THIRD FIVE-YEAR REVIEW REPORT FOR DOVER MUNICIPAL WELL NO. 4 SUPERFUND SITE MORRIS COUNTY, NEW JERSEY

Prepared by

U.S. Environmental Protection Agency
Region 2
New York, New York

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Date

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LIST OF ABBREVIATIONS & ACRONYMS

1,2-DCE	1,2-Dichloroethane
ARAR	Applicable or Relevant and Appropriate Requirement
bgs	Below Ground Surface
CEA	Classification Exception Area
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulation
COCs	Contaminants of Concern
CVOCs	Chlorinated Volatile Organic Compounds
DCE	Dichloroethene
DMW-4	Dover Municipal Well No. 4
EPA	United States Environmental Protection Agency
ft	Feet
FYR	Five-Year Review
gpm	Gallons per Minute
ISCO	In Situ Chemical Oxidation
ICs	Institutional Controls
MCL	Maximum Contaminant Level
MDL	Method Detection Limit
µg/L	Micrograms per Liter
$\mu g/m^3$	Microgram per Cubic Meter
mg/kg	Milligrams per Kilogram
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NJDEP	New Jersey Department of Environmental Protection
NPL	National Priorities List
OU	Operable Unit
PCE	Tetrachloroethene
PDI	Preliminary Design Investigation
RA	Remedial Action
RAO	Remedial Action Objective
RI	Remedial Investigation
ROD	Record of Decision
RPM	Remedial Project Manager
TCA	Trichloroethane
TCE	Trichloroethene
TOC	Total Organic Carbon
VC	Vinyl Chloride
VI	Vapor Intrusion

I. INTRODUCTION

The purpose of a five-year review (FYR) is to evaluate the implementation and performance of a remedy in order to determine if the remedy is and will continue to be protective of human health and the environment. The methods, findings, and conclusions of reviews are documented in FYR reports such as this one. In addition, FYR reports identify issues found during the review, if any, and document recommendations to address them.

The U.S. Environmental Protection Agency (EPA) is preparing this FYR review pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 121, consistent with the National Contingency Plan (NCP)(40 CFR Section 300.430(f)(4)(ii)), and considering EPA policy.

This is the third FYR for the Dover Municipal Well No. 4 Superfund Site. The triggering action for this policy review is the completion date of the previous FYR. The FYR has been prepared due to the fact that the remedial action will not leave hazardous substances, pollutants or contaminants on site above levels that allow for unlimited use and unrestricted exposure but requires five or more years to complete.

The Site consists of two operable units (OUs), and both OUs will be addressed in this FYR. OU1 addresses groundwater contamination at the Site and OU2 addresses the sources of the groundwater contamination.

The Dover Municipal Well No.4 Superfund Site FYR was led by EPA Remedial Project Manager(s) (RPM) David Montoya and Selina Rahman. Participants included Sabrina Gonzalez, EPA Hydrogeologist; Urszula Filipowicz, EPA Human Health Risk Assessor; Abigail DeBofsky, Ecological Risk Assessor; and Natalie Loney, EPA Community Involvement Coordinator. The review began on 4/8/2024.

Site Background

The Site is located in Dover, Morris County, New Jersey. Although most of the Town of Dover is residential, the Site is located in a commercial and industrial section, approximately 1.5 miles east of three potable water production wells which serve a community of approximately 22,000 people. The Dover Water Commission owns and operates this municipal well field. The Dover Municipal Well No. 4 (DMW-4) public water supply well is located approximately 450 feet north of the Rockaway River, on Lot 15, Block 2314. The location of DMW-4 and surrounding area is shown on Figure 1 of Appendix B.

The Site lies within the Rockaway River Valley, which contains a complex three-aquifer, buried-valley hydrogeologic system. In the portion of the valley near the Site, two silt layers separate permeable sands into a "shallow aquifer," an "intermediate aquifer," and a "deep aquifer." The shallow aquifer ranges from 2 feet to 15 feet thick and shallow groundwater flows south toward the Rockaway River. The intermediate aquifer ranges from 6 feet to 32 feet in thickness and is separated from the deep aquifer by a discontinuous confining layer of silt. This silt layer is as much as 50 feet thick in some areas and not present in others. Groundwater in the intermediate and deep aquifers generally flows toward the east. The deep aquifer does not exist beneath the source area property. Groundwater in the area is classified as class II-A, a current source of drinking water.

The up-valley limits of the Site are the Princeton Avenue Well Field, which is 7,000 feet west of DMW-4. The northern and southern limits extend to the edges of the unconsolidated valley-fill deposits. The limits roughly coincide with the sloping topography. The eastern limit ends at Roy Street.

The source of contamination (i.e., source area) to the DMW-4 groundwater is a property on which a former dry cleaning facility operated. The property is located at 272 U.S. Route 46, which is bounded by Route 46 to the north, the former Walt's Radiator Shop and a residential house to the east, Richards Avenue to the south, and Grecco Auto Body to the west. The property is covered with coarse gravel and slopes generally from the north to the south. The property is secured by an eight-foot-high chain-link fence with a locked double-swing gate. The property is accessed via Route 46 (main entrance) and along Richards Avenue via two locked secondary sliding gates. The Rockaway River is located approximately 450 feet south of the property.

A Site Location Map, Site Plan and Adjacent Properties Map, Regional Topographic Map, Geologic Cross-Sections, and Potentiometric Surface Maps from 2024 are included as Appendix B.

FIVE-YEAR REVIEW SUMMARY FORM

SITE IDENTIFICATION		
Site Name: Dover Municipal Well No.4		
EPA ID: NJD980654131		
Region: 2	**State:** NJ	**City/County:** Dover/Morris
SITE STATUS		
NPL Status: Final		
Multiple OUs? Yes	**Has the site achieved construction completion?** Yes	
REVIEW STATUS		
Lead agency: EPA		
Author name (Federal or State Project Manager): David Montoya		
Author affiliation: EPA		
Review period: 4/8/2024 – 9/23/2024		
Date of site inspection: 12/2/2024		
Type of review: Policy		
Review number: 3		
Triggering action date: 3/3/2020		
Due date *(five years after triggering action date)*: 3/3/2025		

II. RESPONSE ACTION SUMMARY

Basis for Taking Action

Drilled in 1962, DMW-4 began pumping in June 1965, and was one of Dover's primary water supply wells with an average pumping rate of 1,100 gallons per minute (gpm). In March 1980, the Town of Dover and the New Jersey Department of Environmental Protection (NJDEP) documented the presence of chlorinated volatile organic compounds (CVOCs), specifically 1,1,1-trichloroethane (1,1,1-TCA), tetrachloroethene (PCE), and trichloroethene (TCE) in the groundwater collected from DMW-4. Based on this information, the Town of Dover voluntarily removed DMW-4 from service and replaced it with standby well No. 3 in September 1980. The Site was placed on the National Priorities List (NPL) in September 1983. In the mid to late 1980s, a remedial investigation (RI) conducted by NJDEP identified CVOCs in all three aquifers near DMW-4. PCE was detected north of DMW-4 in the intermediate and deep glacial sand and gravel aquifers. CVOCs were also detected in the shallow, intermediate, and deep glacial sand and gravel aquifers at various locations throughout the area. The 1990 RI Report, however, did not identify the source of groundwater contamination.

In October 1992, NJDEP requested that EPA assume the lead for addressing the contamination at the Site. In March 1993, EPA initiated a further investigation to determine the source of the CVOCs in the shallow, intermediate, and deep aquifers. While EPA's investigation located numerous potential sources, EPA was unable to identify the specific source of the groundwater contamination.

Based upon the results of the OU1 RI, a baseline risk assessment was conducted to estimate the risks associated with current and future Site conditions. The human health risk assessment concluded that carcinogenic risk was within the range of acceptable exposure and the Hazard Index exceeded one, only for children under a future residential land use scenario. However, cleanup was warranted because groundwater contaminants were present at concentrations exceeding New Jersey Maximum Contaminant Levels (MCLs) in each of the three aquifers. Additionally, concentrations of PCE and other contaminants in the shallow and intermediate aquifers could migrate into the deeper aquifer because the confining layers between the aquifers are not impermeable.

An environmental evaluation was also conducted for OU1 at that time. It concluded that the potential exists for elevated inorganics in groundwater to produce adverse environmental effects in the event that no response action was taken.

A human health risk assessment conducted as part of the OU2 RI evaluated the following current and future scenarios: residents (adult and child) in the vicinity of the dry cleaner who may contact soil in their yards, or who, in the future, may consume or utilize local groundwater; workers in the vicinity of the dry cleaner who may contact soil or may consume or utilize local groundwater; and construction workers whose work may expose them to soil and/or shallow groundwater during work around an excavation. Results of the assessment indicated exceedances of EPA's cancer risk range threshold of 10^{-6} to 10^{-4} and noncancer hazard of 1 for future residents and outdoor commercial/industrial workers from consumption of PCE and TCE contaminated groundwater. In addition, the noncancer hazard index for the future construction/utility worker exposed dermally to PCE and TCE in shallow groundwater exceeded EPA's target threshold value of 1.

Response Actions

Based on the OU1 RI, EPA selected a remedy for OU1 (groundwater) in a September 1992 Record of Decision (ROD). The remedial action objectives (RAOs) for the groundwater remedy were as follows:

- Continue to prevent exposure, due to groundwater ingestion and inhalation, to contaminants at levels exceeding MCLs;
- Minimize further contamination of DMW-4 and prevent contamination of additional existing wells by minimizing the migration of contaminants; and,
- Restore contaminated groundwater for future use.

The selected remedy included:

- Extraction of contaminated groundwater and restoration of the groundwater to drinking water standards;
- Treatment of extracted groundwater to levels attaining drinking water standards;
- Discharge of treated groundwater to the public water supply system to the extent practicable, with reinjection of any surplus quantity; and,
- Appropriate environmental monitoring to ensure the effectiveness of the remedy.

Between 1999 and 2003, EPA conducted a preliminary design investigation (PDI) as part of the OU1 remedial design, which also focused on identifying the source of groundwater contamination (OU2). Based on that work, EPA identified a property located at 272 U.S. Route 46 as the source of the CVOCs found in DMW-4. After discovering the dry cleaner was the source of contamination to DMW-4, EPA conducted an OU2 RI. EPA then began the OU2 RI to determine the extent of the source-related contamination. After the RI was completed for OU2, EPA issued a ROD for OU2 in September 2005, for the source area soils and groundwater, and modified the OU1 sitewide groundwater restoration remedy. The 2005 OU2 ROD identified the following soil and groundwater RAOs for OU2 and modified the OU1 sitewide groundwater RAOs as follows:

Soil

- Reduce the potential for further migration of contaminants from the contaminated soil into groundwater.

Source Area Groundwater

- Prevent exposure by direct contact with or ingestion of shallow contaminated groundwater.
- Reduce the potential for exposure via inhalation of vapors that may migrate from shallow groundwater.

Site Groundwater

- Prevent public exposure to contaminated groundwater that presents a significant risk to human health and the environment.
- Restore the shallow, intermediate, and deep groundwater contamination to drinking water standards within a reasonable time frame.
- Reduce the potential for exposure via inhalation of vapors that may migrate from shallow groundwater.

The major components of the 2005 OU2 ROD included:

- Demolition without replacement of the dry cleaner building to allow for the excavation of contaminated soil beneath it and off-site disposal of demolition debris;
- Excavation of an estimated 2,100 cubic yards of contaminated soil, sampling to verify the soil cleanup criteria or standards were met, and backfilling with clean fill;
- Off-site treatment and/or disposal of contaminated soil; and,
- Chemical oxidation of any remaining sources of groundwater contamination.

In addition, the 2005 OU2 ROD modified the 1992 OU1 sitewide groundwater remedy as follows:

- No extraction, treatment, or discharge of contaminated groundwater;
- Establishment of a network of groundwater monitoring wells;
- Environmental monitoring to ensure the effectiveness of the remedy and the ability of the groundwater to achieve the more stringent of the federal or New Jersey MCLs and/or New Jersey Groundwater Quality Standards; and,
- Institutional controls, such as the implementation of a Classification Exception Area (CEA) to restrict the use of groundwater within the area until the aquifer is restored.

Remedial goals for soil and groundwater identified in the 2005 ROD are identified below in Table 1 and Table 2, respectively.

Table 1: Soil Remedial Goals

Remedial Goals – Soil		
Compounds	**Residential Direct Contact Milligrams per Kilograms (mg/kg)**	**Impact to Groundwater (mg/kg)**
cis-1,2-Dichloroethylene (cis-1,2-DCE)	79	**1**
Tetrachloroethylene (PCE)	4	**1**
Trichloroethylene (TCE)	23	**1**
Vinyl Chloride (VC)	**2**	10

Note: The value shown in **bold** type is the selected standard. The selected standard is the more stringent for the specified compound.

Table 2: Groundwater Remediation Goals

Remedial Goals – Groundwater			
Compounds	**NJDEP Groundwater Quality Standards Micrograms/Liter (µg/L)**	**Federal MCLs (µg/L)**	**NJDEP Drinking Water MCLs (µg/L)**
cis-1,2-Dichloroethylene (cis-1,2-DCE)	**10**	70	70
Tetrachloroethylene (PCE)	**1**	5	1
1,1,2-Trichloroethane (1,1,2-TCA)	**3**	5	3
Trichloroethylene (TCE)	**1**	5	1
Vinyl Chloride (VC)	5	2	**2**

Note: The value shown in bold type is the selected standard. The selected standard is the more stringent criteria for a specified compound.

Status of Implementation

Building Demolitions

In August 2007, EPA entered into an Agreement for Recovery of Response Costs (the "Agreement") with the former owner of the dry cleaner property which resolved EPA's claims under Section 107(a) of CERCLA. Under the terms of the Agreement, the former owner paid the proceeds of an insurance claim to EPA and NJDEP and transferred title of the source area property to EPA.

In order to facilitate implementation of the OU2 source area remediation activities, EPA acquired the former dry cleaner property. Following real estate closing on the source area property, EPA demolished the former dry cleaner building in December 2007. Soil sampling conducted as part of the soil excavation design determined that soil contamination was present in close proximity to three adjacent residential houses. Due to the poor structural condition of these houses, EPA determined that any excavations could compromise the structures. Therefore, EPA acquired the three residential properties and relocated the tenants in August 2008. Demolition of the houses took place in October 2008. Additional information regarding the demolition activities is documented in *Remedial Action Report Demolition of Dry Cleaner* (EPA, 2008) and *Remedial Action Report Demolition of Three Houses* (EPA, 2008).

Soil Excavation Activities

EPA approved a Design Report for the soil excavation portion of the work in March 2009. Extensive sampling of the contaminated areas was conducted prior to completion of the Design Report. Information from the Design Report was used to determine the areas to be excavated. During excavation activities, EPA collected additional soil samples from various depths and locations for delineation purposes. Based on the analytical results, the excavation was either discontinued or expanded to encompass contaminated material. No post-excavation samples were collected below the groundwater table. The depth to groundwater ranged from 8.5 feet along the southern portion to 12.5 feet along the northern portion of the Site.

The depth of excavation varied from 3.5 feet to approximately 12.5 feet below ground surface. The total volume of soil excavated and disposed of off-site was approximately 1,258 cubic yards. All physical work associated with the soil excavation was completed in summer 2009. Additional information regarding the soil excavation activities is documented in *Remedial Action Report Excavation of Soils* (EPA, 2010).

EPA conducted soil sampling in 2017 and groundwater sampling in 2021 in the vicinity of the former dry cleaner building that identified a localized area of PCE mass at approximately 10 ft below ground surface. Groundwater monitoring results indicated that while the CVOC groundwater plumes were generally stable or shrinking, the potential for anaerobic biodegradation may not have been sufficient to reduce residual PCE source material below the site-specific screening values identified in the OU2 ROD. Additional investigation was required to delineate the horizontal and vertical extents of residual CVOCs in soil with concentrations above the remedial goals defined in the OU2 ROD. Therefore, EPA conducted a soil investigation in 2023 to determine the extent of the contamination and developed a remedial design for excavation of the additional source area with the goal of preventing contaminant migration from the soil into groundwater. Excavation of the identified source area began in January 2024 and was completed in February 2024. EPA removed approximately 1,700 cubic yards of contaminated soil, backfilled the area with clean fill and restored the excavated area to previous conditions. Additional information regarding the soil excavation activities is documented in *Remedial Action Report Dover Municipal Well 4 Superfund Ste Operable Unit 2* (EPA, 2024).

<u>Chemical Oxidation Activities</u>
EPA started In-Situ Chemical Oxidation (ISCO) activities at OU2 in March 2010 and has implemented four phases of oxidant injections to date. Phase 1 was conducted in April and May 2010, Phase 2 was conducted in June and July 2011, Phase 3 was conducted in October and November 2012, and Phase 4 in October and November 2014. The remedial technology utilized chemical oxidants (hydrogen peroxide and sodium permanganate) to break down soil and groundwater contamination into harmless byproducts, such as water and carbon dioxide. A two-phased approach was developed utilizing hydrogen peroxide to address the bulk of the contaminant mass, and a subsequent sodium permanganate injection to provide a longer-lasting oxidant breakdown of the contamination. Following the additional source removal activities in 2024, permanganate was applied again to the bottom of the excavation areas prior to backfilling for additional oxidation of any residual contaminants. The details for the implementation of each phase of ISCO treatment are discussed in the four respective Remedial Action (RA) Reports.

<u>*In-situ* Chemical Oxidation Monitoring</u>
During the four injection phases in 2010, 2011, 2012 and 2014, EPA performed continuous monitoring to evaluate the ISCO program’s effectiveness in reducing contaminant source mass. The monitoring programs include the sampling and analysis of groundwater generated as a result of the oxidation reactions. The overall results of the monitoring program verified that the pre-established performance criteria were met, including the successful demonstration of oxidant distribution (measuring and/or observing oxidants in monitoring wells) and verification of oxidant loading (meeting or exceeding the remedial design required oxidant volumes). Additional ISCO effectiveness monitoring was conducted from 2013 through 2016 to determine the efficacy of ISCO activities at the Site. Results of the monitoring are detailed in the *Data Summary Report for In Situ Chemical Oxidation Effectiveness Monitoring at OU2* and indicated that although the performance criteria for the injections established in the design were achieved, not all mass was treated.

<u>Vapor Intrusion Monitoring</u>
Beginning in 2002, EPA initiated a monitoring program to determine whether contaminated groundwater present beneath residential homes in the vicinity of the Site was a source of vapor intrusion (VI) into indoor air of these structures. EPA performed sub-slab soil gas sampling, and indoor and ambient outdoor air sampling in 12 homes located in close proximity to the Site. Six of the homes indicated a potential for exposure to PCE and TCE. Three of the six homes were demolished as part of the remedy, with the remaining three homes requiring further investigation. EPA has continued to monitor those three houses of interest with the latest sampling conducted in February 2024.

<u>Groundwater Monitoring</u>

The remedy for groundwater changed from a pump and treat remedy to a monitored natural attenuation remedy in the 2005 ROD. Wells have been installed in the shallow, intermediate, and deep aquifer. Groundwater monitoring events currently are implemented semi-annually. During each monitoring event, groundwater field parameters are measured, and samples were collected for VOC analyses from LTRA wells using passive diffusion bags (PDBs). LTRA monitoring will continue as necessary until the 2005 ROD criteria are met and the project’s data quality objectives are achieved.

IC Summary Table

Table 3: Summary of Planned and/or Implemented ICs

Media, engineered controls, and areas that do not support UU/UE based on current conditions	ICs Needed	ICs Called for in the Decision Documents	Impacted Parcel(s)	IC Objective	Title of IC Instrument Implemented and Date (or planned)
Groundwater	Yes	Yes	See Appendix C	Restrict installation of groundwater wells and groundwater use.	Classification Exception Area/Well Restriction Area; September 6, 2013

Due to the groundwater contamination, a classification exception area (CEA)/well restriction area (WRA) was established by the NJDEP for this Site to prevent the installation of any new potable wells into the contaminated aquifer. The CEA/WRA includes all three aquifers and adequately addresses the extent of the plume. The CEA/WRA, preventing groundwater use and well installation, was established by NJDEP on September 6, 2013. The CEA will remain in place until the contaminated groundwater meets the remedial goals.

Remedy Resilience Assessment

Two tools were utilized to assess remedy resilience: *CMRA* and the *U.S Landslide Inventory.* As a result of this assessment (provided in Appendix D), it has been determined that the performance of the remedy is currently not at risk due to the expected effects of severe weather in the region and near the Site. This is because the Site is located at a higher elevation away from the coastline, has low flood risks, and the topography of the area does not make the groundwater wells vulnerable to landslides.

III. PROGRESS SINCE THE LAST REVIEW

This section includes the protectiveness determinations and statements from the last FYR as well as the recommendations from the last FYR and the current status of those recommendations.

Table 4: Protectiveness Determinations/Statements from the 2020 FYR

OU #	Protectiveness Determination	Protectiveness Statement
1	Protective	The OU1 remedy is protective of human health and the environment.
2	Protective	The OU2 remedy is protective of human health and environment.
Sitewide	Protective	Both remedies for OU1 and OU2 are considered protective of human health and the environment.

No issues or recommendations were included in the previous FYR.

IV. FIVE-YEAR REVIEW PROCESS

Community Notification, Involvement & Site Interviews

On August 7, 2024, the EPA Region 2 posted a notice on its website indicating that it would be reviewing site cleanups and remedies at Superfund sites in New York, New Jersey, and Puerto Rico, including the Dover Municipal Well No.4 site. The announcement can be found at the following web address: https://www.epa.gov/superfund/R2-fiveyearreviews.

In addition to this notification, the EPA Community Involvement Coordinator (CIC) for the Site, Natalie Loney, will post a public notice on the EPA site webpage https://www.epa.gov/superfund/dover-well-4 and provide the notice to the township by email with a request that the notice be posted in municipal offices and on the town webpages. This notice will indicate that a FYR has been conducted at the Dover Municipal Well No.4 Superfund site to ensure that the cleanup at the Site continues to be protective of people's health and the environment. The FYR is available at the following repository/ies: U.S. Environmental Protection Agency, Superfund Records Center, 290 Broadway, 18th floor, New York, NY 10007 and the Dover Free Public Library, 32 East Clinton Street, Dover, New Jersey. In addition, the final report will be posted on the following website: https://www.epa.gov/superfund/dover-well-4.

Data Review

Groundwater

As part of long-term response action (LTRA) activities at the Site, EPA monitored the groundwater semi-annually from 2020 through 2023. As part of each monitoring event, groundwater samples were collected and analyzed for VOCs from up to 29 monitoring wells, including 13 shallow aquifer wells (Figure 3-1), 11 intermediate aquifer wells (Figure 3-3), and 5 deep aquifer wells (Figure 3-2). Seven monitoring wells (A-1, A-3, A-4, PW-12S, PW-14S, PW-14I, and PW-14D) in the network were properly abandoned in November 2022, following the fall 2022 sampling event. These seven monitoring wells were abandoned due to being located within the extent of the 2024 excavation area. EPA replaced these wells with six new monitoring wells: four shallow aquifer wells (MW-21S-U, PW-14S-R, A-3R, and A-4R), one intermediate aquifer well (PW-14I-R), and one deep aquifer well (PW-14D-R) (Figure 1-2). EPA also conducted additional groundwater elevation gauging, and water quality parameter monitoring. Potentiometric maps can be found in Figures 2-1 through 2-3. The conceptual site model for the Site is included as Appendix E.

Shallow Aquifer Trend Analysis

The March 2023 analytical results from monitoring well MW-11S report PCE at a concentration of 30.3 µg/L, which is above the OU2 ROD cleanup criteria of 1 µg/L. TCE and *cis*-1,2-DCE were also detected above the OU2 ROD cleanup criteria of 10 µg/L in March 2023. PCE concentrations in MW-11S increased through 2023 as a slug of contamination migrated to the south due to shifting of shallow groundwater flow direction. Data from MW-11S in 2023 show an increase in reductive dechlorination daughter products (TCE, cis-1,2-DCE) which is indicative of PCE attenuation. The southern extent of this slug of contamination is delineated by MW-17S. The time-series plots (Figure 6) show a decreasing trend in PCE concentrations over time even with several exceedances above the OU2 ROD cleanup criteria over the past two sampling events.

The source area monitoring well MW-15S shows groundwater PCE, TCE, and *cis*-1,2-DCE concentrations above the OU2 ROD cleanup criteria of 1 µg/L, 1 µg/L, and 10 µg/L respectively. Based on analytical data ranging from October 2000 to November 2023, PCE concentrations in the groundwater at MW-15S demonstrate a decreasing trend (see Figure 4). The continued detection of elevated concentrations of PCE degradation products TCE, *cis*-

1,2-DCE, and VC in the groundwater indicates limited intrinsic reductive dechlorination is occurring at this location.

At well PW-7S, at the upgradient end of the source area, PCE continues to be detected in the groundwater at concentrations above its corresponding OU2 ROD cleanup criteria of 1 µg/L with concentrations of 89.8 µg/L in March 2023 and 50.2 µg/L in November 2023. TCE was not detected above the OU2 ROD cleanup criteria of 1 µg/L in 2023. *Cis*-1,2-DCE and VC were not detected during the March and November 2023 events. PCE concentrations at PW-7S demonstrate an increasing trend over time (Figure 5). Elevated PCE detections at A-3 (close to PW-7S) in March and August 2022 may relate to trends previously noted at PW-7S, with PCE concentrations contributing to displacement of PCE-containing groundwater during ISCO injection events. Concentrations of PCE were approximately 12,500 µg/L in the vicinity of well A-3 in March 2022, indicating a source of DNAPL was possible. Even though concentrations of PCE were high, DNAPL was not observed during excavation activities. The concentrations of PCE in August 2022 decreased to 1,750 µg/L, with corresponding increases in TCE and *cis*-1,2-DCE, suggesting that reductive dechlorination was occurring in this area despite the fluctuating concentrations. The 2023 source excavation activities removed significant residual contamination (PCE, TCE, VC, and DCE), and contaminant concentrations in this area are expected to continue to decline in response to the source removal. It should be noted that the confirmation sample obtained to the northeast of PW-7S during the excavation exceeded the ROD cleanup criteria of 1 µg/L for PCE. PCE was detected at a concentration of 4,000 µg/kg at the sidewall northeast of PW-7S but could not be further excavated due to the location's proximity to the sidewalk and Route 46.

Intermediate Aquifer Trend Analysis

PCE was the only COC detected above OU2 ROD cleanup criteria (1 µg/L) at MW-6I (54.2 µg/L in March and 46 µg/L in November 2023, see Figure 9), MW-10I (11.1 µg/L in March 2022), MW-13I (5.17 µg/L in March 2023), MW-15IR (65.4 µg/L in March 2023, see Figure 7), MW-17I (3.53 µg/L in March 2022), PW-14I (10.3 µg/L in March 2022), PW-14D (33.1 µg/L in March 2022), and PW-5I (4.22 µg/L in March 2023, see Figure 8). For the selected wells, time-series plots (Figures 7-9) demonstrate decreasing trends over time at each location, while Mann-Kendall Tests demonstrate decreasing to probably decreasing trends. The continued decreasing trends are likely due to ISCO treatments and natural attenuation.

Deep Aquifer Trend Analysis

PCE was detected above the OU2 ROD cleanup criteria (1 µg/L) at monitoring wells MW-1DR (3.88 µg/L, see Figure 10) and MW-19DR (21.2 µg/L) during the March 2023 event and in well MW-1DR (13.7 µg/L) during the November 2023 event. PCE concentrations in monitoring wells MW-1DR and MW-9D exhibited no trend, while MW-2D exhibited a decreasing trend. Groundwater contaminant concentrations from the most downgradient well, MW-2D, remain below OU2 ROD cleanup criteria for all chlorinated VOCs except PCE, which was detected in the 123-foot sampling zone above the OU2 ROD cleanup criteria of 1 µg/L (2.26 µg/L) in March 2022. All CVOC concentrations were found to be below OU2 ROD cleanup criteria in MW-2D in 2023.

<u>Vapor Intrusion</u>

EPA conducted vapor intrusion sampling on February 14, 2024 to further evaluate the potential for vapor intrusion at three residential properties located on Richards Avenue in Dover, New Jersey. Sampling included the collection of sub-slab, indoor-air, and ambient-air samples at the three properties. Samples were analyzed for vinyl chloride, cis-1,2-DCE, trans-1,2-DCE, 1,1-DCA, 1,1-DCE, 1,2-DCA, 1,1,1-TCA, TCE, and PCE.

Of the nine compounds analyzed, PCE, TCE and 1,2-DCE were observed at concentrations above the laboratory method detection limit (MDL). PCE was detected in sub-slab samples collected at the three properties ranging from 1 microgram per cubic meter (µg/m^3) to 44 µg/m^3. Concentrations of PCE in indoor air ranged from 0.3 to 0.45 µg/m^3. These detections do not exceed EPA's risk-based indoor air and sub-slab vapor intrusion screening levels for PCE. TCE and 1,2-DCE were detected in one indoor air sample at 0.36 and 0.19 µg/m^3, respectively.

Because TCE and 1,2-DCE were not found in sub-slab samples above the MDL, it is not likely they are originating from a sub-surface source. Further, these detections fell within EPA's cancer risk range indicating no further action is warranted at this time.

The concentrations of PCE detected in sub-slab samples at the three residential properties were below the applicable sub-slab screening levels of 360 $\mu g/m^3$ for PCE. Concentrations of PCE in sub-slab samples collected at two of the properties on Richards Avenue have been below screening levels since February 2013 and at the third since March 2007.

Site Inspection

The inspection of the Site was conducted on 12/2/2024. In attendance were David Montoya, EPA RPM. The purpose of the inspection was to assess the protectiveness of the remedy.

The inspection revealed that the fence around the perimeter of the Site is intact, the gates preventing access to the Site are locked and intact, the injection and monitoring wells are in good condition and maintenance activities are being performed according to schedule. No issues were found that would impact remedy performance or require discussion in this FYR.

V. TECHNICAL ASSESSMENT

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

The primary objectives of the RODs are to remove the continuing sources of contamination into the groundwater, prevent potential future ingestion of Site-related contaminated groundwater, restore the quality of the groundwater and mitigate the off-site migration of the Site-related contaminated groundwater. EPA's review of Site documents and the results of the Site inspections and a review of all monitoring data since the last FYR indicate that the remedy is functioning as intended.

EPA excavated the source area in May 2009 and disposed the contaminated soil off-site. Excavation activities effectively removed source contamination in the vadose zone. Effectiveness monitoring after the 2009 soil removal and four ISCO injection events showed a significant decrease in PCE concentrations from pre-RA levels in soil. Groundwater concentrations in the source area have also decreased significantly. An additional hot spot of PCE contamination in the smear zone centered on well cluster A-3/C-3/D-3 was identified and further delineated in March through October 2023. Soil remediation and source removal in this area was completed in February 2024.

In general, groundwater monitoring to date has shown a reduction in PCE concentrations in the shallow, and intermediate aquifers due to removal of contaminated soil and the implementation of ISCO remedial efforts. PCE concentrations in the deep aquifer portion of the plume also show decreasing trends due to the decrease of mass flux from the overlying aquifer zones and through natural attenuation. Further reductions are anticipated due to the additional source removal in 2024. The monitoring results indicate that the downgradient monitoring network is sufficient to delineate the plume and monitor changes over time.

Due to the effectiveness of the ISCO to shrink the lateral extent of the shallow groundwater plume, recent vapor intrusion data collected in February 2024 show that concentrations of PCE present in sub-slab samples are below their chemical-specific risked-based screening levels. Additionally, concentrations of PCE, TCE, and 1,2-DCE in samples collected from indoor air fell within EPA's cancer risk range and did not exceed noncancer thresholds when compared with EPA's risk-based vapor intrusion screening levels. Because there is still some residual contamination in the shallow aquifer, EPA will continue to assess the VI pathway at the three residential properties on a periodic basis.

QUESTION B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid?

There have been no physical changes to the Site that would adversely affect the protectiveness of the remedy. The exposure assumptions and the toxicity values that were used to estimate the potential risks and hazards to human health followed the general risk assessment practice at the time the risk assessment was performed. Although the risk assessment process has been updated and specific parameters and toxicity values may have changed, the risk assessment process that was used is still consistent with current practice and the need to implement a remedial action remains valid.

The human health risk assessment (HHRA), conducted as part of the 2005 RI, evaluated residents, commercial/industrial workers and construction/excavation workers who may come into contact with Site soils or who may in the future utilize local groundwater for potable uses or come into contact with groundwater while conducting excavation work. Results of the HHRA indicated exceedances of EPA's threshold cancer risk range (of 10^{-6} to 10^{-4}) and noncancer hazard of 1 for future residents and outdoor commercial/industrial workers from consumption of PCE and TCE contaminated groundwater. The noncancer hazard index for the future construction/utility worker exposed dermally to PCE and TCE in shallow groundwater also exceeded EPA's target threshold value of 1.

The selected remedy for the Site included excavation of contaminated soils and back filling with clean soil, along with demolition of the former dry cleaner building to allow for the excavation of contaminated soil beneath the building. In 2008, three residences directly adjacent to the former dry cleaners were also demolished after investigations revealed soil contamination below the structures. The HHRAs conducted for the Site indicated that although Site soil did not pose unacceptable risk to human health, the cleanup of the contaminated soil was necessary to ensure it no longer served as a source of contamination to groundwater. Excavation and chemical oxidation were utilized to target the residual groundwater contamination remaining onsite. An extensive network of monitoring wells exists at the Site to characterize the contamination in the shallow, intermediate and deep aquifer. Data collected from the monitoring well network are used to assess the effectiveness of the selected remedy.

The overall remediation goal for the Site is to protect human health and the environment. Additionally, several media-specific RAOs were identified in the OU2 ROD in order to ensure potential risks associated with exposure to contaminants at the Site were mitigated. These RAOs have been listed in the "Response Actions" section of this document and remain valid for the Site.

Human exposures associated with potable use of contaminated groundwater from beneath the Site are an incomplete exposure pathway because receptors in the vicinity of the Site are connected to the public water supply. Additionally, NJDEP has established a CEA/WRA for the affected area which further restricts potable uses of contaminated groundwater. These measures ensure direct exposures associated with potable uses of contaminated groundwater from beneath the Site remain an incomplete exposure pathway both in the current and future timeframes. Although the shallow, intermediate and deep groundwater have not yet been restored to drinking water standards, it is expected that with continued source remediation and attenuation, this RAO will be met in the future. As discussed in the data review section and Question A of this document, the VI investigation in nearby residential structures, which was initiated in 2002, continues today and ensures the pathway for VI into indoor air is incomplete.

Soil cleanup criteria selected at the time of the 1992 and OU2 RODs were the more stringent of the New Jersey Residential Direct Contact Soil Criteria (NJ RDCSC) and the New Jersey Impact to Groundwater Soil Criteria. Site related soil contaminants of concern (COCs) and their corresponding cleanup goals are shown in Table 1. Out of the four soil COCs, only vinyl chloride has a lower current residential direct contact soil cleanup goal (0.97 mg/kg) as compared with the ROD selected value of 2 mg/kg. However, based on a comparison to EPA's risk-based Regional Screening Levels (RSLs) for residential soil, the current value of 2 mg/kg continues to be protective of human health for both residential and commercial use. Therefore, the ROD established cleanup goals for all soil COCs remain protective of human health.

Cleanup criteria for groundwater included the more stringent of the federal and New Jersey Safe Drinking Water Act MCLs and the New Jersey Groundwater Quality Standards (NJGWQS). Groundwater COCs and their corresponding cleanup standards are shown in Table 2. With the exception of vinyl chloride, the current applicable state and federal standards are higher than those selected in the ROD and hence remain protective of human health. While the current NJGWQS for vinyl chloride is lower than the ROD selected cleanup goal of 2 µg/L, it should be noted that the ROD value of 2 µg/L remains protective.

An environmental evaluation was conducted for the 1992 ROD, while a Screening-Level Ecological Risk Assessment was conducted for the 2005 OU2 ROD. Although the ecological risk assessment screening and toxicity values used to support the 1992 and OU2 RODs may not necessarily reflect the current values, the terrestrial exposure pathway is incomplete with the soil being covered by pavement and buildings. Further, the surface water and sediment data collected during the RI were found to be unimpacted by Site contamination. Consequently, the exposure assumptions remain appropriate and thus the remedy remains protective of ecological resources.

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

No information has come to light that would call into question the protectiveness of the remedy.

VI. ISSUES/RECOMMENDATIONS

Issues/Recommendations
OU(s) without Issues/Recommendations Identified in the Five-Year Review:
OU1 & OU2

VII. PROTECTIVENESS STATEMENT

Protectiveness Statement(s)	
Operable Unit: 1	*Protectiveness Determination:* Protective
Protectiveness Statement: The OU1 remedy is protective of human health and the environment.	

Protectiveness Statement(s)	
Operable Unit: 2	*Protectiveness Determination:* Protective
Protectiveness Statement: The OU2 remedy is protective of human health and the environment.	

Sitewide Protectiveness Statement
Protectiveness Determination: Protective
Protectiveness Statement: Both remedies for OU1 and OU2 are considered protective of human health and the environment.

VIII. NEXT REVIEW

The next FYR report for the Dover Municipal Well No.4 Superfund Site is required five years from the completion date of this review.

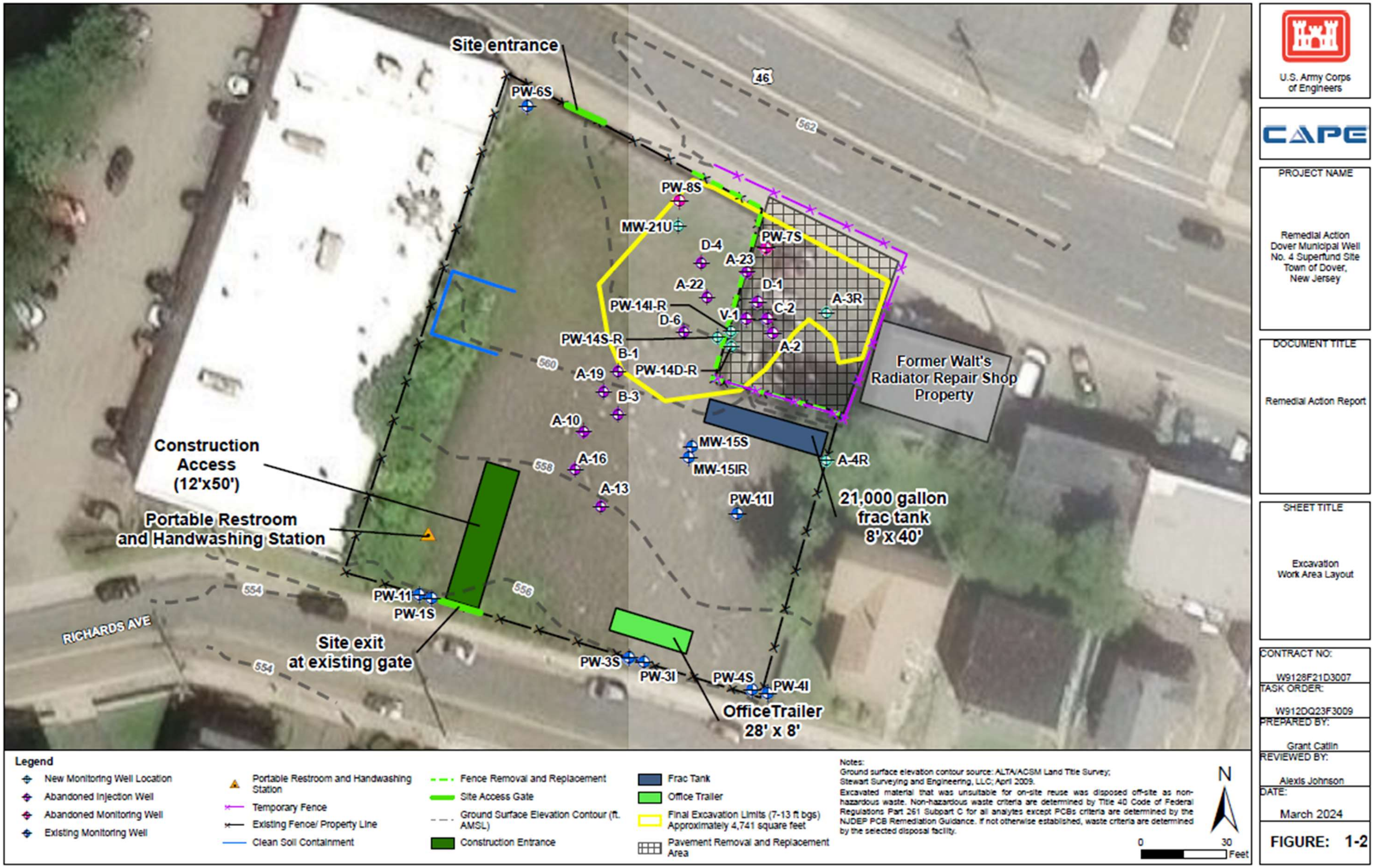
APPENDIX A – REFERENCE LIST

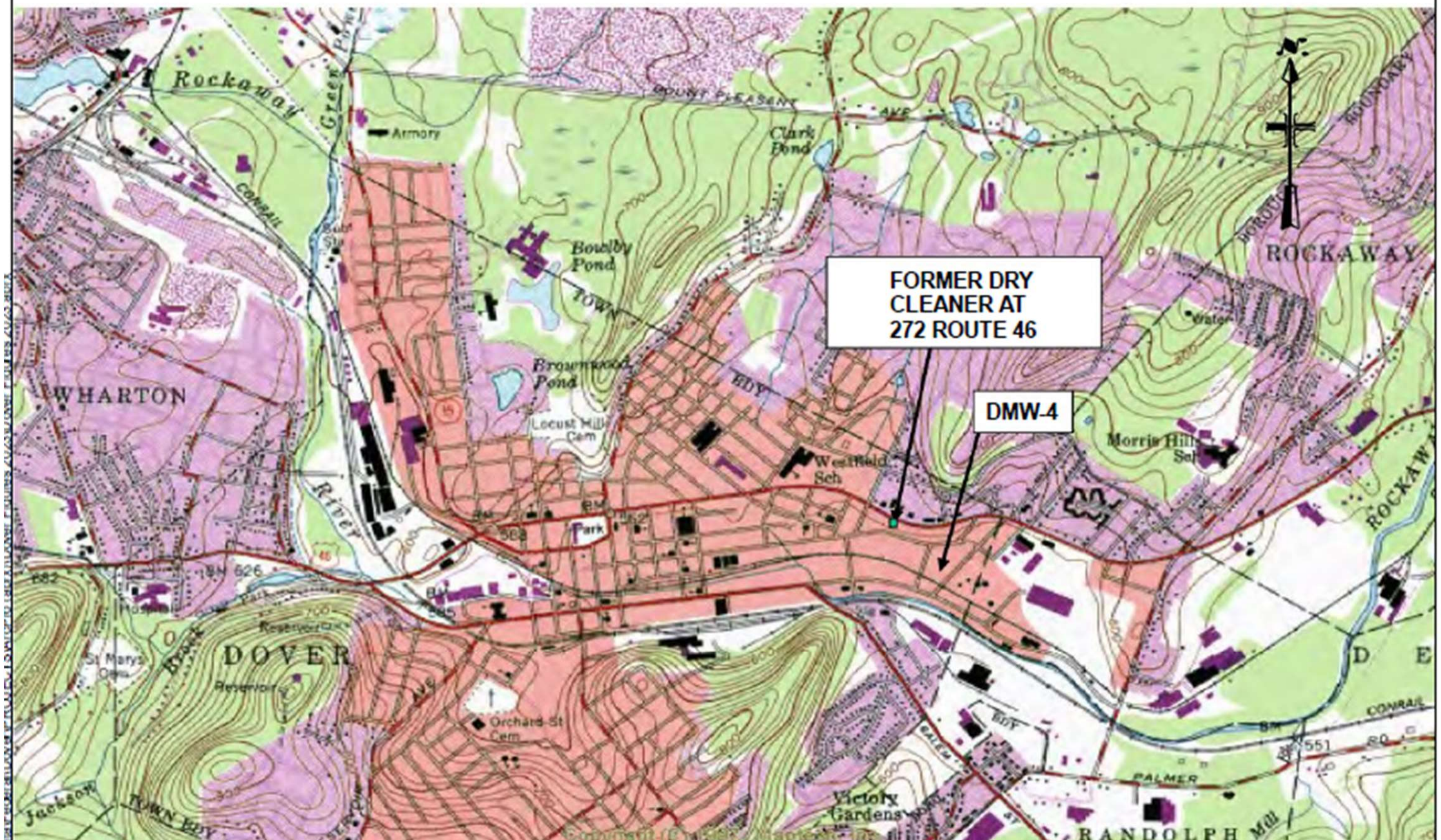
DOCUMENTS REVIEWED AS PART OF THE FIVE-YEAR REVIEW

Record of Decision Operable Unit 1	September 1992
Record of Decision Operable Unit 2	September 2005
Classification Exception Area/Well Restriction Area Permit Fact Sheet Form	September 2012
Data Summary Report for In Situ Chemical Oxidation Effectiveness Monitoring at OU2	March 2017
Data Summary Report for Supplemental ISCO Effectiveness Monitoring and LTRA Construction Support at OU2	March 2017
Superfund Support Team Sampling Report for the Vapor Intrusion Investigation at the Dover Municipal Well No. 4 Site	March 2018
Second Five-Year Review Report – Dover Municipal Well No. 4 Superfund Site	March 2020
Final Dover Sixth Annual LTRA Report	March 2021
Final Dover Seventh Annual LTRA Report	March 2022
Final Dover Eighth Annual LTRA Report	January 2023
Final Dover Eighth Annual LTRA Report	April 2024
Dover Municipal Well 4 Remedial Action Report	May 2024

APPENDIX B – FIGURES AND MAPS


Johnson Truck Accessories
Greooo Auto Body
Former Walt's Radiator Shop
PW-14S
PW-14I
PW-14D
PW-7S
A-1
A-2
A-3
A-4
MW-15S
MW-15IR
PW-1I
PW-2S
PW-4S
MW-11S
PW-10S
PW-5I
MW-5S
MW-17S MW-17I
MW-13I
MW-10I
MW-6I
DMW-4
MW-1DR
MW-1S
MW-1I
MW-16S
MW-9D
MW-7C
MW-19DR
MW-20D
Rockaway River
Perry St
Schley St
Ekstrom St
Palm St
Richards Ave
Sammis Ave
Lee Ave
Blackwell St
E Blackwell St
N Salem St
S Salem St
Wilson St
Jessica Ln
Legend
Dover Municipal Well #4
Shallow Aquifer Network Well
Intermediate Aquifer Network Well
Deep Aquifer Network Well
Site Boundary (Former Dry Cleaner)
Figure 1
OPERABLE UNIT 2 (OU2)
FORMER DRY CLEANER
SITE MAP, WELL LOCATIONS AND
ADJACENT PROPERTIES
Dover Municipal Well 4 Superfund Site
Dover, New Jersey
Map Date: 1/5/2024
Projection: NAD_1983_StatePlane_New_Jersey_FIPS_2900_Feet
0 150 300 600
Feet
1:3,600


Site entrance
46
562
PW-6S
PW-8S
MW-21U
PW-7S
D-4
A-23
A-22
D-1
PW-14I-R
C-2
A-3R
D-6
V-1
PW-14S-R
A-2
B-1
560
Former Walt's Radiator Repair Shop Property
PW-14D-R
A-19
B-3
A-10
MW-15S
A-16
MW-15IR
A-4R
Construction Access (12'x50')
558
A-13
PW-11I
21,000 gallon frac tank 8' x 40'
Portable Restroom and Handwashing Station
554
556
PW-1I
PW-1S
RICHARDS AVE
Site exit at existing gate
PW-3S
PW-3I
554
PW-4S
PW-4I
OfficeTrailer 28' x 8'
Legend
New Monitoring Well Location
Abandoned Injection Well
Abandoned Monitoring Well
Existing Monitoring Well
Portable Restroom and Handwashing Station
Temporary Fence
Existing Fence/ Property Line
Clean Soil Containment
Fence Removal and Replacement
Site Access Gate
Ground Surface Elevation Contour (ft. AMSL)
Construction Entrance
Frac Tank
Office Trailer
Final Excavation Limits (7-13 ft bgs) Approximately 4,741 square feet
Pavement Removal and Replacement Area
Notes:
Ground surface elevation contour source: ALTA/ACSM Land Title Survey; Stewart Surveying and Engineering, LLC; April 2009.
Excavated material that was unsuitable for on-site reuse was disposed off-site as non-hazardous waste. Non-hazardous waste criteria are determined by Title 40 Code of Federal Regulations Part 261 Subpart C for all analytes except PCBs criteria are determined by the NJDEP PCB Remediation Guidance. If not otherwise established, waste criteria are determined by the selected disposal facility.
N
0
30
Feet
U.S. Army Corps of Engineers
CAPE
PROJECT NAME
Remedial Action Dover Municipal Well No. 4 Superfund Site Town of Dover, New Jersey
DOCUMENT TITLE
Remedial Action Report
SHEET TITLE
Excavation Work Area Layout
CONTRACT NO:
W9128F21D3007
TASK ORDER:
W912DQ23F3009
PREPARED BY:
Grant Catlin
REVIEWED BY:
Alexis Johnson
DATE:
March 2024
FIGURE: 1-2



Source: Dover, NJ USGS, 1981

0 scale 2000 ft.

VICINITY MAP

Note:
Red tint indicates areas in which only landmark buildings are shown. Revisions shown in purple were compiled by the Geological Survey from aerial photographs taken in 1970. This information is not field checked. Purple tint indicates extension of urban areas.

Map Date: 4/15/2024
Source: ESRI, 2011
Projection: NAD 1983 State Plane New Jerse

N

Figure 1-3
REGIONAL TOPOGRAPHIC MAP
Dover Municipal Well 4
Superfund Site
Dover, New Jersey

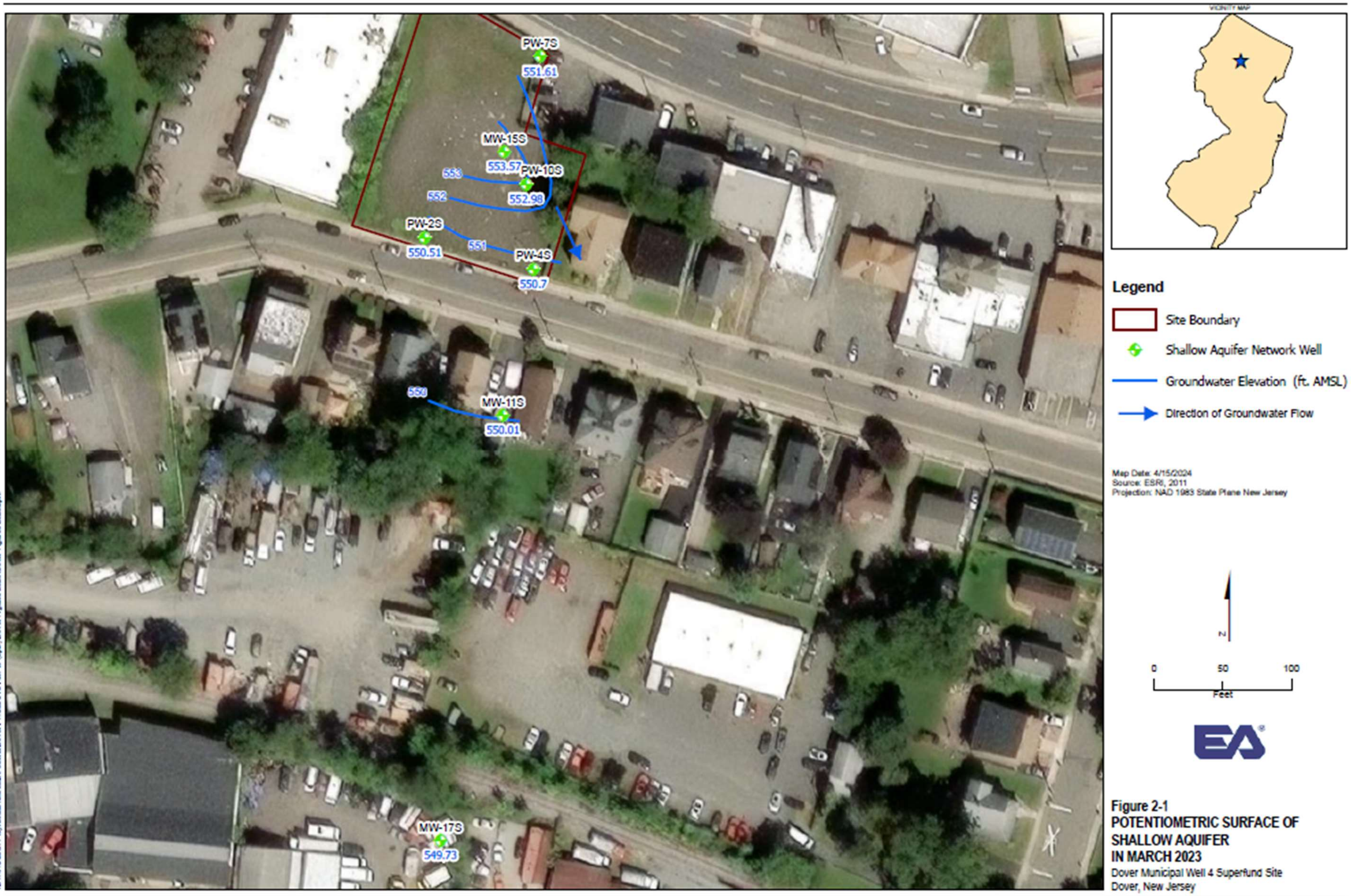


Figure 2-1
POTENTIOMETRIC SURFACE OF SHALLOW AQUIFER IN MARCH 2023
Dover Municipal Well 4 Superfund Site
Dover, New Jersey

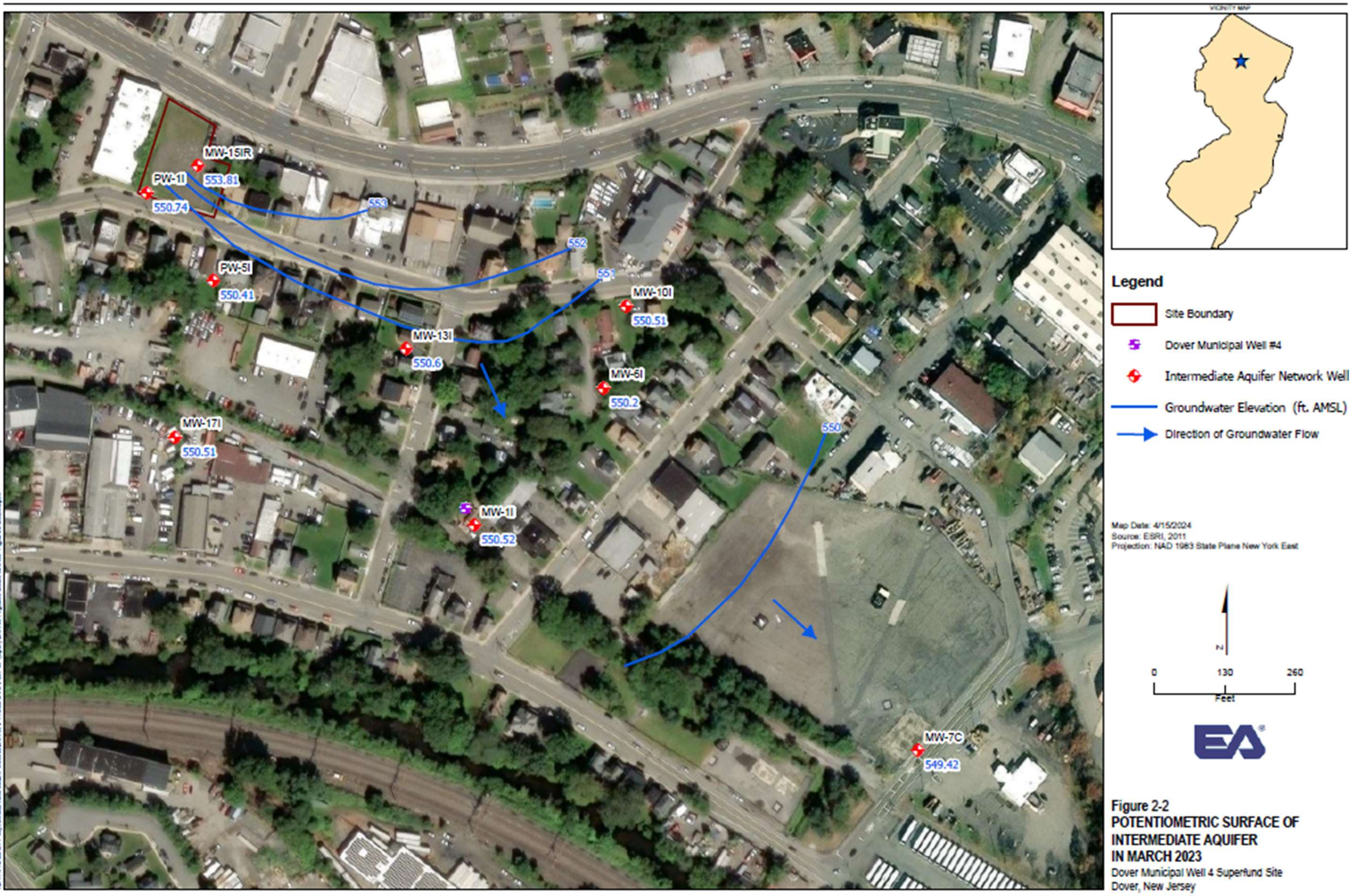
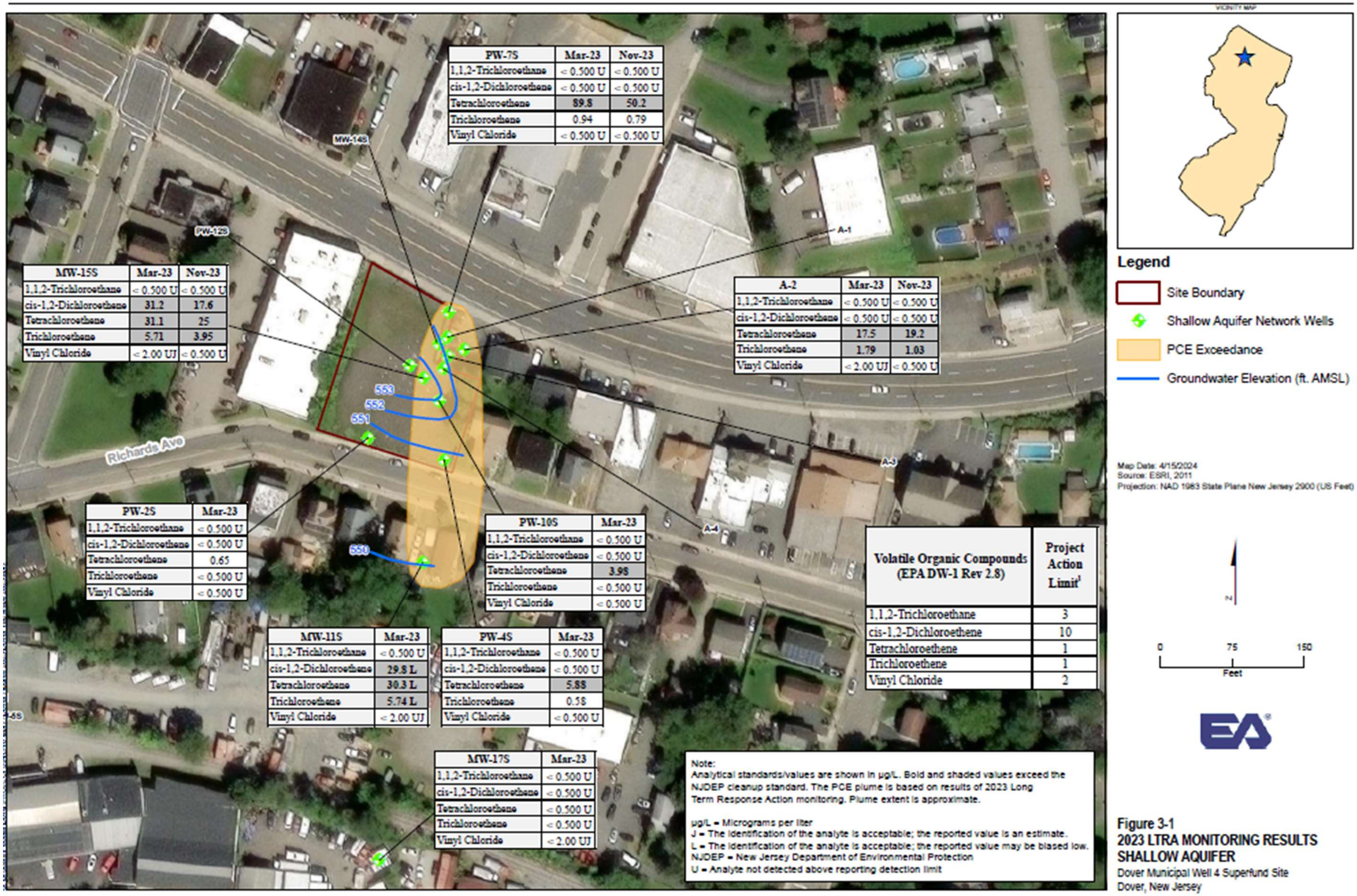


Figure 2-2
POTENTIOMETRIC SURFACE OF INTERMEDIATE AQUIFER IN MARCH 2023
Dover Municipal Well 4 Superfund Site
Dover, New Jersey

Figure 2-3
POTENTIOMETRIC SURFACE OF DEEP AQUIFER IN MARCH 2023
Dover Municipal Well 4 Superfund Site
Dover, New Jersey



PW-7S	Mar-23	Nov-23
1,1,2-Trichloroethane	< 0.500 U	< 0.500 U
cis-1,2-Dichloroethene	< 0.500 U	< 0.500 U
Tetrachloroethene	**89.8**	**50.2**
Trichloroethene	0.94	0.79
Vinyl Chloride	< 0.500 U	< 0.500 U

MW-15S	Mar-23	Nov-23
1,1,2-Trichloroethane	< 0.500 U	< 0.500 U
cis-1,2-Dichloroethene	**31.2**	**17.6**
Tetrachloroethene	**31.1**	**25**
Trichloroethene	**5.71**	**3.95**
Vinyl Chloride	< 2.00 UJ	< 0.500 U

A-2	Mar-23	Nov-23
1,1,2-Trichloroethane	< 0.500 U	< 0.500 U
cis-1,2-Dichloroethene	< 0.500 U	< 0.500 U
Tetrachloroethene	**17.5**	**19.2**
Trichloroethene	**1.79**	**1.03**
Vinyl Chloride	< 2.00 UJ	< 0.500 U

PW-2S	Mar-23
1,1,2-Trichloroethane	< 0.500 U
cis-1,2-Dichloroethene	< 0.500 U
Tetrachloroethene	0.65
Trichloroethene	< 0.500 U
Vinyl Chloride	< 0.500 U

PW-10S	Mar-23
1,1,2-Trichloroethane	< 0.500 U
cis-1,2-Dichloroethene	< 0.500 U
Tetrachloroethene	**3.98**
Trichloroethene	< 0.500 U
Vinyl Chloride	< 0.500 U

Volatile Organic Compounds (EPA DW-1 Rev 2.8)	Project Action Limit[1]
1,1,2-Trichloroethane	3
cis-1,2-Dichloroethene	10
Tetrachloroethene	1
Trichloroethene	1
Vinyl Chloride	2

MW-11S	Mar-23
1,1,2-Trichloroethane	< 0.500 U
cis-1,2-Dichloroethene	**29.8 L**
Tetrachloroethene	**30.3 L**
Trichloroethene	**5.74 L**
Vinyl Chloride	< 2.00 UJ

PW-4S	Mar-23
1,1,2-Trichloroethane	< 0.500 U
cis-1,2-Dichloroethene	< 0.500 U
Tetrachloroethene	**5.88**
Trichloroethene	0.58
Vinyl Chloride	< 0.500 U

MW-17S	Mar-23
1,1,2-Trichloroethane	< 0.500 U
cis-1,2-Dichloroethene	< 0.500 U
Tetrachloroethene	< 0.500 U
Trichloroethene	< 0.500 U
Vinyl Chloride	< 2.00 UJ

Note:
Analytical standards/values are shown in µg/L. Bold and shaded values exceed the NJDEP cleanup standard. The PCE plume is based on results of 2023 Long Term Response Action monitoring. Plume extent is approximate.

µg/L = Micrograms per liter
J = The identification of the analyte is acceptable; the reported value is an estimate.
L = The identification of the analyte is acceptable; the reported value may be biased low.
NJDEP = New Jersey Department of Environmental Protection
U = Analyte not detected above reporting detection limit

Figure 3-1
2023 LTRA MONITORING RESULTS
SHALLOW AQUIFER
Dover Municipal Well 4 Superfund Site
Dover, New Jersey

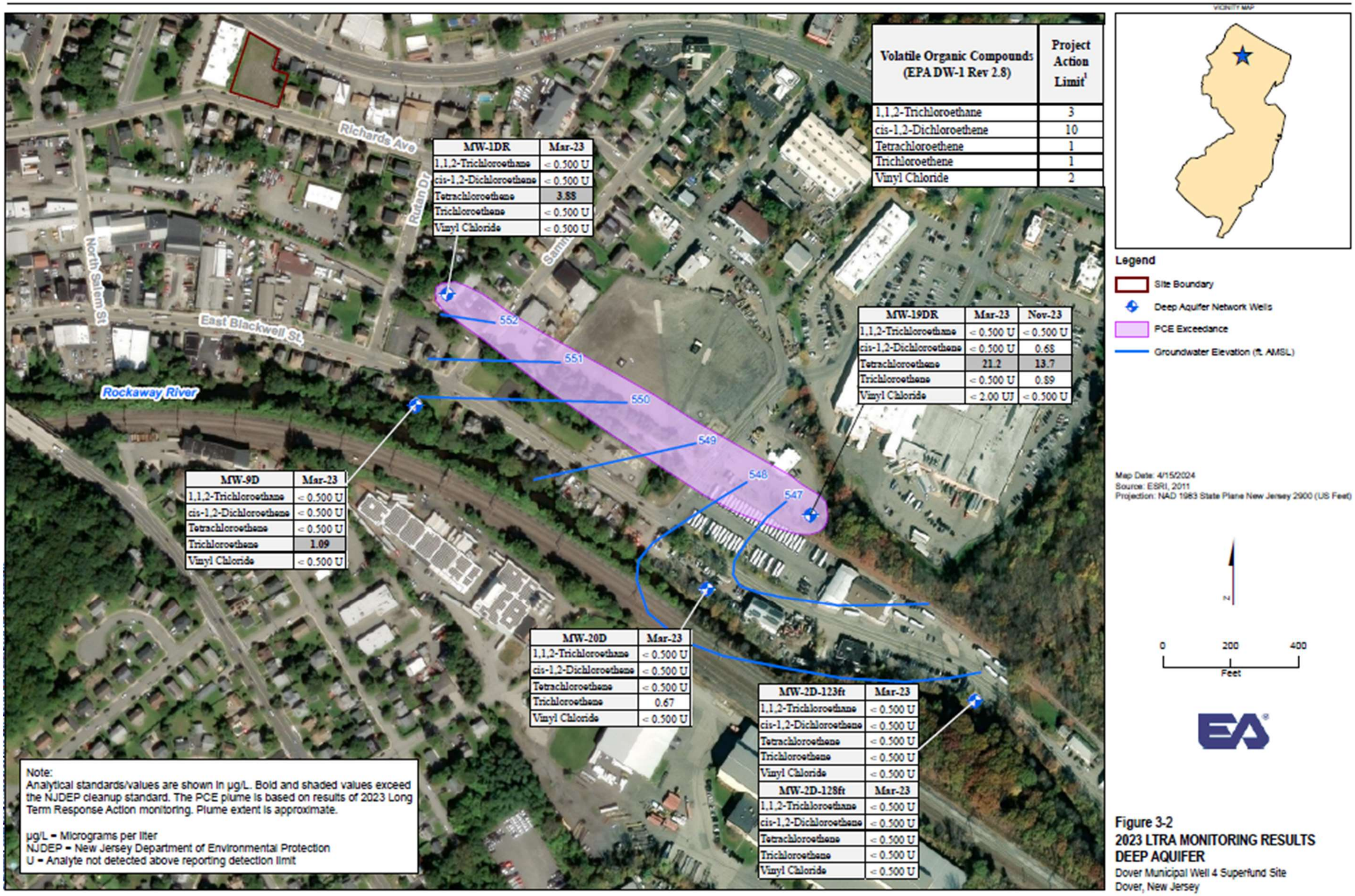


Figure 3-2
2023 LTRA MONITORING RESULTS DEEP AQUIFER
Dover Municipal Well 4 Superfund Site
Dover, New Jersey

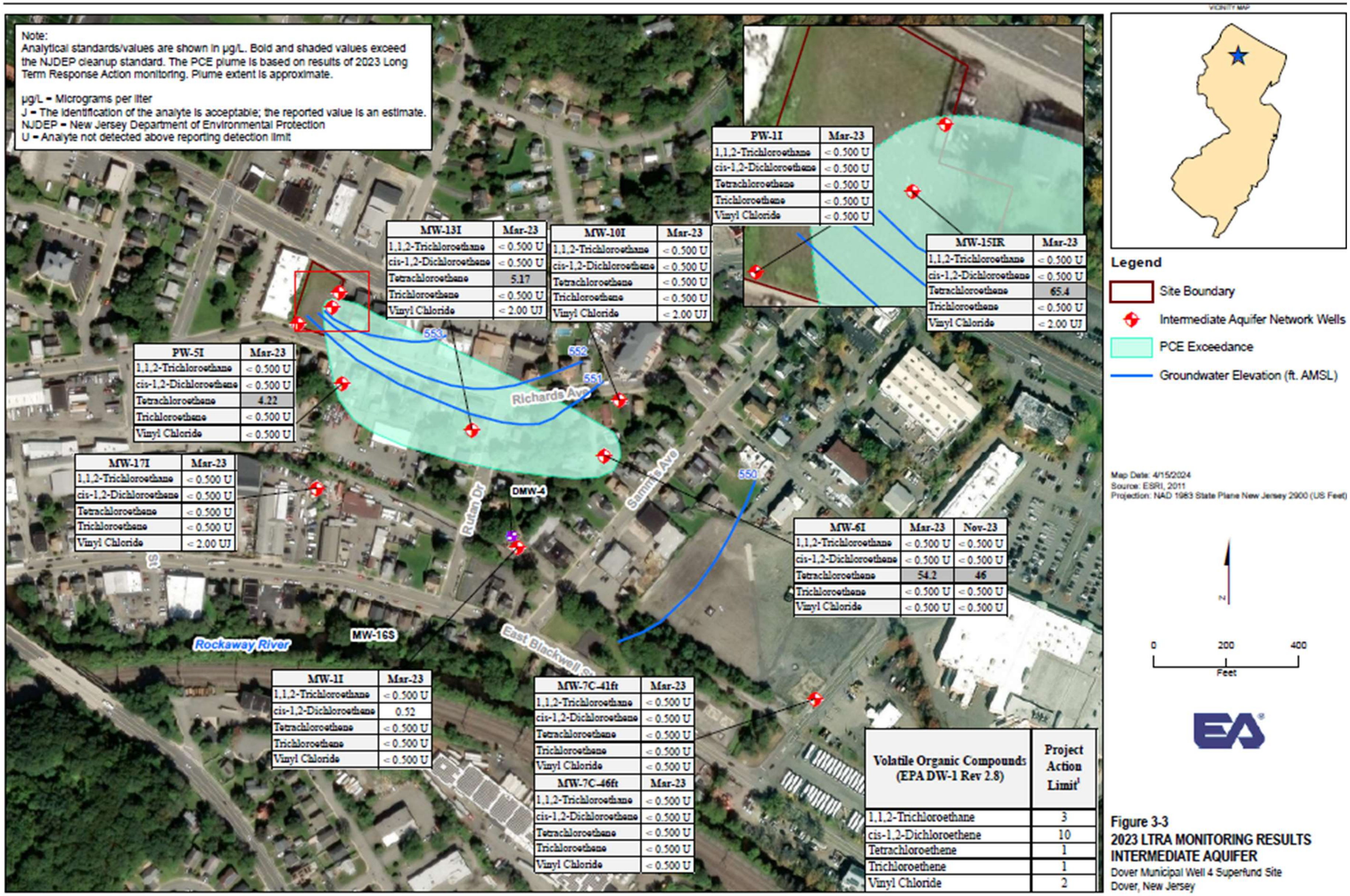
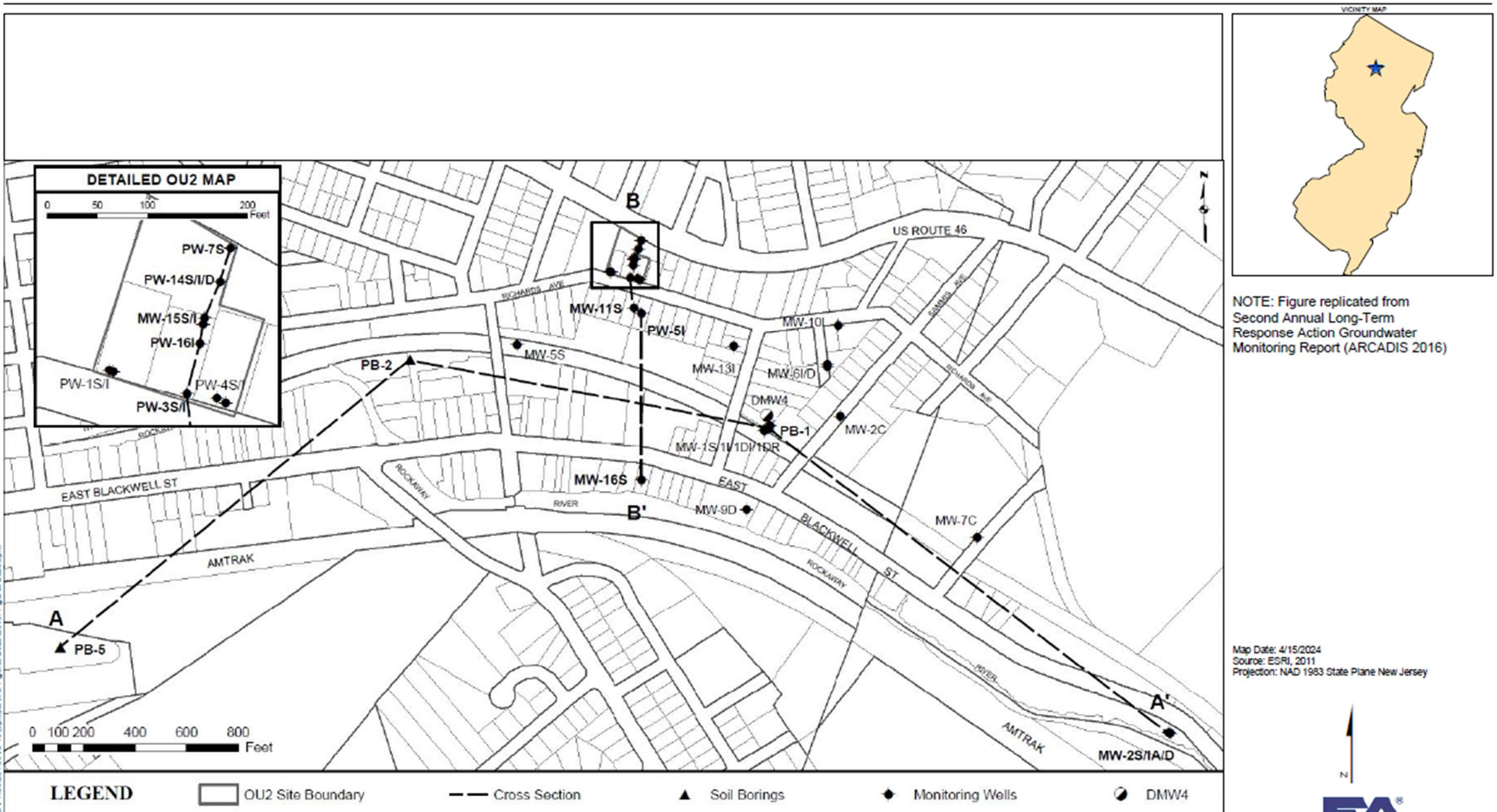


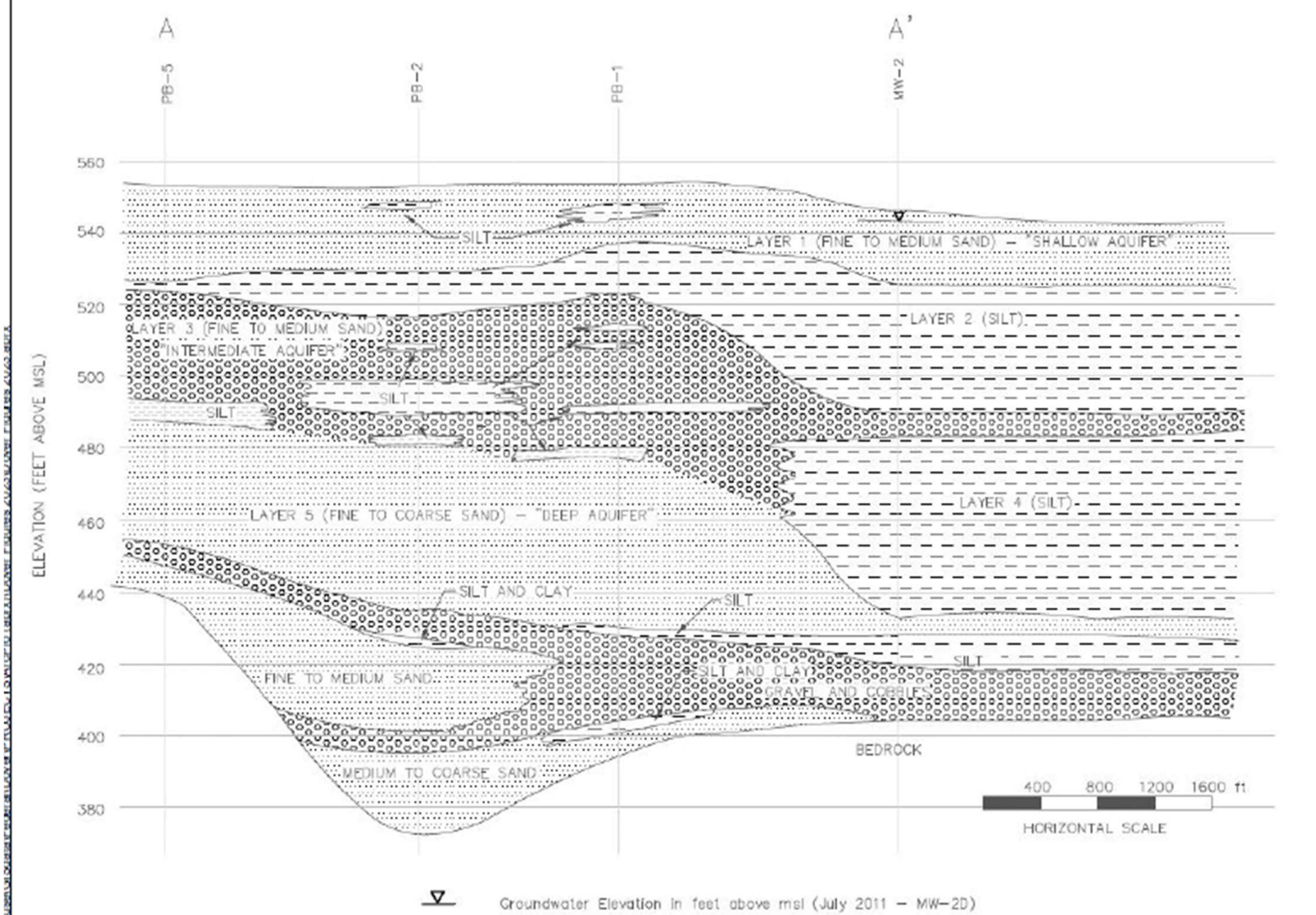
Figure 3-3
2023 LTRA MONITORING RESULTS INTERMEDIATE AQUIFER
Dover Municipal Well 4 Superfund Site
Dover, New Jersey



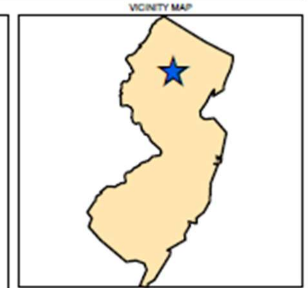
NOTE: Figure replicated from Second Annual Long-Term Response Action Groundwater Monitoring Report (ARCADIS 2016)

Map Date: 4/15/2024
Source: ESRI, 2011
Projection: NAD 1983 State Plane New Jersey

Figure 3-4
LOCATION OF BORINGS USED IN GEOLOGIC CROSS SECTIONS A-A' and B-B'
Dover Municipal Well 4 Superfund Site
Dover, New Jersey

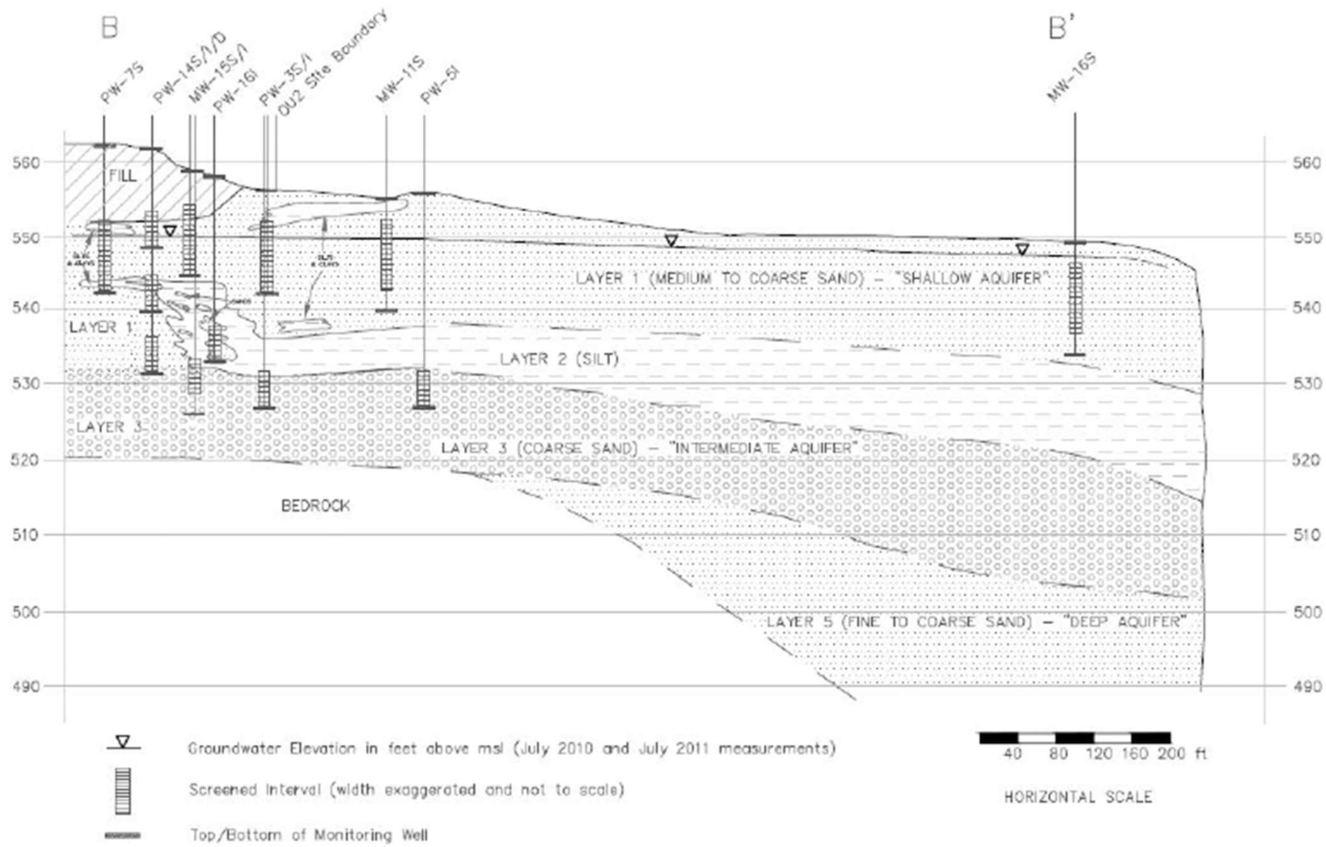


NOTE: Figure replicated from Second Annual Long-Term Response Action Groundwater Monitoring Report (ARCADIS 2016)

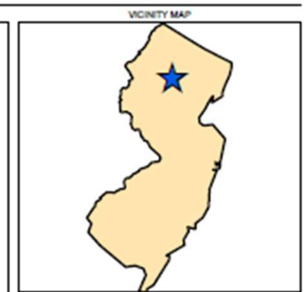


Map Date: 4/15/2024
Source: ESRI, 2011
Projection: NAD 1983 State Plane New Jersey

Figure 3-5
GEOLOGIC CROSS SECTION A-A'
Dover Municipal Well 4 Superfund Site
Dover, New Jersey



NOTE: Figure replicated from Second Annual Long-Term Response Action Groundwater Monitoring Report (ARCADIS 2016)

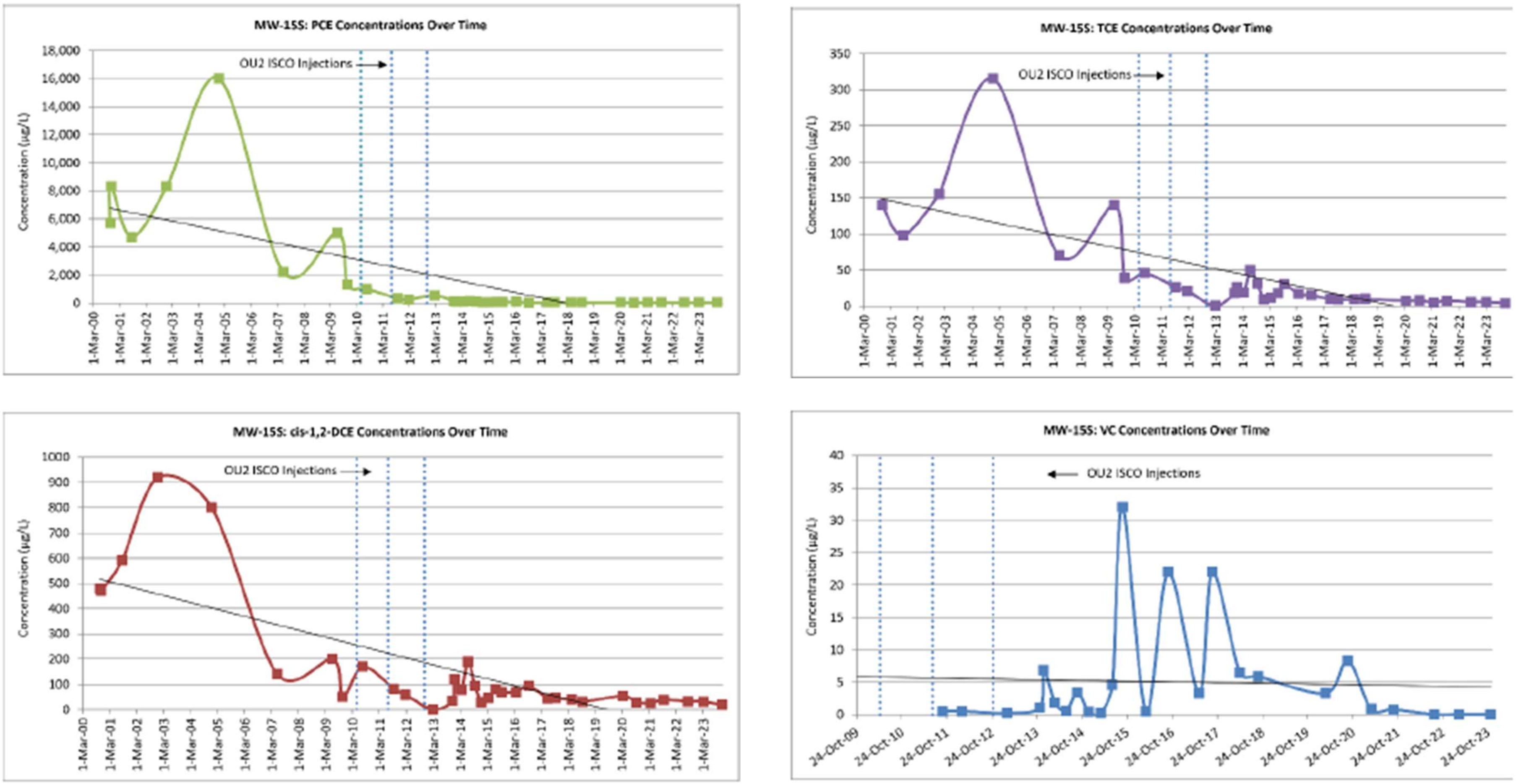


Map Date: 4/15/2024
Source: ESRI, 2011
Projection: NAD 1983 State Plane New Jersey

Figure 3-6
GEOLOGIC CROSS SECTION B-B'
Dover Municipal Well 4 Superfund Site
Dover, New Jersey

Time-Series Plots for Representative Wells and Select Contaminants
Nineth Annual LTRA Groundwater Monitoring Report
Dover Municipal Well No. 4 Superfund Site, Dover, New Jersey

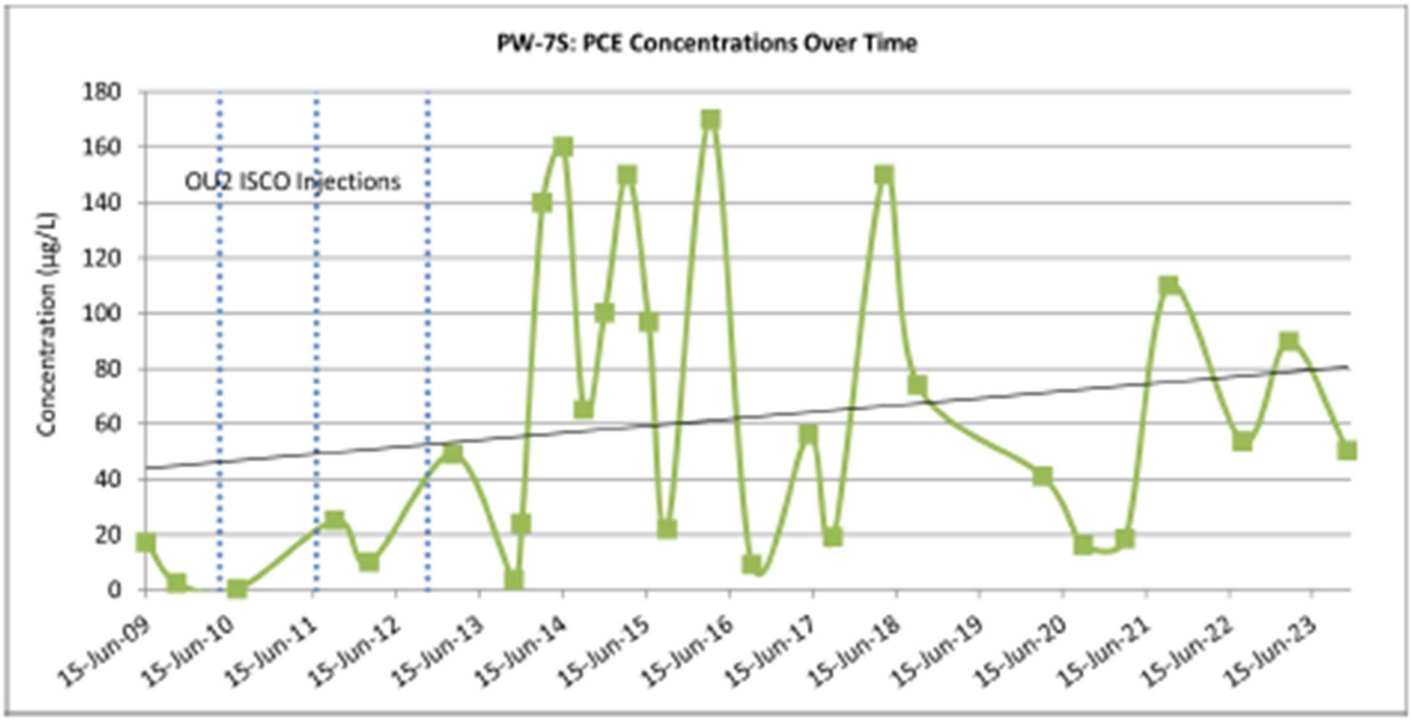
Figure 4 Monitoring Well MW-15S



NOTE: Non-detect values assigned the method detection limit.
OU2 ISCO injections were performed in April/May 2010, June/July 2011 and October/November 2012.

Time-Series Plots for Representative Wells and Select Contaminants
Nineth Annual LTRA Groundwater Monitoring Report
Dover Municipal Well No. 4 Superfund Site, Dover, New Jersey

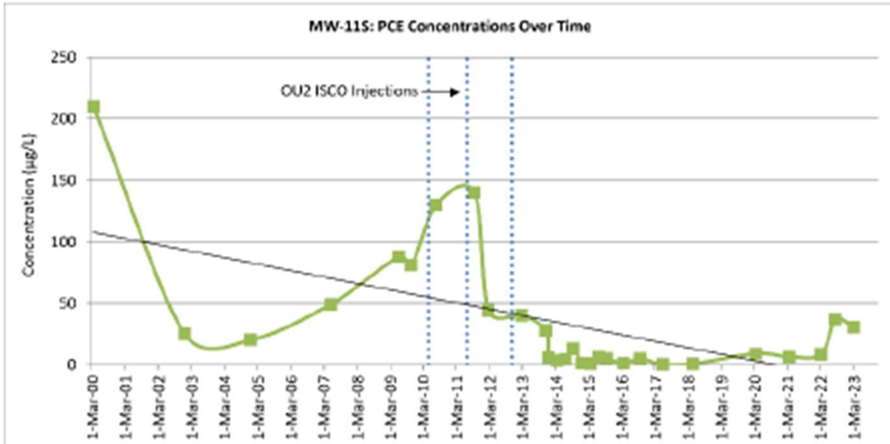
Figure 5 Monitoring Well PW-7S

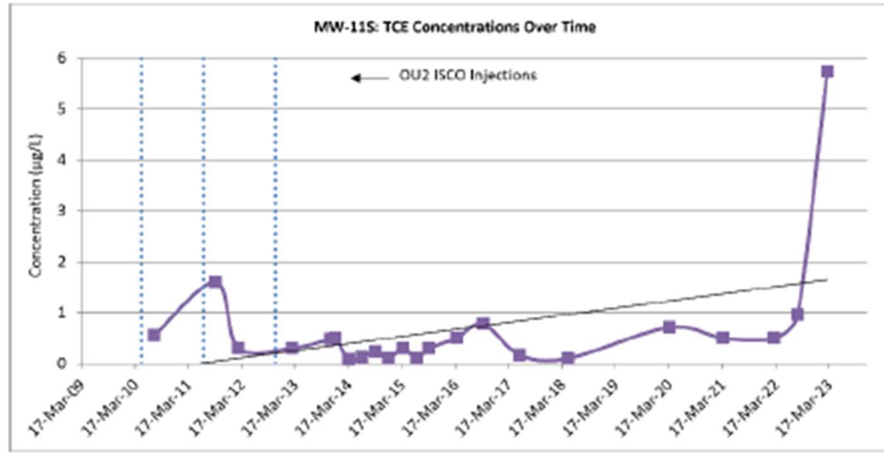


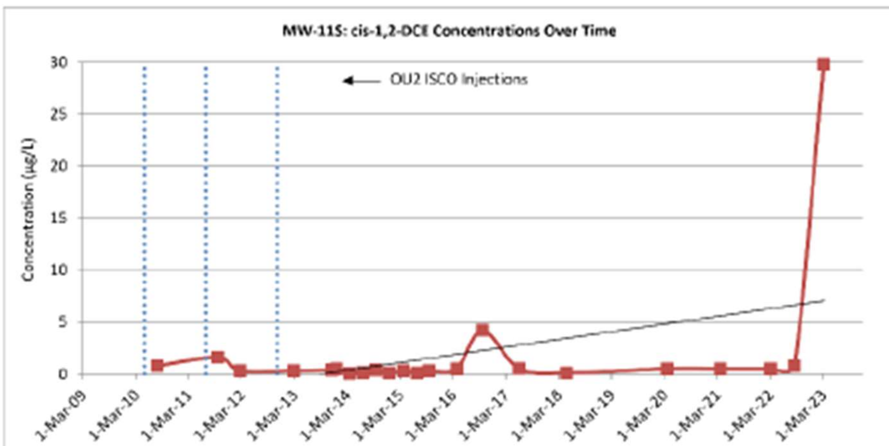
NOTE: Non-detect values assigned the method detection limit.
OU2 ISCO injections were performed in April/May 2010, June/July 2011 and October/November 2012.

Time-Series Plots for Representative Wells and Select Contaminants
Nineth Annual LTRA Groundwater Monitoring Report
Dover Municipal Well No. 4 Superfund Site, Dover, New Jersey

Figure 6 Monitoring Well MW-11S



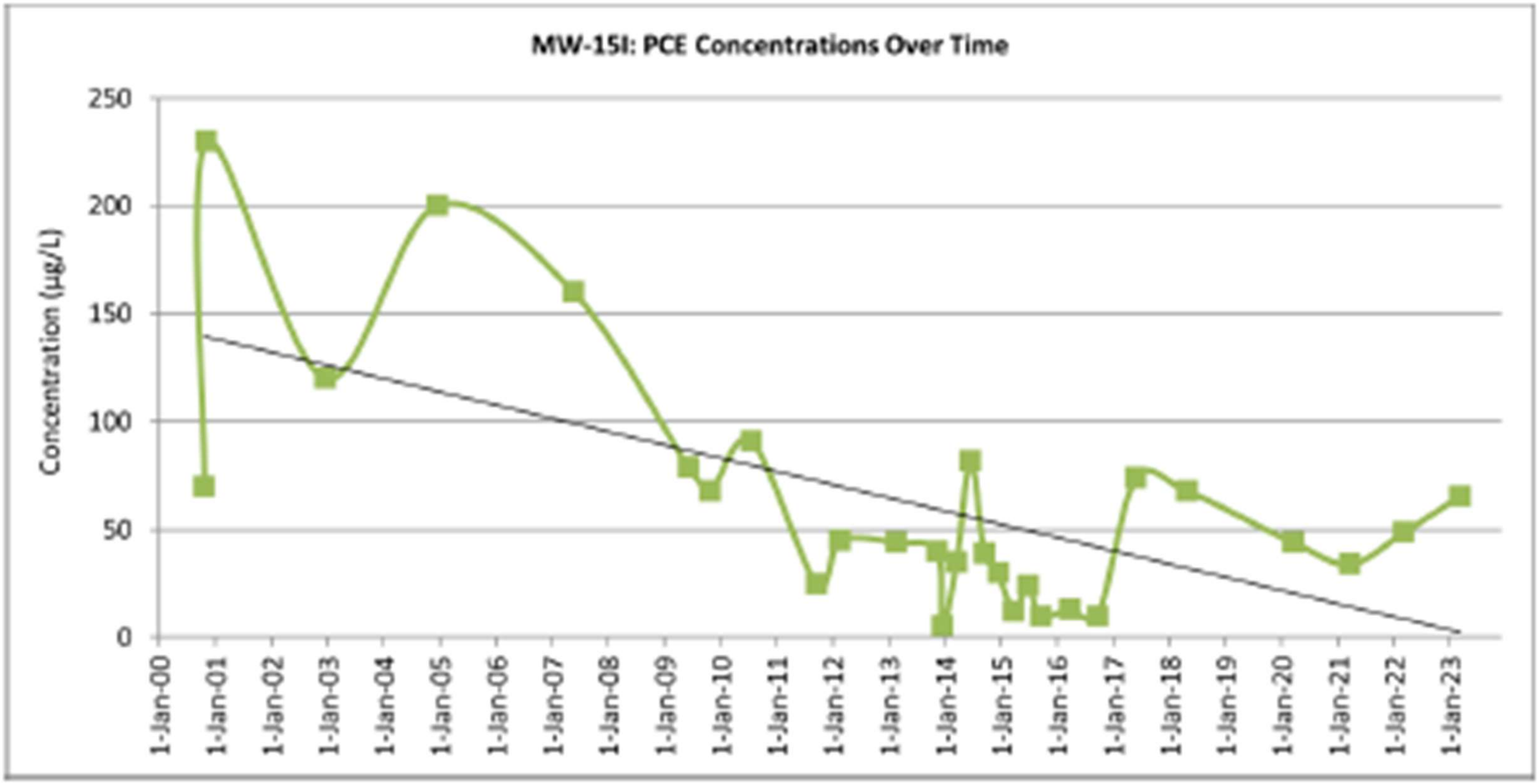




NOTE: Non-detect values assigned the method detection limit.
OU2 ISCO injections were performed in April/May 2010, June/July 2011 and October/November 2012.

Time-Series Plots for Representative Wells and Select Contaminants
Nineth Annual LTRA Groundwater Monitoring Report
Dover Municipal Well No. 4 Superfund Site, Dover, New Jersey

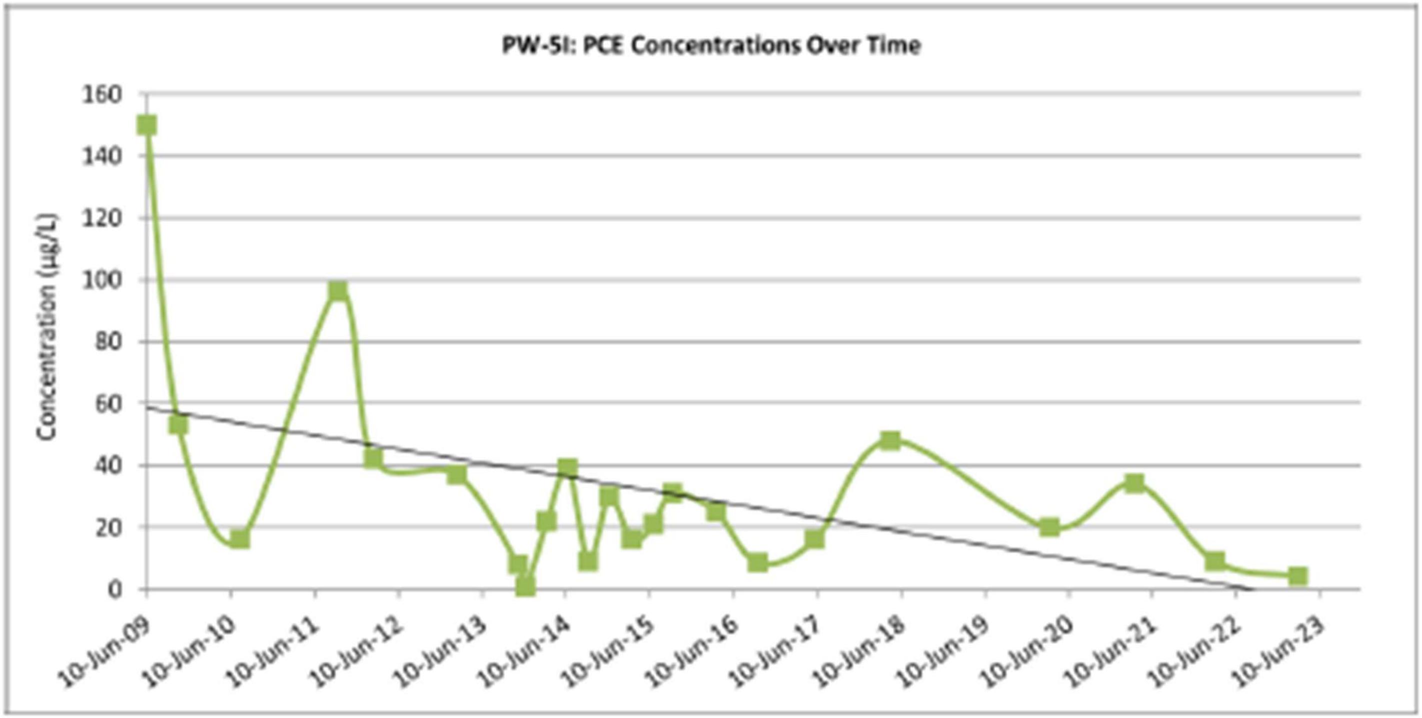
Figure 7 Monitoring Well MW-15I



NOTE: Non-detect values assigned the method detection limit.

Time-Series Plots for Representative Wells and Select Contaminants
Nineth Annual LTRA Groundwater Monitoring Report
Dover Municipal Well No. 4 Superfund Site, Dover, New Jersey

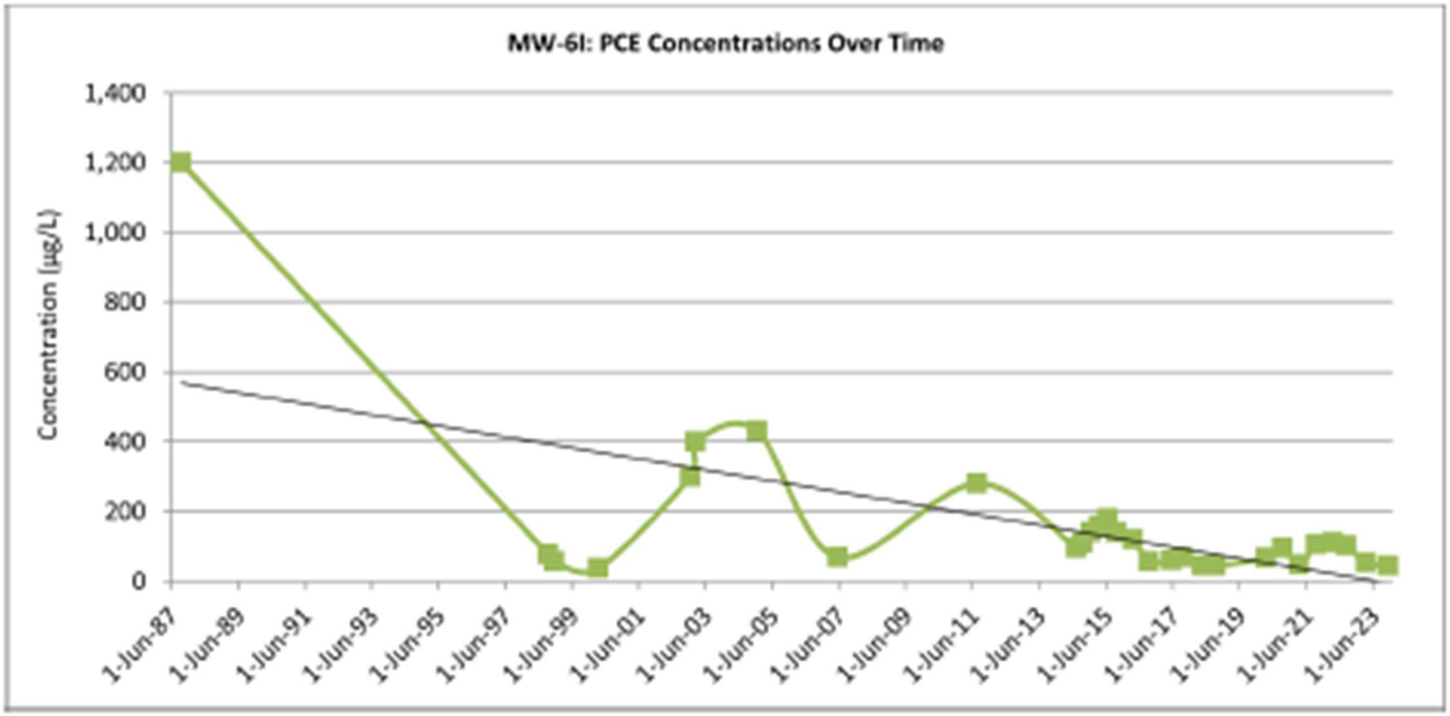
Figure 8 Monitoring Well PW-5I



NOTE: Non-detect values assigned the method detection limit.

Time-Series Plots for Representative Wells and Select Contaminants
Nineth Annual LTRA Groundwater Monitoring Report
Dover Municipal Well No. 4 Superfund Site, Dover, New Jersey

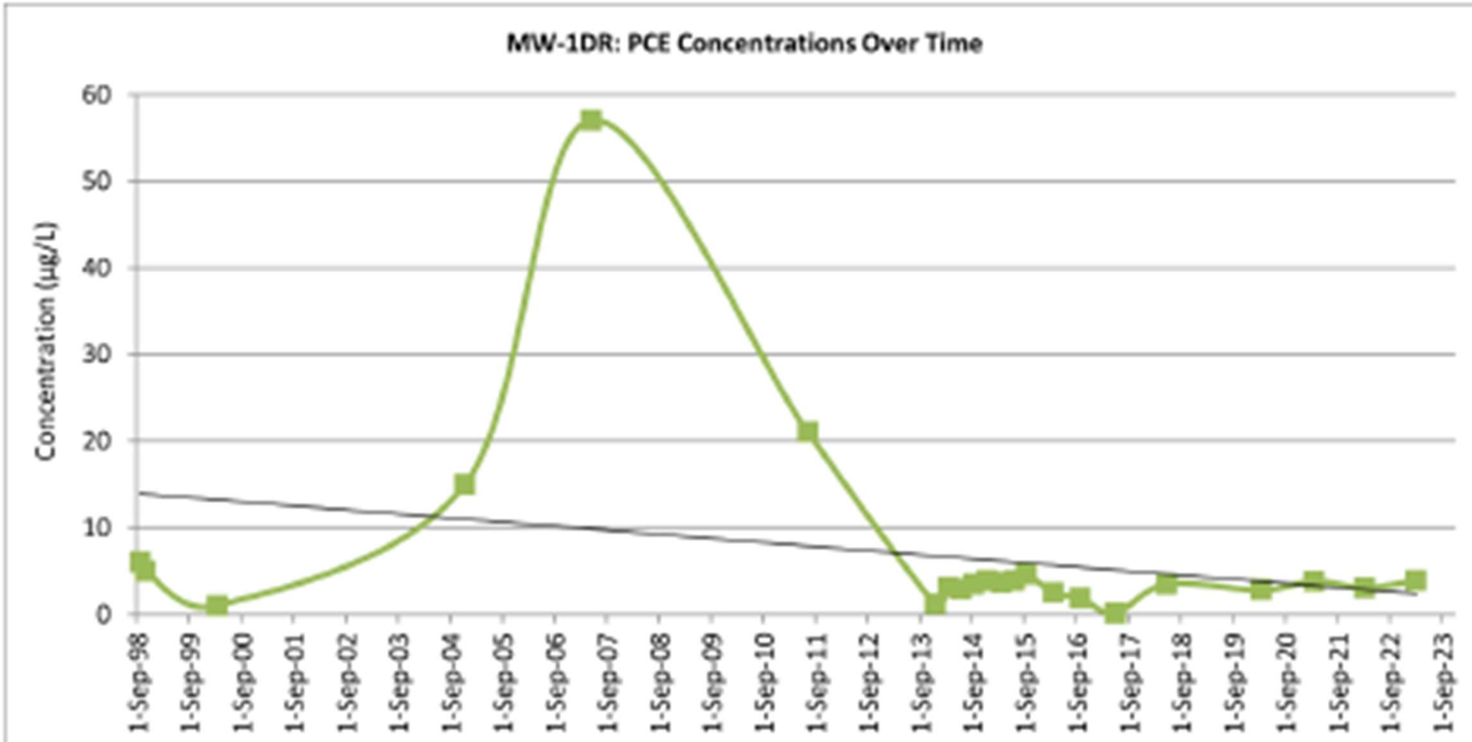
Figure 9 Monitoring Well MW-6I



NOTE: Non-detect values assigned the method detection limit.

Time-Series Plots for Representative Wells and Select Contaminants
Nineth Annual LTRA Groundwater Monitoring Report
Dover Municipal Well No. 4 Superfund Site, Dover, New Jersey

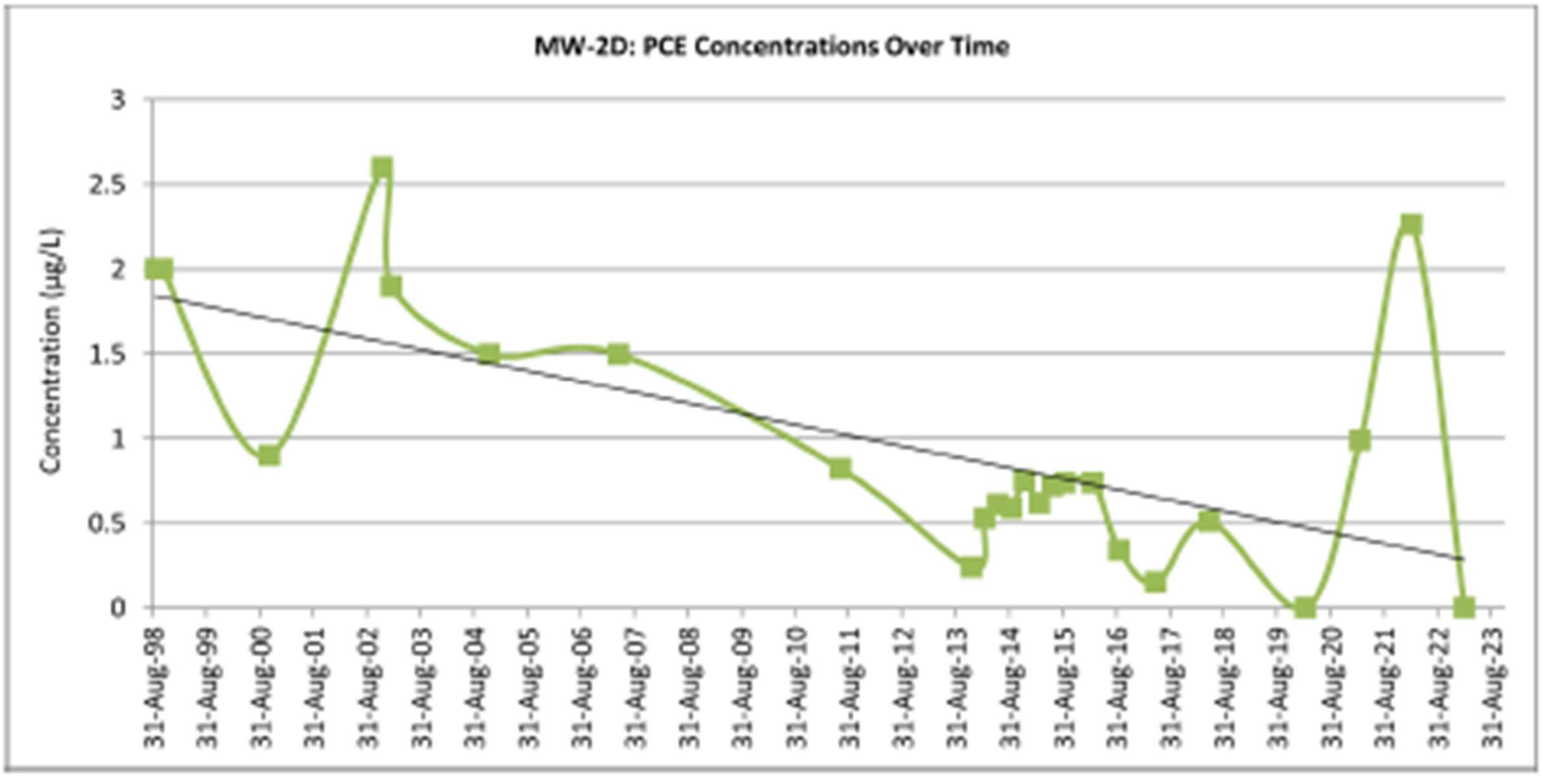
Figure 10 Monitoring Well MW-1DR



NOTE: Non-detect values assigned the method detection limit.

Time-Series Plots for Representative Wells and Select Contaminants
Nineth Annual LTRA Groundwater Monitoring Report
Dover Municipal Well No. 4 Superfund Site, Dover, New Jersey

Figure 11 Monitoring Well MW-2D



NOTE: Non-detect values assigned the method detection limit.

APPENDIX C – CEA/WRA PERMIT FACT SHEET

New Jersey Department of Environmental Protection
Site Remediation and Waste Management Program

CLASSIFICATION EXCEPTION AREA / WELL RESTRICTION AREA (CEA/WRA) FACT SHEET FORM

Date Stamp
(For Department use only)

SECTION A. SITE INFORMATION

Site Name: Dover Municipal Well No. 4 Superfund Site

Program Interest (PI) Number(s): NJD980654131

Case Tracking Number(s) for this submission: ______

This form must be attached to the Cover / Certification Form
if not submitted through the Remedial Phase Report Online Service

1. Indicate the reason for submission of this form *(see instructions)*:

☐ New CEA ☒ Revise CEA ☐ Reestablish CEA ☐ Existing CEA with no changes
☐ CEA for historic fill ☐ CEA for Historically Applied Pesticides (HAP) ☐ CEA lift/removal

If you are submitting this form for an existing CEA provide the CEA Subject Item ID: CEA100124579

2. Indicate the type of ground water Remedial Action (RA):

☐ Natural ☒ Active ☐ Final RA not yet selected

3. Is this form being submitted with a Remedial Action Permit (RAP) Form (for Soil or Ground Water)?....☐ Yes ☒ No

SECTION B. CEA COMPONENT AND VAPOR INTRUSION INFORMATION

Name of document that includes the CEA Fate and Transport Description: 8th Annual Long-Term RA GW Monit Rpt

Date of document: 01/23/2023

1. **Ground Water Classification:** What is the ground water classification within the CEA as per N.J.A.C. 7:9C?

(Check all that apply)

☐ Class I-A ☒ Class II-A
☐ Class I-PL Pinelands Protection Area ☐ Class III-A
☐ Class I-PL Pinelands Preservation Area ☐ Class III-B

2. **Contaminant Data:** This CEA/WRA applies only to the contaminants listed below with concentrations above, or assumed to be above, numeric values established for the applicable classification area via the Ground Water Quality Standards (GWQS), N.J.A.C. 7:9C. Except for historic fill CEAs based on assumed ground water contamination, list the maximum contaminant value for all ground water data that could be representative of **current** conditions for any well or sampling point used to establish the CEA. See form instructions before entering data into the below table.

Contaminant	Concentration (1)	GWQS (2)	SWQS(3)	GWSL(4)
Tetrachloroethene	12,500	1	na	36
cis-1,2-Dichloroethene	106	70	na	-
Trichloroethene	26.1	1	na	3
Vinyl Chloride	ND	1	na	1

Notes: (1) Maximum concentration in Micrograms Per Liter
(2) New Jersey Ground Water Quality Standards, N.J.A.C. 7:9C-1.7 and 1.9(c)
(3) Surface Water Quality Standards, N.J.A.C. 7:9B - Applicable only where contaminants in the CEA may discharge to a surface water body.
(4) Current NJDEP Vapor Intrusion (VI) Ground Water Screening Levels (GWSL) available at http://www.nj.gov/dep/srp/guidance/vaporintrusion/

☐ Check if attaching the form Addendum to list additional contaminants and associated information.

3. **CEA Boundaries and VI Pathway Status:** Year of tax map used: 2024

Are there volatile contaminants in the CEA? ☒ Yes ☐ No

Is there LNAPL currently found in the CEA? ☒ Yes ☐ No

For CEA revisions only:

☐ Check if CEA Boundary has changed (*See instructions*)

☒ Check if Block and Lot numbers have changed (*See instructions*)

List the block(s) and lot(s) included in the areal extent of the CEA and check the appropriate boxes:

Block	Lot(s)	Check if off-site	Check if VI pathway was evaluated*	Check if VI pathway status is indeterminate*
	--- Dover Town ---	☐	☐	☐
23-10	7, 8, 8.01, 9	☐	☒	☐
23-10	4,10,11,12,12.01,13,14,15,16,17	☒	☐	☐
23-10	18, 20, 23, 24	☒	☐	☐
23-13	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11	☒	☐	☐
23-14	1,3,4,5,6,7,8,9,10,11,12,13,14,15	☒	☐	☐
23-14	17, 18, 19, 20, 21, 22, 23, 24, 27	☒	☐	☐

☒ Check if attaching an Addendum to list additional Blocks/Lots and associated information. *(see instructions)*

*Follow instructions for parcels where the vapor intrusion (VI) pathway was evaluated and the status is indeterminate.

Direction of ground water flow: S/SE (*If multiple water bearing zones exist within the CEA and/or there is no predominant flow direction, see instructions.*)

Vertical depth of CEA: 3 - 150 (ft bgs) **and** 403.4 - 552.6 (msl).

Horizontal extent of CEA: 75 Indicate units: ☒ acres or ☐ square feet

Name(s) of the affected Geologic Formation(s)/Unit(s) (*see instructions if multiple formations/units affected*):

Glaciofluvial Terrace Deposits

Narrative description of proposed CEA boundaries:

The extent of the CEA has not changed.

The only changes to the Block/Lots are that some Lots within the CEA boundary no longer appear on the Morris County GIS and Tax Records search. These Lots are: Block 23-10 Lot 21, Block 23-14 Lot 16, Block 23-15 Lot 7, Block 10202 Lot 40, Block 10202 Lot 41, and Block 10202 Lot 43.

4. **Projected Term of CEA:** *(Based on modeling/calculations in the fate and transport description*)

Proposed Duration in Years: 10 Anticipated Expiration Date: 01/01/2035

or ☐ Indeterminate (*Review instructions before selecting* "Indeterminate" *for the CEA duration.*)

5. **ATTACH AND/OR SUBMIT THE FOLLOWING**: (*see instructions for additional information/requirements*)

Exhibit A: Site Location Maps – Based on USGS Quadrangle Map;

Exhibit B: CEA Map and Cross Section Figure – See N.J.A.C 7:26C- 7.3(c)1 and 2 and instructions regarding what is required to be included on the map and the cross-section figure.

Exhibit C: GIS Deliverables – CEA Boundary Extent Map. The CEA Boundary Extent Map shall be submitted via email to srpgis_cea@dep.nj.gov. (*See the instructions for detailed GIS deliverable requirements.)*

Identify format of CEA Boundary Extent Map being submitted: ☐ Shape File ☐ CAD File ☒ N/A

If there is a CEA map already on NJ-GeoWeb, does it need to be revised? ☐ Yes ☒ No ☐ N/A

SECTION C. CURRENT GROUND WATER USE DOCUMENTATION

1. Indicate the year of the most recent well search completed per N.J.A.C. 7:26E-1.14: 2024
2. If this Fact Sheet form is for a revised CEA or an existing CEA with no changes, have new wells been installed since the CEA was established? ☒ Yes ☐ No ☐ N/A
3. Are there any pumping wells (e.g., potable, industrial, irrigation or recovery wells) within the foot print of the CEA? ☒ Yes ☐ No

   If "Yes" list/attach list of the type and status of any pumping well(s) within CEA:

   Pumping wells installed within CEA since September 2013:
   Block 23-10, Lot 34 - 2 Recovery wells installed in 2018: RW 4 (Permit No. E201805968), RW 5 (Permit No. E201805969);
   Block 23-13, Lot 1 - 2 Recovery wells installed in 2018: RW 6 (Permit No. E201805971), RW 7 (Permit No. E201805972);
   Block 23-18, Lot 1 - 2 Recovery wells installed in 2021: RW 11 (Permit No. E202107683), RW 12 (Permit No. E202107684)

SECTION D. WELL RESTRICTION INFORMATION

Certain well restrictions relevant to potable ground water use, such as "Double Case Wells", "Sample Potable Wells", and "Evaluate Production Wells", are consistently set within the boundaries of all CEAs established by the NJDEP in Class I and II-A areas (*see instructions*).

1. Are there any other site-specific well restrictions relevant to potable ground water use that should be set within or near the boundaries of the proposed CEA? ☐ Yes ☒ No

   If "Yes", describe below any such site-specific well restrictions proposed for this CEA:

SECTION E. PUBLIC NOTIFICATION REQUIREMENTS

1. Indicate which of the following entities have been notified pursuant to N.J.A.C. 7:26C-7.3(d) and the dates each notification was sent. (*check all that apply*)

   ☐ Municipal and county clerk(s) .... Dated mailed: ________
   ☐ Local, county or regional health department(s) .... Dated mailed: ________
   ☐ Designated County Environmental Health Act agency (if applicable) .... Dated mailed: ________
   ☐ County Planning Board .... Dated mailed: ________
   ☐ Pinelands Commission (if applicable) .... Dated mailed: ________
   ☐ Owners of real property overlying CEA foot print .... Dated mailed: ________

2. **List of Names and Addresses** – List below and/or in an attachment, the names/addresses of all persons notified pursuant to N.J.A.C. 7:26C-7.3(d) based on the proposed CEA boundaries. If the site property owner differs from the person responsible for conducting the remediation, check here ☐ and enter the site owner's name and address first in the table below. *See instructions for more information regarding the address list.*

Entity or Owner Name	**Notification Address Used** If owner address differs from property address overlying CEA, add an " * " after the address.	**Blocks/Lots overlying CEA owned by this person** Block	Lot(s)

ADDENDUM
Classification Exception Area / Well Restriction Area
Fact Sheet Form

Section B. CEA Component and Vapor Intrusion Information

1. **Contaminant Data** (continued)**:** This CEA/WRA applies only to the contaminants listed on page 1 and in the table below with concentrations above, or assumed to be above, numeric values established for the applicable classification area via the GWQS, N.J.A.C. 7:9C. Except for historic fill CEAs based on assumed ground water contamination, list below the maximum contaminant value for all ground water data that could be representative of **current** conditions for any well or sampling point used to establish the CEA. See form Instructions before entering data into the tables below.

Contaminant	Concentration (1)	GWQS (2)	SWQS(3)	VI GWSL(4)

Notes: (1) Maximum concentration in Micrograms Per Liter
(2) New Jersey Ground Water Quality Standards, N.J.A.C. 7:9C-1.7 and 1.9(c)
(3) Surface Water Quality Standards, N.J.A.C. 7:9B - Applicable only where contaminants in the CEA may discharge to a surface water body.
(4) Current NJDEP Vapor Intrusion (VI) Ground Water Screening Levels (GWSL)

2. **CEA Boundaries and VI Pathway Status** (continued)**:** List additional parcels included in the CEA. Attach additional Addendum sheets if necessary to list all blocks and lots within the CEA.

For CEA revisions, check here if block and lot numbers have changed: ☒

Block	Lot(s)	Check if off-site	Check if VI pathway was evaluated*	Check if VI pathway status is indeterminate*
23-15	8,9,10,11,12,13,14,15,16,17,18,19,19.01	☒	☐	☐
23-15	20, 21, 22, 23, 24, 25	☒	☐	☐
23-16	8, 9, 10, 11, 12	☒	☐	☐
23-17	1, 2, 3, 4, 4.01	☒	☐	☐
23-18	1	☒	☐	☐
604	5	☒	☐	☐
10201	3 --- Rockaway Township ---	☒	☐	☐
10202	27, 32, 33, 34, 35, 36, 37, 38, 39, 42	☒	☐	☐
10202	47, 48, 49, 50	☒	☐	☐

* Follow instructions for parcels where the vapor intrusion (VI) pathway was evaluated and status is indeterminate.

EXHIBIT A

Monitoring Well Analytical Data

EXHIBIT A.1
Shallow Aquifer Analytical Results
Volatile Organic Compounds

Well ID	NJDEP GWQS[1]	A-1	A-2	A-3	A-4	MW-11S	MW-15S	MW-17S	PW-2S	PW-4S	PW-7S	PW-10S	PW-12S	PW-14S
Screened Interval (ft bgs)		**12-15**	**12-15**	**12-15**	**12-15**	**3-13**	**5-15**	**3-13**	**NA-14**	**NA-14**	**10.3-20.3**	**NA-15**	**NA-15**	**9-14**
Screened Interval (ft MSL)		**NA**	**NA**	**NA**	**NA**	**552.2-542.2**	**553.5-543.5**	**549.1-539.1**	**NA-541.7**	**NA-542.4**	**552.3-542.3**	**NA-543.55**	**NA-544.58**	**553.0-548.0**
Sample Date		**3/8/2022**	**3/8/2022**	**3/8/2022**	**3/8/2022**	**3/8/2022**	**3/7/2022**	**3/8/2022**	**3/7/2022**	**3/7/2022**	**3/7/2022**	**3/7/2022**	**3/7/2022**	**3/7/2022**
Volatile Organic Compounds (EPA DW-1 Rev 2.6), (µg/L)														
1,1,2-Trichloroethane	3	< 0.500 U	< 0.500 U	< 0.500 U	< 0.500 U	< 0.500 U	< 0.500 U	< 0.500 U	< 0.500 U	< 0.500 U	< 0.500 U	< 0.500 U	< 0.500 U	< 0.500 U
cis -1,2-Dichloroethene	10	1.32	< 0.500 U	9.65 U	1.04 U	< 0.500 U	**38.3**	< 0.500 U	< 0.500 U	2.77	< 0.500 U	< 0.500 U	< 0.500 U	**10.6**
Tetrachloroethene	1	**49.7**	**75.2**	**12,500**	**180**	**8.26**	**35.3**	**3.07**	0.890	**33.2**	**175 J**	**4.22**	**1.19**	**82.4 J**
Trichloroethene	1	**2.70 K**	**1.20 K**	**3.35 K**	0.710 K	< 0.500 U	**6.36**	< 0.500 U	< 0.500 U	**2.12 K**	**1.06 K**	< 0.500 U	< 0.500 U	**4.23 K**
Vinyl chloride	2	< 0.500 U	< 0.500 U	< 0.500 U	< 0.500 U	< 0.500 U	< 0.500 U	< 0.500 U	< 0.500 U	< 0.500 U	< 0.500 U	< 0.500 U	< 0.500 U	< 0.500 U

Notes:

Bolded and shaded results indicate detections exceeding the GWQS.

[1] NJDEP GWQS per NJAC 7:9C.

< = Qualifier denotes the analyte was analyzed but not detected at or above the provided reporting limit.

µg/L = microgram(s) per liter

ft = feet

GWQS = Ground Water Quality Standard

ID = identification

J = Qualifier denotes the analyte was positively identified, but the associated numerical value is estimated.

K = Qualifier denotes the analyte was positively identified, but the associated numerical value is estimated, bias high.

MSL = mean sea level

NA = not available

NJDEP = New Jersey Department of Environmental Protection

U = Qualifier denotes the analyte was analyzed but not detected at or above the provided reporting limit.

EXHIBIT A.2
Intermediate Aquifer Analytical Results
Volatile Organic Compounds

Well ID	NJDEP GWQS[1]	MW-1I		MW-6I		MW-7C-41		MW-10I		MW-13I		MW-15IR		MW-17I		PW-1I		PW-5I		PW-14I		PW-14D	
Screened Interval (ft bgs)		51-71		3-15		41.6-51.6		42-52		37-47		26.5-31.5		41-46		27-32		25-30		18-23		26.5-31.5	
Screened Interval (ft MSL)		500.8-480.8		552.5-540.5		509.1-499.1		514.9-504.9		519.9-509.9		534.7-529.7		511.3-506.3		529.4-524.4		531.1-526.1		544.1-539.1		535.3-530.3	
Sample Date		3/8/2022		3/8/2022		3/8/2022		3/8/2022		3/8/2022		3/7/2022		3/8/2022		3/7/2022		3/8/2022		3/7/2022		3/7/2022	
Volatile Organic Compounds (EPA DW-1 Rev 2.6), (µg/L)																							
1,1,2-Trichloroethane	3	< 0.500	U	< 0.500	U	< 0.500	U	< 0.500	U	< 0.500	U	< 0.500	U	< 0.500	U	< 0.500	U	< 0.500	U	< 0.500	U	< 0.500	U
cis -1,2-Dichloroethene	10	< 0.500	U	< 0.500	U	< 0.500	U	< 0.500	U	< 0.500	U	< 0.500	U	< 0.500	U	< 0.500	U	< 0.500	U	0.640		< 0.500	U
Tetrachloroethene	1	**1.92**		**111**		**1.91**		**11.1**		**9.11**		**48.8**		**3.53**		0.510		**9.12**		**10.3**		**33.1**	
Trichloroethene	1	< 0.500	U	< 0.500	U	< 0.500	U	< 0.500	U	< 0.500	U	< 0.500	U	< 0.500	U	< 0.500	U	< 0.500	U	< 0.500	U	< 0.500	U
Vinyl chloride	2	< 0.500	U	< 0.500	U	< 0.500	U	< 0.500	U	< 0.500	U	< 0.500	U	< 0.500	U	< 0.500	U	< 0.500	U	< 0.500	U	< 0.500	U

Notes:
Bolded and shaded results indicate detections exceeding the GWQS.
[1] NJDEP GWQS per NJAC 7:9C.
< = Qualifier denotes the analyte was analyzed but not detected at or above the provided reporting limit.
µg/L = microgram(s) per liter
ft = feet
GWQS = Ground Water Quality Standard
ID = identification
MSL = mean sea level
NJDEP = New Jersey Department of Environmental Protection
U = Qualifier denotes the analyte was analyzed but not detected at or above the provided reporting limit.

EXHIBIT A.3
Deep Aquifer Analytical Results
Volatile Organic Compounds

Well ID	NJDEP GWQS[1]	MW-1DR		MW-2D-123		MW-9D		MW-19DR		MW-20D	
Screened Interval (ft bgs)		140-150		122-130		122-132		130-135		130-135	
Screened Interval (ft MSL)		413.5-403.5		425.3-417.3		427.9-417.9		418.3-413.3		417.7-412.7	
Sample Date		3/8/2022		3/7/2022		3/8/2022		3/8/2022		3/7/2022	
Volatile Organic Compounds (EPA DW-1 Rev 2.6), (µg/L)											
1,1,2-Trichloroethane	3	< 0.500	U	< 0.500	U	< 0.500	U	< 0.500	U	< 0.500	U
cis -1,2-Dichloroethene	10	< 0.500	U	< 0.500	U	< 0.500	U	< 0.500	U	< 0.500	U
Tetrachloroethene	1	**3.05**		**2.26**		**1.56**		**25.4**		< 0.500	U
Trichloroethene	1	< 0.500	U	< 0.500	U	**1.06**	**K**	< 0.500	U	0.710	K
Vinyl chloride	2	< 0.500	U	< 0.500	U	< 0.500	U	< 0.500	U	< 0.500	U

Notes:

Bolded and shaded results indicate detections exceeding the GWQS.

[1] NJDEP GWQS per NJAC 7:9C.

< = Qualifier denotes the analyte was analyzed but not detected at or above the provided reporting limit.

µg/L = microgram(s) per liter

ft = feet

GWQS = Ground Water Quality Standard

ID = identification

K = Qualifier denotes the analyte was positively identified, but the associated numerical value is estimated, bias high.

MSL = mean sea level

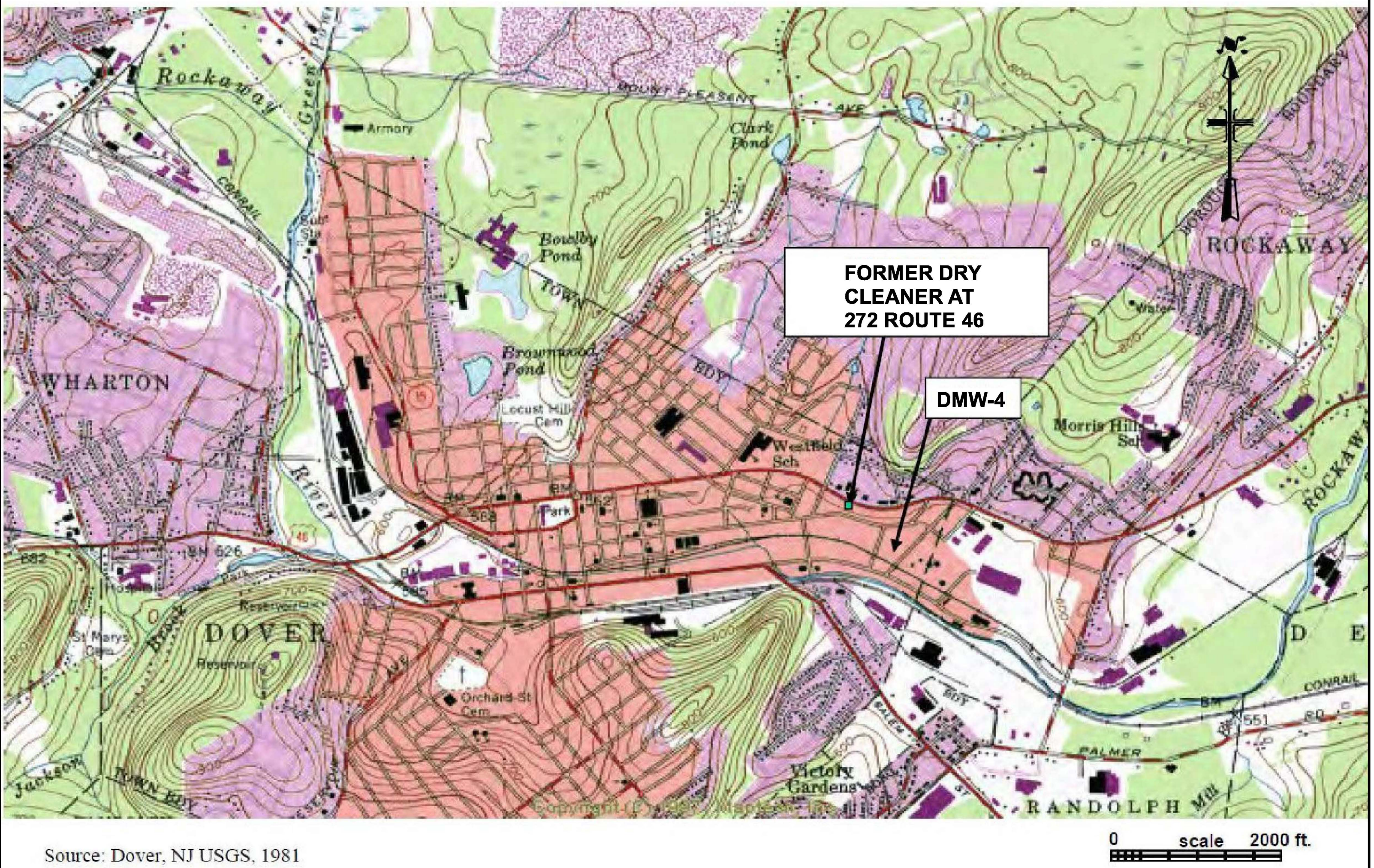
NJDEP = New Jersey Department of Environmental Protection

U = Qualifier denotes the analyte was analyzed but not detected at or above the provided reporting limit.

EXHIBIT B

Topographic and Block/Lot Maps

\\SYRACUSEFP\Syracuse\Projects\Federal\DOD\Dover GIS\MXD\2022 LTRA Report\Figure2-1 RegionalTopo.mxd



Source: Dover, NJ USGS, 1981

VICINITY MAP

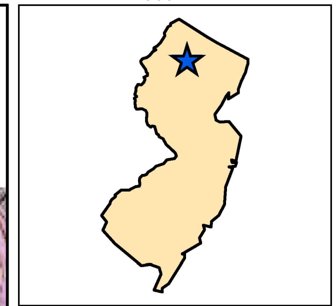


Figure obtained from Eight Annual Long-Term Response Action Groundwater Monitoring Report, January 2023

Map Date: 9/27/2022

Source: ESRI, 2011

Projection: NAD 1983 State Plane New Jersey

N

Exhibit B.1

REGIONAL TOPOGRAPHIC MAP

Dover Municipal Well No. 4 Superfund Site

Dover, New Jersey

Legend

Site Boundary (Former Dry Cleaner)

Morris County NJ Tax Parcels

Classification Exception Area (CEA) Boundary

Well Network

Shallow Aquifer Network Well

Intermediate Aquifer Network Well

Deep Aquifer Network Well

Dover Municipal Well #4

PCE Exceedance- Shallow Network

PCE Exceedance- Intermediate Network

PCE Exceedance- Deep Network

Note:
Tetrachloroethylene (PCE) plumes are based on results of 2023 Long Term Response Action monitoring. Plume extent is approximate.

Map Date: 3/22/2024
Source: ESRI, 2011
Projection: NAD 1983 State Plane New York East

0 0.05 0.1
Miles

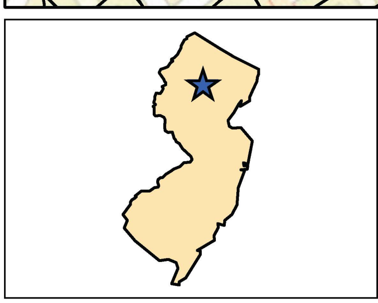
N

Exhibit B.2
CEA Boundary, Property Lots and Plume Extent

Dover Municipal Well No. 4 Superfund Site
Dover, New Jersey

EXHIBIT C

Site and Geologic Cross Section Maps



Legend

- Dover Municipal Well #4
- Shallow Aquifer Network Well
- Intermediate Aquifer Network Well
- Deep Aquifer Network Well
- Site Boundary (Former Dry Cleaner)

0 150 300 600
Feet

1 inch = 300 feet

N

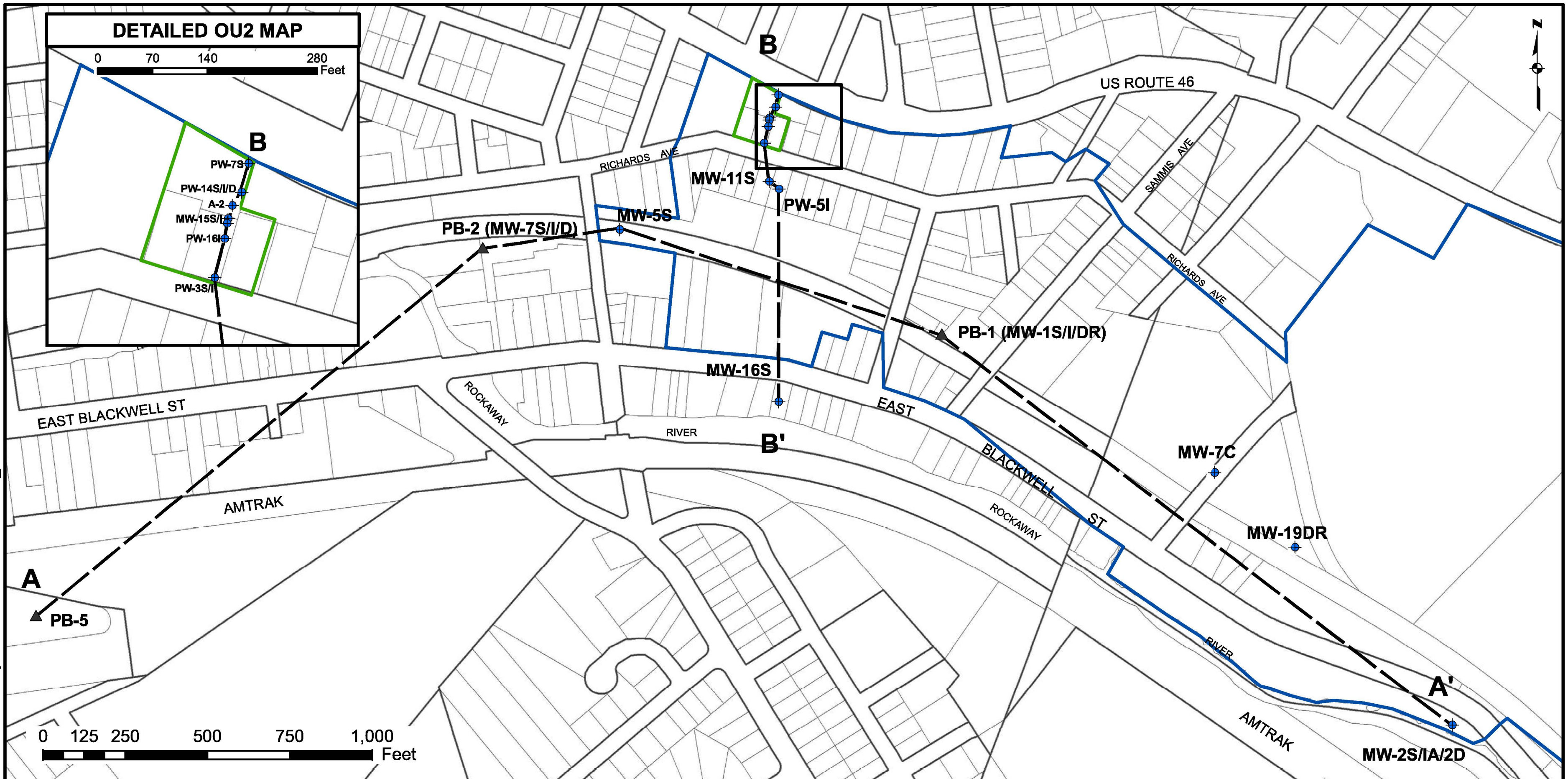
Exhibit C.1

OPERABLE UNIT 2 (OU2)
FORMER DRY CLEANER
SITE MAP, WELL LOCATIONS
AND ADJACENT PROPERTIES

Dover Municipal Well No. 4 Superfund Site
Dover, New Jersey

Map Date: 11/30/2022
Projection: NAD_1983_StatePlane_New_Jersey_FIPS_2900_Feet

\\SYRACUSEFP\Syracuse\Projects\Federal\DOD\Dover GIS\MXD\2022 LTRA Report\Figure1-2 SiteMap&AdjProps.mxd

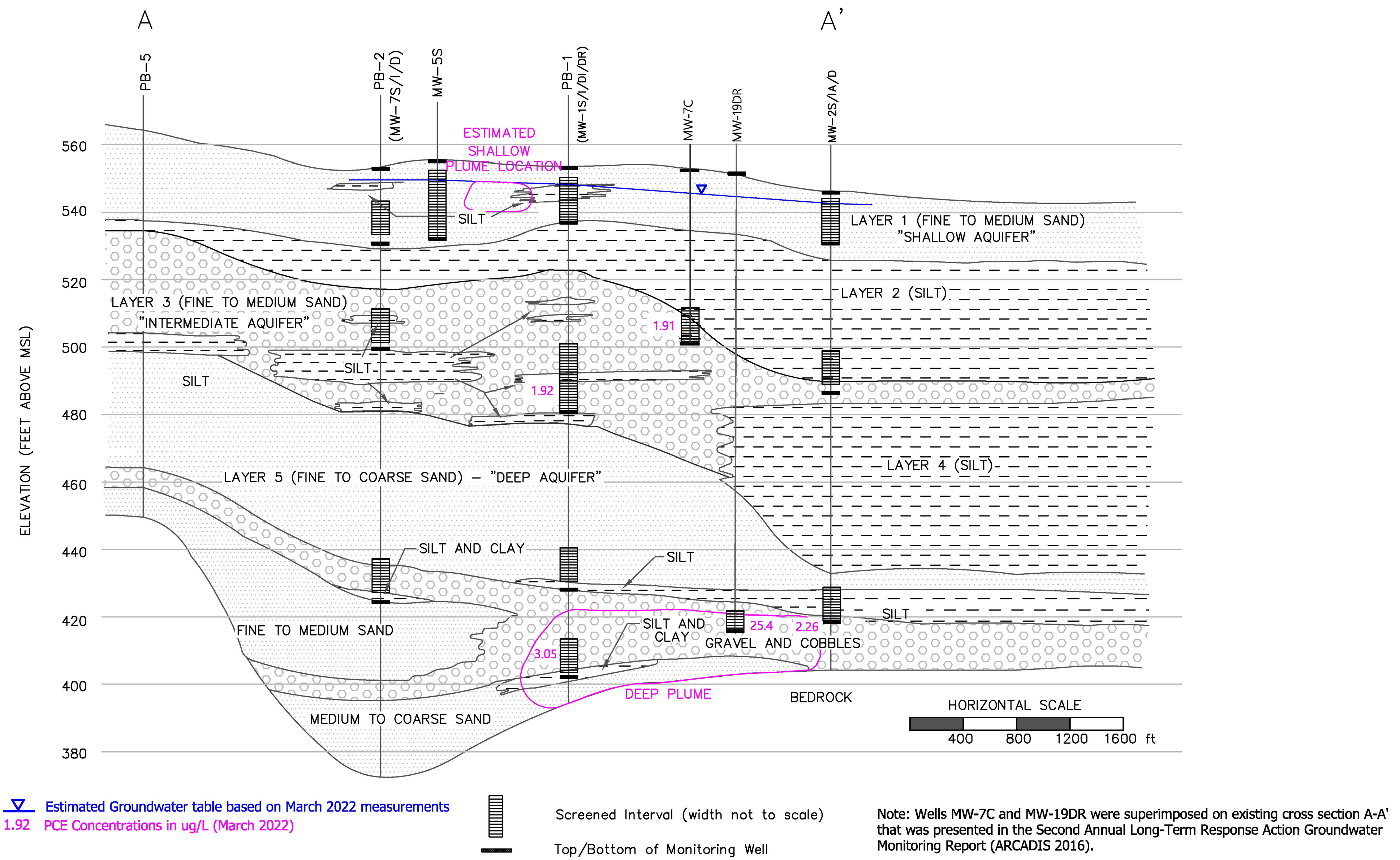


LEGEND

Monitoring Well	Soil Boring	OU2 Site Boundary	Proposed CEA Boundary	Cross Section

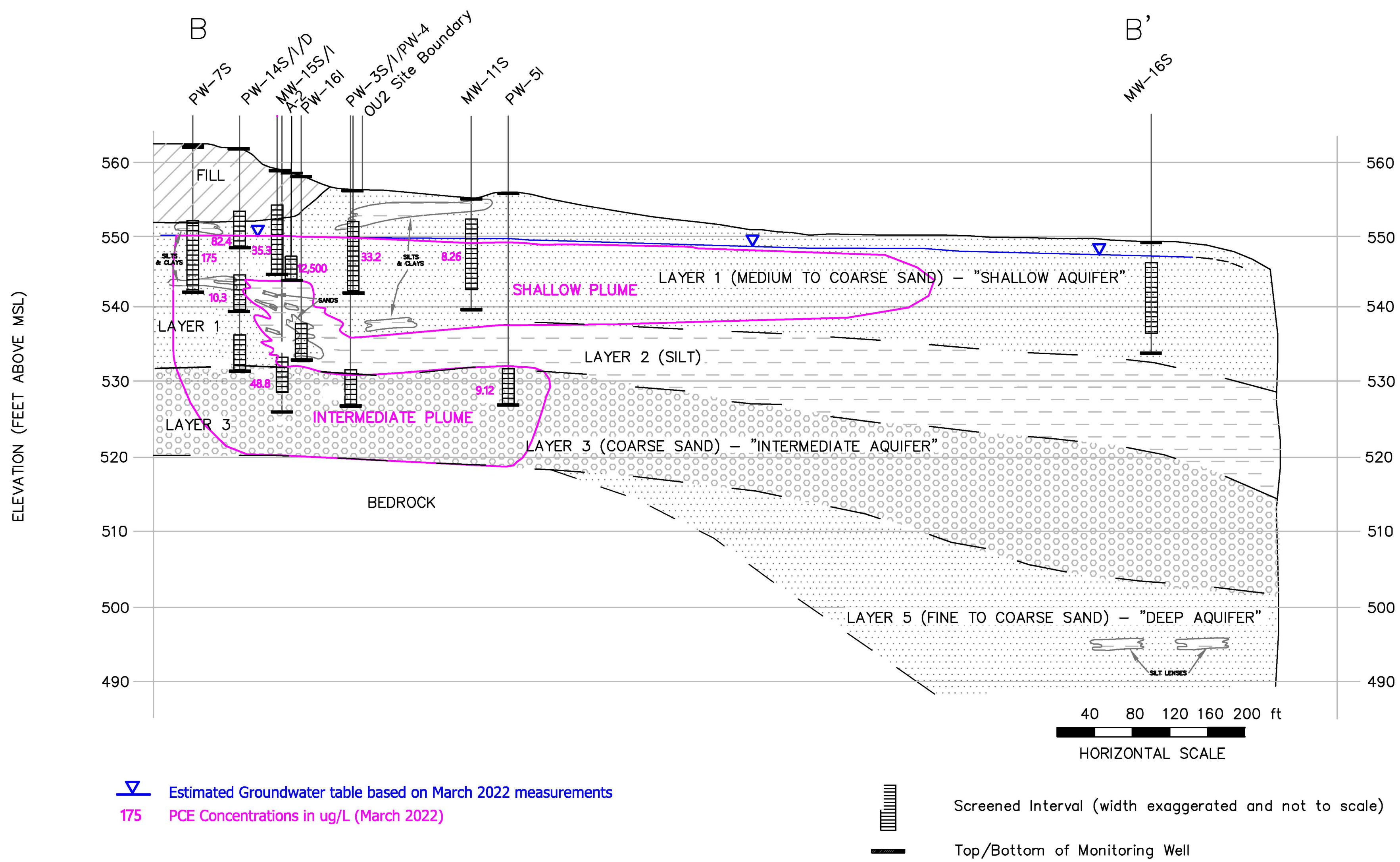
	DOVER MUNICIPAL WELL NO. 4 SUPERFUND SITE: NJD980654131 DOVER, MORRIS COUNTY, NEW JERSEY	LOCATION OF BORINGS USED IN GEOLOGIC CROSS SECTIONS A-A' AND B-B'	EXHIBIT C.2

\\arcadis-us.com\officedata\Fairlawn-NJ\Project\4553047\GIS\Mxds\Exhibit_C2.mxd



Note: Wells MW-7C and MW-19DR were superimposed on existing cross section A-A' that was presented in the Second Annual Long-Term Response Action Groundwater Monitoring Report (ARCADIS 2016).

DOVER MUNICIPAL WELL NO.4 SUPERFUND SITE: NJD980654131 DOVER, MORRIS COUNTY, NEW JERSEY	GEOLOGIC CROSS SECTION A-A'	Exhibit C.3



DOVER MUNICIPAL WELL NO.4 SUPERFUND SITE: NJD980654131 DOVER, MORRIS COUNTY, NEW JERSEY	GEOLOGIC CROSS SECTION B-B'	Exhibit C.4

EXHIBIT D

Vertical Contamination Depth Data

Exhibit D
Vertical Contaminant Data

Well ID	Ground Elevation[1] (MSL)	Top of Screen[1] (ft bgs)	Bottom of Screen[1] (ft bgs)	Top of Screen (MSL)	Bottom of Screen (MSL)	Depth to Water[2] (ft bgs)	Depth to Water[2] (MSL)	Approx. Bottom of Plume[3] (ft bgs)	Approx. Bottom of Plume[4] (MSL)	Approx. Top of Plume (ft bgs)	Approx. Top of Plume (MSL)	Thickness of Clean Water Lens (ft)
Shallow Aquifer Monitoring Well Network												
A-1	---	12	15	---	---	11.34	---	31.5	---	11	---	0
A-2	---	12	15	---	---	11.28	---	31.5	---	11	---	0
A-3	---	12	15	---	---	11.15	---	31.5	---	11	---	0
A-4	---	12	15	---	---	10.99	---	31.5	---	11	---	0
MW-11S	555.24	3	13	552.2	542.2	5.33	549.91	30	525.2	5	550.2	0
MW-15S	558.52	5	15	553.5	543.5	9.31	549.21	31.5	527.0	9	549.5	0
MW-17S	552.10	3	13	549.1	539.1	2.11	549.99	46	506.1	2	550.1	0
PW-2S	555.70	---	14	---	541.7	5.58	550.12	NA	NA	NA	NA	NA
PW-4S	556.40	---	14	---	542.4	7.98	548.42	31.5	524.9	8	548.4	0
PW-7S	562.58	10.3	20.3	552.3	542.3	10.53	552.05	23.0	539.6	10.5	552.1	0
PW-10S	558.55	---	15	---	543.6	9.61	548.94	31.5	527.1	9.6	549.0	0
PW-12S	559.58	---	15	---	544.6	9.42	550.16	31.5	528.1	9.4	550.2	0
PW-14S	561.98	9	14	553.0	548.0	12.57	549.41	31.5	530.5	12.5	549.5	0
Intermediate Aquifer Monitoring Well Network												
MW-1I	551.82	51	71	500.8	480.8	8.16	543.66	71	480.8	51	500.8	43
MW-6I	555.50	38	58	517.5	497.5	4.41	551.09	58	497.5	38	517.5	34
MW-7C	550.65	41.6	51.6	509.1	499.1	1.45	549.20	51.6	499.1	41.6	509.1	40
MW-10I	556.87	42	52	514.9	504.9	6.01	550.86	52	504.9	42	514.9	36
MW-13I	556.93	37	47	519.9	509.9	5.96	550.97	47	509.9	37	519.9	31.0
MW-15IR	561.19	26.5	31.5	534.7	529.7	10.02	551.17	31.5	529.7	3	558.2	0
MW-17I	552.32	41	46	511.3	506.3	1.63	550.69	46	506.3	3	549.3	0
PW-1I	556.38	27	32	529.4	524.4	2.76	553.62	NA	NA	NA	NA	NA
PW-5I	556.07	25	30	531.1	526.1	6.01	550.06	30	526.1	6	550.1	0
PW-14I	562.09	18	23	544.1	539.1	12.64	549.45	23	539.1	12	550.1	0
PW-14D	561.82	26.5	31.5	535.3	530.3	12.64	549.18	31.5	530.3	12	549.8	0
Deep Aquifer Monitoring Well Network												
MW-1DI	553.58	113	123	440.6	430.6	---	---	123	430.6	113	440.6	111.08
MW-1DR	553.49	140	150	413.5	403.5	2.56	550.93	150	403.5	140	413.5	137.5
MW-2D	547.28	122	130	425.3	417.3	1.21	546.07	130	417.3	122	425.3	121
MW-9D	549.93	122	132	427.9	417.9	1.00	548.93	NA	NA	NA	NA	NA
MW-19DR	548.32	130	135	418.3	413.3	0.00	548.32	135	413.3	130	418.3	130
MW-20D	547.72	130	135	417.7	412.7	0.00	547.72	NA	NA	NA	NA	NA

1 - Data was obtained from the Eighth Annual Long-Term Response Action Annual Groundwater Monitoring Report (November 2021 to October 2022), January 2023.
2 - Depth to water measurements taken in March 2022.
3 - The approximate bottom of plume depth was estimated to be either the bottom of the screened interval or the bottom of the screened interval of a nearby deeper well that has contaminants above the cleanup level.
4 - The approximate top of the plume was estimated to be either the top of water for shallow wells, the top of water of a nearby shallow well that has contaminants above the cleanup level, or the top of the screened interval for intermediate and deep wells with no nearby contaminated shallow wells.
bgs - below ground surface
ft - feet
MSL - mean sea level
NA - Not Applicable because well is outside of contaminant plume area.
NS - Not sampled in March 2022. No analytical data are available.
--- - unavailable/unknown

EXHIBIT E.1

Fate and Transport Discussion

(Source: Dover Municipal Well No. 4 Superfund Site 2013 CEA Permit)

Exhibit E: Fate and Transport Discussion

This Exhibit presents a discussion of the fate and transport of chlorinated volatile organic compounds (VOCs) identified at the Dover Municipal Well No. 4 Superfund Site (the Site), located in the Town of Dover, Morris County, New Jersey.

1. Site History

Drilled in 1962, Dover Municipal Well No. 4 (DMW4) began pumping in June 1965 and was one of the town's primary water supply wells with an average pumping rate of 1,100 gallons per minute (gpm). In March 1980, the Town of Dover and the New Jersey Department of Environmental Protection (NJDEP) documented the presence of chlorinated VOCs in the groundwater collected from DMW4. Based on this information, in September 1980, the Town of Dover voluntarily removed DMW4 from service and replaced it with standby well #3.

A Hazard Ranking System report was prepared for the Site in December 1982, and the Site was placed on the National Priorities List (NPL) in September 1983. Numerous investigations were conducted by NJDEP in the mid to late 1980s in an attempt to identify the source of groundwater contamination in the shallow, intermediate, and deep aquifers. While the studies identified contamination at various individual properties, they also showed that these facilities were not the source of the contamination at the Site.

In 1990, a Remedial Investigation (RI) conducted by NJDEP identified chlorinated VOCs in all three aquifers near DMW4. Tetrachloroethene (PCE) was detected north of DMW4 in the intermediate and deep glacial sand and gravel aquifers. Chlorinated VOCs were also detected in the shallow, intermediate, and deep glacial sand and gravel aquifers at various locations throughout the area. The 1990 RI Report, however, did not define the nature, extent, and source of groundwater contamination.

On September 30, 1992, the United States Environmental Protection Agency (EPA) issued a record of decision (ROD) based on the results of the 1990 RI Report. The 1992 ROD divided the project into two operable units (OUs). OU1 was defined as the remedy for the groundwater contamination present in the three aquifers beneath DMW4. OU2 was defined as the source investigation for the groundwater contamination found in DMW4. Since the 1990 RI

Report for OU1 could not define the source of groundwater contamination, the 1992 ROD called for a separate Remedial Investigation and Feasibility Study (RI/FS) for OU2.

In October 1992, NJDEP requested that EPA assume the lead for addressing the contamination at the Site. In March 1993, EPA initiated a further investigation to define the nature and extent of chlorinated VOCs in the shallow, intermediate, and deep aquifers. While EPA's investigation located numerous potential sources, EPA was unable to identify the specific source of the groundwater contamination at that time.

Between 1999 and 2003, EPA conducted a Preliminary Design Investigation (PDI) as part of the OU1 remedial design, which also focused on identifying the source of groundwater contamination. Groundwater and soil samples collected in 2001 indicated that a dry cleaner on U.S. Route 46 was the source of the chlorinated VOCs detected in DMW4. Once EPA identified the source of the contamination of DMW4, EPA began an OU2 RI/FS. In 2003, EPA conducted sampling on the dry cleaner property to characterize the contamination beneath and near the dry cleaner building. The OU2 RI/FS was completed in 2004, and on September 30, 2005 the EPA signed the ROD for OU2.

2. Summary of OU1 and OU2 Remedial Activities Performed to Date

In December 2007, after acquiring title of the dry cleaner property, EPA demolished the former dry cleaner building. Soil sampling conducted during the design phase showed that soil contamination also existed in close proximity to three adjacent houses to the south of the dry cleaner property. The three residential properties were acquired by the EPA in August 2008 and the houses were demolished in October 2008. In March through May 2009, unsaturated soil was excavated from portions of the site where the ROD cleanup criteria were exceeded. In general, the soil excavations extended to the water table. Approximately 1,600 cubic yards of soil were removed and disposed off-site, and the excavations were backfilled with clean fill

The selected remedy for OU2 is in situ chemical oxidation (ISCO). EPA installed ISCO performance monitoring wells on the former drycleaner and residential properties in May 2009. Baseline (pre-treatment) soil samples were collected from the soil borings advanced during performance monitoring well installation, and baseline groundwater samples were collected from the performance monitoring wells in June 2009 and October 2009.

Phase 1 ISCO treatment activities commenced at OU2 in March 2010 with the installation of 33 injection wells and two vent wells. Oxidant injections began on April 13, 2010 and were completed on May 27, 2010. ARCADIS/Pirnie performed Phase 1 ISCO treatment effectiveness monitoring in July 2010. The monitoring showed that ISCO treatment was successful in reducing chlorinated VOC concentrations in soil to below ROD criteria. Although down-gradient wells showed decreased concentrations of VOCs, groundwater concentrations increased at wells near the former drycleaner building in the northeast portion of OU2. In October 2010, groundwater samples were collected from eight injection wells in the northeast portion of the site to better delineate this localized source area. Based on the results from the July 2010 and October 2010 monitoring events, nine additional ISCO treatment injection wells were installed in March 2011. Samples were collected from the nine new injection wells in April 2011 to aid in planning Phase 2 of the ISCO treatment.

Phase 2 of ISCO treatment was initiated on June 6, 2011 and was completed on July 22, 2011. ARCADIS/Pirnie performed Phase 2 ISCO effectiveness monitoring to assess site conditions approximately two months and six months after completion of the Phase 2 ISCO treatment, in September 2011 and February 2012. The results from the September 2011 and February 2012 monitoring show that VOC concentrations in the source area near the former drycleaner building decreased significantly. However, VOC concentrations in certain areas were still elevated. EPA is planning to perform one additional round of ISCO treatment to further reduce VOC concentrations in the fall of 2012. A long-term groundwater monitoring program will be initiated after completion of ISCO activities at OU2.

3. Conceptual Site Model

DMW4 extracted groundwater from the deep aquifer from 1965 until 1980, at which time it was taken out of service because of the presence of chlorinated VOCs. During the period while DMW4 was operational, the chlorinated VOCs were pulled from the shallow aquifer to the deep aquifer and ultimately to the well. Unconsolidated sediments, which fill the Rockaway River Valley, consisting of fine sand and silt layers, act as confining units between the more permeable aquifers above and below them. In the part of the valley close to DMW4, two silt layers separate the sand into three aquifers, an upper water table aquifer (shallow aquifer) and two underlying semi-confined aquifers, identified as intermediate and deep aquifers.

The groundwater quality data indicated that the source of the chlorinated VOCs detected in DMW4 was contaminated soil located beneath and adjacent to the former dry cleaner building at 272 Route 46. Elevated PCE concentrations detected in a sediment sample collected from the sump in the basement of the dry cleaner building indicated that one possible release mechanism was the direct discharge of chlorinated cleaning solvents into the sump. Elevated PCE concentrations were also detected in the unsaturated soil in the parking lot east of the dry cleaner building, indicating surface spills or discharges in this area. In March through May 2009, the USEPA excavated and removed contaminated unsaturated soil from the former drycleaner property. Based on soil sampling performed after the first phase of ISCO treatment, concentrations of VOCs sorbed onto saturated soil were significantly reduced. Therefore, the unsaturated and saturated soil at OU2 no longer present a significant source of VOCs to groundwater at the Site.

Once discharged into the sump and adjacent to the building, the chlorinated solvents moved through the unsaturated soil and into the shallow aquifer. Groundwater in the shallow aquifer flows toward the Rockaway River. However, sampling data indicates that groundwater contamination did not extend to the river (see Figure E.1). The presence of compounds typically associated with the biodegradation of PCE (i.e., trichloroethene [TCE], cis-1,2-dichloroethene [cis-1,2-DCE] and vinyl chloride [VC]) indicates that biologically driven natural attenuation may be occurring and may be controlling the rate and extent of shallow aquifer plume migration. Advection, dispersion and sorption are also contributing to the natural attenuation of chlorinated VOC concentrations within the shallow aquifer.

Groundwater sampling results show that chlorinated VOCs have migrated through the shallow aquifer and first aquitard into the intermediate aquifer immediately down-gradient of the dry cleaner. Groundwater flow in the intermediate aquifer is toward the southeast. Chlorinated VOCs have been detected in the intermediate aquifer as far as Carrol Street, a distance of approximately 1,400 feet southeast of the dry cleaner (see Figure E.2). The plume has been relatively stable over time; however, geochemical indicators do not indicate that significant biodegradation is occurring. Advection, dispersion, and sorption processes are contributing to the natural attenuation of the chlorinated VOCs within the intermediate aquifer.

Groundwater sampling results also show that chlorinated VOCs have migrated through the intermediate aquifer into the deep aquifer. Based on the water quality data from samples collected from an adjacent deep monitoring well (MW-1DR), the contaminant plume has moved northeast of DMW4 as a result of shutting down the well in 1980. Concentrations of PCE slightly above the groundwater standard (i.e., up to 2.6 ug/L versus the groundwater cleanup standard of 1.0 ug/L) have been quantified in samples collected from MW-2D, the furthest down-gradient monitoring well (see Figure E.3). However, for the most recent sampling event (July 2011), groundwater collected from MW-2D contained PCE at a concentration of 0.82 ug/L, slightly below the cleanup standard of 1.0 ug/L.

4. Soil Vapor Investigation

The shallow groundwater plume flows south from property at 272 Route 46 and travels beneath several homes on Richards Avenue. In order to evaluate the potential impact the subsurface contamination may have on indoor air, the EPA conducted indoor and ambient outdoor air sampling, as well as sub-slab and external soil gas sampling, at ten residences on Richards Avenue during 2002 and 2003. PCE and/or TCE concentrations in the basements of ten homes were greater than concentrations in ambient outdoor air in the winter of 2002. In August 2003, however, PCE and TCE concentrations in indoor air in most residences were all less than or equal to concentrations in ambient outdoor air indicating a possible ambient outdoor, rather than subsurface, source.

Sub-slab soil gas samples were collected in conjunction with indoor air samples at seven homes in August 2003. PCE concentrations in the basements of two homes on the north side of Richards Avenue were greater than in the corresponding sub-slab soil gas samples. These findings imply a source, or sources, other than the subsurface since it is unlikely that concentrations in indoor air would exceed those in the corresponding sub-slab soil gas. For the other residences, the subsurface may be contributing to indoor air quality, but, apparently, not significantly.

5. Summary of Natural Attenuation Evaluation

Monitored natural attenuation (MNA) was evaluated as a remedial alternative for the shallow, intermediate, and deep aquifers in the Final Feasibility Study, Dover Municipal Well No. 4, Operable Unit 2, Dover, New Jersey (Malcolm Pirnie, 2005). The 2005 evaluation included plume stability evaluations for chlorinated VOCs in the shallow, intermediate, and deep aquifers. Geochemical data collected from the three aquifers were also evaluated to assess whether intrinsic bioremediation was occurring. Solute transport modeling was performed using the BIOCHLOR model. The results of the 2005 MNA evaluation are summarized below. Tables and figures from the 2005 MNA evaluation are provided as an attachment to this exhibit.

Plume Stability

For the 2005 MNA evaluation, the concentrations of PCE, TCE, cis-1,2-DCE, and VC were plotted versus time on a logarithmic scale for each monitoring well. The best-fit line was then determine by linear regression and evaluated to determine if the slope of the line was significant at the 95% level (see attachment to Exhibit E, Figures 4-1 to 4-4 for graphs of the data and Table 4-2 for a table showing the F-statistic calculated for the regression analyses). For the shallow aquifer plume, the data suggested that PCE and its daughter products were attenuating down-gradient from the source area. The primary attenuation mechanisms were deemed to be anaerobic biodegradation, advection, and dispersion. The intermediate aquifer plume was determined to be stable, as the data indicated that the total mass and plume size remained essentially the same over the period of time from which data were available. For the deep aquifer plume, data indicated that the plume was relatively stable.

Data collected in 2007 to 2011 support the plume stability evaluation. VOC concentrations have decreased markedly at OU2 following ISCO treatment. VOC concentrations in shallow, intermediate, and deep aquifer wells located down gradient of OU2 have remained generally stable (see Figures E.1, E.2, and E.3).

Geochemical Evaluation

Groundwater geochemical data were evaluated to assess whether intrinsic bioremediation was occurring in the groundwater plumes. In the shallow aquifer, elevated chloride concentrations at source area wells and the presence of PCE daughter products suggested that reductive dechlorination was occurring. However, the absence of ethene and ethane indicated incomplete biotransformation of PCE to ethane and ethane. In the intermediate and deep aquifers, chloride concentrations were higher in downgradient wells than in upgradient wells, suggesting that reductive dechlorination may have been occurring. However, unlike in the shallow aquifer, no PCE daughter products were detected in the intermediate and deep aquifers.

A bioattenuation screening process was employed in accordance with the *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Ground Water* (USEPA, 1998). Table 4-3 in the attachment to Exhibit E presents the results of the scoring performed for various monitoring locations in the shallow, intermediate, and deep aquifer wells. Results of the bioattenuation screening indicated that there was limited evidence of anaerobic biodegradation in the shallow aquifer, and inadequate evidence of anaerobic biodegradation in the intermediate and deep aquifers.

Solute Transport Modeling

Solute transport modeling was conducted using the analytical model BIOCHLOR, which has the ability to simulate 1-dimensional (D) advection, 3-D dispersion, linear adsorption, and biotransformation via reductive dechlorination. Model runs for all aquifers were simulated for a 30-year time period. For the shallow aquifer, biodegradation was incorporated in the model based on the geochemical results described above. The model indicated that the PCE plume would attenuate prior to reaching the nearest shallow aquifer receptor, which was determined to be the Rockaway River. For the intermediate and deep aquifers, model simulations were performed without biodegradation because geochemical data indicated that biodegradation was not a significant attenuating mechanism in these aquifers. In the intermediate aquifer, simulations were performed to evaluate whether other attenuation mechanisms could control the rate and extent of plume migration so that cleanup standards would not be exceeded at the closest receptor (the Howmet property well located at 9-10 Roy Street, approximately 3,000 feet downgradient of MW-2C). The simulations showed that significant attenuation in terms of dilution and dispersion would occur before the chlorinated VOCs in the intermediate aquifer would reach the Howmet well. No potential human or ecological receptors were identified for the deep aquifer (given that DMW4 is no longer used); therefore, the objective of the modeling for the deep aquifer was to assess how far the plume would expand over 30 years. Results from the model simulation suggested the PCE concentrations would attenuate below cleanup standards approximately 500 to 600 feet beyond MW-2D. Figures 4-5 through 4-8 in the attachment to Exhibit E illustrate the BIOCHLOR model output for all three aquifer simulations.

6. Effect of Property Use Changes on Fate and Transport of VOCs

The proposed CEA is in an urban setting that includes primarily commercial/industrial properties and also some residential properties. The former drycleaner property, currently owned by EPA, is vacant with the exception of injection wells and monitoring wells associated with ISCO treatment. Additional ISCO treatment is planned, which is anticipated to further reduce VOC concentrations in the shallow and intermediate aquifers beneath OU2. There are no other known property use changes that would have an effect on the fate and transport of VOCs in groundwater within the CEA boundary.

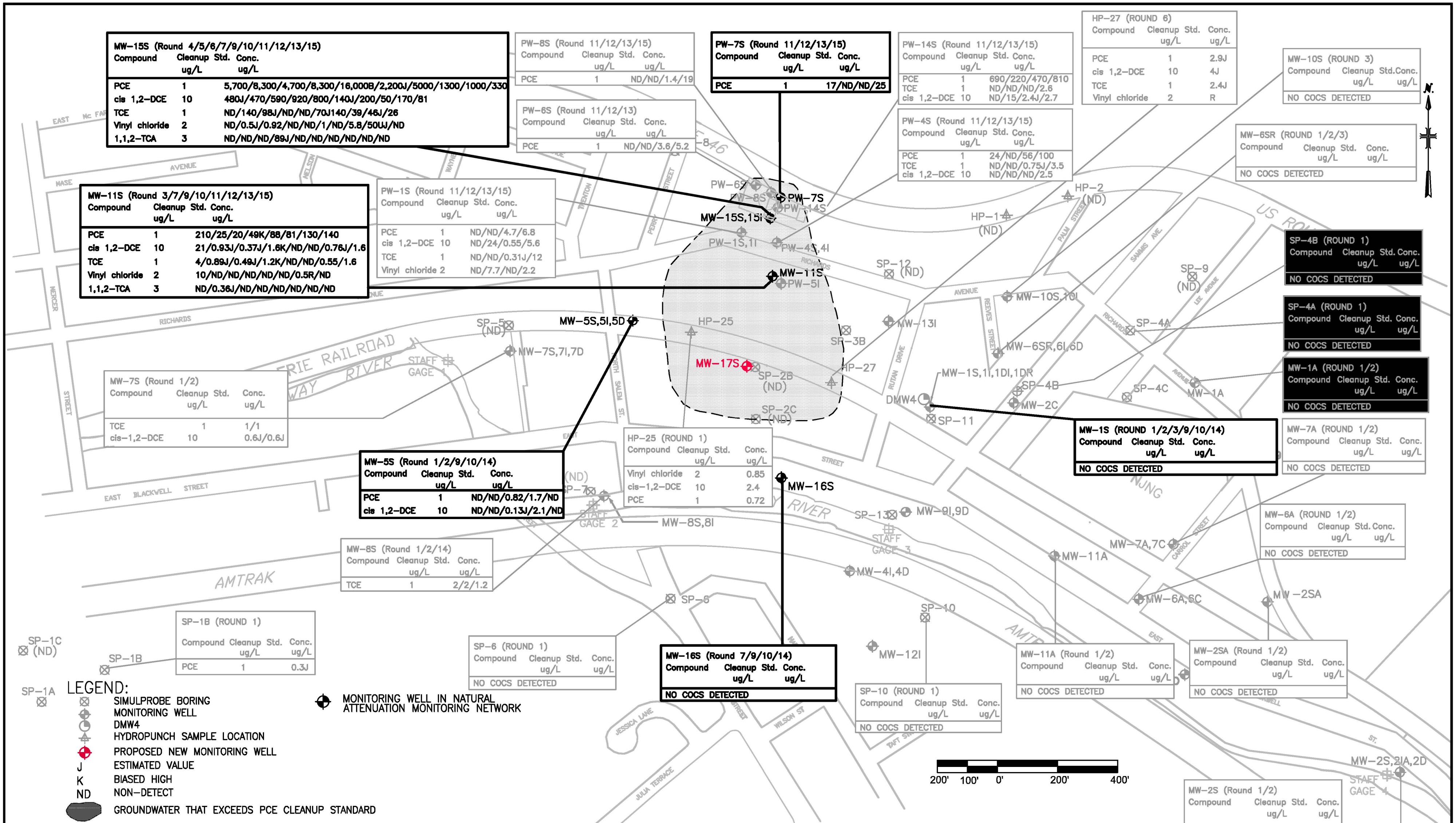
7. Conclusions

Based on the plume stability and geochemical evaluations discussed above, the output from the BIOCHLOR model, and the hydrogeologic properties of the aquifers (e.g., hydraulic conductivities, groundwater velocity), the ROD for OU2 estimated that once the source of chlorinated VOCs had been remediated, natural attenuation processes would reduce VOC concentrations below the cleanup criteria within approximately 10 years.

Attachment to Exhibit E

Tables and Figures from the 2005 Monitored Natural Attenuation Evaluation

Figures E.1, E.2 and E.3



LEGEND:
- SIMULPROBE BORING
- MONITORING WELL
- DMW4
- HYDROPUNCH SAMPLE LOCATION
- PROPOSED NEW MONITORING WELL
- MONITORING WELL IN NATURAL ATTENUATION MONITORING NETWORK
- J ESTIMATED VALUE
- K BIASED HIGH
- ND NON-DETECT
- GROUNDWATER THAT EXCEEDS PCE CLEANUP STANDARD

CLEANUP STD. – THE CLEANUP STANDARD SELECTED IS THE LOWER OF THE FEDERAL OR STATE MCLs FOR EACH COMPOUND OF CONCERN.

ROUND DATES: 1=9/1998, 2=11/1998, 3=3/2000, 4=10/2000, 5=11/2000, 6=8/2001, 7=12/2002, 8=2/2003, 9=12/2004, 10=5/2007, 11=6/2009, 12=10/2009 13=7/2010, 14=7/2011, 15=9/2011

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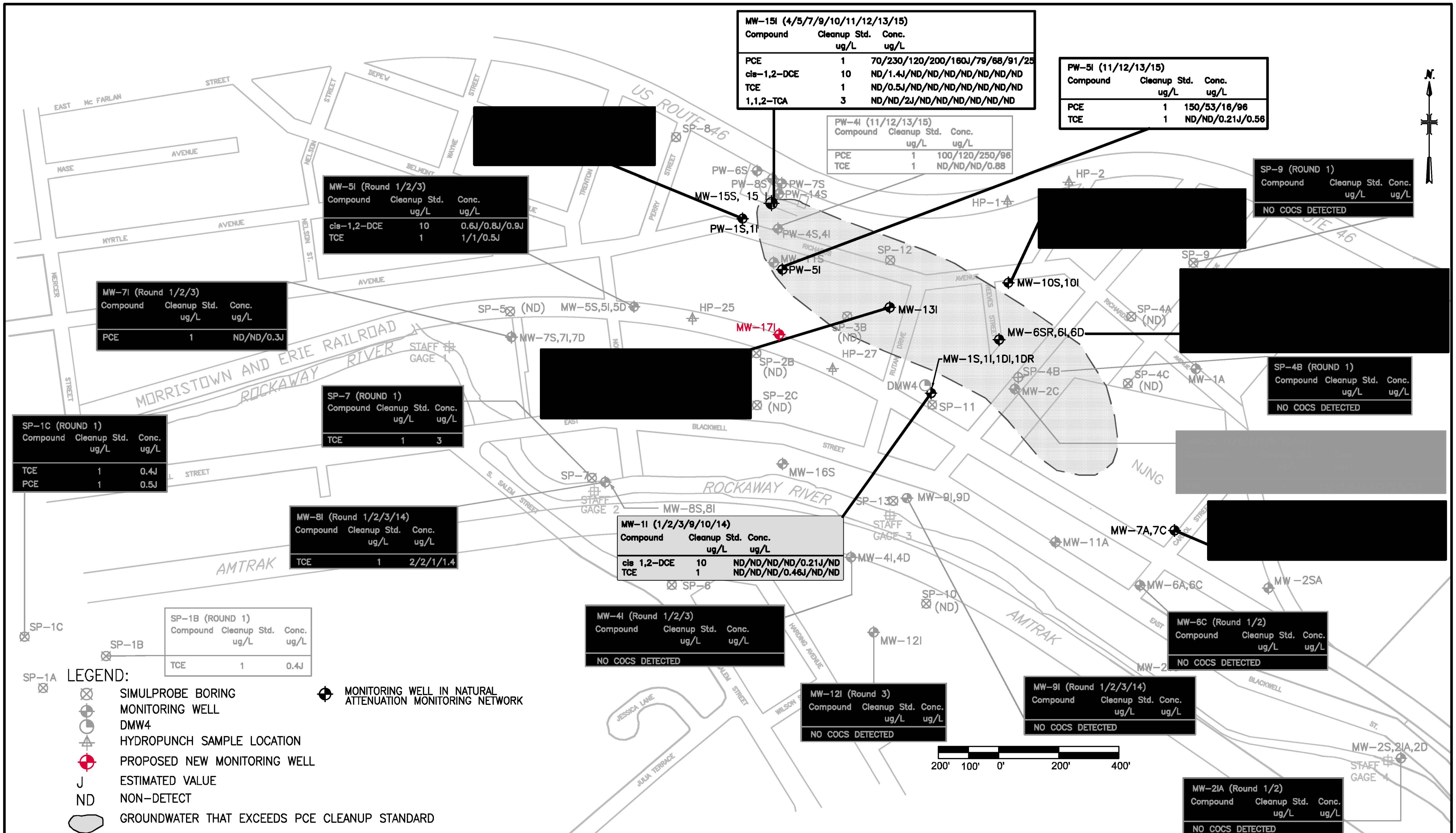
DOVER MUNICIPAL WELL NO.4 SUPERFUND SITE
DOVER, NEW JERSEY

HISTORICAL GROUNDWATER CONCENTRATIONS AND PROPOSED LONG-TERM MONITORING NETWORK
SHALLOW AQUIFER

FIGURE E.1



CLEANUP STD. – THE CLEANUP STANDARD SELECTED IS THE LOWER OF THE FEDERAL OR STATE MCLs FOR EACH COMPOUND OF CONCERN.

ROUND DATES: 1=9/1998, 2=11/1998, 3=3/2000, 4=10/2000, 5=11/2000, 6=8/2001, 7=12/2002, 8=2/2003, 9=12/2004, 10=5/2007, 11=6/2009, 12=10/2009, 13=7/2010, 14=7/2011, 15=9/2011

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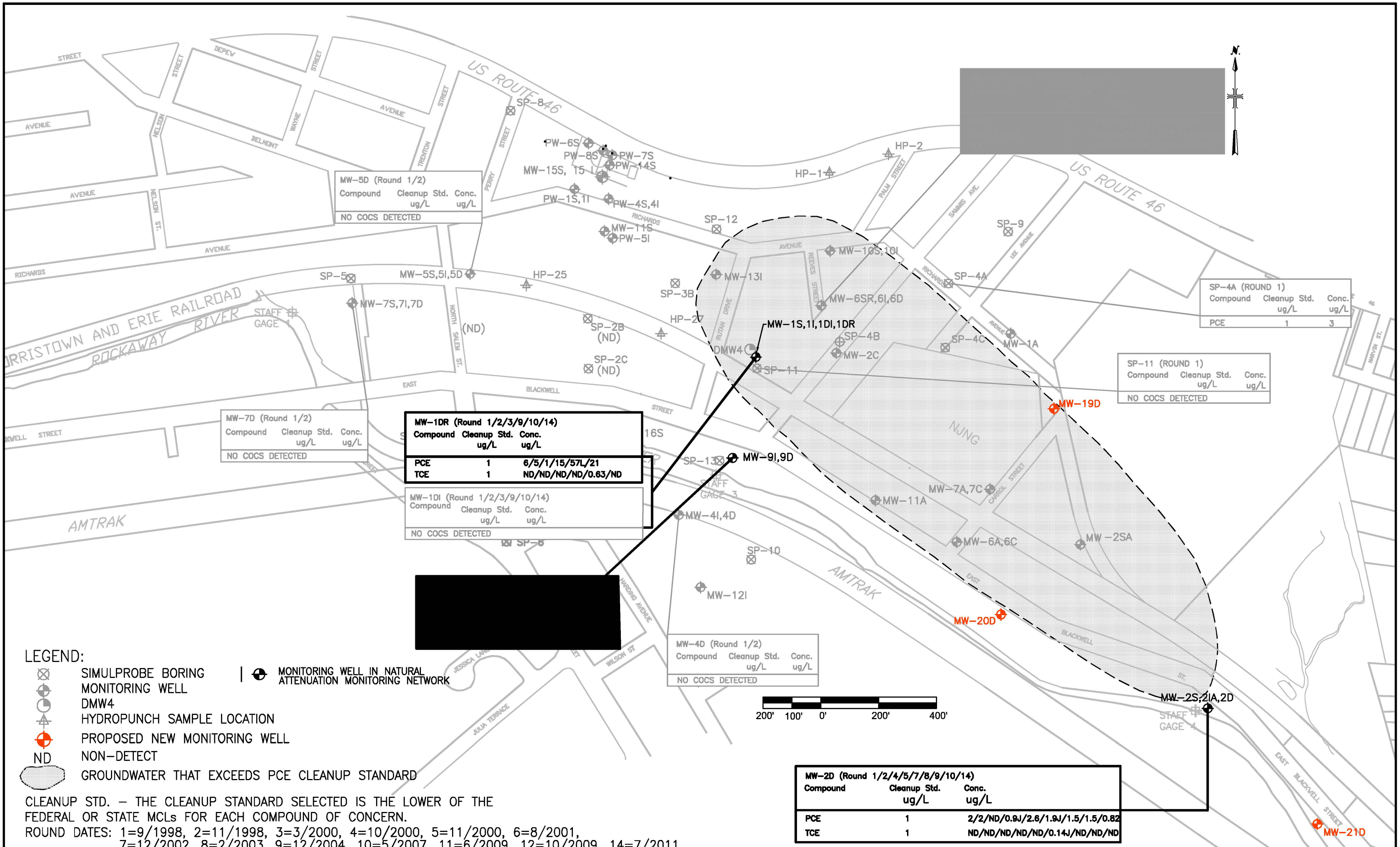
HISTORICAL GROUNDWATER CONCENTRATIONS AND PROPOSED LONG-TERM MONITORING NETWORK INTERMEDIATE AQUIFER

FIGURE E.2



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HISTORICAL GROUNDWATER CONCENTRATIONS AND PROPOSED LONG-TERM MONITORING NETWORK DEEP AQUIFER

FIGURE E.3

TABLE 4-1
MONITORING WELLS USED IN THE EVALUATION OF MNA

Sampling Event	Dates	Round
Draft RI	Sep/Nov 1998	1,2
Phase I PDI	Feb/Mar 2000	3
Phase II PDI	Sep/Oct/Nov 2000	4,5
Phase III PDI	Aug/Sep 2001	6
Phase IV PDI	Dec 2002 to Feb 2003	7,8
Well ID	**# of samples**	**Round**
Shallow		
MW-15S	4	4,5,6,7
MW-11S	2	3,7
MW-16S	1	7
MW-1S	3	1,2,3
Intermediate		
MW-15I	3	4,5,7
MW-6I	4	1,2,3,7,8
MW-2C	4	1,2,3,7
MW-7C	3	1,2,7
Deep		
MW-6D	4	1,2,3,7
MW-2D	5	1,2,4,5,7,8
MW-1DI	2	1,2

TABLE 4-2
F-STATISTIC VALUES CALCULATED TO UNDERSTAND PLUME STABILITY

Monitoring Well	PCE			TCE			cis-DCE			VC		
	F-Statistic	Significant	Value	F-Statistic	Significant	Value	F-Statistic	Significant	Value	F-Statistic	Significant	Value
MW-15S	0.194	N	1,2=18.51	10.55	N	1,1=161.45	331	Y	1,2=18.51	ND		
MW-11S	NA			NA			NA			NA		
MW-15I	0.0004	N	1,1=161.45	0.028	N	1,1=161.45	0.028	N	1,1=161.45	ND		
MW-6I	10.82	Y	1,3=10.13	ND			ND			ND		
MW-2C	5.95	N	1,2=18.51	ND			ND			ND		
MW-6D	1.56	N	1,2=18.51	ND			27.32	Y*	1,2=18.51	ND		
MW-2D	0.064	N	1,4=7.71	1.99	N	1,4=7.71	ND			ND		

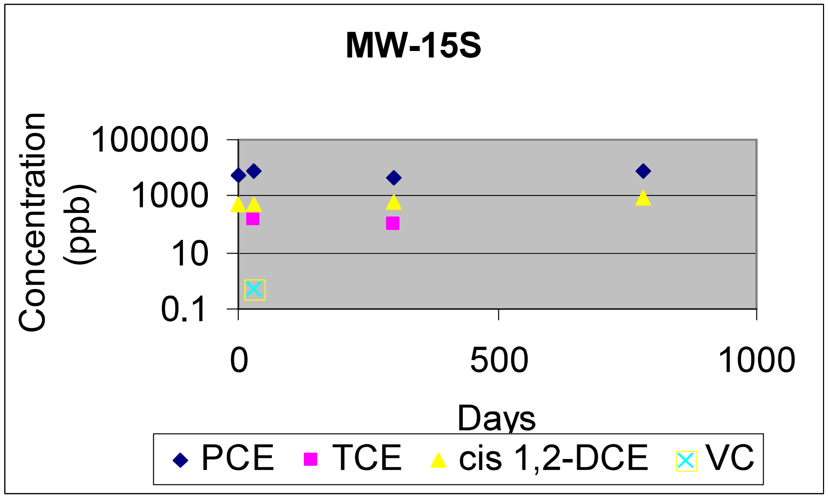
Notes:
(N) - not significant at 95% confidence interval
(Y) - significant at 95% confidence interval
ND - compound not detected, F-statistic value not calculated
NA - Insufficient data points to conduct analysis.
* - cis-DCE was detected during only one sampling event at 0.13 ppb.

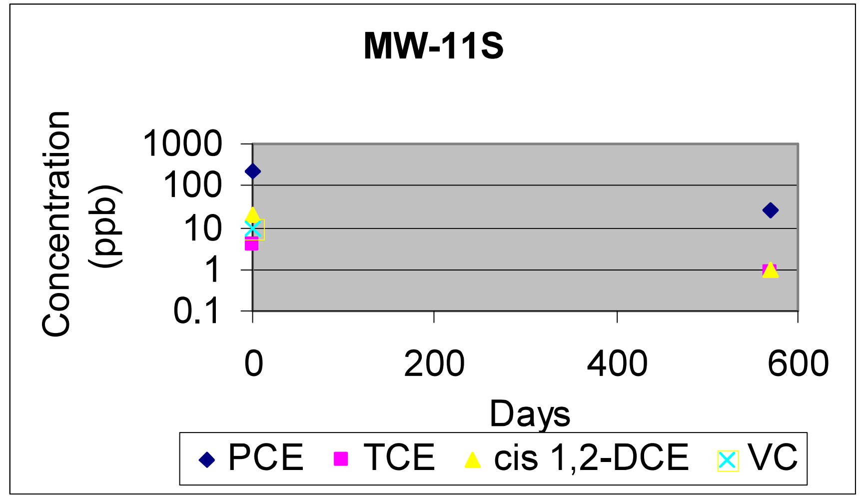
TABLE 4-3
PRELIMINARY SCREENING FOR ANAEROBIC BIODEGRADATION PROCESSES

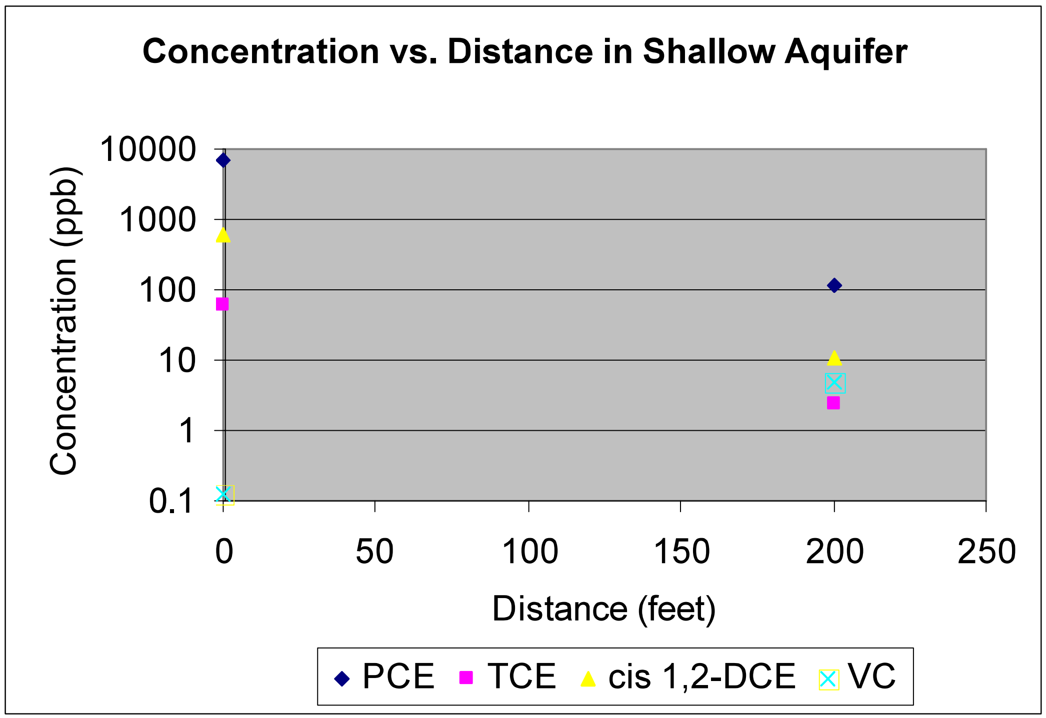
	MW-15S		MW-11S		MW-15I		MW-6I		MW-6D		MW-2D	
Analysis	**Concentration**	**Points Awarded**	**Concentration**	**Points Awarded**	**Concentration**	**Points Awarded**	**Concentration**	**Points Awarded**	**Concentration**	**Points Awarded**	**Concentration**	**Points Awarded**
Dissolved Oxygen	1.8 mg/L	0	5.03 mg/L	0	3.18 mg/L	0	4.37 mg/L	0	0.74 mg/L	0	3.28 mg/L	0
Nitrate	4.51 mg/L	0	0.87 mg/L	0	2.16 mg/L	0	1.61mg/L	0	0.85 mg/L	0	2.26 mg/L	0
Fe(II)	0.0279 mg/L	0	0.037 mg/L	0	0.0722 mg/L	0	0.0098 mg/L	0	0.0752 mg/L	0	0.006 mg/L	0
Sulfate	33.9 mg/L	0	34.6 mg/L	0	18.0 mg/L	2	16.1 mg/L	2	20.8 mg/L	2	17.4 mg/L	2
Sulfide	0.0mg/L	0	0.0mg/L	0	0.0mg/L	0	0.0mg/L	0	0.0mg/L	0	0.0mg/L	0
Methane	0.0 ug/L	0	0.0 ug/L	0	0.0 ug/L	0	0.0 ug/L	0	0.0 ug/L	0	0.0 ug/L	0
Oxidation Reduction Potential	266 mv	0	321 mv	0	269 mv	0	234 mv	0	210 mv	0	262 mv	0
pH	6.09	0	7.18	0	6.13	0	8.34	0	6.2	0	6.78	0
TOC	< 20 mg/L	0	< 20 mg/L	0	< 20 mg/L	0	< 20 mg/L	0	< 20 mg/L	0	< 20 mg/L	0
Temperature	< 20 C	0	< 20 C	0	< 20 C	0	< 20 C	0	< 20 C	0	< 20 C	0
CO2	NA	0	NA	0	NA	0	NA	0	NA	0	NA	0
Alkalinity*	26.8 mg/L as $CaCO_3$	0	77.7 mg/L as $CaCO_3$	0	18.1 mg/L as $CaCO_3$	0	44.9 mg/L as $CaCO_3$	0	70.8 mg/L as $CaCO_3$	0	75.6 mg/L as $CaCO_3$	0
Chloride	149 mg/L	2	247 mg/L	2	127 mg/L	2	83 mg/L	2	140 mg/L	2	61.6 mg/L	0
Hydrogen	NA	0	NA	0	NA	0	NA	0	NA	0	NA	0
VFA	NA	0	NA	0	NA	0	NA	0	NA	0	NA	0
BTEX	<0.1 mg/L	0	<0.1 mg/L	0	<0.1 mg/L	0	<0.1 mg/L	0	<0.1 mg/L	0	<0.1 mg/L	0
PCE	Material released	0	Material released	0	Material released	0	Material released	0	Material released	0	Material released	0
TCE	Daugher product of PCE	2	Daugher product of PCE	2	Negligible amounts	0	ND	0	Negligible amounts	0	ND	0
DCE	Daughter product of TCE	2	Daughter product of TCE	2	Negligible amounts	0	ND	0	Negligible amounts	0	ND	0
VC	Daughter product of DCE	2	Daughter product of DCE	2	Negligible amounts	0	ND	0	Negligible amounts	0	ND	0
Ethane/Ethene	<0.001	0	<0.001	0	<0.001	0	<0.001	0	<0.001	0	<0.001	0
Total Score		**8**		**8**		**4**		**4**		**4**		**2**

* Background alkalinity data unvailable to compare.
NA - Not Analyzed.
ND - Not Detected.

Inadequate evidence for anaerobic biodegradation of chlorinated organics: Score 0-5.
Limited evidence for anaerobic biodegradation of chlorinated organics: Score 6-14.
Adequate evidence for anaerobic biodegradation of chlorinated organics: Score 15-20.
Strong evidence for anaerobic biodegradation of chlorinated organics: Score >20.







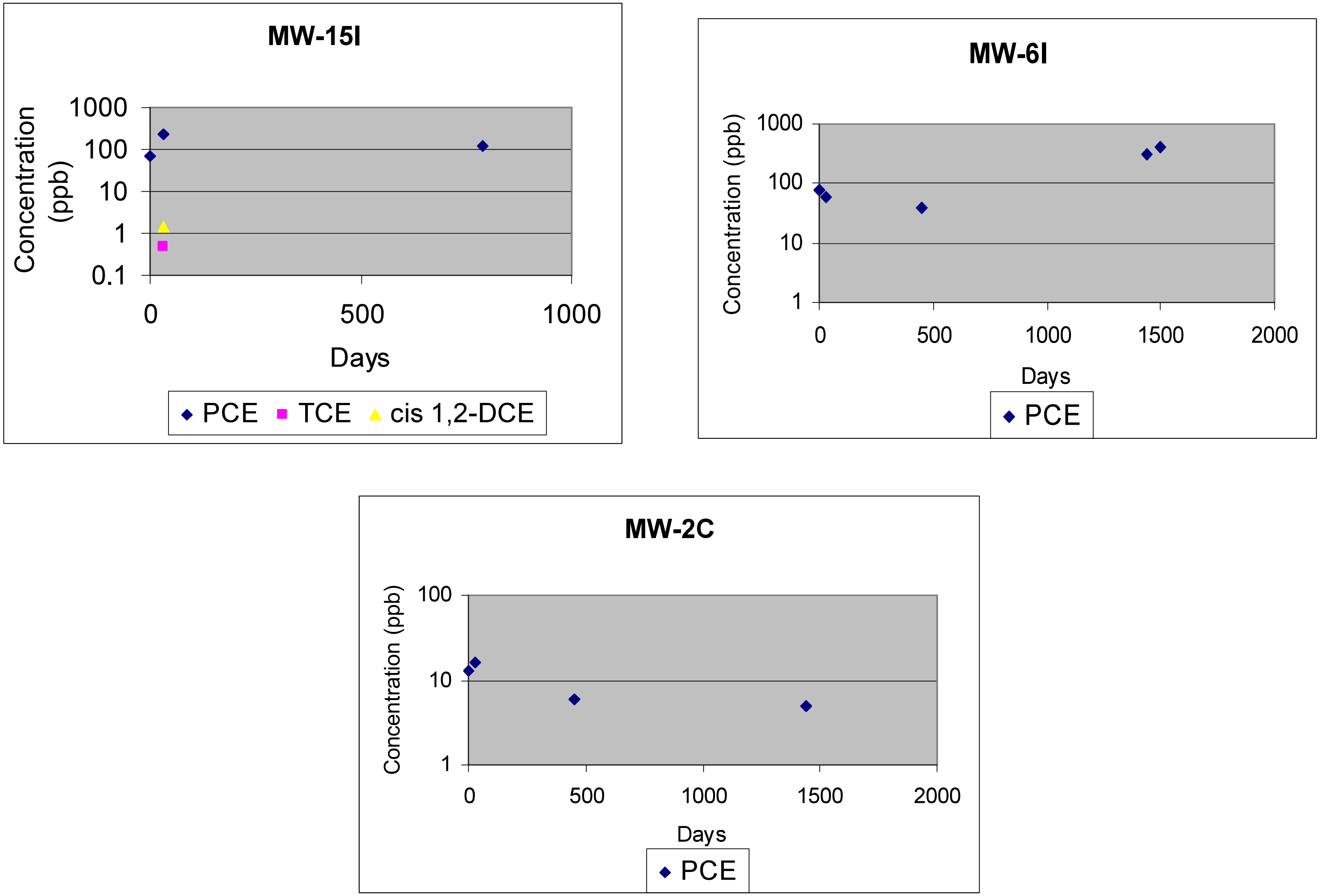
MALCOLM PIRNIE

TRENDS IN VOC CONCENTRATIONS IN SHALOW AQUIFER

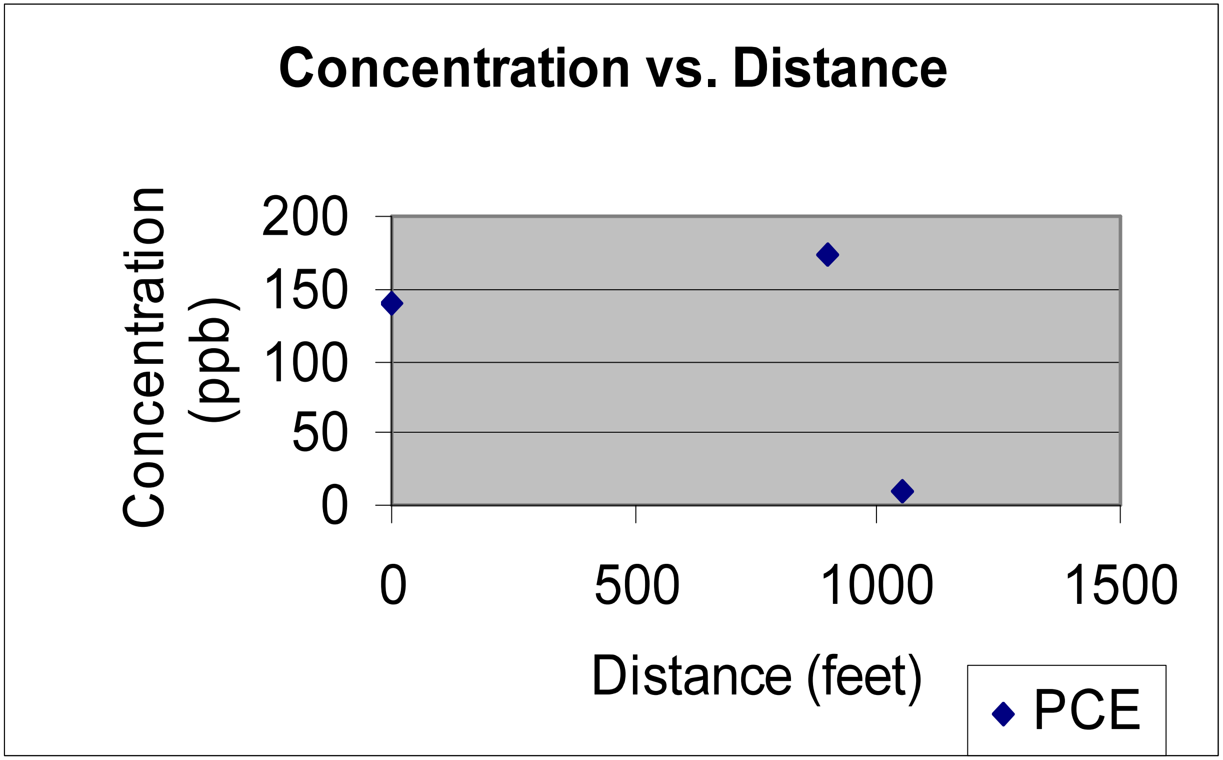
DOVER MUNICIPAL WELL NO. 4
DOVER, NEW JERSEY

MALCOLM PIRNIE, INC.

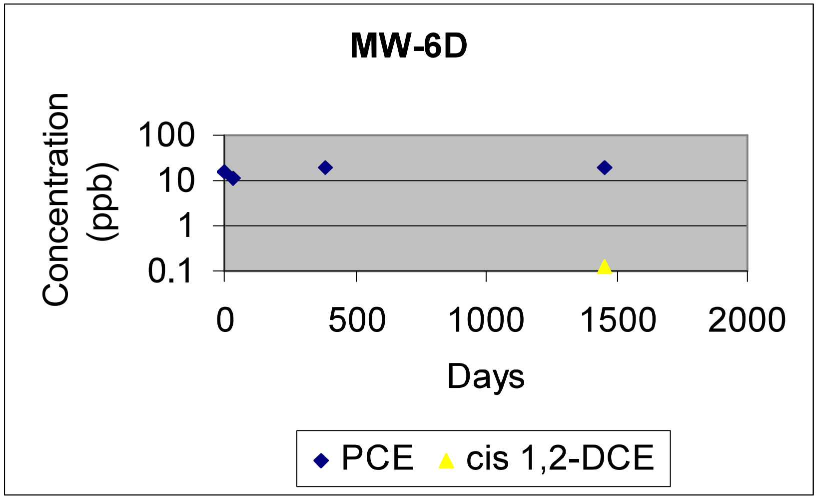
FIGURE 4-1

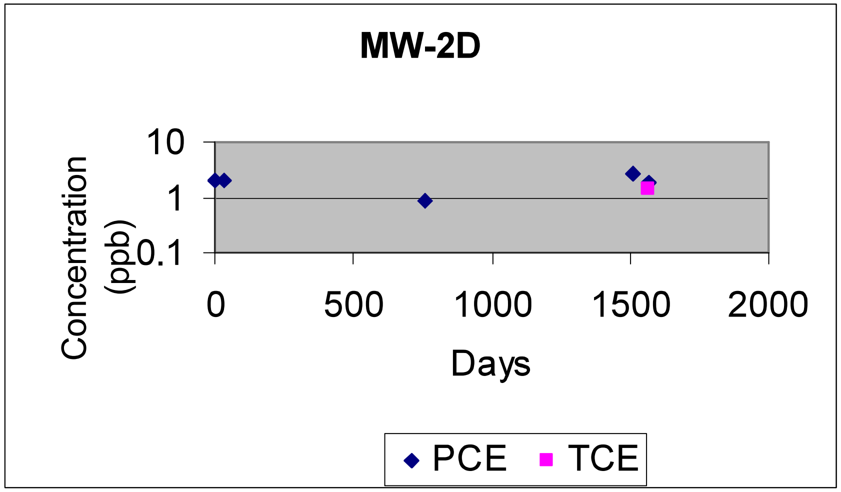


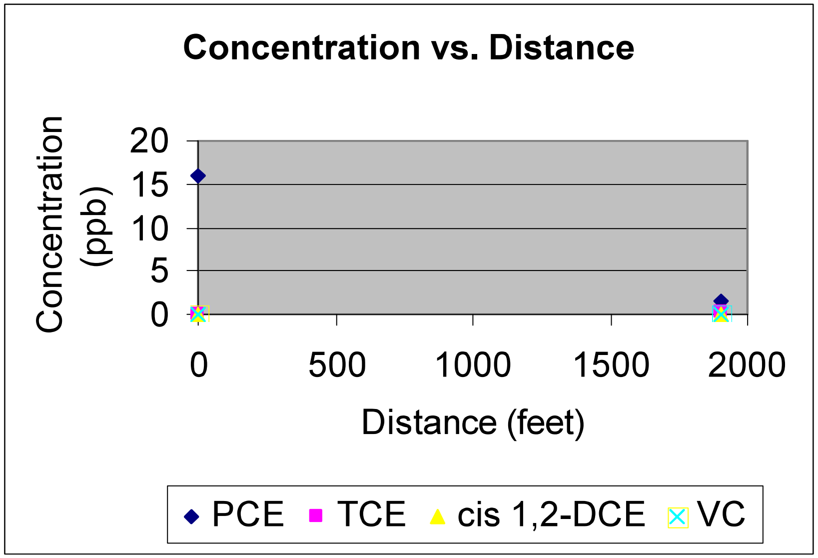
MALCOLM PIRNIE	**TRENDS IN VOC CONCENTRATIONS IN INTERMEDIATE AQUIFER** DOVER MUNICIPAL WELL NO. 4 DOVER, NEW JERSEY	MALCOLM PIRNIE, INC. **FIGURE 4-2**



MALCOLM PIRNIE	**PCE CONCENTRATIONS VERSUS DISTANCE IN INTERMEDIATE AQUIFER** DOVER MUNICIPAL WELL NO. 4 DOVER, NEW JERSEY	MALCOLM PIRNIE, INC. **FIGURE 4-3**







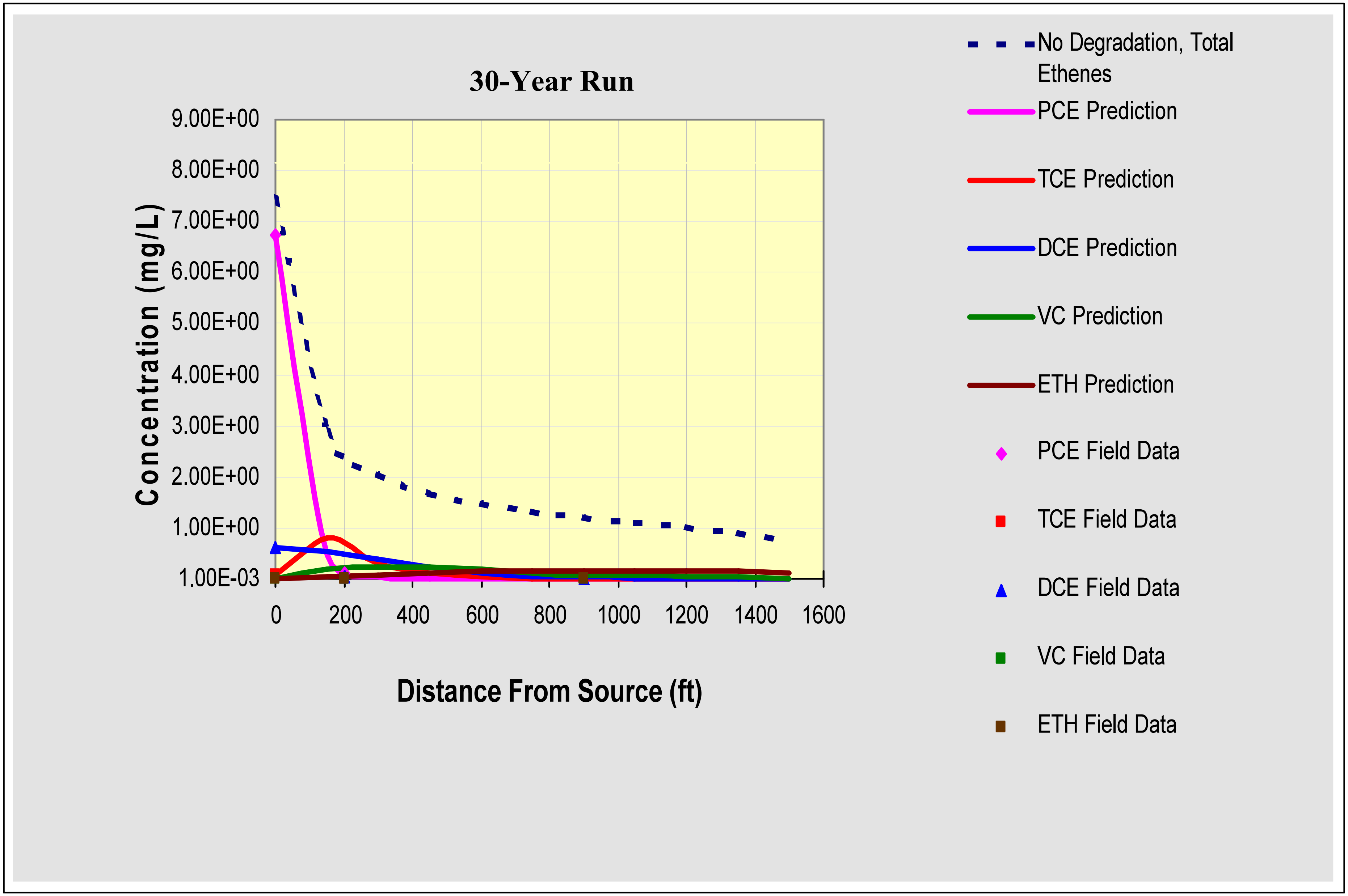
MALCOLM PIRNIE

TRENDS IN VOC CONCENTRATIONS IN DEEP AQUIFER

DOVER MUNICIPAL WELL NO. 4
DOVER, NEW JERSEY

MALCOLM PIRNIE, INC.

FIGURE 4-4



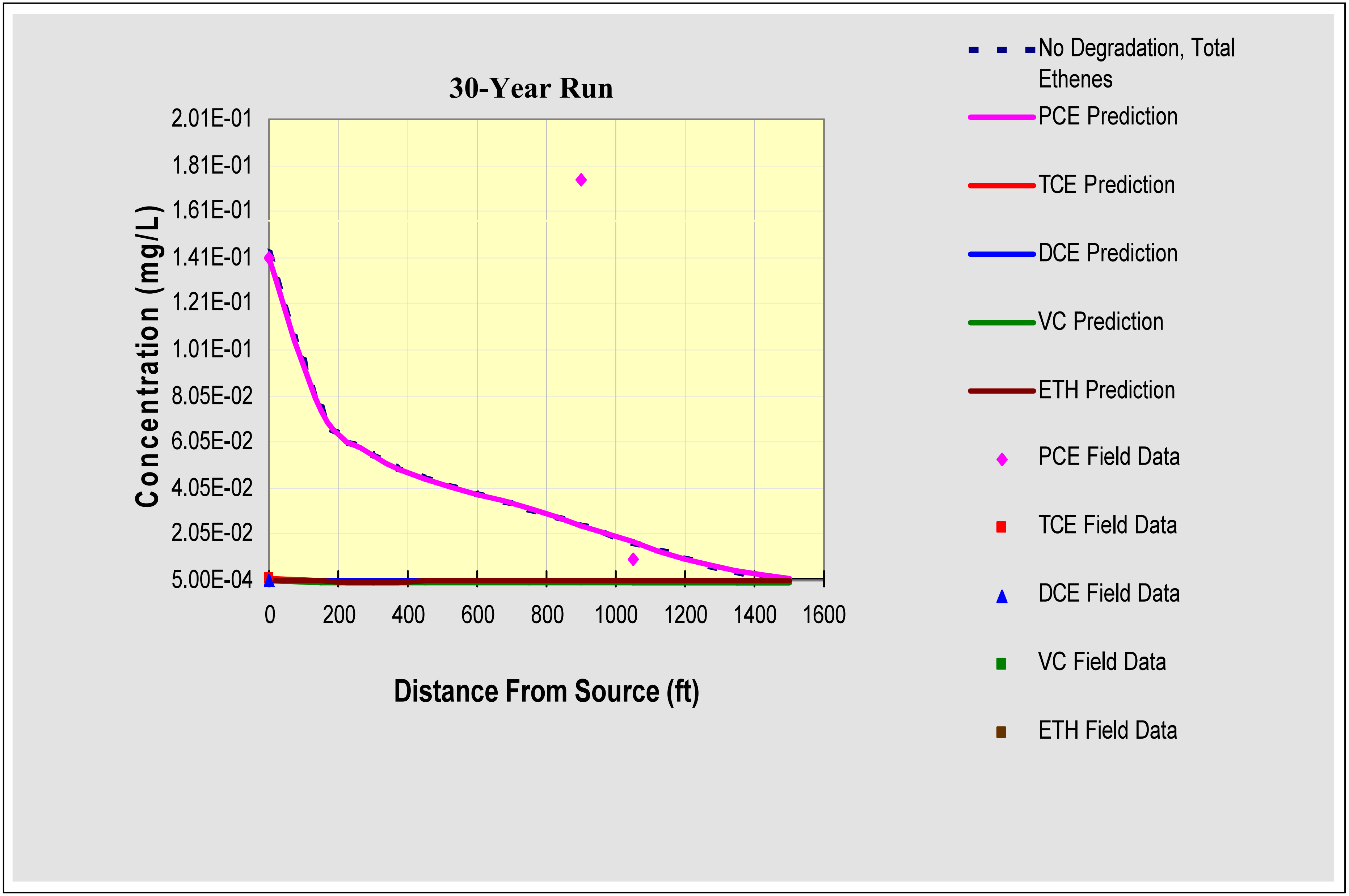
MALCOLM PIRNIE

BIOCHLOR SIMULATION FOR SHALOW AQUIFER

DOVER MUNICIPAL WELL NO. 4
DOVER, NEW JERSEY

MALCOLM PIRNIE, INC.

FIGURE 4-5



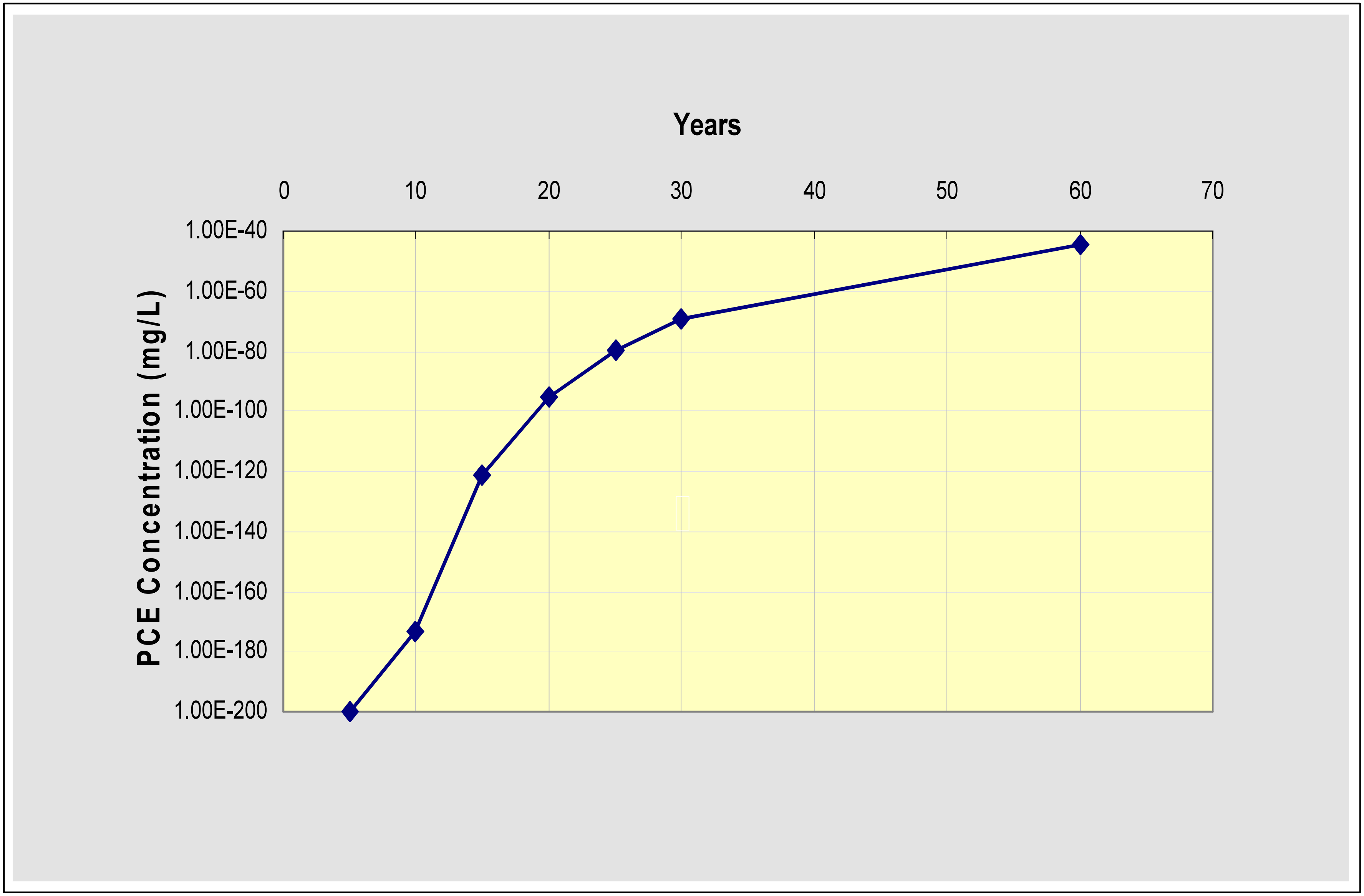
MALCOLM PIRNIE

BIOCHLOR SIMULATION FOR INTERMEDIATE AQUIFER

DOVER MUNICIPAL WELL NO. 4
DOVER, NEW JERSEY

MALCOLM PIRNIE, INC.

FIGURE 4-6



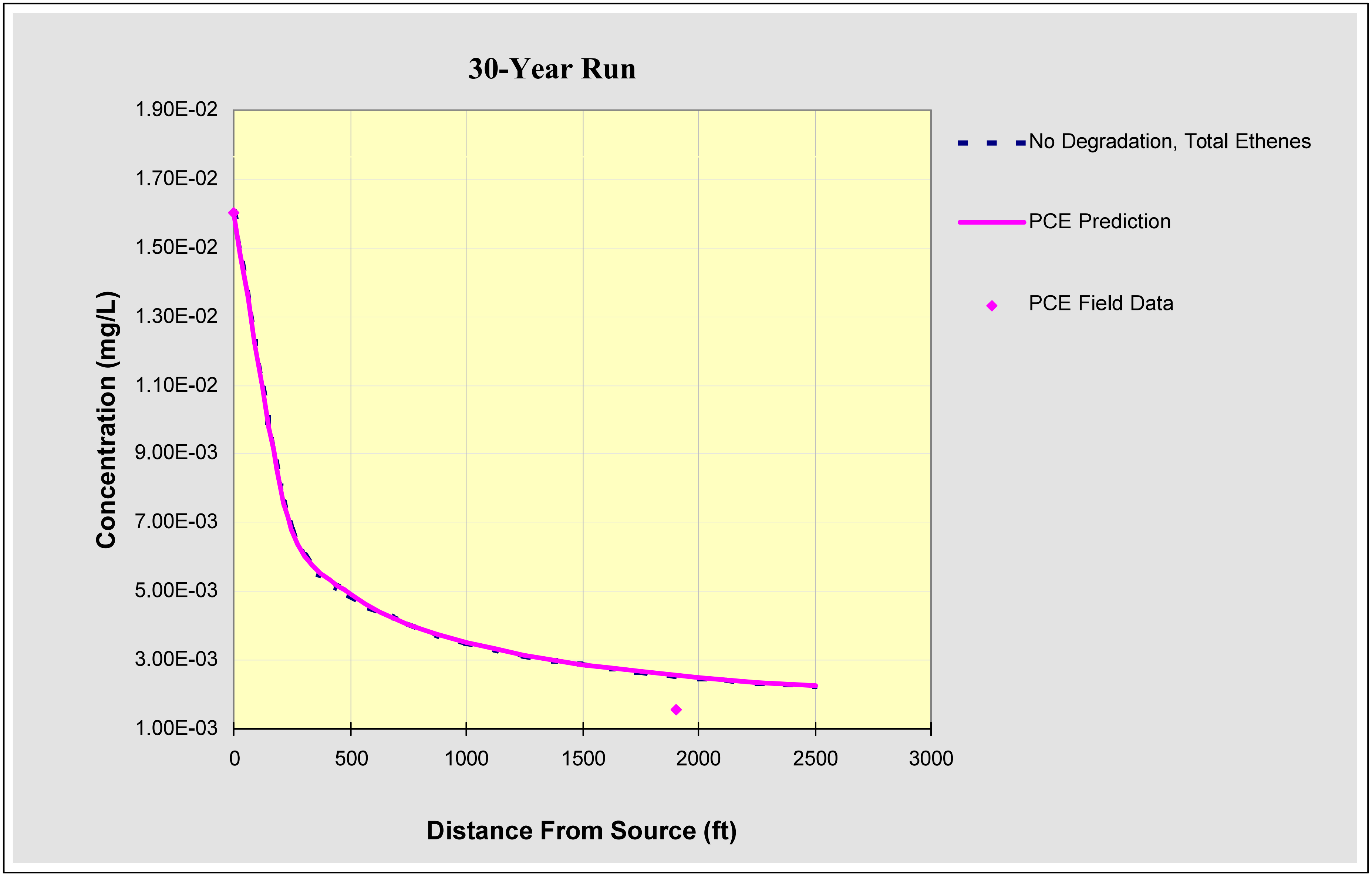
MALCOLM PIRNIE

CONCENTRATION OF PCE AT HOWMET WELL (SLUG ANALYSIS)

DOVER MUNICIPAL WELL NO. 4
DOVER, NEW JERSEY

MALCOLM PIRNIE, INC.

FIGURE 4-7



MALCOLM PIRNIE

BIOCHLOR SIMULATION FOR DEEP AQUIFER

DOVER MUNICIPAL WELL NO. 4
DOVER, NEW JERSEY

MALCOLM PIRNIE, INC.

FIGURE 4-8

EXHIBIT E.2

Conceptual Site Model

(Source: Eight Annual Long-Term Response Action Groundwater Monitoring Report, January 2023)

3. CONCEPTUAL SITE MODEL

3.1 CONTAMINANTS OF CONCERN

Groundwater cleanup standards identified in the 2005 ROD are the more stringent of the federal maximum contaminant levels (MCLs), the New Jersey MCLs, and the New Jersey Groundwater Quality Standards (GWQS). A comparison of the VOC concentrations in groundwater to the MCLs and GWQS showed that PCE, TCE, *cis*-1,2-dichloroethene (*cis*-1,2-DCE), vinyl chloride (VC), and 1,1,2-TCA are the contaminants of concern (COCs) in groundwater. **Table 3-1** lists the groundwater COCs and their associated cleanup criteria.

3.2 SUMMARY OF HISTORICAL GROUNDWATER DATA

Prior to the LTRA monitoring program, groundwater data were collected at various shallow, intermediate, and deep wells located throughout OU1 during 15 sampling events conducted between September 1998 and September 2011. Groundwater monitoring was performed at 17 wells in early July 2011 to assist in planning for long-term monitoring. Many of the wells sampled during the July 2011 event had not been sampled since May 2007. The results of the September 1998 and July 2011 sampling event along with quarterly sampling data from December 2013 through September 2017 are summarized in tables that are provided in **Appendix A**. An interpretation of the historical groundwater data collected prior to and during the first 6 years of the LTRA groundwater monitoring program from the shallow, intermediate, and deep aquifers is discussed below.

3.3 NATURE AND EXTENT OF CONTAMINANTS OF CONCERN

DMW4 extracted groundwater from the deep aquifer from 1965 until 1980 at which time it was taken out of service because of the presence of chlorinated VOCs. Construction details for DMW4 are provided on **Figure 3-1**. Operation of DMW4 likely accelerated the migration of chlorinated VOCs from the shallow aquifer to the intermediate and deep aquifers, and ultimately to the well. Unconsolidated sediments, which fill the Rockaway River Valley, consist of fine sand and silt layers that act as confining units between the more permeable aquifers above and below them. In the valley close to DMW4, two silt layers separate the sand into three aquifers, an upper water table aquifer (shallow aquifer), and two underlying semi-confined aquifers, identified as intermediate and deep aquifers.

The 1990 RI conducted by NJDEP identified chlorinated VOCs near DMW4. PCE was detected north of DMW4 in the intermediate and deep glacial sand and gravel aquifers (TRC Environmental Consultants, Inc. 1990).

The 1990 RI did not define the source of the groundwater contamination. Between 1999 and 2003, EPA conducted a Preliminary Design Investigation as part of the OU1 Remedial Design. Groundwater and soil samples collected in 2001 indicated that the source of the chlorinated VOCs detected in DMW4 was contaminated soil located beneath and adjacent to the former dry-cleaner building at 272 U.S. Route 46. Elevated PCE concentrations detected in a sediment sample collected from the sump in the basement of the dry-cleaner building indicated that one possible release mechanism was the direct discharge of chlorinated cleaning solvents into the sump. Elevated PCE concentrations were also detected in the unsaturated soil beneath the parking lot east of the dry-cleaner building indicating surface spills or discharges in this area.

As discussed in Section 1.1, EPA excavated and removed contaminated unsaturated soil from the Site and adjacent properties. Based on soil sampling performed in July 2010, after the first phase of ISCO treatment, concentrations of VOCs absorbed onto saturated soil were significantly reduced (Malcolm Pirnie, Inc. 2010), with residual PCE concentrations in soil below the ROD cleanup criteria. The results from the September 2011 and February 2012 monitoring conducted following completion of the Phase 2 ISCO treatment showed that VOC concentrations in the source area near the former dry-cleaner building had decreased significantly. Subsequent quarterly groundwater monitoring from 2013 through 2015, and semi-annual sampling in 2016 indicated the shallow, intermediate, and deep aquifer PCE plumes were stable or shrinking. However, PCE in the source area wells (i.e., PW-7S, MW-15S, and MW-15IR) continued to be detected at concentrations above cleanup criteria specified in the 2005 ROD.

Once discharged into the sump and adjacent to the building, the chlorinated solvents moved through the unsaturated soil and into the shallow aquifer. Groundwater in the shallow aquifer flows toward the Rockaway River. However, sampling data indicates that groundwater contamination does not extend to the river. **Figure 3-2** shows the COCs in groundwater samples collected from shallow monitoring wells and shows the approximate extent of the shallow groundwater plume. The presence of compounds typically associated with the intrinsic biodegradation of PCE (TCE, *cis*-1,2-DCE, and VC) indicates that biologically driven natural attenuation may play a role in controlling the rate and extent of shallow aquifer plume migration. Advection, dispersion, and sorption are also contributing to the natural attenuation of chlorinated VOC concentrations within the shallow aquifer.

Groundwater sampling results also show that chlorinated VOCs have migrated through the shallow aquifer and first aquitard into the intermediate aquifer immediately downgradient of the Site. **Figure 3-3** shows the COCs in groundwater samples collected from intermediate monitoring wells and shows the approximate extent of the intermediate groundwater plume. Groundwater flow in the intermediate aquifer is toward the southeast. During previous sampling events, chlorinated VOCs were detected in the intermediate aquifer as far as Carrol Street, approximately 1,400 ft southeast of the Site. The intermediate plume has been relatively stable over time; geochemical indicators do not indicate that significant biodegradation is occurring. Advection, dispersion, and sorption processes are contributing to the natural attenuation of the chlorinated VOCs within the intermediate aquifer.

Groundwater sampling results also show that chlorinated VOCs have migrated through the intermediate aquifer into the deep aquifer. **Figure 3-4** shows the COCs in groundwater samples collected from deep monitoring wells and the extent of contaminated groundwater in the deep aquifer. In May 2017, concentrations of PCE above the groundwater standard of 1.0 micrograms per liter (µg/L) were detected in MW-19DR (15 µg/L), the second furthest downgradient monitoring well. PCE was not detected in groundwater samples collected from furthest downgradient well MW-2D in May 2017. In April 2018, PCE continued to be detected at a concentration above the groundwater standard in MW-19DR (31 µg/L), while PCE concentrations continued to be detected below the 1.0 µg/L groundwater standard at MW-2D. The March and September 2020 results continue to display the same trend with elevated PCE concentrations in MW-19DR at 8.4 µg/L and 7.6 µg/L respectively, with no detections in MW-2D. March and September 2021 results are concurrent with the previous trends for PCE (16.3 µg/L and 18.0 µg/L respectively); however, PCE was detected in MW2D (123 ft) at a concentration of 0.99 µg/L. The March and August 2022 results continue to display a similar trend with elevated PCE concentrations in MW-19DR at 25.7 µg/L and 32.5 µg/L, respectively. PCE was detected in MW-2D (123 ft) at 2.26 µg/L and MW-2D (128 ft) at 0.51 µg/L.

3.4 CURRENT AND FUTURE POTENTIAL RECEPTORS

The Final RI Report (Malcolm Pirnie, Inc. 2005a) contained a human health evaluation and screening-level ecological risk assessment, which established current and future potential receptors for groundwater.

Currently, the Town of Dover supplies treated potable water. The water supply is obtained from local groundwater wells not including DMW4, which has been out of service since 1980. Therefore, there are no human receptors currently exposed through potable use of the groundwater. Should DMW4 become operational in the future while groundwater concentrations still exceed health-based screening levels, potential future human receptors include residents and commercial/industrial workers, if exposed to untreated water. Considering the depth to groundwater in the vicinity of the Site may be as shallow as 4 to 5 ft, construction/utility workers may be exposed to groundwater that infiltrates an excavation for construction/utility work; and are therefore, current and future potential receptors.

Terrestrial ecological receptors are not expected to have direct contact with contaminated groundwater. Groundwater in the shallow aquifer flows toward the Rockaway River. However, sampling data indicate groundwater contamination does not extend to the river. Therefore, there are no ecological receptors currently exposed to contaminated groundwater.

Vapor intrusion into occupied structures is a potential receptor pathway. In 2003, EPA initiated a monitoring program to determine whether contaminated groundwater present beneath residences in the vicinity of OU2 was a source of vapor intrusion. EPA performed sub-slab soil gas sampling, as well as indoor and ambient outdoor sampling in 12 homes located near the dry-cleaner property. Six of the homes indicated a potential for exposure to PCE and TCE. Three of the six homes were demolished as part of the remedy. The remaining three houses are currently being monitored by EPA for vapor intrusion.

3.5 SUMMARY OF PREVIOUS MONITORED NATURAL ATTENUATION EVALUATION

MNA was evaluated as a remedial alternative for the shallow, intermediate, and deep aquifers in the Final Feasibility Study, DMW4, OU2, Dover, New Jersey (Malcolm Pirnie, Inc. 2005b). The 2005 evaluation included plume stability evaluations for chlorinated VOCs in the shallow, intermediate, and deep aquifers. Geochemical data collected from the three aquifers were also evaluated to assess whether intrinsic bioremediation was occurring. Solute transport modeling was performed using the BIOCHLOR model. The results of the 2005 MNA evaluation are summarized below. Tables and figures from the 2005 MNA evaluation are provided in **Appendix B**.

In November 2013, groundwater data were also collected to assess the effectiveness of biodegradation as a mechanism for natural attenuation in the shallow aquifer. Groundwater samples for analysis of biodegradation indicator parameters were collected using low-flow sampling methods from select LTRA wells screened in the shallow aquifer (MW-5S, MW-11S, MW-15S, MW-17S, and PW-7S). Biodegradation indicator parameters included alkalinity, total organic carbon (TOC), chloride, nitrate, sulfate, ferrous iron, and dissolved gases (methane, ethane, and ethene). Analytical results and evaluation of these data were presented in the first annual LTRA groundwater monitoring report (Arcadis 2015).

In March 2020, groundwater samples were collected from each aquifer for VOC and MNA parameters from 29 LTRA monitoring wells using low-flow sampling techniques. The analytical results and evaluation of these data were presented in the sixth annual LTRA groundwater monitoring report (EA 2021) and are also presented in **Appendix B**.

3.5.1 Plume Stability

A historical database showing statistically significant plume stabilization and/or loss of contaminant mass over time can be used to demonstrate that natural attenuation is occurring at a Site. For the 2005 MNA evaluation, the concentrations of PCE, TCE, *cis*-1,2-DCE, and VC were plotted versus time on a logarithmic scale for each monitoring well. The best-fit line was then determined by linear regression and evaluated to determine if the slope of the line was significant at the 95 percent significance level (**Appendix B**, [Figures 4-1 through 4-4 for graphs of the data, and Table 4-2 for a table showing the F-statistic calculated for the regression analyses]). For the shallow aquifer plume, the data suggested that PCE and its daughter products were attenuating downgradient from the source area. The primary attenuation mechanisms were initially deemed to be anaerobic biodegradation, advection, and dispersion. Anaerobic biodegradation was evaluated in 2005 and is further discussed below. The intermediate aquifer plume was determined to be stable, as the data indicated that the total mass and plume size remained essentially the same over the period of time from which data were available. For the deep aquifer plume, data indicated that the plume was relatively stable.

Based on the analytical results from the March 2020 sampling event, it can be noted that plume sizes have been reduced over time and trends continue to remain the same for each aquifer. Although, continued high PCE concentrations in the source area indicate that biodegradation efficacy is not rapid enough to significantly reduce PCE back diffusion rates still present within the former source area.

3.5.2 Geochemical Evaluation

Groundwater geochemical data were evaluated to assess whether intrinsic bioremediation was occurring in the groundwater plumes. In the shallow aquifer, elevated chloride concentrations at source area wells and the presence of PCE daughter products suggested that reductive dechlorination was occurring. However, the absence of methane/ethane/ethene indicated incomplete biotransformation of PCE to methane/ethane/ethene. In the intermediate and deep aquifers, chloride concentrations were higher in downgradient wells than in upgradient wells, suggesting that reductive dechlorination may have been occurring. However, unlike in the shallow aquifer, no PCE daughter products were detected in the intermediate and deep aquifers.

A bioattenuation screening process was employed in accordance with the Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater (EPA 1998). Table 4-3 in **Appendix B** presents the results of the scoring performed for various monitoring locations in the shallow, intermediate, and deep aquifer wells.

Results of the bioattenuation screening for the 2005 MNA sampling event indicated that there was limited evidence of anaerobic biodegradation in the shallow aquifer, and inadequate evidence of anaerobic biodegradation in the intermediate and deep aquifers. However, other degradation mechanisms including dilution, dispersion, abiotic degradation, and co-metabolic degradation, may be a factor in reducing contaminant concentrations, particularly in the shallow aquifer. Further evaluation of natural attenuation was completed in 2020, during which biodegradation parameters (TOC, dissolved gases [methane/ethane/ethene], sulfide, sulfate, nitrate, chloride, and ferrous iron) were collected in addition to the VOC samples.

3.5.3 Solute Transport Modeling

Solute transport modeling was conducted using the analytical model BIOCHLOR, which has the ability to simulate 1-dimensional advection, 3-dimensional dispersion, linear adsorption, and biotransformation via reductive dechlorination. Model runs for all aquifers were simulated for a 30-year time period. For the shallow aquifer, biodegradation was incorporated in the model based on the geochemical results described above. The model indicated that the PCE plume would attenuate prior to reaching the nearest shallow aquifer receptor, which was determined to be the Rockaway River.

For the intermediate and deep aquifers, model simulations were performed without biodegradation because geochemical data indicated that biodegradation was not a significant attenuating mechanism in these aquifers. In the intermediate aquifer, simulations were performed to evaluate whether other attenuation mechanisms could control the rate and extent of plume migration so that cleanup standards would not be exceeded at the closest receptor (the Howmet property well located at 9-10 Roy Street, approximately 3,000 ft downgradient of MW-2C). The simulations showed that significant attenuation in terms of dilution and dispersion would occur before the chlorinated VOCs in the intermediate aquifer would reach the Howmet well.

No potential human or ecological receptors were identified for the deep aquifer (given that DMW4 is no longer used); therefore, the objective of the modeling for the deep aquifer was to assess plume behavior over 30 years. Results from the model simulation suggested the PCE concentrations would attenuate below cleanup standards approximately 500 to 600 ft beyond MW-2D. Figures 4-5 through 4-8 in **Appendix B** illustrate the BIOCHLOR model output for all three aquifer simulations.

EXHIBIT F

Well Search Results

Exhibit F
One-Mile Radius Well Search Results
Dover Municipal Well No. 4 Superfund Site
Dover, New Jersey

Well Permitting XY Well Search - 1,425 wells found within One Mile of Easting = 480146 Northing = 748251

Data Source: State of New Jersey, Department of Environmental Protection, DEP DataMiner XY Well Permit Search ,
https://njems.nj.gov/DataMiner//Report/ReportCriteria?isExternal=y&apiKey=DEP123&itemCUID=AVBjxKUG0eJMsuLrVdA9g_c&BOReportName=XY%20Well%20Permit%20Search

Permit Number	Well Use	Well Name	Potentially Potable	Document	Date (permitted /drilled /sealed)	Physical Address	County	Municipality	Block	Lot	Location Method	Easting (X)	Northing (Y)	Distance (Feet)	Depth (ft)	Capacity (gal/min)
E202400997	Monitoring	A-4R	No	Permit	1/31/2024	271 RICHARDS AVE A&B	Morris	Dover Town	2310	9	GPS	480176	748177	79.85	17.5	0
E202400978	Monitoring	A-3R	No	Permit	1/30/2024	276 U S HWY 46	Morris	Dover Town	2310	10	GPS	480148	748203	48.04	17.5	0
E202400968	Monitoring	PW-14D-R	No	Permit	1/30/2024	272 U S HWY 46	Morris	Dover Town	2310	8.01	GPS	480137	748215	37.11	32	0
E202400966	Monitoring	PW-14I-R	No	Permit	1/30/2024	272 U S HWY 46	Morris	Dover Town	2310	8.01	GPS	480138	748218	33.96	23.5	0
E202400965	Monitoring	PW-14S-R	No	Permit	1/30/2024	272 U S HWY 46	Morris	Dover Town	2310	8.01	Digital Image	480135	748218	34.79	16.5	0
E202400964	Monitoring	MW-21S-U	No	Permit	1/30/2024	272 U S HWY 46	Morris	Dover Town	2310	8.01	Digital Image	480115	748259	32.02	17.5	0
E202311449	Monitoring	MW-3R	No	Permit	11/2/2023	20 Sammis Ave	Morris	Dover Town	2313	2	Digital Image	480985	747466	1,148.98	15	0
E202311448	Monitoring	MW-1R	No	Permit	11/2/2023	20 Sammis Ave	Morris	Dover Town	2313	2	Digital Image	480955	747472	1,123.09	15	0
E202305371	Monitoring	MW-21A	No	Permit	5/30/2023	220 Franklin Road	Morris	Randolph Twp	195	12	Digital Image	484186	744431	5,560.04	55	0
E202304920	Monitoring	MW-018	No	Permit	5/16/2023	10 ROY ST	Morris	Rockaway Twp	10101	29	Digital Image	484022	746878	4,112	15	0
E202304919	Monitoring	MW-014	No	Permit	5/16/2023	10 ROY ST	Morris	Rockaway Twp	10101	29	Digital Image	484446	746512	4,638.33	15	0
E202304918	Monitoring	MW-006	No	Permit	5/16/2023	10 ROY ST	Morris	Rockaway Twp	10101	30	Digital Image	484967	746119	5,271.38	15	0
E202304917	Monitoring	MW-005	No	Permit	5/16/2023	10 ROY ST	Morris	Rockaway Twp	10101	30	Digital Image	485203	745891	5,580.58	15	0
E202304916	Monitoring	MW-004	No	Permit	5/16/2023	10 ROY ST	Morris	Rockaway Twp	10101	30	Digital Image	484874	745930	5,266.97	15	0
E202304915	Monitoring	MW-003	No	Permit	5/16/2023	10 ROY ST	Morris	Rockaway Twp	10101	30	Digital Image	484561	746153	4,888.13	15	0
E202304914	Monitoring	MW-001	No	Permit	5/16/2023	10 ROY ST	Morris	Rockaway Twp	10101	30	Digital Image	484751	745945	5,150.11	15	0
E202209384	Monitoring	MW-4	No	Permit	8/26/2022	Route 15	Morris	Rockaway Twp	10902	1	Digital Image	473636	753335	8,259.97	20	0
E202209383	Monitoring	MW-3	No	Permit	8/26/2022	Route 15	Morris	Rockaway Twp	10902	1	Digital Image	473778	753531	8,272.23	20	0
E202202860	Recovery	RW-1	No	Permit	3/16/2022	258 S Salem St	Morris	Randolph Twp	195	21	Digital Image	482671	743622	5,272.88	15	5
E202202659	Monitoring	MW-1	No	Permit	3/9/2022	E Blackwell St	Morris	Dover Town	510	8	Digital Image	478397	746678	2,352.3	20	0
E202201473	Domestic	Well 1	Yes	Permit	2/18/2022	125 Mt. Pleasant Avenue	Morris	Rockaway Twp	11115	35.02	Digital Image	484418	753325	6,632.91	300	10
E202200016	Monitoring	MW-22AB	No	Permit	1/3/2022	220 Franklin Road	Morris	Randolph Twp	195	12	Digital Image	484270	744206	5,776.63	55	0
E202200015	Monitoring	MW-21AB	No	Permit	1/3/2022	220 Franklin Road	Morris	Randolph Twp	195	12	Digital Image	484223	744354	5,639.91	55	0
E202200014	Monitoring	MW-20	No	Permit	1/3/2022	220 Franklin Road	Morris	Randolph Twp	195	12	Digital Image	483542	744022	5,423.77	55	0
E202111258	Monitoring	MW-2R	No	Permit	11/1/2021	SE corner of Rt 10 exit ramp clover leaf	Morris	Denville Twp	ROW	ROW	Digital Image	486476	742600	8,485.44	20	0
E202110389	Monitoring	PMW-3RR	No	Permit	10/12/2021	353 E Blackwell St	Morris	Dover Town	2318	1	Digital Image	480967	747109	1,406.49	15	0
E202109621	Monitoring	RW-1	No	Permit	9/22/2021	267 US Route 46	Morris	Dover Town	2308	2	Digital Image	480157	748356	105.57	50	0
E202108810	Monitoring	MW-39D	No	Permit	8/30/2021	395 FRANKLIN AVE	Morris	Rockaway Boro	84	7.01	Digital Image	486776	747779	6,646.78	40	0
E202108809	Monitoring	MW-38D	No	Permit	8/30/2021	SE SIDE OF ROCKRIVER	Morris	Rockaway Boro	84	20	Digital Image	486229	747834	6,097.28	40	0
E202108808	Monitoring	MW-38I	No	Permit	8/30/2021	SE SIDE OF ROCKRIVER	Morris	Rockaway Boro	84	20	Digital Image	486231	747836	6,099.14	40	0
E202108807	Monitoring	MW-38S	No	Permit	8/30/2021	SE SIDE OF ROCKRIVER	Morris	Rockaway Boro	84	20	Digital Image	486233	747838	6,100.99	40	0
E202108806	Monitoring	MW-20D	No	Permit	8/30/2021	SE SIDE OF ROCKRIVER	Morris	Rockaway Boro	84	20	Digital Image	486566	748271	6,420.03	40	0
E202108805	Monitoring	MW-19D	No	Permit	8/30/2021	SE SIDE OF ROCKRIVER	Morris	Rockaway Boro	84	20	Digital Image	486410	748182	6,264.38	40	0
E202107684	Recovery	RW 12	No	Permit	7/28/2021	353 E Blackwell St / Job 6802	Morris	Dover Town	2318	1	GPS	481040	747081	1,472.46	23	1
E202107683	Recovery	RW 11	No	Permit	7/28/2021	353 E Blackwell St / Job 6802	Morris	Dover Town	2318	1	GPS	481018	747096	1,447.21	23	1
E202107682	Recovery	RW 10	No	Permit	7/28/2021	E Blackwell St / Job 6802	Morris	Dover Town	R.O.W.	R.O.W.	GPS	480961	747086	1,421.78	30	1
E202105720	Boring/Individual	VDTW-4	No	Permit	6/3/2021	20 Sammis Ave	Morris	Dover Town	2313	2	Digital Image	480975	747465	1,142.38	140	0
E202011958	Monitoring	MW-11	No	Permit	11/6/2020	246 US Highway 46	Morris	Dover Town	2023	2	Digital Image	479346	748487	834.08	20	0
E202011957	Monitoring	MW-10	No	Permit	11/6/2020	246 US Highway 46	Morris	Dover Town	2023	2	Digital Image	479399	748552	805.36	20	0
E202011956	Monitoring	MW-9	No	Permit	11/6/2020	246 US Highway 46	Morris	Dover Town	2023	2	Digital Image	479408	748608	819.81	20	0
E202011955	Monitoring	MW-8	No	Permit	11/6/2020	246 US Highway 46	Morris	Dover Town	2023	2	Digital Image	479293	748638	936.68	20	0
E202011316	Monitoring	VTW-1B	No	Permit	10/21/2020	200 Richards Ave	Morris	Dover Town	1905	50	Digital Image	479253	747882	966.23	70	0
E202010999	Monitoring	MW-4R	No	Permit	10/14/2020	4 Commerce Center Drive	Morris	Dover Town	901	1.06	Digital Image	476435	752295	5,488.67	30	0
E202010807	Monitoring	MW-3	No	Permit	10/9/2020	60 N Sussex St.	Morris	Dover Town	1325	1	Digital Image	476021	747772	4,152.72	20	0
E202010806	Monitoring	MW-2	No	Permit	10/9/2020	60 N Sussex St.	Morris	Dover Town	1325	1	Digital Image	476046	747817	4,122.91	20	0
E202010805	Monitoring	MW-1	No	Permit	10/9/2020	60 N Sussex St.	Morris	Dover Town	1325	1	Digital Image	475982	747794	4,189	20	0
E202010385	Monitoring	MW-4R	No	Permit	10/1/2020	4 Commerce Center Drive	Morris	Dover Town	901	1.06	GPS	476430	752197	5,420.29	26	0
E202009476	Monitoring	MW-3	No	Permit	9/10/2020	59 East Mc Farlan Street	Morris	Dover Town	1308	7	Digital Image	476654	748398	3,495.09	15	0
E202009475	Monitoring	MW-2	No	Permit	9/10/2020	59 East Mc Farlan Street	Morris	Dover Town	1308	7	Digital Image	476640	748432	3,510.67	15	0
E202009474	Monitoring	MW-1	No	Permit	9/10/2020	59 East Mc Farlan Street	Morris	Dover Town	1308	7	Digital Image	476666	748453	3,485.86	15	0
E202008727	Monitoring	MW-11	No	Permit	8/24/2020	3164 Rt 10	Morris	Denville Twp	20801	30	Digital Image	485982	742756	8,015.85	60	0
E202008726	Monitoring	MW-1D	No	Permit	8/24/2020	3164 Rt 10	Morris	Denville Twp	20801	30	Digital Image	485954	742983	7,841.22	60	0
E202006225	Monitoring	MW-10R	No	Permit	6/15/2020	NW Corner of Route 10 (exit ramp)	Morris	Denville Twp	ROW	ROW	Digital Image	486465	742590	8,483.91	25	0
E202003734	Boring/Individual	B-7	No	Permit	4/8/2020	20 Sammis Avenue	Morris	Dover Town	2313	2	Digital Image	480920	747420	1,135.62	50	0
E202002513	Monitoring	MW-9	No	Permit	3/9/2020	116 E Blackwell Street	Morris	Dover Town	1902	4	Digital Image	477639	747171	2,729.73	20	0
E202002477	Monitoring	MW-8	No	Permit	3/9/2020	112 E Blackwell Street	Morris	Dover Town	1902	3	Digital Image	477599	746959	2,855.95	30	0
E202002476	Monitoring	MW-7	No	Permit	3/9/2020	112 E Blackwell Street	Morris	Dover Town	1902	3	Digital Image	477572	747105	2,817.59	30	0
E202002445	Boring/Individual	B-6	No	Permit	3/9/2020	20 Sammis Ave	Morris	Dover Town	2313	2	Digital Image	481000	747425	1,188.1	50	0
E202002444	Boring/Individual	B-5	No	Permit	3/9/2020	20 Sammis Ave	Morris	Dover Town	2313	2	Digital Image	480980	747405	1,187.97	50	0
E202002443	Boring/Individual	B-4	No	Permit	3/9/2020	20 Sammis Ave	Morris	Dover Town	2313	2	Digital Image	480910	747410	1,136.21	50	0
E202002442	Boring/Individual	B-3	No	Permit	3/9/2020	20 Sammis Ave	Morris	Dover Town	2313	2	Digital Image	480925	747424	1,136.12	50	0
E202002441	Boring/Individual	B-2	No	Permit	3/9/2020	20 Sammis Ave	Morris	Dover Town	2313	2	Digital Image	480980	747490	1,129.02	50	0

APPENDIX D - REMEDY RESILIENCE ASSESSMENT

In accordance with the Region 2 practice, two tools were utilized to assess the Dover Well No. 4 Site. Screenshots from each of the tools assessed are included here.

The first tool utilized is the U.S. Landslide inventory. The site is not associated with any landslide concerns, as shown on Figure D-1. The final tool is CMRA, which identifies Morris county as relatively high risk of flooding (Figure D-5).

Increases in temperature over time are not expected to impact the site. The site itself is also located at a higher elevation away from the coastline, has low flood risks, and the topography of the area does not make the groundwater wells vulnerable to landslides. Thus, the performance of the remedy is currently not at risk due to the expected effects of severe weather events in the region and near the site.

Figure D-1 Landslide Inventory

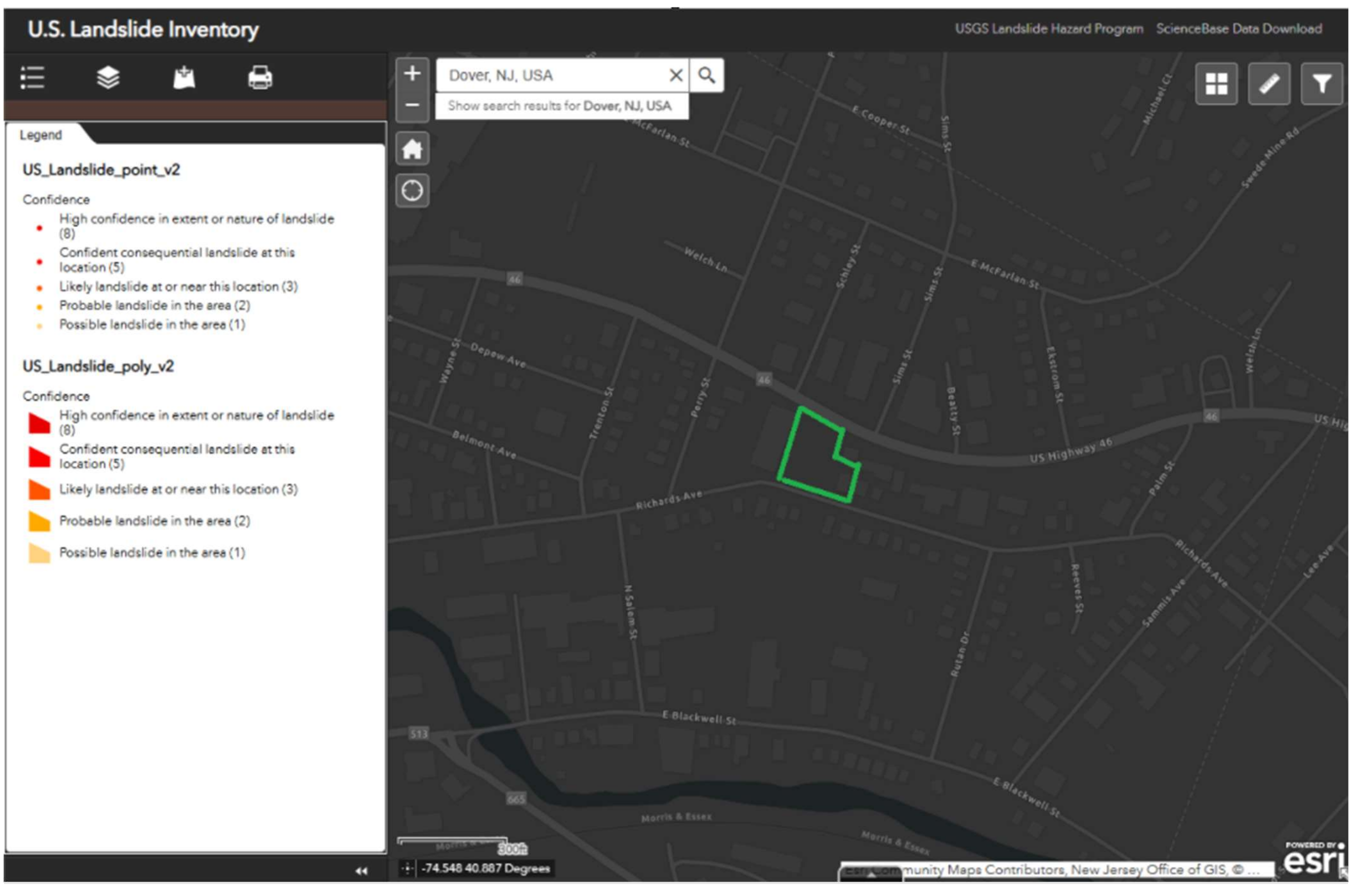
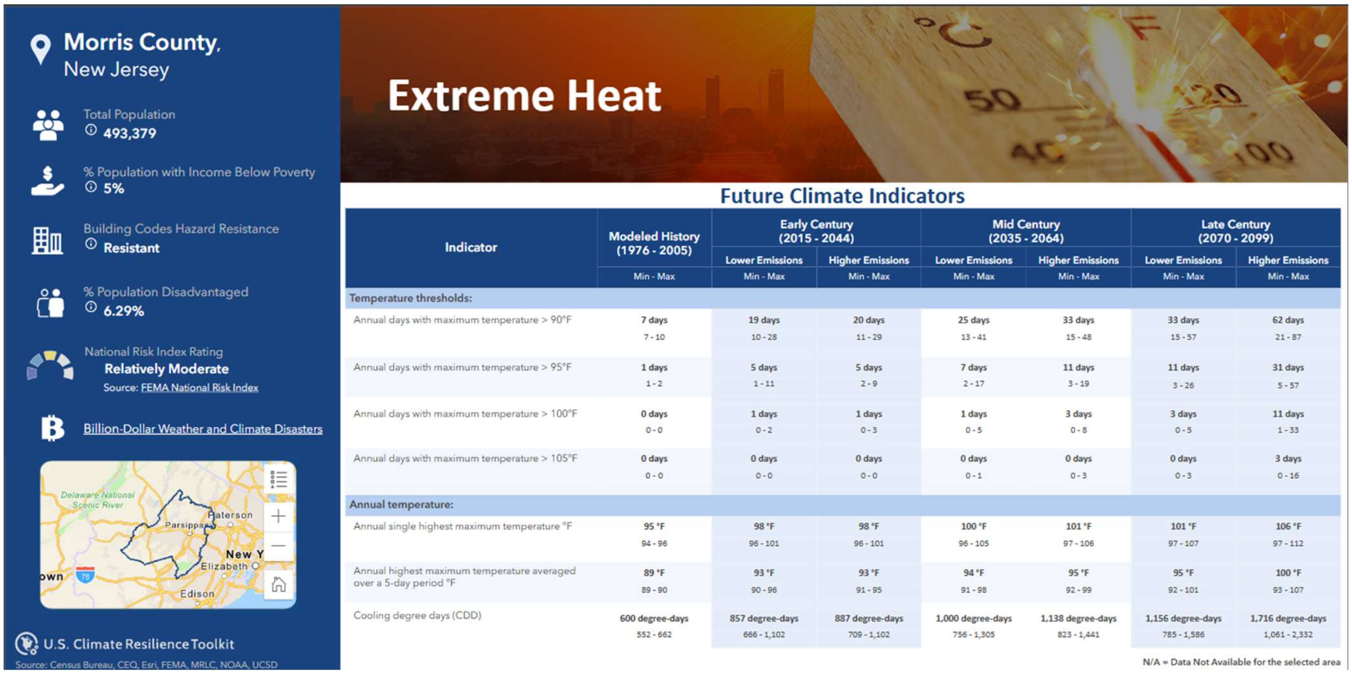


Figure D-2 Extreme Heat

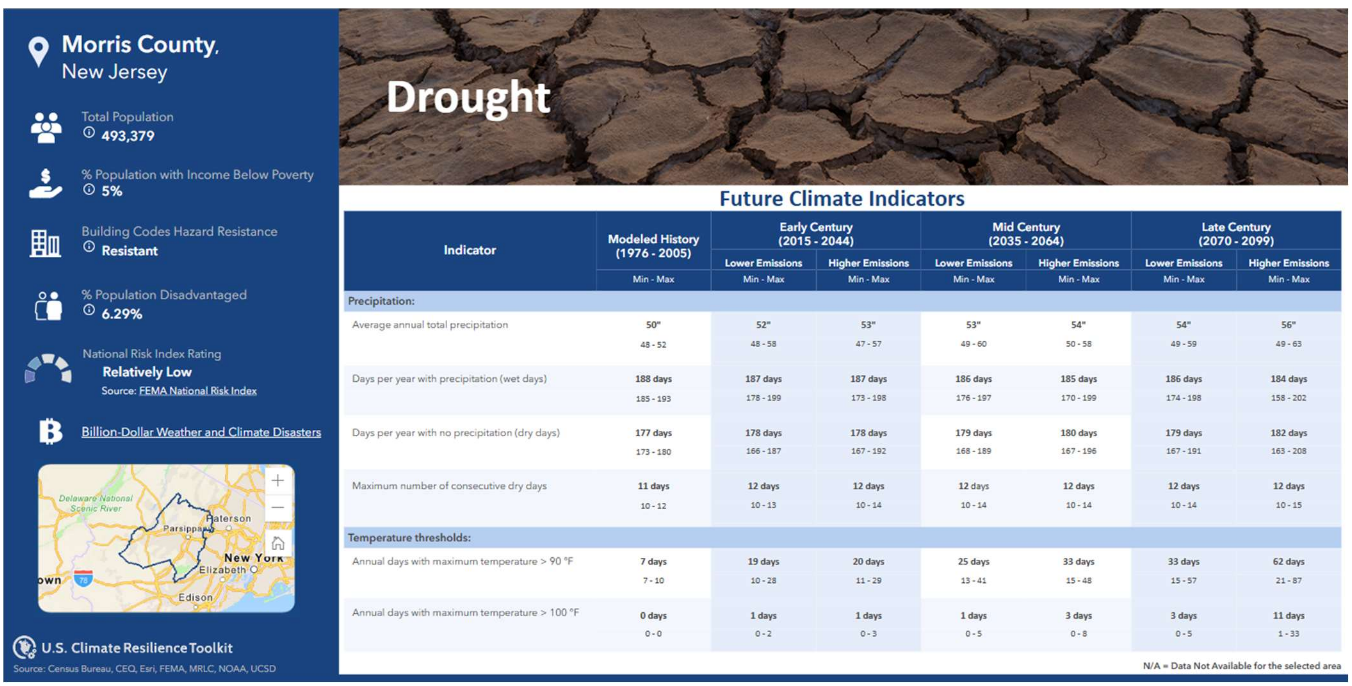


Future Climate Indicators

Indicator	Modeled History (1976 - 2005)	Early Century (2015 - 2044)		Mid Century (2035 - 2064)		Late Century (2070 - 2099)	
		Lower Emissions	Higher Emissions	Lower Emissions	Higher Emissions	Lower Emissions	Higher Emissions
	Min - Max	Min - Max	Min - Max	Min - Max	Min - Max	Min - Max	Min - Max
Temperature thresholds:							
Annual days with maximum temperature > 90°F	7 days 7 - 10	19 days 10 - 28	20 days 11 - 29	25 days 13 - 41	33 days 15 - 48	33 days 15 - 57	62 days 21 - 87
Annual days with maximum temperature > 95°F	1 days 1 - 2	5 days 1 - 11	5 days 2 - 9	7 days 2 - 17	11 days 3 - 19	11 days 3 - 26	31 days 5 - 57
Annual days with maximum temperature > 100°F	0 days 0 - 0	1 days 0 - 2	1 days 0 - 3	1 days 0 - 5	3 days 0 - 8	3 days 0 - 5	11 days 1 - 33
Annual days with maximum temperature > 105°F	0 days 0 - 0	0 days 0 - 0	0 days 0 - 0	0 days 0 - 1	0 days 0 - 3	0 days 0 - 3	3 days 0 - 16
Annual temperature:							
Annual single highest maximum temperature °F	95 °F 94 - 96	98 °F 96 - 101	98 °F 96 - 101	100 °F 96 - 105	101 °F 97 - 106	101 °F 97 - 107	106 °F 97 - 112
Annual highest maximum temperature averaged over a 5-day period °F	89 °F 89 - 90	93 °F 90 - 96	93 °F 91 - 95	94 °F 91 - 98	95 °F 92 - 99	95 °F 92 - 101	100 °F 93 - 107
Cooling degree days (CDD)	600 degree-days 552 - 662	857 degree-days 666 - 1,102	887 degree-days 709 - 1,102	1,000 degree-days 756 - 1,305	1,138 degree-days 823 - 1,441	1,156 degree-days 785 - 1,586	1,716 degree-days 1,061 - 2,332

N/A = Data Not Available for the selected area

Figure D-3 Drought



Future Climate Indicators

Indicator	Modeled History (1976 - 2005)	Early Century (2015 - 2044)		Mid Century (2035 - 2064)		Late Century (2070 - 2099)	
		Lower Emissions	Higher Emissions	Lower Emissions	Higher Emissions	Lower Emissions	Higher Emissions
	Min - Max	Min - Max	Min - Max	Min - Max	Min - Max	Min - Max	Min - Max
Precipitation:							
Average annual total precipitation	50" 48 - 52	52" 48 - 58	53" 47 - 57	53" 49 - 60	54" 50 - 58	54" 49 - 59	56" 49 - 63
Days per year with precipitation (wet days)	188 days 185 - 193	187 days 178 - 199	187 days 173 - 198	186 days 176 - 197	185 days 170 - 199	186 days 174 - 198	184 days 158 - 202
Days per year with no precipitation (dry days)	177 days 173 - 180	178 days 166 - 187	178 days 167 - 192	179 days 168 - 189	180 days 167 - 196	179 days 167 - 191	182 days 163 - 208
Maximum number of consecutive dry days	11 days 10 - 12	12 days 10 - 13	12 days 10 - 14	12 days 10 - 14	12 days 10 - 14	12 days 10 - 14	12 days 10 - 15
Temperature thresholds:							
Annual days with maximum temperature > 90 °F	7 days 7 - 10	19 days 10 - 28	20 days 11 - 29	25 days 13 - 41	33 days 15 - 48	33 days 15 - 57	62 days 21 - 87
Annual days with maximum temperature > 100 °F	0 days 0 - 0	1 days 0 - 2	1 days 0 - 3	1 days 0 - 5	3 days 0 - 8	3 days 0 - 5	11 days 1 - 33

N/A = Data Not Available for the selected area

Figure D-4 Wildfire

Morris County,
New Jersey

Total Population
493,379

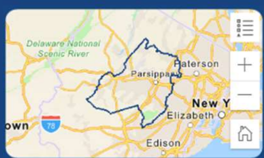
% Population with Income Below Poverty
5%

Building Codes Hazard Resistance
Resistant

% Population Disadvantaged
6.29%

National Risk Index Rating
Very Low
Source: FEMA National Risk Index

Billion-Dollar Weather and Climate Disasters



U.S. Climate Resilience Toolkit
Source: Census Bureau, CEQ, Esri, FEMA, MRLC, NOAA, UCSD

Future Climate Indicators

Indicator	Modeled History (1976 - 2005)	Early Century (2015 - 2044)		Mid Century (2035 - 2064)		Late Century (2070 - 2099)	
		Lower Emissions	Higher Emissions	Lower Emissions	Higher Emissions	Lower Emissions	Higher Emissions
	Min - Max	Min - Max	Min - Max	Min - Max	Min - Max	Min - Max	Min - Max
Precipitation:							
Days per year with no precipitation (dry days)	**177 days** 173 - 180	**178 days** 166 - 187	**178 days** 167 - 192	**179 days** 168 - 189	**180 days** 167 - 196	**179 days** 167 - 191	**182 days** 163 - 208
Maximum number of consecutive dry days	**11 days** 10 - 12	**12 days** 10 - 13	**12 days** 10 - 14	**12 days** 10 - 14	**12 days** 10 - 14	**12 days** 10 - 14	**12 days** 10 - 15
Days per year with precipitation (wet days)	**188 days** 185 - 193	**187 days** 178 - 199	**187 days** 173 - 198	**186 days** 176 - 197	**185 days** 170 - 199	**186 days** 174 - 198	**184 days** 158 - 202
Temperature thresholds:							
Annual days with maximum temperature > 90°F	**7 days** 7 - 10	**19 days** 10 - 28	**20 days** 11 - 29	**25 days** 13 - 41	**33 days** 15 - 48	**33 days** 15 - 57	**62 days** 21 - 87
Annual days with maximum temperature > 100°F	**0 days** 0 - 0	**1 days** 0 - 2	**1 days** 0 - 3	**1 days** 0 - 5	**3 days** 0 - 8	**3 days** 0 - 5	**11 days** 1 - 33

N/A = Data Not Available for the selected area

Figure D-5 Flooding

Morris County,
New Jersey

Total Population
493,379

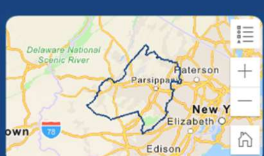
% Population with Income Below Poverty
5%

Building Codes Hazard Resistance
Resistant

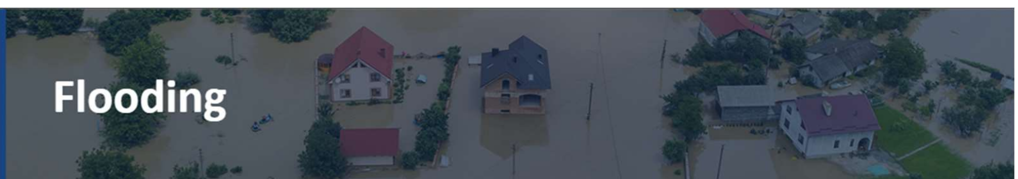
% Population Disadvantaged
6.29%

National Risk Index Rating
Relatively High
Source: FEMA National Risk Index

Billion-Dollar Weather and Climate Disasters



U.S. Climate Resilience Toolkit
Source: Census Bureau, CEQ, Esri, FEMA, MRLC, NOAA, UCSD



Future Climate Indicators

Indicator	Modeled History (1976 - 2005)	Early Century (2015 - 2044)		Mid Century (2035 - 2064)		Late Century (2070 - 2099)	
		Lower Emissions	Higher Emissions	Lower Emissions	Higher Emissions	Lower Emissions	Higher Emissions
	Min - Max	Min - Max	Min - Max	Min - Max	Min - Max	Min - Max	Min - Max
Precipitation:							
Annual average total precipitation	**50"** 48 - 52	**52"** 48 - 58	**53"** 47 - 57	**53"** 49 - 60	**54"** 50 - 58	**54"** 49 - 59	**56"** 49 - 63
Days per year with precipitation (wet days)	**188 days** 185 - 193	**187 days** 178 - 199	**187 days** 173 - 198	**186 days** 176 - 197	**185 days** 170 - 199	**186 days** 174 - 198	**184 days** 158 - 202
Maximum period of consecutive wet days	**11 days** 10 - 13	**12 days** 10 - 13	**12 days** 10 - 13	**12 days** 10 - 13	**12 days** 10 - 14	**12 days** 10 - 13	**12 days** 9 - 15
Annual days with:							
Annual days with total precipitation > 1inch	**7 days** 6 - 8	**8 days** 6 - 9	**8 days** 7 - 10	**8 days** 6 - 10	**9 days** 7 - 11	**9 days** 7 - 10	**10 days** 7 - 12
Annual days with total precipitation > 2 inches	**1 days** 0 - 1	**1 days** 1 - 1	**1 days** 1 - 1	**1 days** 0 - 2	**1 days** 1 - 1	**1 days** 1 - 2	**1 days** 1 - 2
Annual days with total precipitation > 3 inches	**0 days** 0 - 0	**0 days** 0 - 0	**0 days** 0 - 0	**0 days** 0 - 1	**0 days** 0 - 0	**0 days** 0 - 1	**0 days** 0 - 1
Annual days that exceed 99th percentile precipitation	**6 days** 6 - 7	**7 days** 7 - 8	**8 days** 7 - 8	**8 days** 8 - 8	**9 days** 8 - 9	**9 days** 9 - 10	**10 days** 10 - 11
Days with maximum temperature below 32 °F	**24 days** 22 - 28	**17 days** 7 - 23	**17 days** 9 - 24	**14 days** 5 - 20	**12 days** 6 - 20	**12 days** 3 - 19	**6 days** 1 - 13

N/A = Data Not Available for the selected area

APPENDIX E – CONCEPTUAL SITE MODEL

CONCEPTUAL SITE MODEL

E.1 CONTAMINANTS OF CONCERN

Groundwater cleanup standards identified in the 2005 ROD are the more stringent of the federal Maximum Contaminant Levels (MCLs), the New Jersey Drinking Water MCLs, and the New Jersey Groundwater Quality Standards (GWQS). A comparison of the VOC concentrations in groundwater to the MCLs and GWQS showed that PCE, TCE, cis-1,2-dichloroethene (cis-1,2-DCE), vinyl chloride (VC), and 1,1,2-TCA are the contaminants of concern (COCs) in groundwater.

E.2 NATURE AND EXTENT OF CONTAMINANTS OF CONCERN

DMW4 extracted groundwater from the deep aquifer from 1965 until 1980, at which time it was taken out of service because of the presence of chlorinated VOCs. During the period while DMW4 was operational, the chlorinated VOCs were pulled from the shallow aquifer to the deep aquifer and ultimately to the well. Unconsolidated sediments, which fill the Rockaway River Valley, consisting of fine sand and silt layers, act as confining units between the more permeable aquifers above and below them. In the part of the valley close to DMW4, two silt layers separate the sand into three aquifers, an upper water table aquifer (shallow aquifer) and two underlying semi-confined aquifers, identified as intermediate and deep aquifers.

The groundwater quality data indicated that the source of the chlorinated VOCs detected in DMW4 was contaminated soil located beneath and adjacent to the former dry cleaner building at 272 Route 46. Elevated PCE concentrations detected in a sediment sample collected from the sump in the basement of the dry cleaner building indicated that one possible release mechanism was the direct discharge of chlorinated cleaning solvents into the sump. Elevated PCE concentrations were also detected in the unsaturated soil in the parking lot east of the dry cleaner building, indicating surface spills or discharges in this area. In March through May 2009, the USEPA excavated and removed contaminated unsaturated soil from the former drycleaner property. Based on soil sampling performed after the first phase of ISCO treatment, concentrations of VOCs sorbed onto saturated soil were significantly reduced. Therefore, the unsaturated and saturated soil at OU2 no longer present a significant source of VOCs to groundwater at the Site.

Once discharged into the sump and adjacent to the building, the chlorinated solvents moved through the unsaturated soil and into the shallow aquifer. Groundwater in the shallow aquifer flows toward the Rockaway River. However, sampling data indicates that groundwater contamination did not extend to the river (see Figure E.1). The presence of compounds typically associated with the biodegradation of PCE (i.e., trichloroethene [TCE], cis-1,2-dichloroethene [cis-1,2-DCE] and vinyl chloride [VC]) indicates that biologically driven natural attenuation may be occurring and may be controlling the rate and extent of shallow aquifer plume migration. Advection, dispersion and sorption are also contributing to the natural attenuation of chlorinated VOC concentrations within the shallow aquifer.

Groundwater sampling results show that chlorinated VOCs have migrated through the shallow aquifer and first aquitard into the intermediate aquifer immediately down-gradient of the dry cleaner. Groundwater flow in the intermediate aquifer is toward the southeast. Chlorinated VOCs have been detected in the intermediate aquifer as far as Carrol Street, a distance of approximately 1,400 feet southeast of the dry cleaner (see Figure E.2). The plume has been relatively stable over time; however, geochemical indicators do not indicate that significant biodegradation is occurring. Advection, dispersion, and sorption processes are contributing to the natural attenuation of the chlorinated VOCs within the intermediate aquifer. Groundwater sampling results also show that chlorinated VOCs have migrated through the intermediate aquifer into the deep aquifer.

Based on the water quality data from samples collected from an adjacent deep monitoring well (MW-1DR), the contaminant plume has moved northeast of DMW4 as a result of shutting down the well in 1980. Concentrations of PCE slightly above the groundwater standard (i.e., up to 2.6 ug/L versus the groundwater cleanup standard of 1.0 ug/L) have been quantified in samples collected from MW-2D, the furthest down-gradient monitoring well (see Figure E.3). However, for the most recent sampling event (July 2011), groundwater collected from MW-2D contained PCE at a concentration of 0.82 ug/L, slightly below the cleanup standard of 1.0 ug/L.

For complete CSM, see Second Five-Year Review Report – Dover Municipal Well No. 4 Superfund Site (EPA, 2020)