre, and a stormwater pollution prevention plan would not be required. The only surface water bodies are on the golf course where no remedial action is planned. There are no stream channels on the MI and stormwater drains to the golf course lakes or the two retention basins. Army disagrees that the requirements for land disturbance or prevention of stormwater runoff should be added as ARARs.

<u>Supplemental Specific Comment 12</u>: The comment states requirements for solid and hazardous waste management should be included as ARARs.

Characterization of solid waste will be added to Table 3 as an ARAR. Army does not agree that characterization of remediation hazardous waste or management and storage of hazardous waste should be included as ARARs

Remedial activities at DDMT have not generated hazardous since excavation of a disposal site on Dunn Field in 2006. The remedial alternatives (SVE and AS/SVE) will generate solid waste such as soil cuttings from borings and wastewater from decon and sampling activities, as has been done for investigations and remedial actions since 2006 without generation of hazardous waste. Hazardous waste has not been generated in SVE or AS/SVE operations at DDMT to date and there is no reasonable expectation that hazardous waste will be generated in future operations.

REGION 4
ATLANTA, GA 30303

December 14, 2023

Mr. James Foster
Base Realignment and Closure Division (ACSIM-ODB)
2530 Crystal Drive (Taylor Building), Room 5000
Arlington, VA 22202-3940

Dear Mr. Foster,

The Unites States Environmental Protection Agency (EPA/USEPA) has completed its review of the Army Responses to EPA Comments On The Red-Line Strikeout Main Installation (MI), Focused Feasibility Study, Revision 1 (FFS), dated august 11, 2023 and the Red-Line Strikeout Main Installation Focused Feasibility Study (the RLSO), Revision 1, submitted by the United States Army (Army/Lead Agency/ USARMY) in November 2023 (the Responses).

As previously mentioned, while the EPA has received some updates regarding the wastewater discharge, we kindly request to review the "agreement" with the state, which presumably refers to the permit covering this discharge. This review is necessary to determine whether the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) discharge is protective and complies with Applicable or Relevant and Appropriate Requirements (ARARs). The information, which is presumably a state-issued permit, should clearly indicate the precise location of the discharge. Additionally, it should outline the requirements to evaluate concentrations of the discharge and the fate of transport. This will enable the EPA to determine the designated use of the stream and assess the protective, ARAR-compliant nature of the discharges, particularly if the discharge is considered "on-site." It's important to note that only the "on-site" requirements need to identify the ARARs.

Furthermore, it is unclear how contaminated the Memphis Aquifer is in the vicinity of the erosional window. As such, the FFS should discuss how the projected extended restoration times are more reasonable and feasible when compared to rapid restoration.

Additionally, the decision-making authority is delegated to the EPA, ensuring that remedial actions comply with necessary environmental standards, whether federal or state, to protect human health and the environment. The EPA's determination is crucial in guaranteeing that the selected remedy is comprehensive and aligned with the specific site issues, as outlined in 40

CFR § 300.430. The EPA's discretion to assess the sufficiency of the response and the potential need for revisions to incorporate ARARs is a fundamental aspect of the regulatory framework governing remedial actions under CERCLA. This responsibility is established in Section 121(d)(2)(A) of CERCLA, which mandates that on-site remedial actions must attain or waive federal and more stringent state ARARs upon completion of the remedial action, as well as comply with ARARs during removal and remedial actions to the extent practicable, as per the 1990 National Oil and Hazardous Substances Pollution Contingency Plan (NCP).

The comments below were created to convey regulatory concerns about the current version of the FFS and the responses from the lead agencies.

GENERAL COMMENTS

Review Comments Regarding MNA in Remedy: The Army's decision to remove Monitored Natural Attenuation (MNA) as an alternative or part of an alternative is a complex issue. While the exclusion of MNA may be considered positive due to the need for thorough site-specific characterization data and analysis to support its effectiveness, the reduction in the number of alternatives may raise concerns.

Therefore, considering the regulatory flexibility outlined in the NCP and the site-specific complexity, we kindly request a thorough justification for the current set of alternatives and the consideration of an additional alternative to ensure a comprehensive and regulatory-aligned remedy selection process.

Review Comment Regarding Modifications/Flexibility in Remedial Action: The EPA request the Lead Agency to submit an updated Remedial Design/Remedial Action workplan as a primary document for EPA approval before implementing any part of the updated remedial action, in accordance with 40 CFR § 300.430. This requirement is essential to ensure that the selected remedy reflects the scope and complexity of the site problems being addressed, as well as to provide an opportunity for EPA oversight and approval of the proposed actions.

Review Comments Regarding UU/UE: It appears to have been addressed.

Please provide sufficient documentation to determine whether the discharge is protective, should or should not have ARARs, and whether the FFS has appropriately identified those ARARs."

REVIEW OF SPECIFIC AND SUPPLEMENTAL SPECIFIC COMMENTS

Evaluation of the Responses to EPA Specific Comment 17 and Supplemental Specific Comments 4 and 9: The comment is partially addressed by stating the Industrial Wastewater Discharge Agreement Permit # S-NN3-092 with the City of Memphis was terminated on February 11, 2022, as wastewater from CERCLA sites were no longer accepted. Additionally, the response indicates the Maynard C. Stiles Wastewater Treatment Plant restrictions remain in effect for publicly owned treatment works (POTW) to accept wastewater from a Superfund site. However, a copy of the existing agreement the Lead Agency has with the Tennessee Department of Environmental Control (TDEC) for field testing and disposal requirements for wastewater were not provided.

Currently, the specific location of the discharge, including the stream name and Geographic Information System (GIS) location, is unclear. Also, the response states if discharge per the agreement with TDEC is not approved, the wastewater will be disposed at an off-site facility approved for receipt of CERCLA waste, with pre-treatment if required; however, the response does not identify the off-site facility and it is unclear whether it is a permitted facility since a copy of the permit was not provided for review.

Please revise the RLSO to provide a copy of the existing agreement the Army has with TDEC for field testing and disposal requirements for wastewater and the specific location of the discharge, including the stream name and GIS location or clarify if the wastewater will be disposed at an off-site facility approved for receipt of CERCLA waste and provide that facility's permitting information.

Review Comments Regarding MNA and Meeting ARAR (MCL) at Site Boundary Response to EPA Supplemental Specific Comment 5: As explained on the SMT Call, Alternative #2 is no longer considered in this FFS as it will not be expected to meet the MCLs on resealable time.[1]

Evaluation of the Response to EPA Supplemental Specific Comment 6: The comment is partially addressed by the response. The response indicates the remedial action in the erosional window under both alternatives will reduce the concentrations, and the estimated time required to meet remedial action objectives (RAOs) is reasonable; however, the estimated time for Alternatives 2 and 3 of 20 years and 15 years, respectively, to meet RAOs is extended considering the Memphis Aquifer is a Class I drinking water source and the expectation for rapid restoration, when practicable per the NCP. It is noted that per the NCP, the size of the contaminant plume is one of the factors considered in the determination of the minimum restoration time frame; ***however, the extent of contamination in the Memphis Aquifer near the erosional window is unclear.*** As such, the text should discuss how the estimated extended time frames for restoration are more appropriate and practical as compared to rapid restoration.

Please revise the RLSO to discuss how the data gap in the extent of contamination in the Memphis Aquifer impacts the reasonableness of the restoration time frame estimated and explain why the extended times are more appropriate and practical than the expectation for rapid restoration.

Evaluation of the Response to EPA Supplemental Specific Comment 10: The response does not address the comment. The cited National Emission Standards for Hazardous Air Pollutants

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[1] See response: **Review Comments Regarding MNA in Remedy**

(NESHAPS) requirements and state requirements for groundwater contaminants were not included as ARARs in the RLSO. ***Specifically, it remains EPA's decision on whether the response is deficient and whether the RLSO should be revised to include ARARs:***

- In re air NESHAPS: While the Army may be correct in noting that the prerequisites that render the legal requirements to be "applicable" are not present at this site, requirements that are found not to be "applicable" may nonetheless be found to be "relevant and appropriate," to the circumstances of the release, as discussed in the NCP at 40 CFR 300.400(g)(2). EPA has evaluated the factors in this section of the NCP and has found that the requirements address "problems or situations sufficiently similar to the circumstances of the release or remedial action contemplated, and whether the requirement is well suited to the site," and is, therefore, both relevant and appropriate for this release/action. In addition, EPA does not find the size of the release, as described in the Army's response, to overcome the similarity of the problem or situation at the site to render the requirements not relevant and appropriate.

- In re state groundwater citation: As stated in EPA's response, the state groundwater citation is not precisely parallel to a federal one, and could be, therefore, considered to be a different requirement (by definition, more stringent than a nonexistent federal one).

As a result, please address the preceding comments to reinstate the ARARs to attend to related deficiencies in the RLSO.

Evaluation of the Response to EPA Supplemental Specific Comment 11: The response does not address the comment. The requirement for the land disturbance or prevention of stormwater runoff were not included as ARARs in the RLSO as requested in the comment. It remains EPA's decision on whether the response is deficient and whether the RLSO should be revised to include the ARARs.

Furthermore, the dust emission requirements should be reinstated, as the Army has not provided any argument other than the minor nature of the land disturbance. While this may be favorable, it does not exempt the requirements from being applicable or relevant and appropriate. Please include the fugitive dust emission requirements in the ARARs table. On the other hand, the Army has presented additional facts that may render the cited surface water requirements inapplicable, and therefore, they can be proposed to be removed from the ARARs table.

Likewise, as additional facts come to light before the Record of Decision (ROD), the Lead Agency could propose to EPA ARARs that could be either added or removed from the table, but those in the FFS will be based on the facts known at the time.

Evaluation of the Response to EPA Supplemental Specific Comment 12: The response does not address the comment. The requirements for hazardous waste management were not included as ARARs in the RLSO as requested in the comment. As previously stated, it remains EPA's decision on whether the response is deficient and whether the RLSO should be revised to include the ARARs.

The EPA notes that the Army has agreed to retain the requirement to characterize any solid waste generated in the action and to determine whether it is a hazardous waste. The Army has provided process knowledge from the past years' implementation of the remedy and the fact that no hazardous waste has been generated during this action as the rationale for excluding from the ARARs table the remainder of the hazardous waste requirements.

The EPA is persuaded by the Army's demonstration of process understanding and agrees that, except for the solid waste characterization requirement, the other RCRA hazardous waste standards may be removed from the ARARs table (unless not applicable). ***If it is determined that any solid waste is hazardous during the implementation of the action, EPA expects that the ARARs table will be changed, and the other required hazardous waste requirements will be included on the ARARs table of the revised ROD.***

The USEPA commends the USARMY for its efforts on further investigating the DDMT environmental conditions. If you have any questions about this letter, please contact me via email at martinez-torres.fernando@epa.gov or at 404-695- 4991.

Sincerely,

Fernando Martinez Torres

Digitally signed by Fernando Martinez Torres
Date: 2023.12.14 20:38:06 -05'00'

Fernando Martinez Torres
Remedial Project Manager
Department of Defense Section
Superfund & Emergency Management Division
United States Environmental Protection Agency

cc: Jamie A. Woods, TDEC
William Millar, CALIBRE
Ben Bentkowski, USEPA, R4
Kevin Koporec, USEPA, R4

DEPARTMENT OF THE ARMY
OFFICE OF THE DEPUTY CHIEF OF STAFF, G9
600 ARMY PENTAGON
WASHINGTON, DC 20310-0600

09 February 2024

DAIN-ISE

MEMORANDUM FOR

Mr. Fernando Martinez-Torres, U.S. Environmental Protection Agency (USEPA) Region 4
Mr. Jamie Woods, Tennessee Department of Environment and Conservation (TDEC)

SUBJECT: Response to EPA comments letter 14 December 2023 Focused Feasibility Study, Main Installation, Defense Depot Memphis, Tennessee

The Army is pleased to submit this response to your letter of 14 December 2023 reviewing the Army responses to EPA comments on the MI FFS submitted 24 October 2023 and the MI FFS RLSO submitted 10 November 2023. Statements in the letter and the following comments refer to five issues: wastewater discharges, extent of contamination in the Memphis Aquifer, deletion of MNA as a component of the remedy, modifications/flexibility in remedial action and ARARs. The comments and Army's responses are provided below.

Wastewater Discharge: EPA requests a copy of the existing agreement the Army has with TDEC for field testing and disposal requirements for wastewater and the specific location of the discharge, including the stream name and GIS location or clarify if the wastewater will be disposed at an off-site facility approved for receipt of CERCLA waste and provide that facility's permitting information.

Response: The existing agreement for wastewater (WW) discharges is contained in emails between TDEC and Army contractor HDR and has been provided. In 2011, the DDMT Site Management Team at that time agreed that a formal permit was not required due to the permitting exemption for NPL sites. Discharge reports have been submitted to TDEC and copied to EPA since 2011 without comment.

Army has decided that all future WW will be transferred to an off-site facility authorized for disposal of hazardous or non-hazardous waste, as required. WW from well installation and development at DDMT has previously been disposed as non-regulated industrial waste at VLS Recovery Services, LLC (USEPA ID No. TND981920119), a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)-approved facility in Mt. Pleasant. TN. This facility or another approved facility will be identified in the remedial action work plan.

Memphis Aquifer: EPA requests additional information on the extent of contamination in the vicinity of the erosional window and states per the NCP, the size of the contaminant plume is one of the factors considered in the determination of the minimum restoration time frame; however, the extent of contamination in the Memphis Aquifer near the erosional window is unclear. Revise the RLSO to discuss how the data gap in the extent of contamination in the Memphis Aquifer impacts the reasonableness of the restoration time frame estimated and explain why the extended times are more appropriate and practical than the expectation for rapid restoration.

Response: VOC contamination in the MAQ is shown for the six LTM wells on figures in LTM reports; 2022 and 2023 results are listed below. MAQ groundwater flow at these wells is to the southwest and west.

Wells MW-67, MW-229 and MW-290 are located upgradient of the erosional window. MW-140 is located at the downgradient edge of the window, with MW-255 located 500 feet to the northwest and MW-255 located 350 feet further west.

	October 2022				October 2023			
Well	PCE	TCE	CT	CF	PCE	TCE	CT	CF
Upgradient of erosional window								
MW-67	NS	NS	NS	NS	<0.5	<0.2	<0.2	<0.3
MW-229	<0.5	<0.2	<0.2	<0.3	NS	NS	NS	NS
MW-290	<0.5	<0.2	<0.2	<0.3	NS	NS	NS	NS
Downgradient of erosional window,								
MW-140	7.07	0.042	<0.2	<0.3	4.41	0.39	<0.2	<0.3
MW-255	3.13	0.89	0.11	<0.3	3.1	1.33	0.34	0.16
MW-254	7.62	9.21	0.71	0.51	10.5	9.0	0.45	0.55
MW-254-RE	1.82	4.13	0.42	0.27	-	-	-	-

- The upgradient wells have been non-detect since installation (MW-67 in 2000 to MW-290 in 2018).
- At MW-140, PCE increased from 1 ug/L in 2010 to 14 ug/L in 2018 and has since ranged from 7 to 12 ug/L. TCE has not exceeded 2 ug/L since installation.
- At MW-255, PCE and TCE increased above LOQ in 2016; since then, PCE has been in a range of 2.5 to 3.5 ug/L and TCE in a range of 1 to 2 ug/L.
- At MW-254, PCE was below 1 ug/L until 2015 and has increased to 10 ug/L in October 2023. TCE was in a range of 1 to 3 ug/L until 2021 and increased to 9 ug/L in 2022. The low-flow 'RE' sample in October 2022 showed concentrations below MCLs.

Low concentrations in wells upgradient to MW-254 indicate further increase and downgradient impacts to groundwater should be limited. As contaminant migration from the FDAQ is the source of contaminants from past DDMT operations, approval of the

FFS should not be delayed for additional well installation. Well installation for performance monitoring of the remedial action will be considered in the remedial design.

Monitored Natural Attenuation (MNA): EPA states the decision to remove MNA as an alternative or part of an alternative is a complex issue. request a thorough justification for the current set of alternatives and the consideration of an additional alternative

Response: EPA comments on the FFS Rev0 were received in December 2022 and January 2023. General Comment 3 (GC3) stated that site conditions at DDMT did not meet criteria in EPA's 1999 MNA Guidance and requested that trend graphs for representative monitoring wells be provided. The Army response for GC3, submitted in June 2023, provided the trend graphs and described how inclusion of MNA was consistent with remedy selection in the MI ROD and that use of MNA on the MI met conditions of the guidance.

EPA comments in the letter dated 8/11/2023 stated the response was unsatisfactory and that "MNA should have been screened out and should not be part of the recommended remedial actions". EPA also stated "this is not to say that attenuation through dilution does not occur or cannot be expected to continue. … As a result, it is expected that the air sparge and soil vapor extraction remedial actions will readily reduce groundwater contamination to 20 ug/L, where attenuation by dilution will cause the groundwater to be 'restored.'" The FFS RLSO submitted 11/10/23 was revised accordingly.

The remedial technologies remaining after screening were limited to SVE for soil vapor and AS/SVE for groundwater. EPA's December 14 letter does not comment on technology screening as presented in the FFS, and Army does not consider use of other technologies to be applicable based on MI site conditions. There are two remaining alternatives, other than No Action. Current Alternative 2 includes AS/SVE at the site boundary where plumes migrate on to the MI and in the window where contaminants migrate to deeper areas, and SVE to address soil vapor in TTA-2; current Alternative 3 adds SVE and AS/SVE in additional areas in order to reduce the time required to achieve RAOs. Alternatives with less action than current Alternative 2 or more action than current Alternative 3 are not considered to be appropriate.

Modifications/Flexibility in Remedial Action: EPA requests submittal of an updated Remedial Design/Remedial Action workplan as a primary document.

Response: An updated RD & RAWP will be prepared following the RPP and ROD Amendment; see schedule in 2024 SMP.

ARARs: EPA states Army responses do not address the comments regarding ARARs, specifically: NESHAPS requirements, state requirements for groundwater contaminants, requirements for land disturbance and prevention of stormwater runoff.

Response: FFS Tables 2 and 3 will be revised to include the following:

- Requirements for 40 CFR Part 63 Subpart GGGGG NESHAP for Site Remediation provided by EPA 8/11/23.
- TN GW criteria for organic contaminants.
- Activities causing fugitive dust emissions.
- Activities causing stormwater runoff.

For additional information please contact: Mr. Tom Holmes, HDR Project Manager at (404) 295-3279, email: thomas.holmes@hdrinc.com; or Mr. Bill Millar, BRAC Environmental Coordinator at (703) 819-0100, email: william.w.millar.ctr@army.mil.

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for

Encl

JAMES C. FOSTER
Program Manager,
Base Realignment and Closure Division

REGION 4
ATLANTA, GA 30303

March 15, 2024

Mr. James Foster
Base Realignment and Closure Division (ACSIM-ODB)
2530 Crystal Drive (Taylor Building), Room 5000
Arlington, VA 22202-3940

Dear Mr. Foster,

The Unites States Environmental Protection Agency (EPA/USEPA) has completed its review of the Army Responses to EPA Comments Letter 14 December 2023 Focused Feasibility Study, Main Installation, (RTCs), and the Redline Main Installation Focused Feasibility Study, Revision 1 (FFS), Defense Depot Memphis, Tennessee, submitted by the United States Army (USARMY/lead agency) in February 2024.

In general, the EPA recognizes that the Army has satisfactorily addressed concerns raised regarding the previous version of the FFS and related USARMY's responses. However, to improve clarity and completeness of the FFS, the EPA reaffirms its position on requirements for discharges and associated Applicable or Relevant and Appropriate Requirements (ARARs).

Primarily, it is EPA's stance that the only situation which a permit would not be needed for the discharge of Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) wastewaters would be if the discharge is determined to be part of a remedial action conducted entirely onsite, where the action is selected and carried out in compliance with Section 121 (*see* CERCLA Section 121(e)(1)). In such case, ARARs for the protective discharge of the wastewater, as well as the specific location of the discharge, and the volume and background concentrations in the receiving water at that location should be noted in the FFS and decision documents to identify discharge limits that would be protective of the receiving water.[1]

In their response, the lead agency provided emails from 2011 as proof of an agreement with Tennessee Department of Environment and Conservation (TDEC) concerning the discharge,

[1] The Army has been informed of this position during the review of the FFS.

stating that no permit was required for the wastewater discharge at this site “due to the permitting exemption for NPL sites."

Overall, the lead agency has not provided the requested information. These emails do not sufficiently demonstrate compliance with federal laws and regulations designed to protect human health and the environment. Specifically, they lack evidence to support the claim that the CERCLA wastewaters resulting from this action will be managed in accordance with ARARs, CERCLA, and the NCP[2] requirements, ensuring the protection of human health and the environment. As a result, if the remedial action outlined in the FFS involves discharging wastewaters into surface waters, it is imperative that the FFS includes the required information on CERCLA 121.

Therefore, if the Army’s remedial action results in onsite discharges of CERCLA wastewaters, the lead agency should identify the information and work with the EPA to develop protective discharge limits and ARARs under the CERCLA decision documents.

Additionally, further modifications are needed to existing information on ARARs:

- The requirement TDEC 0400-40-03-.03 in the second line in Table 2 should be deleted as a groundwater requirement. It is appropriately captured in the “Requirement” column and cited at the appropriate specificity.

- The citation to TDEC 0400-40-03-.08(2) should be noted as “Applicable.”

- EPA recommends that the column citing the websites be removed. It provides superfluous text when what is most important is already in the table. With this exception, the Army has followed EPA’s new guidance, Documenting Applicable, or Relevant and Appropriate Requirements in Comprehensive Environmental Response, Compensation, and Liability Act Response Action Decisions, OLEM Directive 9234.0-07, March 1, 2023, for guidance on how to cite in ARARs tables.

- When the issue about wastewater discharge is addressed, EPA will provide the pertinent chemical- and action-specific ARARs. Bear in mind, that if wastewater is not discharged to surface water (for example, if treated and ARAR-compliant groundwater is reinjected), the discharge ARARs will no longer be pertinent. In the end, if wastewater is generated, its disposition must be addressed in the FFS.

The USEPA commends the USARMY for its efforts on further investigating the DDMT environmental conditions. If you have any questions about this letter, please contact me via email at martinez-torres.fernando@epa.gov or at 404-695- 4991.

---

[2] eCFR :: 40 CFR Part 300 -- National Oil and Hazardous Substances Pollution Contingency Plan

Sincerely,

Fernando Martinez Torres

Digitally signed by Fernando Martinez Torres
Date: 2024.03.15 19:17:30 -04'00'

Fernando Martinez Torres
Remedial Project Manager
Department of Defense Section
Superfund & Emergency Management Division
United States Environmental Protection Agency

cc: Jamie A. Woods, TDEC
William Millar, CALIBRE
Ben Bentkowski, USEPA, R4
Kevin Koporec, USEPA, R4

DEPARTMENT OF THE ARMY
OFFICE OF THE DEPUTY CHIEF OF STAFF, G9
600 ARMY PENTAGON
WASHINGTON, DC 20310-0600

19 March 2024

DAIN-ISE

MEMORANDUM FOR

Mr. Fernando Martinez-Torres, U.S. Environmental Protection Agency (USEPA) Region 4
Mr. Jamie Woods, Tennessee Department of Environment and Conservation (TDEC)

SUBJECT: Main Installation Focused Feasibility Study, Response to EPA Comments 15 March 2024, rev 0 Defense Depot Memphis, Tennessee

The Army is pleased to submit this response to your letter of March 15, 2024, reviewing the Army responses to EPA comments on the MI FFS, the FFS RLSO, and ARARs tables submitted February 9, 2024. The comments and Army's responses are provided below. A mark-up version of Table 2 is provided with revisions shown; a current version of Table 2 with the revisions made is also provided.

Comments

1. The requirement TDEC 0400-40-03-.03 in the second line in Table 2 should be deleted as a groundwater requirement. It is appropriately captured in the "Requirement" column and cited at the appropriate specificity.

Response 1: "TDEC 0400-40-03-.03" has been deleted from the 'Citation ' column at Row 2.

2. The citation to TDEC 0400-40-03-.08(2) should be noted as "Applicable."

Response 2: "Relevant and Appropriate" in the 'Prerequisite' column at Row 2 has been changed to "Applicable".

3. EPA recommends that the column citing the websites be removed. It provides superfluous text when what is most important is already in the table. With this exception, the Army has followed EPA's new guidance, Documenting Applicable, or Relevant and Appropriate Requirements in Comprehensive Environmental Response, Compensation, and Liability Act Response Action Decisions, OLEM Directive 9234.0-07, March 1, 2023, for guidance on how to cite in ARARs tables.

Response 3: The 'Website' column has been deleted.

4. When the issue about wastewater discharge is addressed, EPA will provide the pertinent chemical- and action-specific ARARs. Bear in mind, that if wastewater is not discharged to surface water (for example, if treated and ARAR-compliant

groundwater is reinjected), the discharge ARARs will no longer be pertinent. In the end, if wastewater is generated, its disposition must be addressed in the FFS.

Response 4: As stated on page 1 of Army's response dated February 9, 2024, all future wastewater generated by restoration activities at DDMT will be transferred to an off-site facility authorized for disposal of hazardous or non-hazardous waste, as required. The off-site facility will be identified in the remedial action work plan.

Tables 2 and 3 of the FFS do not currently include ARARs for wastewater discharge, except for characterization of solid waste on Table 3. If EPA has suggestions for additional ARARs related to wastewater discharge, Army requests they be provided for review and discussion.

For additional information please contact: Mr. Tom Holmes, HDR Project Manager at (404) 295-3279, email: thomas.holmes@hdrinc.com; or Mr. Bill Millar, BRAC Environmental Coordinator at (703) 819-0100, email: william.w.millar.ctr@army.mil.

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Digitally signed by MILLAR.WILLIAM.WINSTON.SR.1391460309
Date: 2024.03.26 14:03:49 -04'00'

for

Encl

JAMES C. FOSTER
Program Manager,
Base Realignment and Closure Division

REGION 4
ATLANTA, GA 30303

April 12, 2024

Mr. James Foster
Base Realignment and Closure Division (ACSIM-ODB)
2530 Crystal Drive (Taylor Building), Room 5000
Arlington, VA 22202-3940

Dear Mr. Foster,

The purpose of this letter is to respond to the Army's March 19, 2024, (reissued on March 26, 2024) letter and to provide both general and site-specific feedback. The United States Environmental Protection Agency (EPA/USEPA), having completed its review of all the responses, emails, and documents provided in support of the Focused Feasibility Study (FFS), Revision 1, Main Installation (MI), Defense Depot Memphis, Tennessee (DDMT), has additional concerns that should be corrected in the next submittal of the FFS.

EPA notes, further, that the FFS has undergone multiple reviews under Revision 0 (12/18/2022, 1/18/2023), and Revision 1 (8/11/2023, 12/14/2023 and 3/15/2024), resulting in an extended back-and-forth that should be avoided. Furthermore, EPA notes that the draft final version[1] is due on May 3, 2024[2], and advises that the Army should make no further revisions as "Revision 0" or "Revision 1." As a general comment, to improve clarity among the parties, the EPA 'advises the Army to use the terminology and timelines established in the Federal Facility Agreement (FFA) for submittal of primary documents. Specifically, EPA notes that "Revision 0" and "Revision 1" are not terms used in the DDMT FFA, which has created some inconsistencies in the citation of documents during the review of the FFS. Rather, FFA Section XV - CONSULTATION PROCESS FOR PRIMARY AND SECONDARY DOCUMENTS provide for "draft" and "draft final" documents to constitute the full primary document review process. Therefore, to make forward progress consistent with the FFA, EPA recommends that the Army incorporates EPA comments to the maximum extent possible per FFA Section XV.B.4 into the next submittal, which should be noted as a "draft final."

Regarding the site-specific issues that EPA has identified in its comments on the FFS, the Army appears to have addressed most of EPA's comments, but specific deficiencies remain regarding

[1] Federal Facility Agreement designation.
[2] As noted in the 2024 Site Management Plan.

wastewater management. As previously discussed during recent site management calls. there are several options for wastewater management at Superfund sites, but generally speaking, only two are related when the disposition includes discharge of CERCLA wastewater into surface water. The first option for wastewater discharge into surface water is to discharge on-site[3]. The Army has stated that it does not intend to discharge wastewater on-site, so this option does not need to be discussed further. The second option is for wastewater to be sent to an off-site National Pollutant Discharge Elimination System (NPDES) -permitted wastewater treatment facility. In this case, the Army should identify the NPDES facility and provide a copy of the permit to EPA during the feasibility study stage so that EPA can confirm that the facility is appropriate under EPA guidance on publicly-owned treatment works, *Guide to Discharging CERCLA Aqueous Wastes to Publicly Owned Treatment Works (POTWs)*, OSWER 9330.2-13FS, March 1991,[4] and that the CERCLA wastewater can be managed protectively.

In prior communication during review of the FFS, on November 27, 2023, the Army transmitted the enclosed emails, but as EPA noted in earlier responses, these do not provide sufficient basis for an evaluation of whether the CERCLA wastewater will be handled protectively or in a legally compliant manner. Subsequently, EPA searched the Administrative Record for DDMT, and found a reference to *City of Memphis Letter to Depot Concerning Revised Industrial Wastewater Discharge Agreement Permit*, S-NN3-097, dated June 4, 2002 (AR696-1.pdf). The “Agreement Permit” was not attached, and even if it had been, it is not clear that it addresses discharge from the Main Installation and instead, may be intended to address discharge under the Dunn Field ROD.[5] If the Army believes this to be an active NPDES or another permit, please provide it to EPA as soon as possible.

Therefore, to facilitate the review of the draft final FFS and subsequent primary documents, the EPA requests that the Army identify the off-site NPDES-permitted facility and provide the permit (whether the one discussed above or one for another facility) for its review prior to the Army's submittal of a draft final FFS. Alternatively, if the NPDES-permitted facility is not known at this time, it is requested to be provided to the regulators before the Draft version of the Revised Proposed Plan is submitted for approval. If the NPDES-permitted facility is determined to be acceptable, it can be included in the Final FFS and subsequent primary documents. For the contrary, if the facility is found to be unacceptable, the Army may need to identify another facility to consider.

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[3] 40 CFR 300.5 (“*On-site* means the area extent of contamination and all suitable areas in very close proximity to the contamination necessary for implementation of the response action).”

[4] EPA has no guidance on privately-owned treatment works since these are rarely utilized. This guidance is a suitable surrogate for those facilities, since all the same factors should be considered at both types of treatment works before CERCLA wastewater is sent to those facilities.

[5] In addition to the issue in the Main Installation FFS, further discussion is warranted for any wastewater discharge at Dunn Field. A review of the Dunn Field Record of Decision Amendment (2009) indicates that wastewater is being discharged, but the Record of Decision does not contain proper documentation; a modification to the Dunn Field AROD is, therefore, necessary to ensure that the discharge is being selected as part of the remedy consistent with CERCLA and the NCP.

In general, this will allow the regulators to assess the suitability of the facility as part of the remedial alternatives analysis.

If you have any questions about this letter, please contact me via email at martinez-torres.fernando@epa.gov or at 404-695- 4991.

Sincerely,

FERNANDO MARTINEZ-TORRES

Digitally signed by FERNANDO MARTINEZ-TORRES
Date: 2024.04.12 14:21:57 -04'00'

Fernando Martinez Torres
Remedial Project Manager
Department of Defense Section
Superfund & Emergency Management Division
United States Environmental Protection Agency

ENCLOSURES
1. B1 TDEC Discharge Criteria
2. POTW Restriction Contact 081723
3. Wastewater Discharge Report Defense Depot Memphis, Tennessee

cc: Jamie A. Woods, TDEC
William Millar, CALIBRE
Ben Bentkowski, USEPA, R4
Kevin Koporec, USEPA, R4

DEPARTMENT OF THE ARMY
OFFICE OF THE DEPUTY CHIEF OF STAFF, G9
600 ARMY PENTAGON
WASHINGTON, DC 20310-0600

23 May 2024

DAIN-ISE

MEMORANDUM FOR

Mr. Fernando Martinez-Torres, U.S. Environmental Protection Agency (USEPA) Region 4
Mr. Jamie Woods, Tennessee Department of Environment and Conservation (TDEC)

SUBJECT: Response to EPA comments letter 12 April 2024 Focused Feasibility Study, Main Installation, Defense Depot Memphis, Tennessee

The Army is pleased to submit this response to your letter of 12 April 2024 reviewing the Army responses to EPA comments on the MI FFS. The letter presents concerns about two issues: FFA Requirements and Wastewater Management.

FFA Requirements

In the letter, EPA advises Army to use the terminology and timelines in the DDMT FFA and notes that “Revision 0” and “Revision 1” are not terms used in the FFA. In order for the FFA requirements to be clear to all, the following statements are taken directly from Section XV of the FFA. Section numbers are provided for reference although the full text of the sections is not provided. Although the FFA references the Defense Logistics Agency (DLA), responsibility for environmental restoration at DDMT was transferred to Army in 2010.

A. The designation of a document as "draft” or "draft final" is solely for purposes of consultation with EPA and TDEC in accordance with this Section. Such designation does not affect the obligation of the Parties to issue document, which may be referred to herein as “final," to the public for review and comment as appropriate and as required by law.

B. 3. Unless the Parties mutually agree to another time period, …, all draft Primary Documents shall be subject to a sixty (60) Day period for review and comment. … Comments by EPA and/or TDEC shall be provided with adequate specificity so that DLA may respond to the comment and, if appropriate, make changes to the draft document. Comments shall refer to any pertinent sources of authority or references upon which the comments are based. In cases involving complex or unusually lengthy documents, EPA and/or TDEC may extend the comment period for an additional twenty (20) Days by written notice to DLA prior to the end of the comment period.

B. 4. DLA shall give full consideration to all written comments on said document which were submitted during the comment period. DLA shall transmit a written response to said comments such that the response is received by EPA and TDEC *as soon as possible, and no later than sixty (60) Days from the close of the comment period on said draft Primary Document. DLA shall transmit a draft final Primary Document such that said document is received by EPA and TDEC no later than one hundred and twenty (120) Days from the close of the comment period for the corresponding draft Primary Document. While the resulting draft final Primary Document shall be the responsibility of DLA, it shall be the product of consensus to the maximum extent possible.*

B. 5. DLA may extend the one hundred and twenty (120) day period for issuing the draft final Primary Document by an additional twenty (20) Days by providing written notice to EPA and TDEC.

B. 6. Dispute resolution shall be available to the Parties for draft final Primary Documents as set forth in section XXV (Resolution of Disputes) of this Agreement.

7. Except for a ROD, the draft final Primary Document shall become the final Primary Document if no Party invokes dispute resolution within thirty (30) Days of issuance of the document or, if invoked, at completion of the dispute resolution process should the DLA position be sustained.

C. 3. Secondary Documents shall be subject to the review process specified for Primary Documents unless otherwise agreed to by the Parties.

C. 4. Although EPA and TDEC may comment on Secondary Documents, and DDMT shall respond to any comments received, Secondary Documents shall not necessarily be subject to review and comment, and may be finalized in the context of the corresponding Primary Documents. A Secondary Document may be. disputed only in the context of the corresponding Primary Document.

As described above, the FFA provides a single comment period to EPA and TDEC following submittal of the ‘Draft’ document. DLA (now Army) would then issue the Draft Final document, which would be final unless EPA and/or TDEC invoked dispute resolution. The use of ‘Revision 0’ for ‘Draft’ and ‘Revision 1’ for ‘Draft Final’ had been in use for several years when HDR began work at DDMT in 2006. The reason for the change from designations in the FFA is not known, but it has not been identified as a source of confusion before now.

Army has not directly followed the requirements of the FFA in order that ‘Final’ documents “be the product of consensus to the maximum extent possible”. Army has also allowed completion of Secondary documents to be significantly delayed in order to address multiple rounds of EPA comments when that is not required by the FFA.

EPA recommends in their letter that Army “incorporate EPA comments to the maximum extent possible per FFA Section XV.B.4”. However, the FFA seeks “consensus to the maximum extent possible”, not maximum acceptance of EPA comments.

Army, EPA and TDEC do not always meet the timelines for submittal of documents or comments. However, the documents and schedules are discussed in monthly Site Management Team calls, and Army considers that all parties are diligently working to meet the timelines.

Wastewater Management

In the letter, EPA states Army appears to have addressed most of EPA's comments, but specific deficiencies remain regarding wastewater management. EPA notes Army has stated that it does not intend to discharge wastewater on-site and that Army has identified a permitted facility previously used for disposal of wastewater. However, EPA requests that Army identify the off-site NPDES-permitted facility and provide the permit to facilitate the review of the draft final FFS and subsequent primary documents. EPA then states that if the permitted facility is not known at this time, it is requested to be provided to the regulators before the Draft Revised Proposed Plan is submitted for review.

Wastewater from well installation and development on the MI in 2018 was transported to VLS Recovery (EPA ID NO. TND981920119) in Mount Pleasant, TN; the facility conducts wastewater disposal through its use in stabilization of other waste materials. It does not discharge wastewater and does not have an NPDES permit. TDEC has suggested two other facilities which may be appropriate for disposal of wastewater from DDMT, Onsite Environmental and Vangold Industries; additional information regarding these facilities has been requested from TDEC.

It is not clear that the identification of a specific NPDES-permitted facility is necessary at present or that is needed for the Revised Proposed Plan (RPP). It will be a few years until disposal of wastewater at a permitted facility is required. A permitted facility identified at this stage may not be available when remedial action begins or a different permitted facility may be more cost-effective for DDMT. Prior to beginning remedial action at the MI, DDMT has to complete an RPP, a ROD Amendment, a Remedial Design and a Remedial Action Work Plan (RAWP); the Waste Management Plan in the RAWP would seem to be the appropriate document to identify the permitted facility for wastewater treatment and disposal. In addition, Army cannot select a disposal facility without following the typical competitive process unless it is deemed that there is only one source that meets the requirements. Multiple facilities capable of providing wastewater treatment/disposal have been identified; the selection will have to wait for award of a task order for the remedial action.

EPA states the information provided by Army regarding past wastewater discharges does not provide sufficient basis for an evaluation of whether the CERCLA wastewater will be handled protectively or in a legally compliant manner. Permit S-NN3-097, identified by EPA from the Administrative Record, allowed the discharge from the Interim Remedial Action on Dunn Field to the city sanitary sewer system; that discharge was also used for wastewater generated during on-site investigation and remedial activities. When discharge to the sewer was no longer allowed, discussions with TDEC documented in the referenced emails were the basis for on-site discharges to a stormwater drain on Dunn Field. The EPA Remedial Project Manager at the time was aware of the discussions with TDEC and the requirements specified in the emails. EPA was copied on reports for each discharge. No concerns were raised until the discharge was considered an option in the FFS. After EPA raised concerns about the discharge, Army directed that it be removed as an option for wastewater disposal in the FFS and that all wastewater generated through environmental restoration activities at DDMT be transported to a permitted, off-site facility for disposal. EPA has received all the available information about the discharges. If further discussion is required, it should be separate from the FFS.

Document Submittal

Further revision of the FFS, except the addition of 'Draft Final', is not necessary.

For additional information please contact: Mr. Tom Holmes, HDR Project Manager at (404) 295-3279, email: thomas.holmes@hdrinc.com; or Ms. Bill Millar, BRAC Environmental Coordinator at (703) 819-0100, email: william.w.millar.ctr@army.mil.

MILLAR.WILLIAM.WINSTON.SR.1391460309 Digitally signed by MILLAR.WILLIAM.WINSTON.SR.1391460309 Date: 2024.05.29 13:33:24 -04'00'

for

Encl

JAMES C. FOSTER
Program Manager,
Base Realignment and Closure Division

Holmes, Thomas C

From: Martinez-Torres, Fernando <martinez-torres.fernando@epa.gov>
Sent: Monday, June 10, 2024 3:27 PM
To: Millar, William W Sr CTR USARMY HQDA DCS G-9 (USA); Jamie Woods; Bentkowski, Ben; Koporec, Kevin; Berg, Shannon; McRae, Mac
Cc: Foster, James C CIV USARMY HQDA DCS G-9 (USA); Melissa.L.Shirley; Chase.E.Carter; Holmes, Thomas C; Mokri, Clayton R; Larry Pannell
Subject: RE: DDMT MI FFS RTC Letter Response to EPA letter dated 12 April 2024

Good evening, Bill,

Thank you for continuing to work toward the selection of the new remedy. I'd like to clarify today's call about the FFS. The EPA is requesting a Draft Final (as a PDF and Word document) so that the lead agency can submit a draft proposed plan. The FFS becomes final once the Record of Decision is signed; otherwise, it is not considered final.

Sincerely,

Fernando Martinez Torres
U.S. Environmental Protection Agency/R4
Federal Facilities Branch
Department of Defense Section
404-695-4991

You are the driving force behind our ability to achieve our objectives of safeguarding the environment, protecting live, and ensuring a sustainable future.

-----Original Message-----
From: Millar, William W Sr CTR USARMY HQDA DCS G-9 (USA) <william.w.millar.ctr@army.mil>
Sent: Wednesday, May 29, 2024 1:35 PM
To: Martinez-Torres, Fernando <martinez-torres.fernando@epa.gov>; Jamie Woods (Jamie.Woods@tn.gov) <Jamie.Woods@tn.gov>; Bentkowski, Ben <Bentkowski.Ben@epa.gov>; Koporec, Kevin <Koporec.Kevin@epa.gov>; McRae, Mac <mac.mcrae@techlawinc.com>
Cc: Foster, James C CIV USARMY HQDA DCS G-9 (USA) <james.c.foster10.civ@army.mil>; Shirley, Melissa L CIV USARMY CESAM (USA) <Melissa.L.Shirley@usace.army.mil>; Carter, Chase E CIV (USA) <chase.e.carter@usace.army.mil>; Holmes, Thomas C <Thomas.Holmes@hdrinc.com>; Mokri, Clayton R <clayton.mokri@hdrinc.com>; Larry Pannell <lpannell@komangs.com>
Subject: RE: DDMT MI FFS RTC Letter Response to EPA letter dated 12 April 2024

REGION 4
ATLANTA, GA 30303

July 2, 2024

Mr. James Foster
Base Realignment and Closure Division (ACSIM-ODB)
2530 Crystal Drive (Taylor Building), Room 5000
Arlington, VA 22202-3940

Dear Mr. Foster,

The United States Environmental Protection Agency (EPA/USEPA) concurs with the information provided in the Draft Final version of the Focused Feasibility Study (FFS) for the Main Installation, submitted by the United States Army (lead agency/ USARMY) in June 2024. The EPA request that a designated document as “Final” be share among the Federal Facility Agreement parties for record keeping and to allow progress towards the completion of the Draft Propose Plan for the Main Installation.

As a reminder, the FFS remains subject to potential reevaluation under two key circumstances. First, if the Record of Decision (ROD) encounters significant opposition during the public comment period, a reassessment may be necessary to address community concerns. Second, should EPA or TDEC [Tennessee Department of Environment and Conservation] management express reservations or disagreement with the current conclusions, it could prompt a reexamination of the FFS. These provisions ensure that both public input and internal agency expertise are fully considered in the final remediation approach.

While there is no explicit EPA guidance stating that an FFS is not final until ROD is signed, the overall CERCLA [Comprehensive Environmental Response, Compensation, and Liability Act] process and EPA's federal facility cleanup approach supports this practice. The EPA's "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA” provides a framework for the remedy selection process. It states that the Feasibility Study (FS), which would include an FFS for a focused study, is an iterative process that allows for adjustments based on new information:

"The FS is an iterative process that continues throughout the RI/FS and into the Proposed Plan and ROD stages. The FS is refined as more information becomes available and as the results of treatability studies and pilot tests are incorporated."

This iterative nature of the FS/FFS is further emphasized in the guidance:

"The FS is not a static document, but rather a dynamic analysis that is revised as new information becomes available."

Additionally, the EPA's "A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents" reinforces the concept that the FFS is not considered final until the ROD is signed:

"The Proposed Plan and ROD are the final documents in the remedy selection process. They build upon the RI/FS and provide the public with EPA's preferred alternative and the rationale for its selection."

The FFS serves as a critical input, but it is not the final decision document. Instead, the ROD represents the culmination of the process, where the preferred alternative is selected based on the FFS and other factors. The EPA emphasizes public participation and professional judgment in evaluating remedial actions, as outlined in their guidance on federal agency demonstrations. This iterative approach allows for adjustments based on new information and stakeholder input throughout the process.

The agency's primary goal of protecting human health and the environment requires flexibility to incorporate emerging scientific information and substantiated facts. Furthermore, the coordination between regulatory agencies for federal facility enforcement actions, as outlined in EPA policies, contributes to the evaluation between the FFS and ROD. Ultimately, these factors collectively suggest that the lead agency should maintain flexibility in the process until the ROD is signed, ensuring that all stakeholder inputs are considered, the latest scientific information is incorporated, and the best decision for environmental protection is made.

If you have any questions about this letter, please contact me via email at martinez-torres.fernando@epa.gov or at 404-695- 4991.

Sincerely,

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