2026 Remedial Site Optimization
Mr. C's Dry Cleaners Site
NYSDEC Site No. 915157
Village of East Aurora
Erie County, New York

May 2026

Prepared for:

NEW YORK STATE
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Table of Contents

Section **Page**

Table of Contents (cont.)

Section **Page**

List of Tables

Table **Page**

List of Figures

Figure **Page**

List of Abbreviations and Acronyms

COC	contaminant of concern
COPC	contaminant of potential concern
CSM	conceptual site model
cVOC	chlorinated volatile organic compound
DCE	dichloroethane
DER	Division of Environmental Remediation
EEEGPC	Ecology and Environment Engineering and Geology, P.C.
EEEPC	Ecology and Environment Engineering, P.C.
EC	engineering controls
FS	Feasibility Study
IC	institutional controls
LTM	long-term monitoring
µg/L	microgram per liter
Mr. C's / Site	Mr. C's Dry Cleaners site
MNA	monitored natural attenuation
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
OM&M	operations, maintenance, and monitoring
P&T	pump and treat
PCE	perchloroethylene or tetrachloroethene
PRR	Periodic Review Report
RAO	Remedial Action Objective
RI	Remedial Investigation
ROD	Record of Decision
RSO	Remedial Site Optimization
SEFA	Spreadsheets for Environmental Footprint Analysis
SMP	Site Management Plan
SSDS	subslab depressurization system

List of Abbreviations and Acronyms (cont.)

SVI	soil vapor intrusion
SVII	soil vapor intrusion investigation
TCE	trichloroethylene
VOC	volatile organic compound

Executive Summary

This Remedial Site Optimization (RSO) report was prepared by Ecology and Environment Engineering and Geology, P.C. (EEEGPC) at the request of the New York State Department of Environmental Conservation (NYSDEC) to evaluate alternatives to the existing remedy at the Mr. C's Dry Cleaners Site (the Site). This RSO is warranted due to the shutdown of the pump and treat remedy at the Site in September 2022 and the stability of the groundwater contamination plume since the shutdown.

According to NYSDEC's RSO guidance, an RSO plan may include a critique of the site conceptual model, recommendations to improve a selected remedy, or identification of a better remedy that was not available at the time of the issuance of the Record of Decision (ROD) (NYSDEC 2011). For the Mr. C's Dry Cleaners Site, this RSO report has been prepared in the manner of a focused feasibility study to determine whether chemical or biological remediation, used alone or in conjunction with monitored natural attenuation, would constitute a significantly better remedy that would facilitate progress toward site closure while improving the effectiveness and cost efficiency of the remedy. Bioremediation and monitored natural attenuation, which were not considered in the Mr. C's Feasibility Study (MPI 1996), have been demonstrated to stimulate and result in, respectively, in situ anaerobic degradation of the volatile organic compounds (VOCs) that comprise the Site's contaminants of concern (COCs): tetrachloroethene (PCE), trichloroethene (TCE), cis-1,2-dichloroethene (cis-1,2-DCE), and vinyl chloride.

A conceptual site model (CSM) using contaminant fate and transport processes was developed as part of the Feasibility Study for the Mr. C's Site (MPI 1996). The Site contamination was described in the Mr. C's Remedial Investigation (MPI 1995a) as having resulted from the release of dry-cleaning fluid from the former Mr. C's Dry Cleaners facility in East Aurora, New York. As a result of changes to waste management practices at the Site prior to implementation of the ROD and the cessation of active dry-cleaning operations in 2012, there is no source for continued release of contaminants from the Site (EEEPC 2014).

However, since installation of the pump-and-treat (P&T) system in 2003, over 10 times the volume of contaminated groundwater has been processed and nearly 10 times the mass of PCE has been removed than the volume and mass identified in the responsiveness summary of the ROD. The ROD recognized that the mass of contamination will never be known, but it is clear that the amount is greater than initially estimated. In addition, structures (both residential and commercial) that have been determined through sampling to have sub-slab or indoor air contamination have been fitted with sub-slab depressurization systems (SSDS) to eliminate the human exposure pathway.

Despite the high rate of VOC removal through the Mr. C's pumping well system and air stripper, the overall concentrations and types of contaminants in the plume remained relatively stable between long-term groundwater monitoring events from 2006 through 2013 after implementation of a bioremediation pilot study (Pilot Study). Though the composition of the plume changed from primarily PCE to primarily cis-1,2-DCE immediately after the Pilot Study, both PCE and TCE increased in concentration with the continued operation of the P&T system. A system shutdown study was conducted from February to October 2016, and a pulsed pumping program was tested in 2017, resulting in an increase in removed VOCs after the pulsed pumping was implemented. Removal of VOCs by the P&T system decreased following the initial increase with pulsed pumping due to decreased efficiency of the P&T system. The P&T system has exceeded its intended life span and was shut down in 2022 because major treatment components failed. While routine groundwater sampling has continued to be periodically conducted, no groundwater treatment has been performed since the system shutdown. However, groundwater sampling results have shown that after the shutdown of the P&T system, the plume area and average concentrations of all COCs have either remained stable or decreased, prompting the completion of this RSO to evaluate the cost effectiveness and appropriateness of both monitored natural attenuation and in-situ treatment for meeting site Remedial Action Objectives (RAOs).

Three alternatives are presented in this RSO: (1) continuing operation of a P&T system with (1a) a modification for the addition of surfactant injection and recovery, (2) monitored natural attenuation of contaminant degradation, and (3) monitoring the use of injected chemical or biological amendments to enhance natural attenuation processes.

Continued operation of a P&T system is subject to several limitations. During the first few years, the P&T system was very effective at removing contamination; however, fewer pounds of VOCs were removed in the last years of system operation despite average VOC removal rates of 90% to 100%. The declining trend in pounds of VOCs removed annually is matched by declines in process volume and average influent concentrations due to declining effectiveness of the system pumps. Given the critical failure of multiple components of the P&T system and need for part replacement, as well as the partial decommissioning of the P&T system that has already taken place and the stable and decreasing trends in plume area and concentrations since the P&T system shutdown, Alternative 1 is included for comparison purposes and is not recommended.

All alternatives are all subject to additional limitations that would prevent them from reaching New York State Class GA groundwater standards throughout the entire contaminant plume, because of the plume's location in a residential and commercial neighborhood with public roads, homes and buildings above the plume. The alternatives evaluated in this RSO and their cost estimates are based on the use of these technologies only in those areas where they would be implementable. The contamination controls proposed in each alternative are intended to address two of the three Site RAOs: mitigating the source area of the contaminant plume and achieving groundwater standards to the extent practicable. Every alternative also includes LTM and a soil vapor intrusion investigation (SVII) and mitigation program that is intended to address the remaining site RAO to protect human health from soil vapor intrusion.

Based on the analysis presented in this RSO, EEEGPC recommends the use of in situ treatment with long-term monitoring (LTM), which offers a substantially more effective means of reducing plume contamination than the existing pump-and treat system, and at a substantially reduced cost. The recommended alternative consists of the following:

1. Source control through in situ treatment, conducted as a pilot study for the first round of injections, with a follow-up treatment occurring after four to five years of monitoring, as needed.
2. Complete decommissioning of the existing treatment system, including downgrading the electrical capacity of the treatment system building, removal of remaining equipment and pumping system infrastructure, and transportation of usable remaining equipment to a NYSDEC storage facility.
3. Continued LTM and SVII and mitigation.

Although not the primary selection factor, EEEGPC reviewed the alternatives for consistency with NYSDEC's Green Remediation program policy (DER-31) by conducting a SEFA (Spreadsheets for Environmental Footprint Analysis) and determined that in situ, passive technologies such as bioremediation would contribute fewer direct and indirect greenhouse gas emissions than the P&T system by reducing vehicle miles traveled for operation and maintenance and reducing the demand for electricity. As such, in-situ treatment is consistent with NYSDEC's current Green Remediation policy.

As this RSO is recommending a fundamental change to the Site Remedy, it must be presented to the NYSDEC commissioner for consideration. Per NYSDEC's RSO policy, a change to the Site Remedy must go through the same rigorous analysis, risk assessment, and community involvement as the original remedy. Public participation and community involvement should be solicited for this change in the Site Remedy, especially because site access has not historically been granted for all residential properties. Consequently, all remedies considered, particularly the SVII program, are limited in their ability to protect public health and safety.

While this RSO documents the relative benefits and cost effectiveness of the technology, in-situ treatment will result in a short-term increase in the overall toxicity of the COCs. While cis-1,2-DCE is less toxic than PCE, both TCE and vinyl chloride are more toxic. The final degradation byproduct, ethene, is non-hazardous. A risk assessment may be warranted to determine whether the increased COC toxicity poses an overall increased risk to human health. For many residences, the overall risk has been reduced through the installation of a sub-slab depressurization system (SSDS), which removes the exposure pathway for soil vapor intrusion.

1 Introduction and Background

The New York State Department of Environmental Conservation (NYSDEC) contracted Ecology and Environment Engineering and Geology, P.C. (EEEGPC; formerly Ecology and Environment Engineering, P.C. or EEEPC) to perform remedial site optimization (RSO) as part of operations, maintenance, and monitoring (OM&M) for the Mr. C's Dry Cleaner's Site (Mr. C's, the Site), NYSDEC Site No. 915157. This report presents options for RSO at the Site and was prepared by EEEGPC for NYSDEC under the 2022 modification to Work Assignment D009807-07.1, which was approved by NYSDEC's Division of Environmental Remediation (DER) on November 17, 2022.

1.1 Site Location and Description

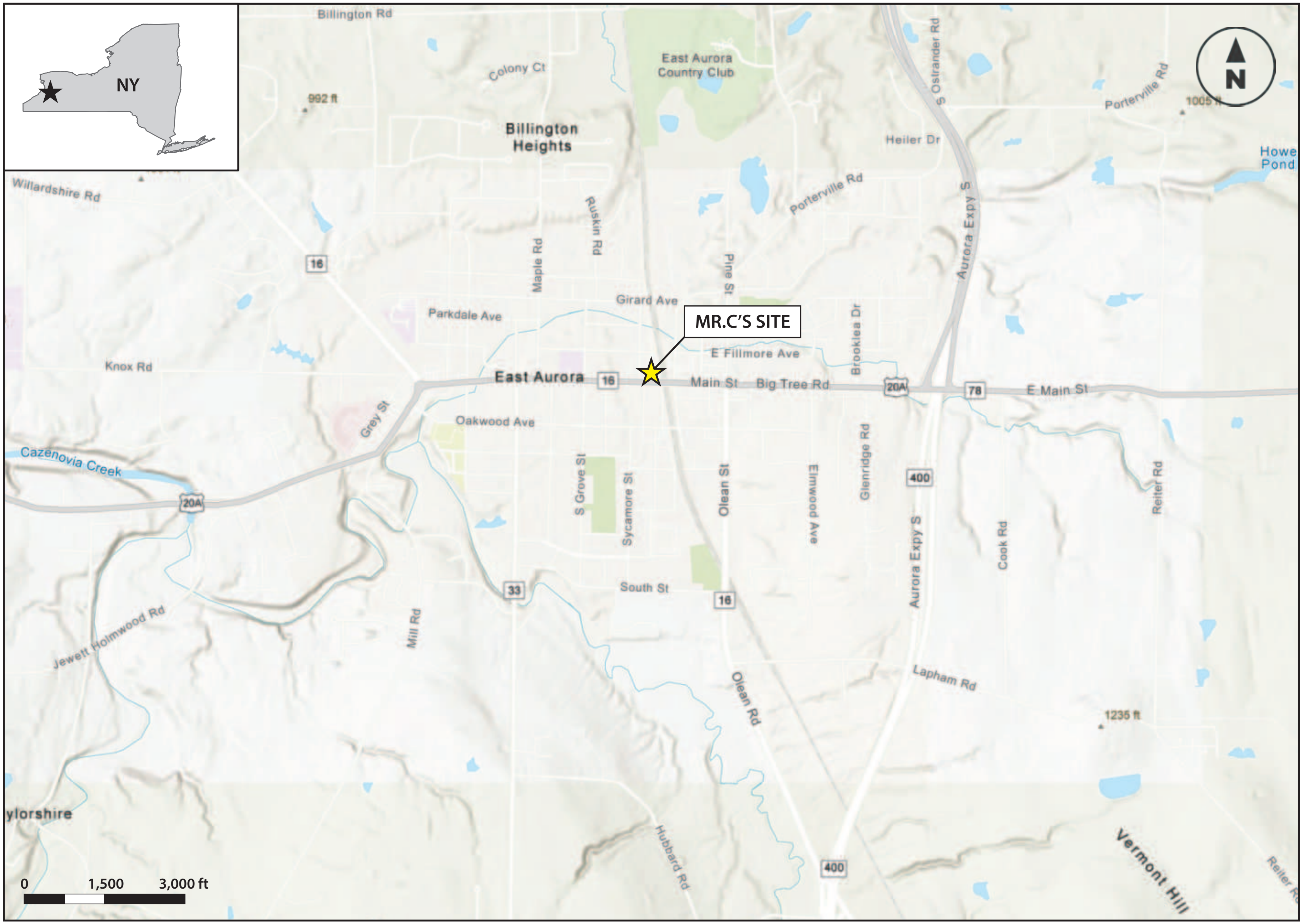
The Site is located on an approximately 0.5-acre parcel at 586 Main Street in the village of East Aurora, in Erie County, New York (see Figure 1-1). Mr. C's Dry Cleaners formerly occupied the front portion of the building along Main Street, and the remainder of the building was occupied by other commercial businesses. The Site is surrounded by residential homes along Whaley Avenue to the west and Fillmore Avenue to the north. Other commercial businesses are adjacent to the Site on the east side and across Main Street to the south. (See Figure 1-2)

The existing building, that was used by Mr. C's, is believed to have been built around 1927. It has been in use as a dry-cleaning operation prior to 1970 and the site was reportedly used for other businesses (laundry, auto repair/spray painting, and a hotel) since 1912.

1.2 Remedial Background

Perchloroethene (PCE), also known as tetrachloroethene, and its chlorinated sequential reduction degradation byproducts are the primary COCs at the Site. The contamination at the Site is the result of improper handling and management of PCE, a solvent used in the dry-cleaning process. Poor management practices reportedly resulted in contamination of the groundwater beneath and downgradient of the Mr. C's facility. Remedial investigations (RIs) were performed between 1993 and 1995 (MPI 1995a, b). A feasibility study (FS) was completed in 1996 (MPI 1996).

Figure 1-1 General Site Location Map



Source: Esri Community Maps Contributors, Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, US Census Bureau, USDA, USFWS | Esri, NASA, NGA, USGS, FEMA

Figure 1-1
Site Location Map
Mr.C's Dry Cleaner Site
East Aurora, NY

Figure 1-2 Mr. C's Dry Cleaners Site Map

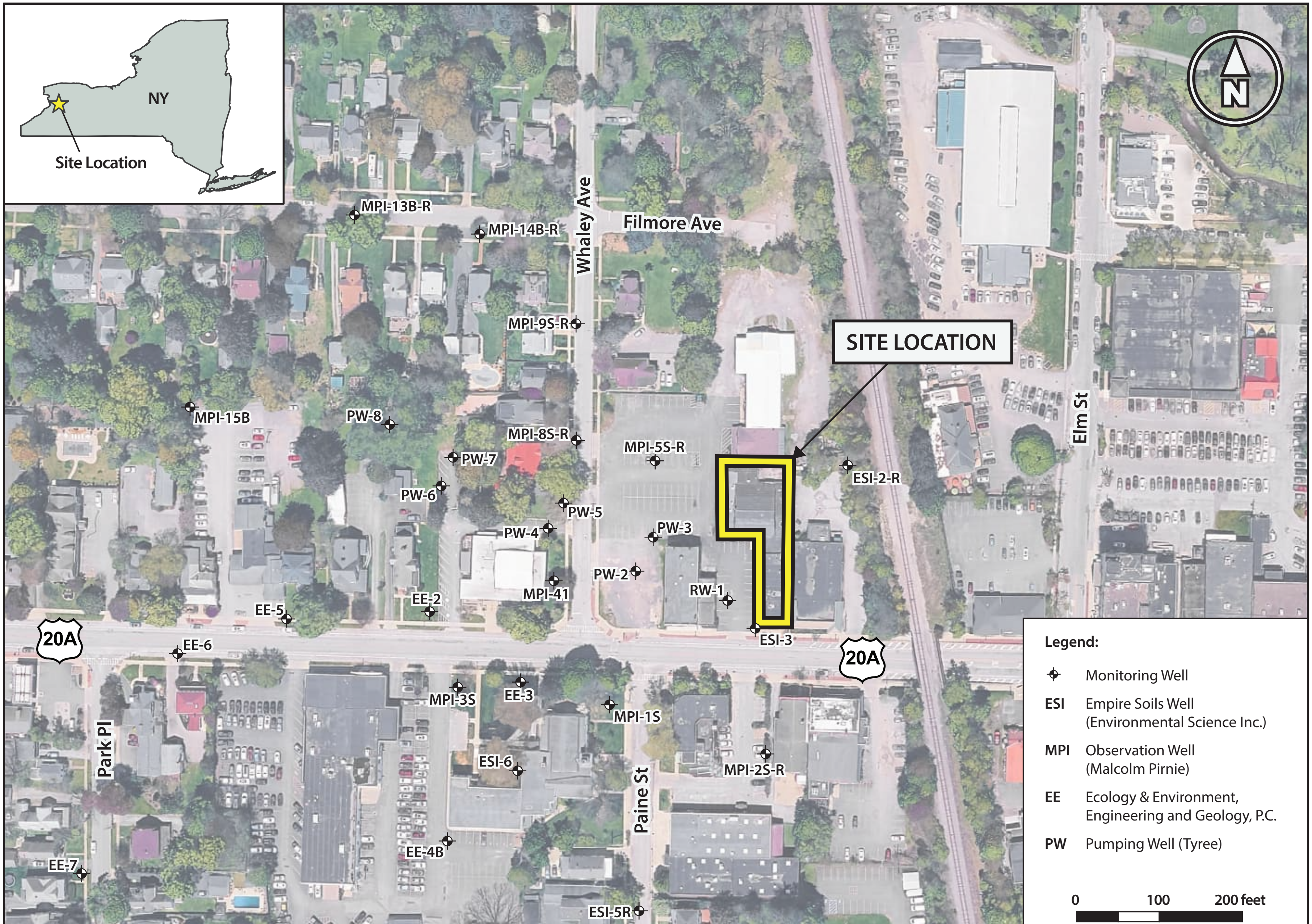


Figure 1-2 Mr.C's Drycleaners Site Location Map, NYSDEC Site # 91517, Village of East Aurora, Erie County

ecology and environment engineering and geology, p.c.

A Record of Decision (ROD) for the Site was issued by NYSDEC in 1997 and revised in 2000. In the 2000 Explanation of Significant Differences, NYSDEC changed the selected remedy to groundwater pumping and ex-situ air stripping treatment (the Site Remedy). The groundwater pumping well network and an air stripper were installed between 2001 and 2003 (NYSDEC 1997, 2000). A Final Engineering Closure Report for the remedial construction was prepared by EEEPC and issued to NYSDEC in March 2005 (EEEPC 2005).

In 2011, after the P&T system had been operating successfully for 10 years, NYSDEC implemented the Mr. C's Enhanced Bioremediation and Bioaugmentation Pilot Study (Pilot Study). Declines in the efficiency of the pump-and-treat system (see Section 1.6) prompted the investigation of alternate technologies for potential optimization of the Site Remedy. The Pilot Study demonstrated that bioremediation was capable of reducing PCE concentrations at the Site. The Pilot Study concluded in 2014 and is described in the Summary Report for the Mr. C's Dry Cleaners Site Enhanced Bioremediation and Bioaugmentation Pilot Study (EEEPC 2015a).

In 2017, the groundwater pumping wells to the east of Whaley Avenue were shut off and pumping from 2018 through 2022 focused on the wells to the west of Whaley Avenue. Due to treatment system equipment failure, the groundwater extraction system was shut off in September 2022, with plans to restart the system once the necessary equipment had been replaced. However, analysis of additional long-term groundwater monitoring data has indicated that the groundwater plume is stable, and the treatment system was providing little benefit in recent years. In addition, the original treatment equipment has exceeded its expected life expectancy and would require significant repair to remain operational. Therefore, in consultation with NYSDEC, the treatment system has remained shut off since late 2022.

Multiple soil vapor intrusion investigations (SVIIs) have been performed beneath the Mr. C's treatment facility and surrounding properties. Based on the results of these investigations, a total of nine sub-slab depressurization systems (SSDSs) were installed from 2004 to 2016. These systems have operated on a continuous basis since installation.

1.3 Objectives of this RSO

This RSO report is designed to evaluate pathways to site closure given remediation technology developments since the P&T remedy was installed, the stabilization and asymptotic conditions of COC groundwater concentrations during P&T operation, the success of the Bioremediation and Bioaugmentation Pilot Study, and the stability of the groundwater contamination plume since the P&T system shutdown in September 2022 (discussed in Section 1.6.1). This report evaluates restarting the P&T system operation, monitoring the site for natural COC attenuation, and introducing chemical or biological amendments to enhance natural degradation by reducing both maximum COC concentrations and mass flux to lower concentration areas. Each alternative is evaluated according to implementability, effectiveness, protection of human health and the environment (including green & sustainable remediation considerations), reduction of the groundwater plume toxicity, mobility, and volume through treatment, and present worth estimated cost.

1.4 Geology and Hydrology

The Site is located in a residential/commercial area with both paved and unpaved (lawns and soil fill) sections. The Site is situated on top of fill overlaying glacial deposits from the last glacial ice.

The uppermost bedrock unit beneath the Site is the Rhinestreet Shale member of the West Falls Formation. Bedrock is estimated to be 150 to 200 feet below ground surface directly below Mr. C's (MPI 1995a).

Native unconsolidated sediments at the Site consist of four stratigraphic units differentiated by types of depositional events that occurred primarily during the last ice age of the Pleistocene. The uppermost is a glacial till deposit consisting of clayey silt that is the result of re-advancement of glacial ice. Where the till is present, it is underlain by a glacial fluvial outwash deposit of sand and gravel starting at zero to 20 feet below ground surface which resulted from the meltwater outwash during the retreat of glacial ice. Lacustrine deposits underlay the outwash sequence consisting of sandy silts indicative of a pro-glacial lake (MPI 1995a). The final stratigraphic layer observed right above the bedrock is a stratified till and sand layer that is an indication of simultaneous depositional events likely near the ice front. As shown on the cross sections in Figures 1-3a, 1-3b, and 1-3c, glacial till deposits of silt, silty sand, and clay are found near the surface. In most cases, particularly north of Main Street, the stratigraphy is uniform and well defined with glacial till overlaying the sandy fluvial outwash. However, areas south present a shallower glacial till layer with defined lenses of clay or gravel.

There are three major hydrostratigraphic units present at the Site, including an unconfined aquifer of saturated outwash deposits (outwash aquifer); the underlying lacustrine aquifer; and a confining layer consisting of the stratified till deposits, discussed in further detail below (MPI 1995b). The outwash and lacustrine aquifers are hydraulically connected and have nearly the same hydraulic heads. However, they are characterized by different hydraulic conductivities and porosities.

A. Outwash Aquifer – The outwash aquifer is an unconfined aquifer with a saturated thickness of approximately 18 feet. Wells screened across the entire outwash aquifer exhibited a geometric mean hydraulic conductivity of 0.004 centimeter per second (cm/s), equal to 11.3 feet per day (ft/day). Precipitation and infiltration are the main recharge sources for this aquifer, with possible exfiltration from sewers located above the water table (MPI

1995b). Figure 1-4 shows a groundwater contour map of the Site based on data collected in August 2023.

B. Lacustrine Aquifer – The lacustrine aquifer is a rather uniform aquifer with a saturated thickness of approximately 13 feet. Wells screened across the lacustrine aquifer exhibited hydraulic conductivities that ranged from 1.5 x 10^{-4} to 4.9 x 10^{-4} cm/s (MPI 1995b), equal to 0.43 to 1.39 ft/day. During the RI, groundwater flow direction in this aquifer appeared very similar to that in the outwash aquifer.

C. Stratified Till Unit – The confining stratified till unit consists of interbedded layers of clayey till and sand. The hydraulic conductivity for the unit was estimated at 8.8 x 10^{-6} cm/s, equal to 0.025 ft/day, based on slug testing performed at well MPI-4D. A previously calculated upward vertical hydraulic gradient for this unit indicated that the outwash and lacustrine aquifers beneath the Site are not the source of recharge to the stratified till unit (MPI 1995b).

Most monitoring wells for the Site are constructed in the Outwash Aquifer but there is evidence that the Outwash and Lacustrine Aquifer are hydrologically connected.

Estimates of groundwater velocities for each unit, calculated from slug tests performed during the RI, are presented in Table 1-1. Based on these values, the Outwash Aquifer is the most hydraulically conductive unit and is the primary aquifer unit involved in the transport of contaminants from the Site.

Table 1-1 Groundwater Flow Parameters

Hydrostratigraphic Unit	Hydraulic Conductivity (cm/s)	Average Hydraulic Gradient (ft/ft)	Estimated Groundwater Velocity (ft/day)
Outwash Aquifer	0.004	0.004	0.045
Lacustrine Aquifer	0.00049	0.004	0.006
Stratified Till	0.0000088	0.004	0.0001

Notes:
Hydraulic conductivities are taken from the Mr. C’s RI (MPI 1995a).

Key:
cm/s = centimeters per second
ft = feet

Figures 1-3 Geology Plan View and Cross Sections A-A', B-B' and C-C'

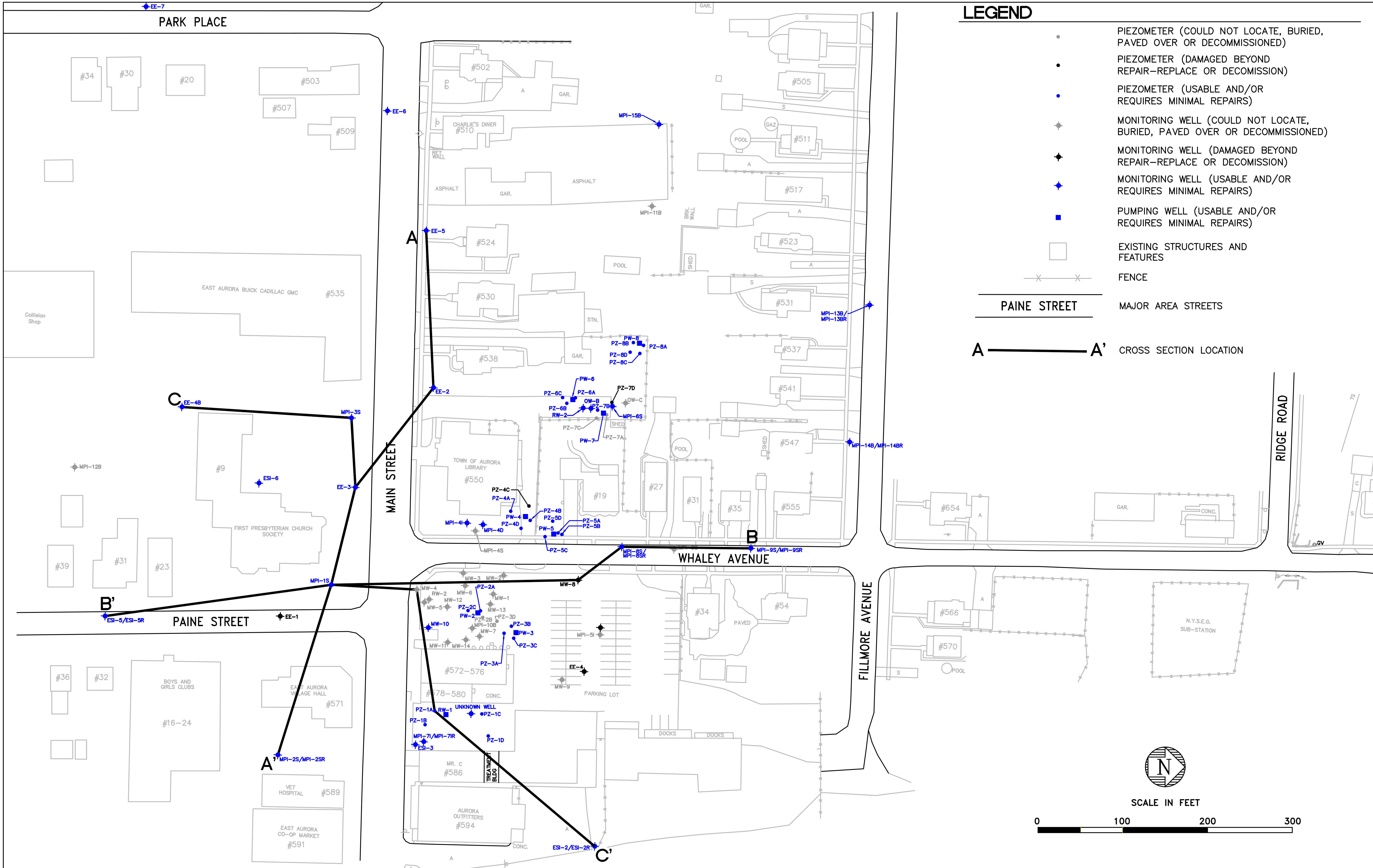
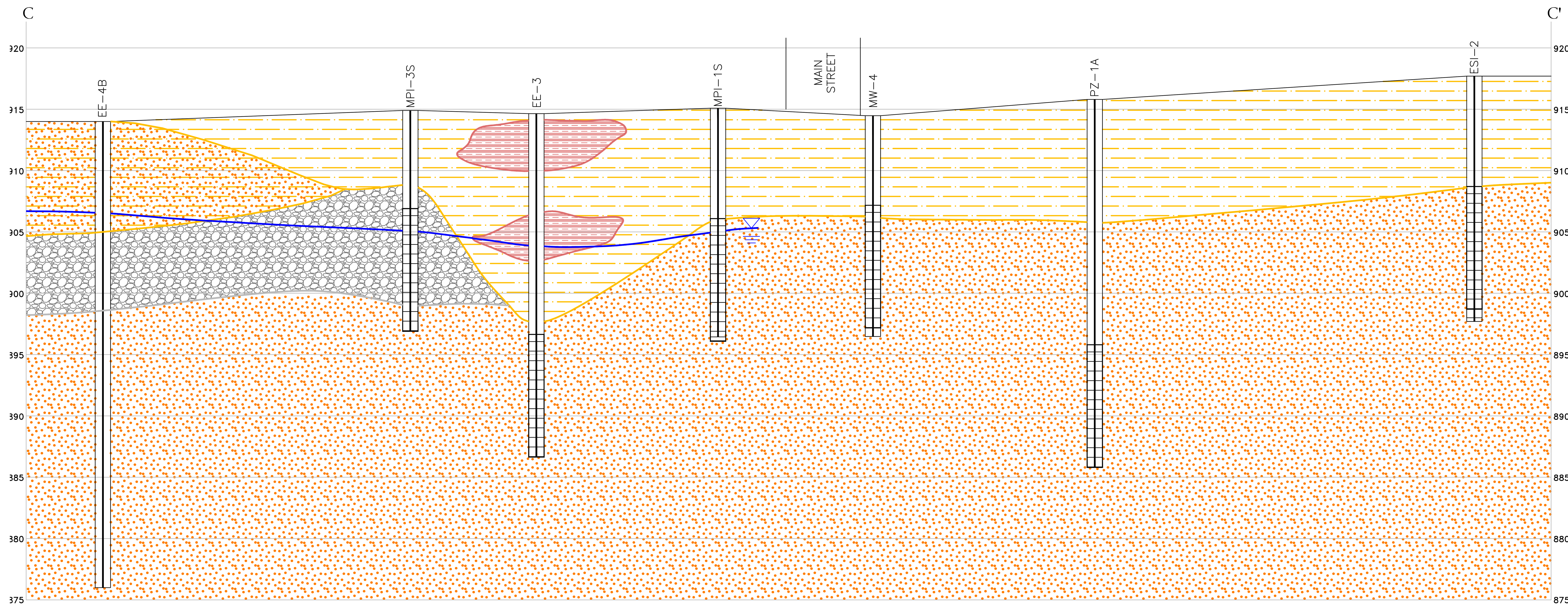
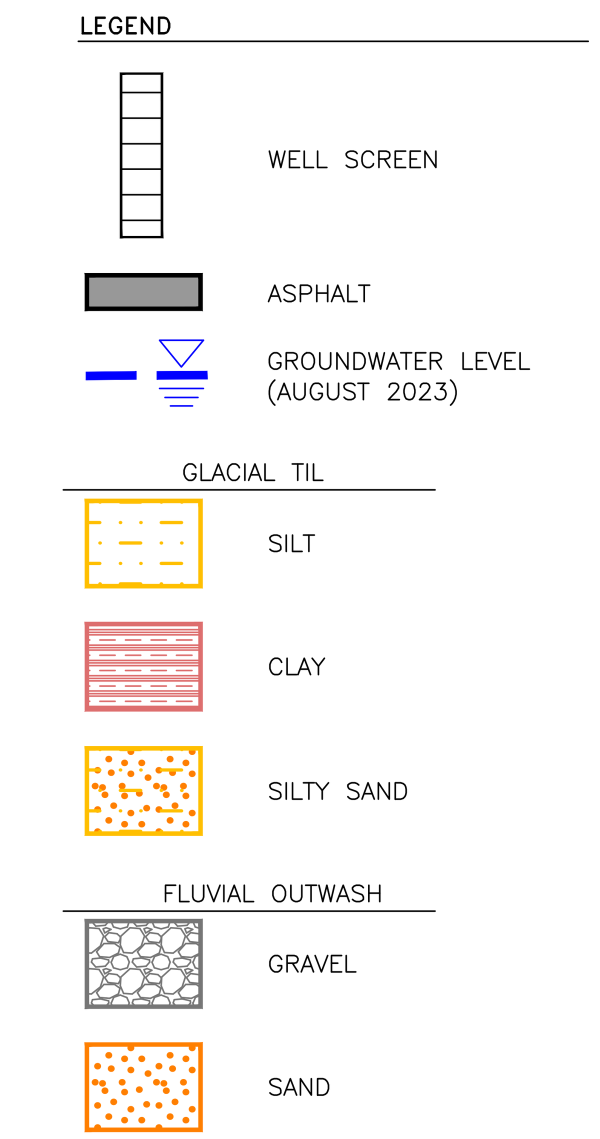


FIGURE 1-3a CROSS SECTION PLAN VIEW
MR.C'S DRY CLEANERS
EAST AURORA, NEW YORK

FIGURE 1-3b
MR.C'S DRY CLEANERS
CROSS SECTIONS A-A' AND B-B'
EAST AURORA, NEW YORK





NOTES

1. DASHED LINES SHOWN ARE INFERRED.
2. TOP OF WELLS EE-4A AND PZ-1A ARE APPROXIMATE.
2. NO WATER LEVEL DATA AVAILABLE FOR WELLS MW-4, PZ-1A, AND ESI-2.

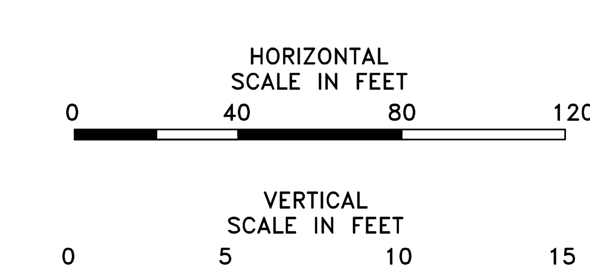


FIGURE 1-3c
MR.C'S DRY CLEANERS
CROSS SECTIONS C-C'
EAST AURORA, NEW YORK

Figure 1-4 August 2023 Groundwater Contour Map

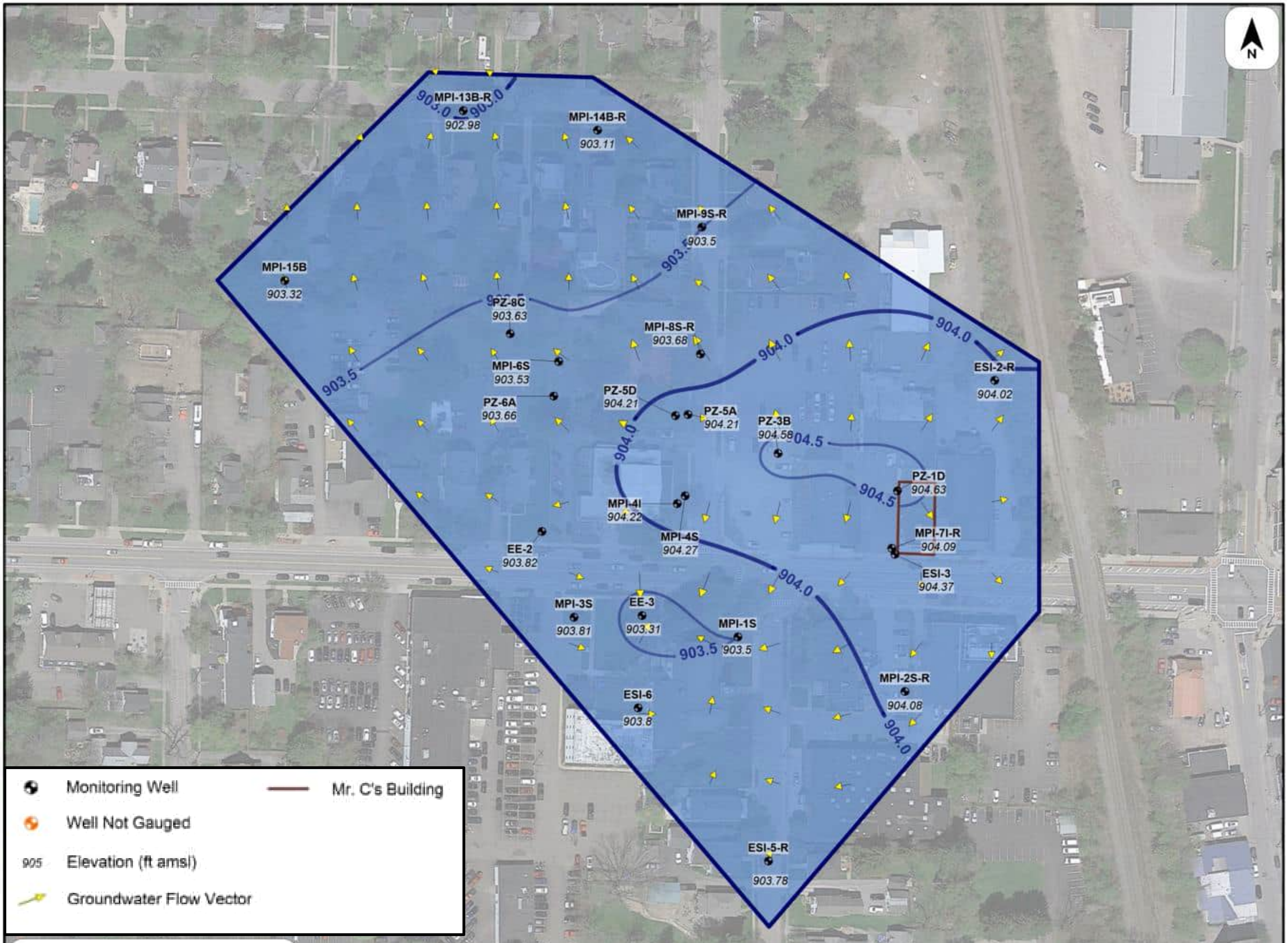


Figure 1-4 August 2023 Groundwater Contour Map

1.5 Conceptual Site Model

A conceptual site model (CSM) is a written or pictorial representation of an environmental system and the biological, physical, and chemical processes that determine the transport of contaminants from sources through the environmental media to environmental receptors within the system (American Society for Testing and Materials E1689-95). The 1995 RI previously presented the elements of the CSM, including: (1) potential sources of contamination, (2) types of contaminants and affected media, (3) release mechanisms and potential contaminant pathways, and (4) actual/potential human and environmental receptors. These elements were carried over into the 1996 FS and the 2016 RSO.

A CSM is meant to be periodically reviewed and updated as more site data become available, and long-term monitoring (LTM) at the site has additional information with which to refine the Mr. C's CSM. Several initiatives have been undertaken that affect the contaminants at the site, their concentrations, and potential contaminant pathways. This section aims to refine the previous presentation of the CSM to identify and set priorities for evaluation of the alternatives presented in this RSO in accordance with DER-10 (NYSDEC 2010).

1.5.1 Potential Sources of Contamination

The former Mr. C's Dry Cleaners is believed to be the primary source of contamination. Dry cleaning operations at Mr. C's utilized a solvent comprised predominantly of PCE. The existing building that houses the Mr. C's treatment facility and the former Mr. C's Dry Cleaners is believed to have been built around 1927 and was used as a dry-cleaning facility since before 1970 (NYSDEC 1997). It operated as the Mr. C's Dry Cleaners from 1974 to 2012. Since 1985, all dry-cleaning wastes from the Site, including filters and sludges, have been disposed of through a commercial disposal firm in accordance with NYS and Federal regulations (NYSDEC 1997). Prior to 1985, waste was disposed of via the sanitary sewer. It was also reported that filters and sludge were also disposed of in dumpsters behind the building and collected by the Village of East Aurora. According to the 1995 RI, the cleaning agent used at the Mr. C's Dry Cleaners Site between 1989 and 1991 was a solvent comprised of approximately 99.1 to 100% PCE with traces of 1,2-DCE (20 parts per million [ppm]), tetrachloromethane (50 ppm), and TCE (100 ppm).

Based on previous findings, the primary release mechanism was thought to be infiltration into the groundwater from a leaking sewer lateral. Since 2012, the dry-cleaning service has operated strictly as a drop-off and pick-up location; dry cleaning is no longer performed on the Site. As such, the primary release mechanism identified in the RI no longer presents a pathway for contaminant release.

At the time of the original site study, the contaminated groundwater plume was recognized to be a secondary contaminant source in the RI (MPI 1995a). The Mr. C's FS defined the contaminant source as this secondary source, i.e., the impacted groundwater plume's center of contaminant mass as characterized by elevated

PCE concentrations (MPI 1996). However, LTM results now indicate that the current groundwater plume constitutes the only contaminant source remaining at the project site, which has extended in a west-northwesterly direction from the Mr.C’s project site location (EEEGPC 2024b). Given the stability of the groundwater plume, it is assumed that there is no remaining source of additional contamination onsite.

1.5.2 Types of Contaminants and Affected Media

The ROD identified the primary COCs to be VOCs, specifically PCE. In addition, 1,2-DCE, vinyl chloride, and chloroform were identified as contaminants of potential concern (COPCs) for the Mr. C’s Superfund Site (MPI 1995a). 1,2-DCE includes both cis- and trans- isomers. Compounds associated with petroleum spills at the adjacent former Agway property had also previously been found at specific locations near the site and were identified as COPCs. These contaminants include benzene, toluene, ethylbenzene, and xylene, which had mixed with compounds from the dry-cleaning operation to create a complex groundwater contamination plume (NYSDEC 1997). Current monitoring data, which are summarized in the periodic review report (PRR), are consistent with this selection of the COCs and COPCs (EEEGPC 2024a).

Groundwater

As of 2024, the long-term groundwater monitoring results have indicated that seven VOCs (1,2-dichloroethane, cis-1,2-DCE, trans-1,2-DCE, tert-butyl methyl ether, PCE, TCE, and vinyl chloride) were detected at levels that exceed the NYSDEC Class GA guidance values (EEEGPC 2025). The results of the most recent long term groundwater monitoring event are provided in the forthcoming 2024 Annual Report (EEEGPC 2025).

Soil Vapor and Indoor Air

Based on a review of the analytical results from the soil vapor intrusion investigations (SVII) conducted between 2013 and 2015, SSDSs were installed at nine properties. The SSDSs are inspected annually to ensure that they are operating as designed. Additional soil vapor intrusion sampling was conducted in 2022 and 2023 at 13 properties adjacent to or near the site. Based on these results, DEC and DOH determined that no further action was recommended for the sampled properties. This recommendation was based on comparison of the sampling results to established DOH guidance values. Additional information is summarized in the soil vapor intrusion sampling summary reports (EEEGPC 2024c, EEEGPC 2023a).

Soil

According to the 1995 RI Report prepared by Malcolm Pirnie, Inc., soil was analyzed at two locations to identify the source of PCE. One shallow boring (SB-1) was located near the Mr. C’s sewer lateral and the second boring (SB-2) was located near the side entrance of the shoe repair shop nearby. Two soil samples were collected from SB-1 from six to eight feet below ground surface (a) and eight to ten feet below ground surface (b), and one soil sample was collected from

SB-2 from eight to ten feet below ground surface. Detected PCE concentrations were 48,000 parts per billion (a) and 6,400 parts per billion (b) at SB-1 and 12,000 parts per billion at SB-2 (NYSDEC 1997).

In 2011, samples from two additional borings were analyzed for VOCs at the location of new wells EE-3 and EE-4 as part of the monitoring well network improvement initiative. Eighteen samples were collected from the soil borings in 2-foot intervals and analyzed for VOCs (GES 2012). The total VOC concentrations detected in these samples were below the highest PCE concentration detected previously. The soil analytical data is presented in Table 1 of the Well Upgrade and Installation Report prepared by Groundwater & Environmental Services, Inc. (2012), which is provided in Attachment C to the Mr. C's Monitoring Well Network Improvements Close-out Report, in Appendix G of the 2012 PRR (EEEPC 2013). The highest concentration of total VOCs, 1,828.78 parts per billion, was detected at a depth of 20 to 22 feet below ground surface in EE-3 and is below the sum of the unrestricted soil cleanup objectives for the four primary COCs at the Site (2,040 parts per billion). Given these sampling results, soil media will not be evaluated further as part of this RSO.

1.5.3 Release Mechanisms

Based on the available data, a summary of contaminant fate and transport processes was developed as part of the FS for the Mr. C's Site (MPI 1996). The following mechanisms of contaminant transport at the Site have been updated from those included in the FS:

- Lateral movement of groundwater, particularly in the outwash aquifer; and,
- Volatilization of VOCs from groundwater.

Infiltration/percolation, leaching and volatilization of remaining contaminants in underlying soil, and the sanitary sewer system are unlikely to be pathways of contaminant migration, according to the FS (MPI 1996) because the facility is no longer using chlorinated VOCs (cVOCs) in their cleaning process at the site and contaminated soils that exceeded guidance values were removed from the site during the original remediation activities. The hydrogeological setting of the site has not changed significantly since the FS, and the previously identified release mechanisms are consistent with the current understanding of the Site.

1.5.4 Exposure Pathway Analysis

The RI identified several potential routes of exposure by which receptors could come in contact with site COCs. Receptors considered in the RI included site occupants, off-site residents, and municipal workers (MPI 1995a). Pathways considered complete had (1) a source, (2) a contaminant migration pathway, and (3) a point where exposure of a receptor could occur. Toxicological data were also presented for the RI's COPCs (since COCs had not yet been selected by the ROD) (MPI 1995a).

Figure 1-5 was prepared according to the American Society for Testing and Materials E1689-95 Standard Guide for Developing Conceptual Site Models for Contaminated Sites and presents the exposure pathways present at the site. The pathways identified in the RI have been revised to reflect current site conditions based on the remedial activities that have been historically performed at the site.

No potable water supply wells are currently present on or immediately downgradient of the site. Potable water in the area has been provided by the Erie County Water Authority since 1980.

Based on indoor air monitoring results, PCE volatilization from groundwater is a source of indoor air contamination in basements in several structures in the vicinity of the site. This exposure pathway is being addressed via engineering controls in the form of sub-slab depressurization systems (SSDS) and institutional controls in the form of soil-vapor intrusion investigations. Periodic monitoring of these controls will continue as part of the Site’s periodic review reporting. LTM of the site should continue to be performed to determine whether the SSDSs remain protective of indoor air quality and whether plume migration or changes in plume composition would trigger the need for additional soil vapor intrusion investigations and installation of SSDS at additional structures.

Additional discussion on health exposures and exposure pathways can be found in Section 3.3 of the ROD, Section 1.3.6 of the FS, and Section 6 of the RI (NYSDEC 1997; MPI 1996, 1995a).

1.6 Remedy Performance and Progress Made Toward Site Cleanup Goals

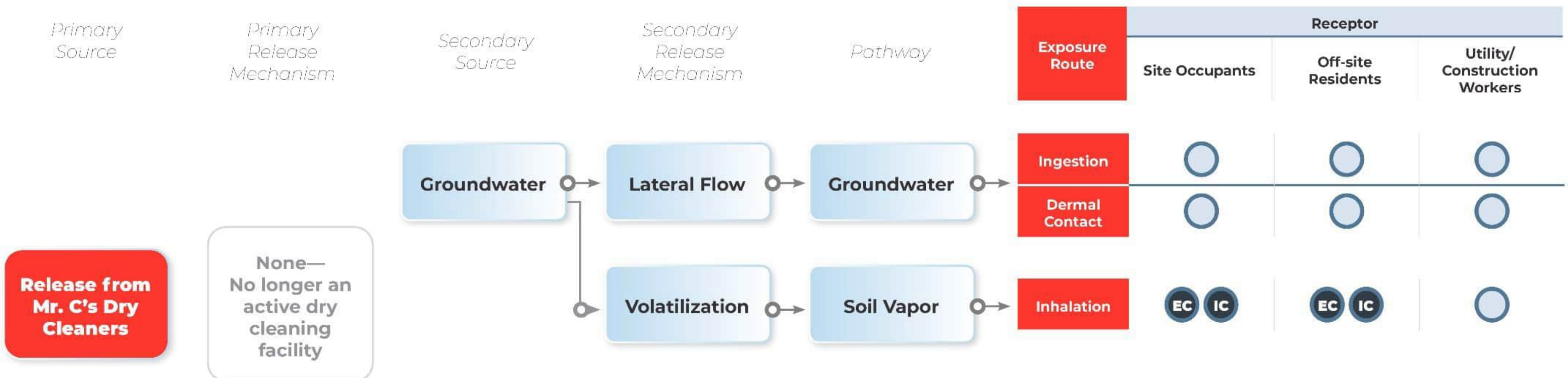
The P&T system performance and results of LTM of groundwater are discussed in the following subsections with regards to progress towards site cleanup and closure.

1.6.1 Pump-and-Treat System Performance

From treatment startup in September 2002 through the system shutdown in September 2022, approximately 1,881 pounds of VOCs were removed from groundwater (EEEGPC 2024a). In over 20 years of operation, the system has gone from removing as much as 340 pounds of VOCs in 2003 to removing as little as 30.8 pounds of VOCs in 2012 and 14.9 pounds of VOCs in 2022 (see Figure 1-6) (EEEGPC 2024a). The decrease in mass removal between 2003 and 2012 was related to both a decrease in system removal efficiency (i.e., reduction in influent concentration and reduction in the volume of groundwater treated. The decrease observed between 2012 and 2022, during which groundwater extraction was focused on high-concentration areas, was largely due to the system not being consistently operational (i.e., decreased volume of water extracted).

Figure 1-5 Conceptual Site Model and Exposure Pathways

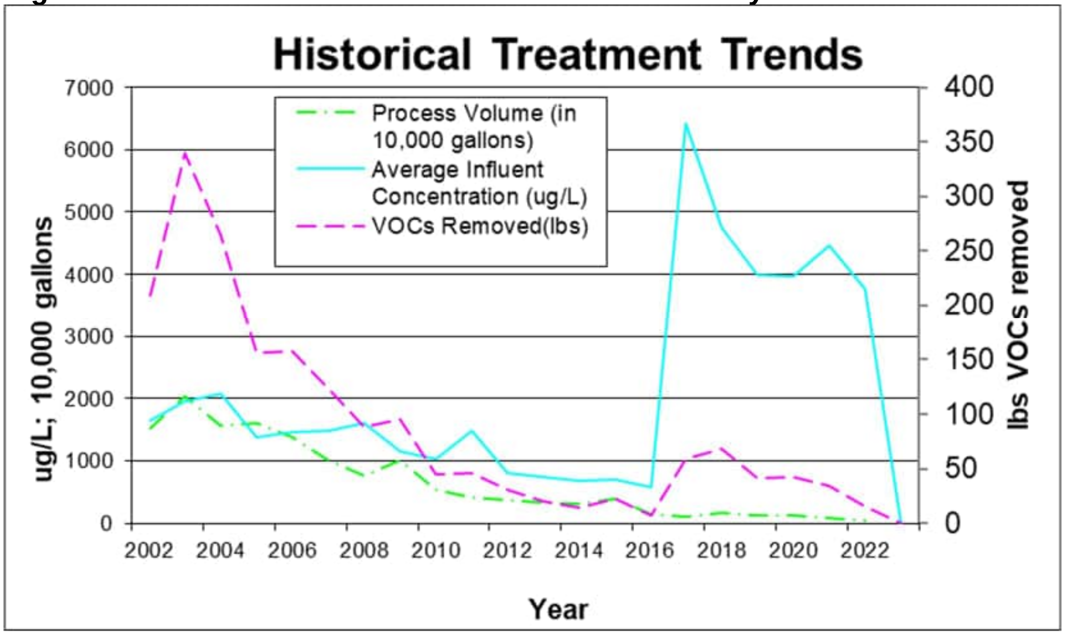
Figure 1-5 Conceptual Site Model and Exposure Pathways



KEY

- Pathway evaluated and found incomplete; no further evaluation recommended
- EC Pathway complete and managed by use of engineering controls
- Pathway complete; further evaluation recommended
- IC Pathway complete and managed by use of institutional controls

Figure 1-6 Historical Treatment Trends – Mr. C's Dry Cleaners Site



After equipment failure led to the system shutdown in September 2022, it was determined through groundwater data analysis that groundwater contamination had decreased significantly since the initial installation of the system. As a result, NYSDEC and NYSDOH agreed that the system was not providing a significant benefit and monitoring would continue with the P&T system no longer in operation.

1.6.2 Contaminant Plume Treatment Performance

The extent of the dissolved contaminant plume at the Site was interpolated using the results from long-term groundwater monitoring performed since 2003. From 2003 to 2013, the plume remained fairly stable in size and composition during this period of active remediation by the P&T system.

Beginning in 2013, which corresponds to the implementation of a bioremediation Pilot Study and diminished performance of the P&T system, significant changes were observed in the plume composition (EEEPC 2015a). By July 2014, PCE and TCE in the injection areas had been effectively reduced to below the NYSDEC Class GA groundwater standards in MPI-6S and MW-8 (EEEPC 2015a). Detected cVOC concentrations changed from primarily PCE to primarily cis-1,2-DCE. Later, most of the balance of the plume followed a similar trend.

At the request of NYSDEC, the P&T system was shut down beginning February 4, 2016 to evaluate stability of the plume under natural conditions. The 2016 results showed only limited evidence of PCE rebound stemming from the system shutdown. The system was returned to service in early October 2016. This is discussed in detail in the previous RSO (EEEPC 2016).

Long-term groundwater monitoring was conducted while the treatment system was operating and has continued after the 2022 system shutdown discussed in Section 1.6.1. As of August 2024, seven VOCs (1,2-dichloroethane, cis-1,2-DCE, trans-DCE, tert-butyl methyl ether, PCE, TCE, and vinyl chloride) were detected in the groundwater samples at levels that exceed the NYSDEC Class GA groundwater standards and guidance values used to screen the groundwater data, in 21 of the 31 wells sampled (EEEGPC 2025). Before the shutdown, in 2021, seven VOCs (1,2-dichloroethane, cis-1,2-DCE, tert-butyl methyl ether, PCE, trans-1,2-dichloroethene, trichloroethylene [TCE], and vinyl chloride) were detected at concentrations in excess of the NYSDEC Class GA groundwater standards and guidance values in 23 of the 32 wells sampled (EEEGPC 2024a). In order to evaluate plume-wide trends and differences observed in the plume since the system shutdown, a plume stability analysis was performed and is discussed below.

The Ricker Method® was used to perform plume stability analysis for four individual constituents (PCE, TCE, cis-1,2-DCE, and vinyl chloride) and the combined constituent plume, termed here “Total Analyzed cVOCs”, to evaluate trends for the period of May 2009 through August 2024. The Ricker Method® plume stability analysis compares relative changes in contaminant plume characteristics over time, including area, average concentration, and COC mass indicator. The term “mass indicator” does not necessarily represent the entire mass in the subsurface but rather an expression of the aqueous phase mass based on a fixed assumption of aquifer thickness and porosity to serve as a meaningful way of combining plume area and average concentration into one metric. The main purpose of the plume stability analysis was to observe relative changes in plume characteristics between sampling events. More details on methodology can be found in the Draft Technical Memorandum for Groundwater Plume Analytics Services at Mr.C’s Dry Cleaners (EEEGPC 2023b). The Ricker Method® plume stability analysis trend conclusions for each of the constituents evaluated through August 2024 are summarized in Table 1-2.

Table 1-2 Ricker Method® Plume Stability Trend Results

Trend Period	Constituent	Area	Average Concentration	Mass Indicator
Before Remediation System Shutdown (Oct-2014 to Sep-2021)	PCE	Stable	Increasing Trend	Increasing Trend
	TCE	Increasing Trend	Increasing Trend	Increasing Trend
	Cis-1,2-DCE	Stable	No Trend	No Trend
	Vinyl Chloride	Decreasing Trend	Stable	Stable
	Total Analyzed cVOCs	Stable	No Trend	No Trend
After Remediation System Shutdown (Feb-2023 to Aug-2024)	PCE	Stable	Stable	Stable
	TCE	Decreasing Trend	Stable	Stable
	Cis-1,2-DCE	Decreasing Trend	Stable	Stable
	Vinyl Chloride	Stable	Stable	Stable
	Total Analyzed cVOCs	Stable	Decreasing Trend	Decreasing Trend

Results of the Ricker Method® plume stability analysis showed increasing PCE and TCE mass indicator trends and observed increasing trends in the Total Analyzed cVOC mass indicator, though not statistically significant, prior to the remediation system shutdown (Oct-2014 to Sep-2021). In the Sep-2021 event before the remediation system was shutdown, the PCE plume area, average concentration, and mass indicator were determined to be 11.6 acres, 232 µg/L, and 67.9 lbs, respectively; the Total Analyzed cVOCs plume area, average concentration, and mass indicator were determined to be 11.5 acres[1], 366 µg/L, and 107 lbs, respectively. Figures 1-7 and 1-8 show the PCE and Total Analyzed cVOCs plumes for the Sep-2021 event.

After the remediation system was shutdown, the Ricker Method® plume stability analysis showed stable or decreasing trends across all plume stability metrics for

[1] The Total Analyzed cVOCs plume area, in reality, is not smaller than the PCE plume area. The program (Golden Software Surfer®) used to calculate the area of the four constituent plumes added together uses a raster “blanking file” to determine the edges of contours, and this raster is subject to rounding issues on the edges which has caused a disparity. Regardless, all Total Analyzed cVOCs areas are calculated by the same methodology and comparable to one another.

all constituents (Feb-2023 to Aug-2024). In the most recent Aug-2024 event, the PCE plume area, average concentration, and mass indicator fell to historic lows of 6.3 acres, 37.7 µg/L, and 6.0 lbs, respectively; the Total Analyzed cVOCs plume area, average concentration, and mass indicator were determined to be 7.5 acres, 125 µg/L, and 23.5 lbs, respectively. Figures 1-9 and 1-10 show the PCE and Total Analyzed cVOCs plumes for the Aug-2024 event.

Overall, the analysis found that the area of the Total Analyzed cVOCs plume was stable and there was no determined trend for the Total Analyzed cVOCs plume mass indicator from 2014 to 2021 (i.e., after the bioremediation pilot study until the shutdown of the P&T system). Since the shutdown of the P&T system (Feb-2023 to Aug-2024), the Total Analyzed cVOCs plume area has been stable, and the average concentration and mass indicator have been decreasing. Changes in the constituent makeup of the Total Analyzed cVOCs plume (e.g. decreases in PCE fraction and increases in cis-1,2-DCE and vinyl chloride fractions) show evidence of reductive dechlorination with a majority of the reductive dechlorination taking place on the northwestern portion of the plume where significant concentrations of cis-1,2-DCE and vinyl chloride are present. PCE has been persistent in the eastern portions of the plume with relatively low daughter product generation detected (EEEGPC 2023b). Conditions appear to be favorable for natural attenuation after the shutdown of the pumping wells and treatment system.

1.6.3 Progress Made Toward Cleanup Goals

Per the 1997 ROD for the Mr. C's Site (NYSDEC 1997), the RAOs chosen for the Site include the following:

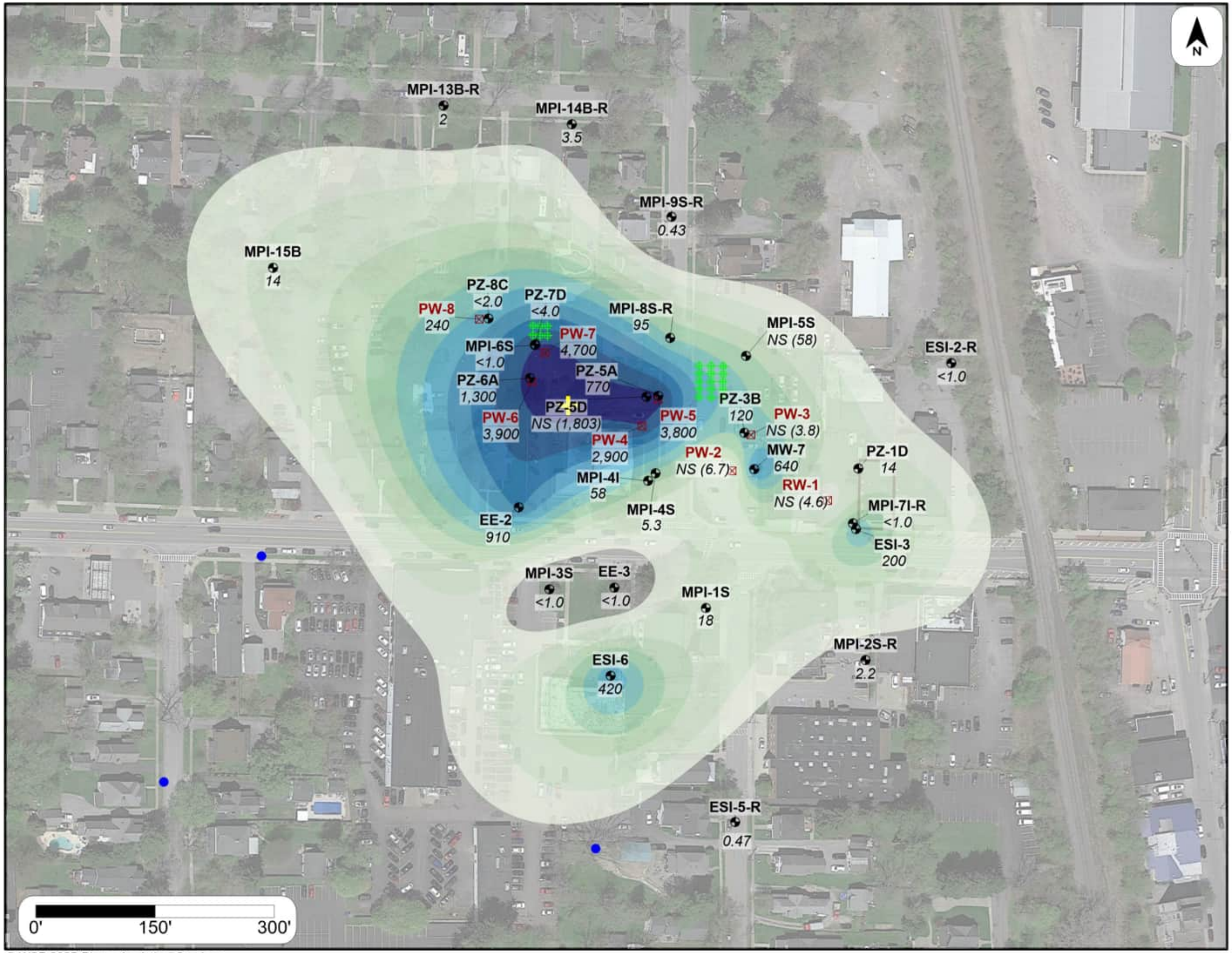
1. Mitigate human health risk by reducing the potential for inhalation of vapors in on-site and off-site basements.
2. Mitigate the source area of the contaminant plume to prevent further migration of the cVOCs and reduce volatilization into adjacent basements.
3. Achieve NYSDEC groundwater quality standards to the extent practical.

Since no property owners in the vicinity of the Site rely on groundwater-derived potable water, exposure to contaminated groundwater is not a consideration.

Mitigation of human health risk from soil vapors and sub-slab vapor intrusion has been addressed separately from the P&T system by performing SVIIs and, based on the results, installing ECs. The Site ECs include SSDSs installed in structures above the contaminated groundwater plume. Figure 1-11 shows the locations where SVIIs have been performed as part of the site remediation as well as the locations where SSDSs have been installed. For many properties, the results of the soil vapor intrusion samples did not indicate the need for an SSDS, based on the NYSDOH criteria matrix (NYSDOH 2006). For those properties that did exceed NYSDOH criteria, SSDSs were installed and are currently operating. If the plume migrates, additional SVIIs should be performed, and SSDSs should be installed, as necessary, to maintain the protectiveness of the Site Remedy. However, implementation of the remedies evaluated herein should contain or shrink the plume such that a need for additional SVIIs is limited.

Per groundwater sampling conducted in August 2024, NYSDEC groundwater quality standards have been achieved for PCE and TCE in 14 of the site wells. However, PCE, TCE, and cis-1,2-DCE are still being detected at concentrations above groundwater quality standards in the larger plume area. Only 3 wells have detections of vinyl chloride above NYSDEC groundwater quality standards. The highest remaining concentrations of PCE and TCE are 1,300 µg/L and 500 µg/L, respectively, at well EE-2. The highest remaining concentration of cis-1,2-DCE is 2,500 µg/L measured at PW-6, and the highest remaining concentration of VC is 67 µg/L measured at MPI-4I. The proposed remedies in this RSO are evaluated according to the potential success at further reducing the concentrations and plume area of the site COCs.

Figure 1-7 September 2021 PCE Plume Map



PCE
Sep-2021

Concentration (µg/L)

5 10 25 50 100 200 400 800 1,500 3,000

Plume Characteristics

Plume Area: **11.6 acres**

Plume Average Concentration: **232 µg/L**

Plume Mass Indicator: **67.9 lbs**

Monitoring Well
Hanging Well
Pumping Well (Active)
Pumping Well (Inactive)
112 Concentration (µg/L)
NS (146) Well Not Sampled (Assigned Value Shown)
Plume Center of Mass
Control Point
Mr. C's Building
Injection Point

Figure 1-7

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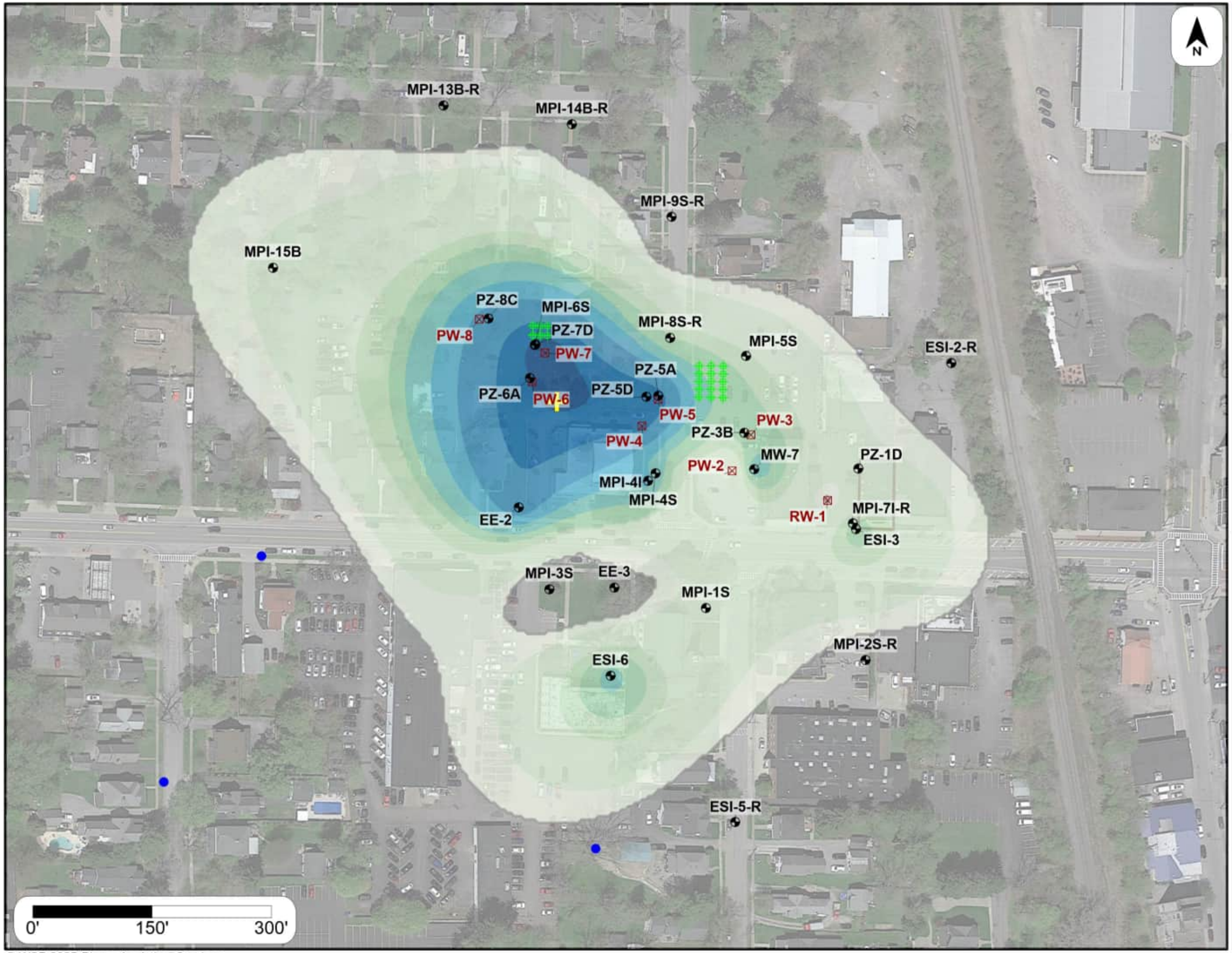
Figure 1-8 September 2021 Total Analyzed cVOCs Plume Map



Total Analyzed cVOCs
Sep-2021

Concentration Above Constituent MCLs (µg/L)

0, 10, 50, 100, 250, 500, 1,000, 2,500, 5,000, 10,000

Plume Characteristics

Plume Area: **11.5 acres**

Plume Average Concentration: **366 µg/L**

Plume Mass Indicator: **107 lbs**

- Monitoring Well
- Hanging Well
- Pumping Well (Active)
- Pumping Well (Inactive)
- Plume Center of Mass
- Control Point
- Mr. C's Building
- Injection Point

Figure 1-8

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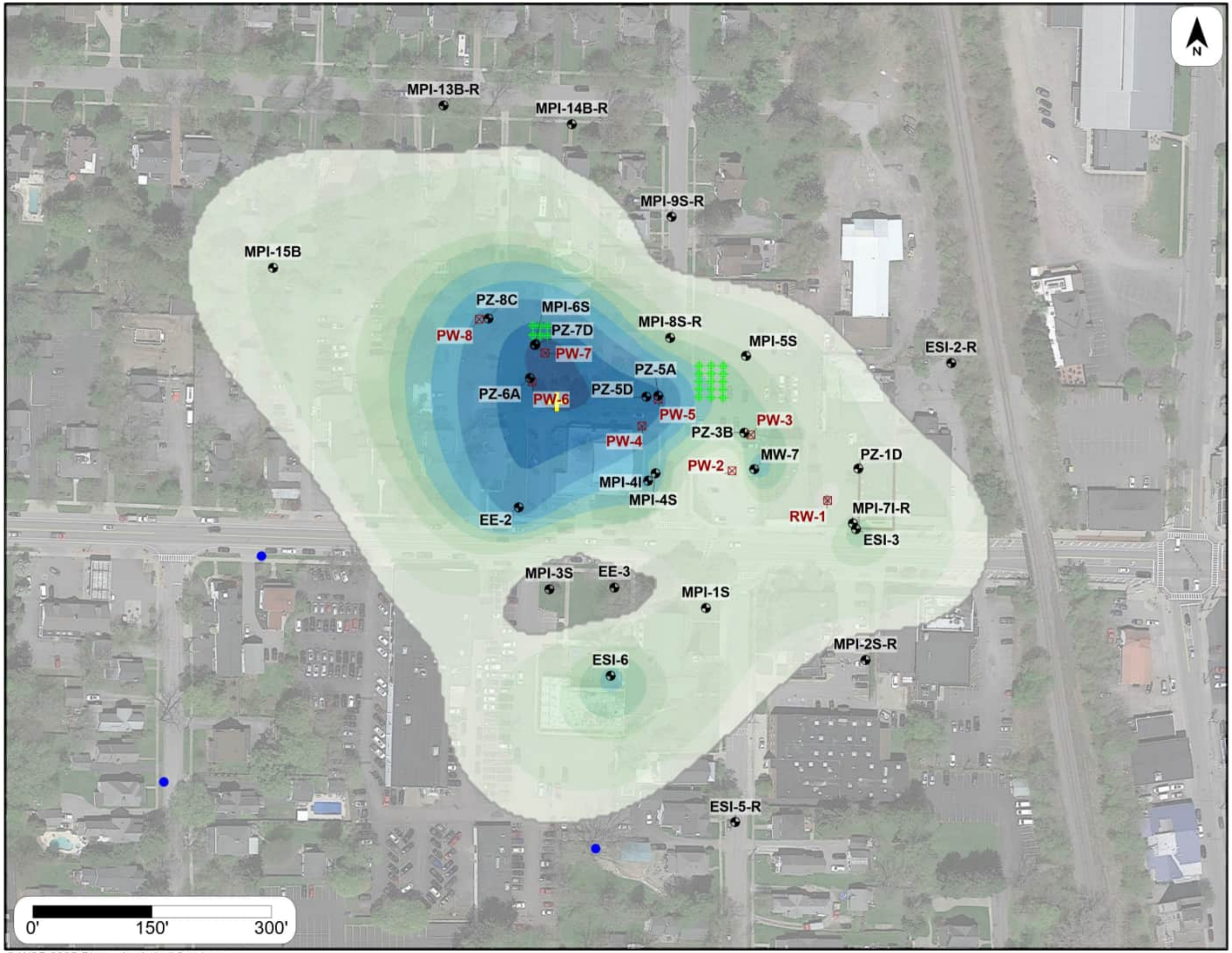
Figure 1-9 August 2024 PCE Plume Map



Total Analyzed cVOCs
Sep-2021

Concentration Above Constituent MCLs (µg/L)

0, 10, 50, 100, 250, 500, 1,000, 2,500, 5,000, 10,000

Plume Characteristics

Plume Area: **11.5 acres**

Plume Average Concentration: **366 µg/L**

Plume Mass Indicator: **107 lbs**

- Monitoring Well
- Hanging Well
- Pumping Well (Active)
- Pumping Well (Inactive)
- Plume Center of Mass
- Control Point
- Mr. C's Building
- Injection Point

Figure 1-8

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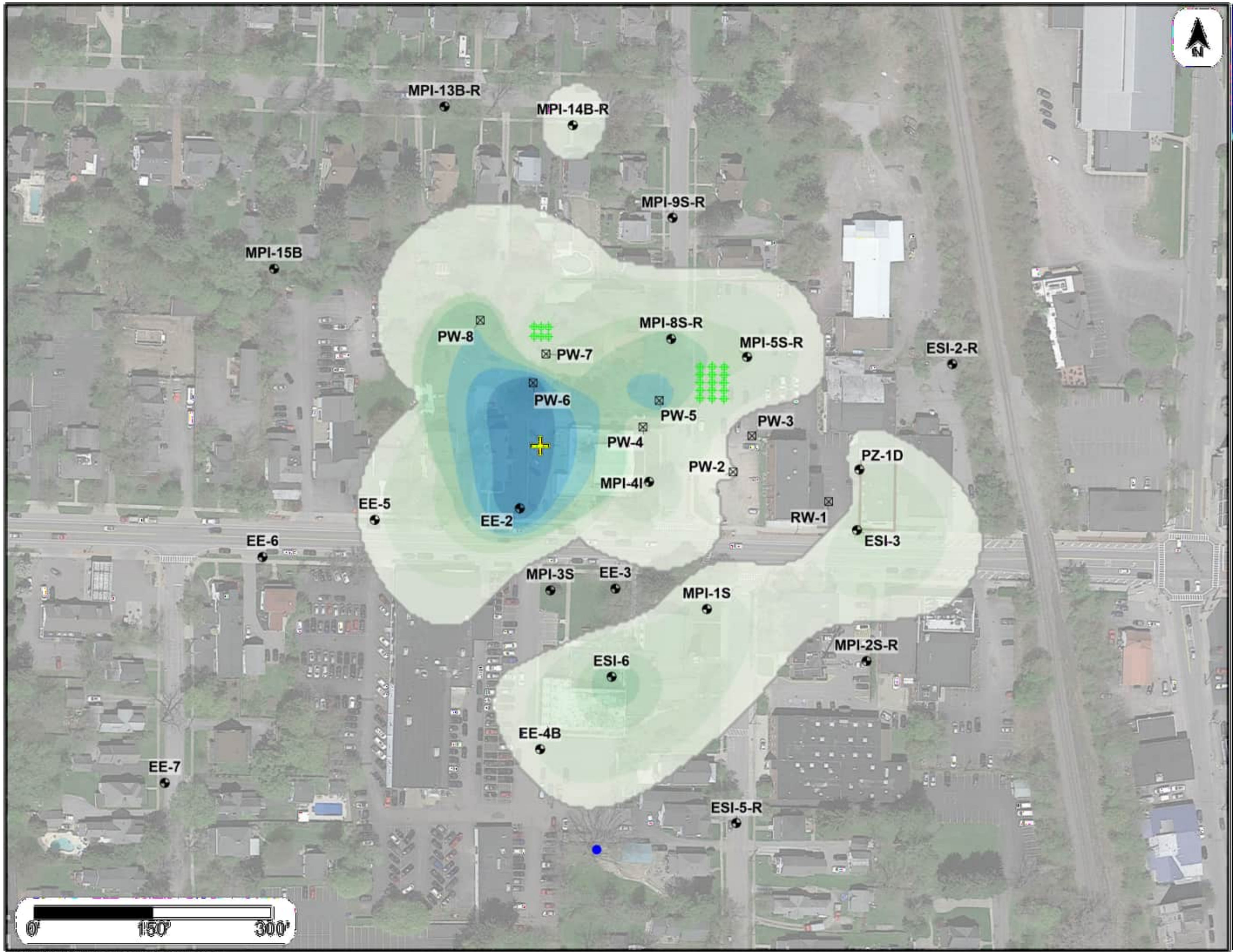
Figure 1-10 August 2024 Total Analyzed cVOCs Plume Map



Total Analyzed cVOCs
Aug-2024

Concentration Above Constituent MCLs (µg/L)

0, 10, 50, 100, 250, 500, 1,000, 2,500, 5,000, 10,000

Plume Characteristics

Plume Area: **7.5 acres**

Plume Average Concentration: **125 µg/L**

Plume Mass Indicator: **23.5 lbs**

- Monitoring Well
- Hanging Well
- Pumping Well (Active)
- Pumping Well (Inactive)
- Plume Center of Mass
- Control Point
- Mr. C's Building
- Injection Point

Figure 1-10

ecology and environment engineering and geology, p.c.
Environmental Specialists

Figure 1-11 Soil Vapor Intrusion Sampling and Sub Slab Depressurization System Map

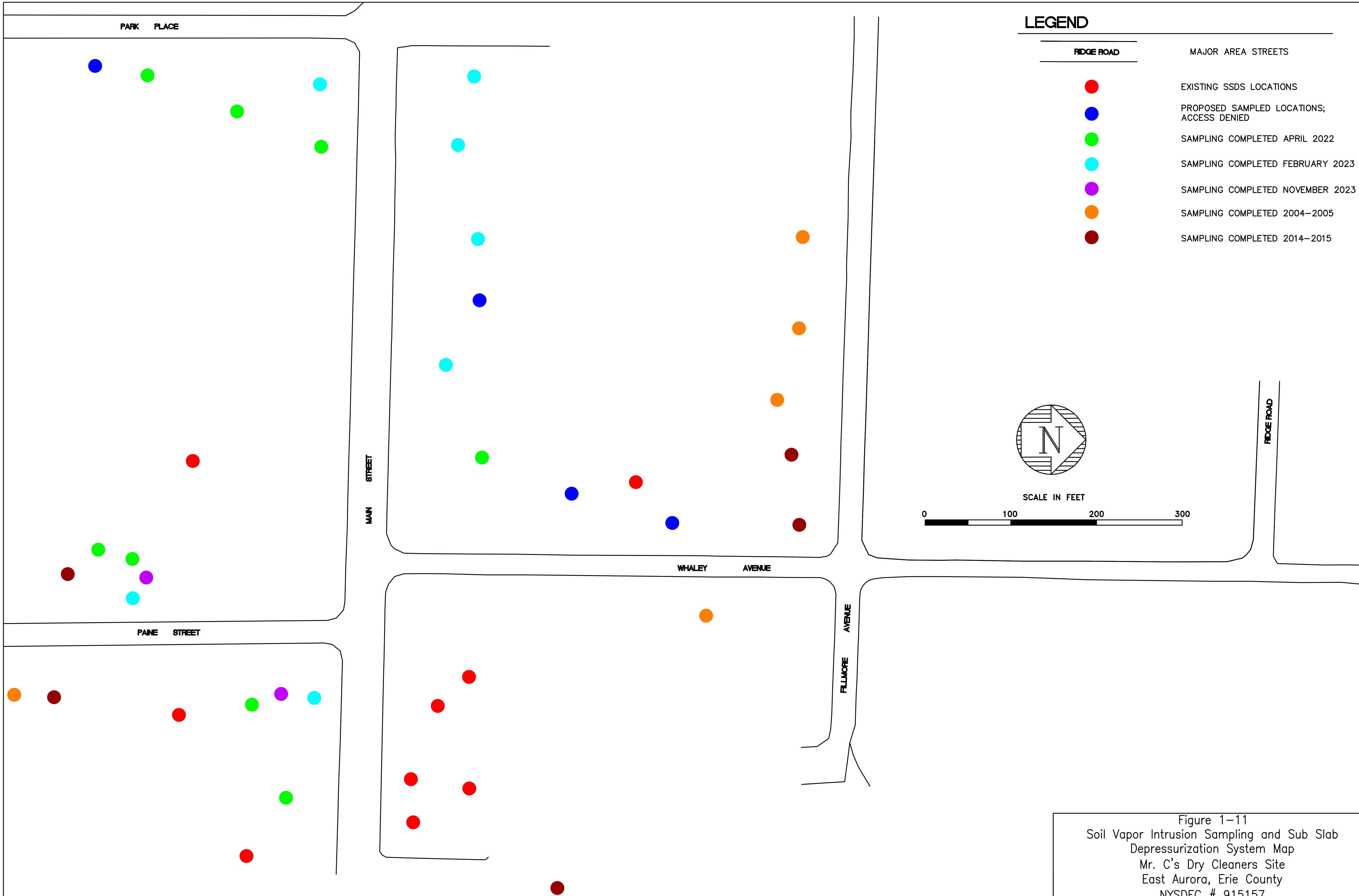


Figure 1–11
Soil Vapor Intrusion Sampling and Sub Slab Depressurization System Map
Mr. C's Dry Cleaners Site
East Aurora, Erie County
NYSDEC # 915157

2 Development of Remedial Optimization Alternatives

This section describes the general response actions and the various remedial optimization alternatives under consideration for contaminant migration management and source control at the Mr. C's Site. The remedial optimization alternatives comprise multiple response actions necessary to achieve the RAOs established in the ROD, as identified in Section 1.6.3. Each alternative includes an environmental notice, long-term groundwater monitoring, and ongoing SVIIs and installation of SSDSs, as deemed necessary.

2.1 General Response Actions and Technologies

The RAOs for the Mr. C's Site can be met with a combination of institutional controls (ICs) and ECs, which together comprise the site remedy.

ICs are non-engineered methods of minimizing potential exposure to contamination, usually through the use of administrative and legal controls. ICs in place at the Mr. C's Site include an Environmental Notice, a long-term groundwater monitoring program, and an SVII and mitigation program. In order to limit exposure, ICs generally restrict land and resource use and future land development. ICs can be implemented as soon as contamination is discovered and are generally maintained until residual contamination has been reduced to levels allowing for unrestricted exposure and unlimited use. While not adequate for contamination control, ICs used in conjunction with ECs limit present and future risks to human health from contaminant exposure (USEPA 2024).

ECs are designed to control/remove contamination (e.g., through pumping and treating) and physically limit contaminant exposure (e.g., through fencing). ECs can be associated with ICs, such as monitoring wells for LTM programs and SSDS and vapor barriers installed to mitigate soil vapor intrusion identified from a monitoring program. The ECs considered for remediation of a contaminated groundwater plume consist of both source controls and migration controls. The ECs currently in place at Mr. C's are the groundwater monitoring well network and SSDSs.

Source controls are actions taken to remove or reduce the highest dissolved contaminant concentrations or residual non-aqueous-phase liquids in the area of the original contaminant release. The technologies determined to have the potential to provide source control or reduction at the Mr. C's Site are P&T, enhanced bioremediation, in-situ chemical reduction or oxidation, and monitored natural attenuation (MNA). These technologies are included in the remedial optimization alternatives.

Migration controls are implemented outside the source area and are used to prevent contaminant migration. The technologies determined to have the potential to provide migration control at the Mr. C's site are P&T.

The current ICs and ECs are described below in terms of their applicability to the Mr. C's Site, either as part of the existing Site remedy or as a potential optimization of the remedy.

2.1.1 Environmental Notice

The main IC for the Mr. C's site is an environmental notice. The notice refers to non-physical mechanisms designed to:

- Restrict the use or development of the site;
- Limit human exposure to site contaminants;
- Prevent any action that would threaten the effectiveness or operation and maintenance of a remedy at or pertaining to the site; and
- Implement, maintain, and monitor ECs.

In addition to the ICs identified above, the environmental notice also stipulates the following:

- Compliance with the Site Management Plan (EEEPC 2015b);
- Restrictions on the use of groundwater as a source of potable or process water, without necessary water quality treatment as determined by the NYSDOH;
- Periodic certification of ICs and ECs, where present, by the responsible party, unless such party is NYSDEC or NYSDEC's designee; and
- Restrictions on future property use that is no less restrictive than "restricted-residential use" as defined by 6 New York Codes, Rules and Regulations Part 375

Permanent access agreements and easements are in place to facilitate the long-term operation and maintenance of the treatment systems and network of ground-water pumping wells associated with the NYSDEC-approved Remedial Design dated October 2000.

All alternatives considered in this RSO report include an environmental notice.

2.1.2 Long-term Monitoring

LTM of the Site Remedy is performed to evaluate the effectiveness of the remedy and to assess the overall reduction of groundwater contaminants. Groundwater monitoring is performed at wells located upgradient and downgradient of the contaminant plume, in the source area, in the centerline of the plume, and lateral to the plume. Currently, monitoring of the groundwater plume and off-site SSDSs is performed routinely. Both monitoring programs and their respective schedules are provided in Table 2-1.

Table 2-1 Mr. C's Inspection Schedule

Monitoring Program	Inspection Frequency[1]	Engineering Controls[2,3]
Groundwater	Every three to five quarters to stagger seasonal events	Monitoring wells
Vapor Intrusion	Sampling as needed and annual inspections of SSDSs	SSDS components, seals

Notes:
1 The inspection frequency will continue as indicated unless otherwise specified by NYSDEC.
2 Specific requirements for inspections are described in Section 4 of the SMP (EEEPC 2015b).
3 Reporting requirements are summarized in Section 5 of the SMP (EEEPC 2015b).

Key:
SMP = Site Management Plan
SSDS = sub-slab depressurization system

As of 2024, the groundwater monitoring well network remains in operable condition. Following RSO discussions between EEEGPC, NYSDEC, and NYSDOH in 2022, four new wells (EE-4B, EE-5, EE-6, and EE-7) were installed the week of January 16, 2023, and developed on February 2, 2023, to further delineate the southwestern portion of the groundwater plume. In 2023, EEEGPC staff inspected all the monitoring and pumping wells and piezometers to evaluate physical condition and the need for repair. In 2024, EEEGPC published a memo evaluating whether the wells needing repair are critical to the understanding of the groundwater contamination plume and recommended several wells for decommissioning in addition to the repair recommendations. In May 2024, several wells were repaired so they could continue to be utilized in the LTM program, and multiple wells were decommissioned. One well was replaced (ESI-5SR). The locations of all current wells are shown in Figure 1-2 and the well decommissioning work is described in the forthcoming 2024 Annual Report (EEEGPC 2025).

In 2022, NYSDEC requested that annual groundwater sampling be scheduled for every five quarters. As a result, no groundwater sampling occurred in 2022. In 2023, sampling was performed from February 14 to 21 and again from August 21 to 28 based on project team discussions to sample on a six-month basis for two years to establish a record of groundwater samples collected after the treatment system shutdown. Accordingly, sampling was also performed in 2024 from March 11 to 14 and from August 26 to 29.

All alternatives considered in this RSO report include LTM. It is assumed that LTM results will be periodically reviewed against site-specific decision frameworks to identify opportunities to reduce costs by mothballing or decommissioning monitoring wells, as warranted, and evaluating the progress toward site closure.

2.1.3 Soil Vapor Intrusion Evaluations and Sub-Slab Depressurization Systems

Soil vapor intrusion is a concern for this site due to the presence of residences and businesses in the vicinity of the groundwater contamination plume. PCE and its daughter products can volatize from the contaminated groundwater and migrate through gaps and cracks in foundations and walls of property basements into the air, where they could potentially be inhaled by occupants. As discussed in Section 1.5.2, previous sampling efforts have identified properties that require SSDS installation and properties that do not require further action due to concentrations below DOH guidance values.

An SSDS works by creating a low-pressure area beneath a building to extract VOCs from soil vapors. A fan is used to draw the VOC-contaminated air through a hole cut into the building slab and into pipes, which convey the contaminated air outside the building, where it is released to the atmosphere (MDEP 1995). This remedial system is currently installed at nine different properties adjacent to the site, and these systems are inspected annually along with the conditions of the basements to confirm compliance with the RAO of mitigating human health risk by reducing the potential for inhalation of vapors in on-site and off-site basements.

Given the stability of the groundwater plume, additional SVIIs are assumed not to be required as the affected properties are already addressed with existing SSDSs. As a result, all remedial optimization alternatives include annual inspection of SSDSs and no further SVIIs.

2.1.4 Pump-and-Treat System

The pump and treat system at the Mr. C’s Site has been shut down since September 2022. Prior to shut down the P&T system was used to reduce the concentration and extent of COCs present in the groundwater plume. Groundwater was directed toward the treatment system and was subsequently treated by using an air stripper to volatilize contaminants out of the liquid phase and then venting to the atmosphere and discharging the treated water to Tannery Brook. Though the system has been partially decommissioned, new equipment could be brought in to restart the system if it is determined that a P&T system is the best option for reducing the groundwater contaminant plume. Given the age of the system, most of the equipment required to run a P&T system at the Site would need to be purchased to replace decommissioned equipment. Based on the results of the contaminant plume treatment performance, and the performance of the P&T system as discussed in Sections 1.6.1 and 1.6.2, this technology is evaluated for comparison purposes only, as discussed further in Section 2.2.1.

2.1.5 Monitored Natural Attenuation

MNA can be used as a contaminant source control only if a site has been thoroughly investigated and the investigations have revealed that contaminant concentrations are decreasing by natural processes, or if an engineered process has stabilized or reduced a contaminant plume and established ongoing conditions favorable for MNA to degrade the remainder of the contamination after removal or shutdown of the engineering process. In general, MNA alone as an initial remedy could take decades to reduce contaminant concentrations to below groundwater standards (USEPA 2021).

The main processes involved in MNA are sorption, evaporation, chemical reactions, dilution, and biodegradation (USEPA 2021). Sorption is the process of contaminants becoming retained to soil particles, removing them from the groundwater. When contaminants evaporate into a gaseous phase, they can leave the soils and groundwater of an area and volatize into the atmosphere. Under ideal conditions, some chemicals will undergo reactions that transform them into compounds that are no longer hazardous. While dilution does not degrade contaminants, in situations with low level contamination it may reduce contaminant concentrations to levels that fall beneath pertinent standards. Biodegradation is the process by which microbes metabolically degrade contaminants. Biodegradation may occur without human intervention at sites where microbes are present that are able to metabolize the COC. The shutdown of the P&T system has shown that MNA is a potentially viable remedy for the Mr. C's site, which is discussed further in Sections 1.6.2 and 2.2.2.

2.1.6 In-Situ Treatment

In-situ treatment involves the injection of a chemical or biological material or amendment that reacts with or degrades contaminants. The most common forms of in-situ treatment are in-situ chemical oxidation, in-situ chemical reduction, and in-situ biological degradation.

2.1.6.1 In-Situ Chemical Remediation

In-situ chemical remediation involves placing a chemical amendment into the subsurface to stimulate chemical reactions that convert dissolved contaminants into inert compounds. The chemical can be directly injected into target areas with or without the intention of recovery or incorporated into a permeable reactive barrier through which groundwater flows. The choice of the chemical used depends on the contaminants and other environmental conditions present at the site. Chemical oxidants, such as potassium permanganate, activated sodium persulfate, and Fenton's reagent may be injected to oxidize the contaminant. Reducing agents such as zero valent iron can be used to stimulate a reduction reaction, often enhanced by emulsification with vegetable oil.

An additional form of in-situ chemical remediation is surfactant flushing. Surfactants can mobilize contaminants through making them more soluble or increasing partitioning from the soil sorbed phase to the aqueous phase. They are injected with the intent of recovery, so they are typically used in conjunction with P&T systems. In addition, this method is often used as a treatment for DNAPL or groundwater with high concentrations of contaminants given that it is the most intrusive form of in-situ treatment and requires recovery wells installed in a dense pattern to fully capture the injected material.

2.1.6.2 In-Situ Bioremediation

In-situ biological remediation relies on bacteria to metabolize target contaminants. This treatment approach can involve the injection of various amendments to the subsurface to optimize conditions for existing bacteria, but it may also involve the addition of certain strains of bacteria selected for their ability to break down the target contaminant (USEPA 2013). Similar to in-situ chemical remediation, the selection of additives depends on existing site conditions and what is needed to optimize conditions for biological degradation.

2.2 Remedial Optimization Alternatives

The ECs and ICs present on site and identified as potentially useful for further remediation of the site have been organized into alternatives for evaluation, which are described below. As discussed in the previous section, all alternatives include an environmental notice as described in Section 2.1.1, long-term monitoring of groundwater, and SSDS inspections. All alternatives are evaluated for a lifetime of 10 years, given that the Site has been undergoing OM&M for 23 years since the start of the P&T system operation in 2002.

2.2.1 Alternative 1 - Pump-and-Treat System Operation

Alternative 1 involves reconstruction of the P&T system, as necessary due to the deterioration of the originally installed system. This alternative includes purchase of the equipment listed below, installation of the new equipment and an existing gently used air stripper currently stored on-site, reconnection of the wiring for the extraction well pumps, labor to restart the system and continue monthly maintenance, and utility costs for running the system continuously after restart.

The equipment assumed to be purchased as part of this alternative includes:

- System influent and effluent pumps (1 each);
- A blower to run the air stripper;
- One stainless steel bag filter housing;
- HDPE piping to connect the equalization tank to the pumps and air stripper and to connect the air stripper effluent to the system effluent pipe; and
- Five extraction well pumps to replace existing pumps for wells PW-4 through PW-8 with new controllers and electrical boxes.

The elements of long-term monitoring of groundwater and SSDS inspections that are included in this, and all subsequent alternatives are discussed in Section 2.2.2.

The costs associated with OM&M for the system for this alternative are included with the annual OM&M costs associated with SSDS and groundwater well network repairs, as needed.

2.2.1.1 Alternative 1a - Pump-and-Treat System Operation with Surfactant Flushing

This alternative is the same as Alternative 1a with the addition of injection and recovery of a surfactant solution. This would involve installation of four to six additional recovery wells given that the spacing of the existing pumping wells is too far apart for adequate recovery of injected material, as well as installation of injection wells to circulate the surfactant through the system. Surfactant injections would be targeted where the highest concentrations of COCs are located, primarily around PW-5, PW-6 and EE-2.

2.2.2 Alternative 2 - Long Term Groundwater Monitoring with Monitored Natural Attenuation

Long-term monitoring for this and all alternatives includes groundwater sampling every three quarters for the first four years to establish seasonal patterns, and groundwater sampling every five quarters for the subsequent six years. It is assumed that each sampling event will take one week and involve a team of two field personnel, with additional hours of labor for mobilization planning and data validation. A total of 46 samples will be analyzed for VOCs using EPA method 8260C each event, which includes all of the groundwater monitoring wells, field duplicates, matrix spike/matrix spike duplicates, rinse blanks, and trip blanks.

Annual SSD system inspections will be conducted under all alternatives. It is assumed that inspections & documentation work will be performed by an engineer and take up to 3 days per year. Potential SSDS repair work is included in overall OM&M costs which also includes groundwater well network inspections and repairs, as needed.

This alternative and Alternative 3 both include full decommissioning of the P&T system. Partial decommissioning has already begun onsite, so the items included in this cost are as follows: downgrading of the electrical system from 420 V to 220 V, decommissioning of system influent and effluent piping, removal and disposal of remaining equipment onsite, and transportation of remaining functional equipment to a DEC storage facility, assumed to be located 50 miles from the existing treatment system garage. Four different options were evaluated for decommissioning of system influent and effluent piping: full below-grade removal of all piping and manholes, below-grade removal of piping and manholes within grass and parking lot areas (avoiding roadway impacts), removal of manholes to their full depth (8 feet), and removal of manholes to the depth of piping (4 feet) and grouting in place of remaining manholes and all system piping, including capping the effluent discharge point at Tannery Brook. The costs for these piping decommission options are discussed in Section 3.

2.2.3 Alternative 3 - Long Term Groundwater Monitoring with In-Situ Remediation

This alternative includes all the elements of Alternative 2 with the addition of two rounds of in-situ amendment injections. The first round of injections will be conducted as a pilot study, with the pilot study work plan to be written in the first year and implemented at the end of the first year, with a second round of injections occurring in the sixth year of this alternative. Injections will be clustered around and/or upgradient of the areas of highest contamination near wells PW-5, PW-6, and EE-2. The amendments to be used will either be chemical reductants or bioremediation amendments, given the success of MNA at the Site. Chemical oxidants would work against the pre-existing processes of MNA and therefore are not practical for use at the site.

3 Alternative Analysis

The alternatives discussed in Section 2.2 are analyzed in this section according to six criteria as listed below. The comparison of the alternatives is presented in Section 3.2 and associated tables.

3.1 Evaluation Criteria

The evaluation criteria that will be used to assess the 3 alternatives to optimize remediation at the Mr. C's site are listed below and are consistent with the requirements of NYSDEC DER-10 Technical Guidance for Site Investigations and Remediation dated May 2010.

- **Overall Protection of Human Health & the Environment:** This criterion evaluates the ability of each alternative or remedy to protect the health of the public and environment. This includes an evaluation of the sustainability of the alternative or remedy.
- **Long-term Effectiveness and Permanence:** This criterion evaluates the long-term effectiveness and permanence of an alternative or remedy after implementation.
- **Reduction of Toxicity, Mobility, or Volume through Treatment:** This criterion evaluates the ability of an alternative or remedy to reduce the toxicity, mobility and volume of site contamination. Preference should be given to remedies that permanently or significantly reduce the toxicity, mobility or volume of the contamination at the site.
- **Short-term Effectiveness**: This criterion evaluates the potential short-term adverse environmental impacts and human exposures during the construction and/or implementation of an alternative or remedy.
- **Implementability:** This criterion evaluates the technical and administrative feasibility of implementing an alternative or remedy.
- **Cost:** This criterion evaluates the overall cost effectiveness of an alternative or remedy.
- **State and Community Acceptance**: This criterion is evaluated based on acceptance by the Community and the State of New York after public notice and review of the remedial alternatives presented. This evaluation

criterion is not evaluated in this document as it requires public input. It is noted that if Alternative 2 or 3 is selected for the Site, an amended ROD will need to be issued, which will require public input. This criterion will then be included in the amended ROD after a public meeting is held and comments on the proposed remedy are received from the public.

3.2 Evaluation of Alternatives

Table 3-1 presents the evaluation of alternatives according to the criteria described in Section 3.1. Costs for the four options for decommissioning of the pump and treat system are summarized in Table 3-2. The lowest cost and most reasonable option for decommissioning of the treatment system involves the removal of piping manholes to the depth of piping and grouting and sealing the remainder of the manholes and all piping, as this involves the least surface disturbance while also functioning as a full decommissioning of piping associated with the system. Costs associated with system decommissioning by this method are included in the total costs for Alternatives 2 and 3. Costs for the three alternatives and the four options for decommissioning the pump and treat system are included in Appendix A, with summary costs for the three alternatives shown in Table 3-3.

Table 3-1 Evaluation of Alternatives

Table 3-1 Evaluation of Alternatives

Overall Protection of Human Health & the Environment	Long Term Effectiveness & Permanace	Reduction of Toxicity, Mobility, or Volume through Treatment:	Short Term Effectiveness	Implementability	Cost
Alternative 1 Pump and Treat (P&T) Operation					
* This remedy is protective of human health and the environment as it provides removal of contaminated ground water and relies on continued operation of sub-slab depressurization systems on affected structures. * Operation of the P&T system will result in a higher direct production of greenhouse gases through vehicle miles traveled for OM&M and site visits and a higher indirect production of greenhouse gases through electricity consumption required to power equipment.	P&T technologies are effective at controlling exposure to PCE due to off-site migration; however, P&T technologies face declining efficiencies with respect to source control. As shown with Site groundwater data, the effectiveness of this alternative to reduce the volume of contaminated groundwater has decreased over time.	A P&T system will reduce mobility and the overall volume of the contaminant plume with extraction of the contaminated groundwater. It is not expected that P&T will provided reduction of toxicity of the contaminant plume through any type of dechlorination mechanism. SVIIs and mitigation with vapor barriers and SSDSs will reduce the exposure pathway for VOCs in the properties whose owners agree to them.	There is limited to no short term effectiveness in terms of reduction of contamination expected given the stability of the plume before system shutdown.	Components of a P&T system are readily available, and an air stripper, equalization tank, and system piping is already present onsite. Electrical systems would need to be reconnected, including controls for the extraction well pumps.	$2,515,000
Alternative 1a Pump and Treat (P&T) with Surfactant Flushing					
* This remedy is protective of human health and the environment as it provides removal of contaminated ground water and relies on continued operation of sub-slab depressurization systems on affected structures. * Operation of the P&T system will result in a higher direct production of greenhouse gases through vehicle miles traveled for OM&M and site visits and a higher indirect production of greenhouse gases through electricity consumption required to power equipment. * The continued introduction of surfactant (either continually or periodically) will require additional construction to install injection points and recovery wells.	P&T technologies are effective at controlling exposure to PCE due to off-site migration; however, P&T technologies face declining efficiencies with respect to source control. As shown with Site groundwater data, the effectiveness of this alternative to reduce the volume of contaminated groundwater has decreased over time. It is anticipated that with the addition of surfactant flush, remedial times will be reduced, though effectiveness is limited by the extent of the injections and recovery area.	A P&T system will reduce mobility and the overall volume of the contaminant plume with extraction of the contaminated groundwater. The addition of surfactant will reduce the toxicity of the plume through treatment, and will reduce the volume at a greater speed than the P&T system alone. However, it is possible that injection of surfactant may increase the mobility of the plume. SVIIs and mitigation with vapor barriers and SSDSs will reduce the exposure pathway for VOCs in the properties whose owners agree to them.	There is limited short term effectiveness in terms of reduction of contamination expected, depending on the efficiency of the surfactants in targeting the remaining contamination.	Components of a P&T system are readily available, and an air stripper, equalization tank, and system piping is already present onsite. Electrical systems would need to be reconnected, including controls for the extraction well pumps. It may be difficult to provide full recovery of the surfactant across the targeted depth and width of the groundwater plume.	Additional costs of surfactant flushing were not evaluated due to high base cost of Alternative 1; this alternative is not recommended.

Table 3-1 Evaluation of Alternatives

Overall Protection of Human Health & the Environment	Long Term Effectiveness & Permanace	Reduction of Toxicity, Mobility, or Volume through Treatment:	Short Term Effectiveness	Implementability	Cost
Alternative 2 Long Term Groundwater Monitoring with Natural Attenuation					
* This remedy is protective of human health and the environment by providing continued long term monitoring of the contanimant plume in conjuntion with continued operation of sub-slab depressurization system on affected structures. * Long-term monitoring results in the lowest production of greenhouse gases due to decrease in vehicle miles traveled for OM&M and site visits and the elimination of the electrical costs associated with P&T system operation. * Short term environmental effects will result from decommissioning the remaining features of the P&T system and restoration of the site and surrounding properties.	Recent groundwater monitoring has shown that a dechlorination and reduction of contaminants is naturally occuring since the shut down of the P&T system that occurred in fall 2022. The effectiveness of this alternative to reduce the volume of contaminated groundwater is expected to continue over time.	There will be no reduction of toxicity, mobility, or volume through treatment, since no active groundwater treatment will be conducted. However, natural reduction is expected to continue due to the anaerobic dichlorination that will continue to occur. SVIIs and mitigation with vapor barriers and SSDSs will reduce the exposure pathway for VOCs in the properties whose owners agree to them.	There is limited to no short term effectiveness in terms of reduction of contamination expected.	Long term groundwater monitoring is a readily implementable technology. The full decommissioning of the P&T system will use readily available equipment and is easily implementable as well.	$757,000
Alternative 3 Long Term Groundwater Monitoring with In-situ Remediation					
* This remedy is protective of human health and the environment by providing continued long term monitoring of the contanimant plume in conjuntion with continued operation of sub-slab depressurization system on affected structures. * This remedy results in the second lowest production of greenhouse gases due to decrease in vehicle miles traveled for OM&M and site visits and the elimination of the electrical costs associated with P&T system operation. The addition of in-situ treatment of groundwater increases greenhouse gas emissions through vehicle miles traveled for in-situ injections and additional monitoring, operation of heavy equipment to complete injections, and shipment of amendment material to the site. * Short term environmental effects will result from decommissioning the remaining features of the P&T system and restoration of the site and surrounding properties.	Recent groundwater monitoring has shown that a dechlorination and reduction of contaminants is naturally occuring since the shut down of the P&T system that occurred in fall 2022. The effectiveness of naturally occuring processes to reduce the volume of contaminated groundwater is expected to continue over time, with an increase in effectivness expected after each round of in-situ amendment injections.	With the introduction of a treatment amendment, the natural reduction of toxicity and volume of contamination is expected to be enhanced and expedited due to the enhanced anaerobic biodegradation or chemical reduction. There is a potential increase in mobility of contamination from this alternative due to the injection of amendments, which will be monitored closely through continued groundwater sampling. SVIIs and mitigation with vapor barriers and SSDSs will reduce the exposure pathway for VOCs in the properties whose owners agree to them.	Short term effectiveness in terms of reduction of contamination expected.	Long term groundwater monitoring and amendment injection are a readily implementable technologies. The full decommissioning of the P&T system will use readily available equipment and is easily implementable as well.	$1,587,000

Note: Calculated costs represent the present worth value for a period of 10 years.

Table 3-2 Pump & Treat System Decommissioning Options

Table 3-2 Pump & Treat System Decommissioning Options

Option	Name	Description	2025 Cost
1	Treatment System Garage Decommissioning	Downgrade electrical service from 420 V to 220 V, remove and disposal of all remaining unusable equipment, and transportation of reusable equipment to a separate DEC storage facility.	$17,632
1a	Full below-grade removal of all treatment system facilities	Full below-grade removal of all piping and manholes, and restoration of disturbed surfaces to existing conditions (asphalt road/parking, grass, etc.).	$144,005
1b	Full below-grade removal of all treatment system facilities except within roadways	Full below-grade removal of all piping and manholes except in areas where they are below public roads, and restoration of disturbed surface areas to existing conditions (asphalt parking, grass, etc.)	$82,517
1c	Removal of piping manholes	Removal of piping manholes to full depth and restoration of disturbed surfaces to existing conditions (asphalt road/parking, grass, etc.).	$49,852
1d	Removal of piping manholes to depth of piping and grouting in place of all system piping	Removal of piping manholes to the depth of piping (4 feet) and restoration of disturbed surfaces to existing conditions (asphalt road/parking, grass, etc.), and grouting in place of all system piping, including sealing of the effluent outlet at Tannery Brook.	$30,782

Note: Only monitoring and pumping wells that are to be used for future long term monitoring remain at the site.

Table 3-3 Summary of Total Present Values of Alternatives at the Mr. C's Dry Cleaners Site

Table 3-3 Summary of Total Present Values of Alternatives at the Mr. C's Dry Cleaner Site

Description	Alternative 1 Pump and Treat System Operation	Alternative 2 Groundwater Monitoring with Monitored Natural Attenuation	Alternative 3 Groundwater Monitoring with In-Situ Chemical Reduction or Enhanced Bioremediation
Estimated timeframe of remedy (years):	10	10	10
Capital Cost	$372,300	$61,300	$891,000
Annual Costs [1]	$1,710,000	$281,000	$281,000
Long-Term Monitoring Costs	$373,582	$373,582	$373,582
Periodic Costs [2]	$59,000	$41,000	$41,000
2025 Total Present Value of Alternative[3]	**$2,515,000**	**$757,000**	**$1,587,000**

Notes:

1 - Annual costs include utility costs and treatment sytem OM&M for the pump and treat system, where applicable, and OM&M on the monitoring well network and annual reporting for all alternatives.

2 - Periodic costs include 3-year periodic review reporting for all alternatives.

3 - The Total Present value of Alternative represents the estimated present value of the capital costs and annual and periodic costs for the given timeframe.

4 Recommended Alternative for Remedial Optimization

EEEGPC recommends that NYSDEC consider Alternative 3, Long Term Groundwater Monitoring with In-situ Remediation, for remedial site optimization at the Mr. C's Dry Cleaners Site. Alternative 3 is recommended because it is the most cost-effective option that meets the evaluation criteria, is readily implementable, is sustainable and will provide the greatest reduction of toxicity, mobility, and volume of site contaminants. Alternative 3 is estimated to cost $1,587,000 over 10 years, whereas Alternative 1, continued operation of the P&T system, is estimated to cost $2,515,000 over the same time period and requires the reconstruction of the existing P&T system. Choosing Alternative 3 over Alternative 1 would reduce annual operating costs from an estimated $1,710,000 to $281,000.

Chemical/bioremediation source control is an effective long-term control for the PCE plume. Although it increases PCE toxicity in the short term due to dechlorination of PCE to vinyl chloride, SSDSs in areas experiencing soil vapor intrusion problems will protect human health during this increase in toxicity.

Bioremediation and chemical reduction technologies are in line with the objectives of NYSDEC's Green Remediation Program Policy. As an in-situ technology, injection of chemical reductants or bioremediation agents would involve less greenhouse gas emissions because less OM&M would be required, and minimal electricity would be used to inject the treatment amendment.

Implementation of Alternative 3 requires an update to the SMP, which needs to be updated for all the alternatives. Sections pertaining to operation, maintenance, and monitoring of the P&T system would be removed. Updates would clearly define the elements of the LTM program and response actions. The monitoring program would be supplemented with additional monitoring parameters if enhanced bioremediation is selected instead of in-situ chemical reduction, such as monitoring for secondary groundwater quality impacts and methane generation. Groundwater monitoring is currently performed annually; however, the net present cost analysis for the alternatives presented in this RSO report assumes that groundwater monitoring can be reduced to once every 5 quarters after seasonality is established to account for seasonal changes after implementation of the alternative.

Annual OM&M of the SSDSs may in the future be transferred for performance under NYSDEC's current statewide vapor mitigation system maintenance program should the site be otherwise considered ready for closure. Environmental restrictions must be filed with the Village of East Aurora Clerk for new buildings constructed over the contaminant plume and should include institutional controls to protect construction and utility workers from potential exposure to site contamination. Periodic reporting on the remedy would continue to serve as the avenue for monitoring the adequacy of these Site ICs.

Monitoring, reporting, and response actions such as maintenance injections would continue until the RAOs are met, meaning that:

1. Human health risks have been mitigated through the installation of SSDS systems and vapor barriers and reduction of PCE; and the LTM program at the site includes a decision framework for continued protection of human health against soil vapor intrusion until NYSDEC groundwater quality standards are met;
2. LTM and plume analysis has shown that the plume is stable; and,
3. NYSDEC groundwater quality standards have been achieved to the extent practical.

Based on this RSO analysis, EEEGPC concludes that chemical reduction or bioremediation is a substantially better alternative for reducing site contamination at a substantial cost savings compared to Alternative 1. Though Alternative 3 has a higher cost and is more difficult to implement than Alternative 2, it is expected to achieve RAOs faster than Alternative 2 through active treatment, leading to an earlier site closure and better effectiveness in both the long- and short-term.

Implementation of either Alternative 2 or 3 constitutes a fundamental change to the Site Remedy, which must ultimately be recommended by the NYSDEC Bureau Director to Division Management for consideration. Public participation and community involvement should be solicited for this change in the Site Remedy, with the publication of an amended ROD issued to document this change in remedy, with a subsequent update to the SMP. The issuance of the amended ROD should not involve significant work as much of this document would provide the material justification for the amendment. The amended ROD will address the generic remedies of monitored natural attenuation and injection of amendments for the treatment of groundwater. The parameters for monitoring, including specific injection locations, as well as the exact amendment to be used will be determined during the pre-design investigation (PDI).

The 1997 ROD discusses monitoring residential irrigation wells as a component of the selected remedy. However, since DEC-permitted irrigation wells have no longer been identified in the area, this component will be removed from the amended ROD and all groundwater monitoring will be performed from monitoring wells specifically installed for monitoring purposes, in the vicinity of the site.

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A Alternative Costing Tables

Table A-1: Preliminary Cost Estimate for Alternative 1: Pump & Treat System Operation
Mr. C's Dry Cleaner's Site, East Aurora, New York

Item Description	Comment	Unit	Quantity	Unit Cost	Cost
Capital Costs					
Construction Management (10% of total capital cost)	Includes submittals, reporting, subcontract management	LS	1	$19,807.50	$19,808
Construction Oversight	Assume 25 days work duration	Day	25	$965.00	$24,125
System Upgrades					
Concrete Equipment Pads	6" slab, 4000psi concrete, includinf forming and reinforcement	SF	480	$7.85	$3,768
Reinstall Air Stripper Body	1 skilled laborer + 2 common laborers. Assume 3 day to assemble	HR	24	$243.90	$5,854
Skid Steer	Crew to move equipment during reinstillation	HR	24	$149.92	$3,598
Influent & Efluent Pumps	5 HP 230/460V, 3phase TEFC, 160 GPM	EA	2	$4,575.04	$9,150
Blower	25 HP, 460V, 3 phase TEFC	EA	2	$10,611.31	$21,223
Bag Filter Housing	304 stainless steel, 2" NPT inlet, dual side or bottom 2" NPT outlet, 150psi	EA	2	$1,075.13	$2,150
Piping (material) Water	4" HDPE piping	LF	200	$2.70	$540
	Pipe elbows	EA	8	$18.15	$145
	Pipe Tees	EA	6	$31.83	$191
Piping (labor)	2 plumbers. Assume 2 day to assemble	HR	16	$227.30	$3,637
Piping (material) Air	10" HDPE piping	LF	30	$15.82	$475
	Pipe elbows	EA	4	$522.50	$2,090
	Pipe Tees	EA	2	$589.00	$1,178
Piping (labor)	2 plumbers. Assume 2 day to assemble	HR	16	$227.30	$3,637
System install and restart	Assume 2 days to assemble with skilled worker and electrician	HR	48	$205.80	$9,878
Level "D" contract charges	PPE & field monitoring equipment costs	Day	25	$3.00	$75
Staff Mileage		mile	3,000	$5.50	$16,500
Controls Replacement					
Materials					
Submersible pump and motor	1/2 HP, 230V, 1 Phase, 5gph submersible pump	EA	5	$1,712.14	$8,561
Pressure Transducer	Submersible level transmitter - 0-20 psig, 60ft cable, 316 stainless steel diaphragm with polyamide protective cap	EA	5	$475.67	$2,378
Level Controller	FRANKLIN ELECTRIC Pump Control Panel: 1/3 hp Motor/Pump HP, 220V AC, 4.6, CSIR	EA	5	$135.63	$678
Control wiring and programming	2 Electricians for 3 days	Day	5	$1,745.60	$8,728
Pumping Well Electrical Replacement	PW-4, PW-5, PW-6, PW-7, and PW-8				
Traffic Control					
Labor	Assume one flagmen directing traffic, assume 10 LF removed per hour, 10 LF restored per hour	Hr	10	$96.70	$967
Traffic cones	2' tall reflective traffic cones, 1/four ft of work area, both sides of work area	LF	25	$5.28	$132
Barrier tape	Polyethylene barricade tape, 7mil, 3" wide, 300' long roll	LF	100	$0.04	$4
Steel plate	Steel roadway plate 1" thick, 8'x20' - week rental	Week	1	$527.38	$527
Asphalt sawcut	Asphalt saw cut, up to 3" thick	LF	1,202	$2.39	$2,872
Asphalt disposal	Assume 5 mile haul to recycling facility	CY	298	$20.07	$5,988

Existing Conduit Removal						
Excavation	Trench excavation 1-4' deep, 3/4 CY excavator, common earth	BCY	226	$8.67	$1,960	
Haul to Stockpile	Common earth, 80HP loader, 300' haul	LCY	283	$5.31	$1,501	
Pipe demolition	Conduit, 2" diameter, PVC, no concrete	LF	713	$1.76	$1,255	
Pipe and wire disposal	2 dumpsters, 40 CY capacity, weekly rental, 1 dump/week	Week	1	$1,700.00	$1,700	
New Conduit and Wiring						
PVC conduit	2" PVC, Schedule 40	LF	955	$12.44	$11,880	
Electrical Wiring	#12, 3 conductor wire	LF	2,707	$4.86	$13,161	
Control Wiring	#14, 2 connector wire	LF	2,707	$3.68	$9,960	
Detectable Warning Tape	Electric detectable warning tape	LF	955	$0.22	$211	
Backfill						
Material	Bedding sand for conduits	Ton	42	$18.19	$771	
Transportation	16.5 Cy truck, cycle hauling 25min wait, 40 MPH, 10 mile cycle	LCY	283	$7.60	$2,148	
Placement (imported material and existing)	Common earth, 80HP loader, 300' haul	LCY	283	$5.31	$1,501	
Compaction	Walk behind vibrating plate tamper, 12" lifts, 2 passes, 21" wide	BCY	226	$1.31	$296	
Grass area repair						
Topsoil						
Material and transport	Screened topsoil, assume 6" thick, includes delivery	LCY	5	$54.30	$292	
Placement	Sandy clay and loam, 80HP loader, 300' haul	LCY	5	$4.86	$26	
Sodding	1" deep bluegrass sod, level ground, 1,000 SF	SF	232	$0.75	$175	
Watering	Assume 1/day for 2 weeks for establishment. 2hrs/day, common laborer	LS	1	$1,472.00	$1,472	
Paving						
Asphalt hauling	16.5 Cy truck, cycle hauling 25min wait, 40 MPH, 10 mile cycle	LCY	35	$7.60	$266	
Binder	Binder course, 2" thick, includes compaction	SY	133	$16.86	$2,236	
Topcoat	Wearing course, 1" thick, includes compaction	SY	133	$8.93	$1,184	
Mill and re-top library parking lot	Cold asphalt milling and cleaning 1"-3"	SY	610	$2.59	$1,581	
Topcoat	Wearing course, 1" thick, includes compaction	SY	610	$8.93	$5,450	
Subtotal						$217,883
					Capital Cost Subtotal:	$217,883
					10% Legal, administrative, engineering fees:	$21,788
					30% design costs:	$65,365
					18% NRC subcontractor Energy, Insurance, and Inflation Fee	$31,311
					15% Contingencies:	$35,951
					Total Capital Cost:	**$372,300**

Alternative 1: Pump and Treat System Operation

Annual Costs					
Gas	National Fuel	Year	1	$1,175.83	$1,176
Electric	NYSEG	Year	1	$18,405.45	$18,405
SSDS annual inspection and reporting	Assume 3 hours per system (includes inspection and associated office work)	EA	12	$466.89	$5,603
Monthly compliance sampling	Subcontracted. Includes analysis for VOCs (EPA 8260C) for monthly influent, effluent and discharge, and quarterly samples from the 5 active pumping wells.	Sample	56	$67.70	$3,791
OM&M	OM&M for P&T system, monitoring well network, and SSDS systems	Year	1	$146,039.47	$146,039
Replacement Equipment	May include the replacement of pumps, blowers, motors, etc. and sequestering agent	Year	1	$7,622.74	$7,623
Annual Reporting	Publication of an annual report detailing OM&M and groundwater sampling analysis results	Year	1	$8,622.67	$8,623
Subtotal					$175,015
				Annual Cost Subtotal:	$175,015
				10% Legal, administrative, engineering fees:	$17,501
				15% Contingencies:	$28,877
				Annual Cost Total:	**$221,400**
				10-Year Present Value of Annual Costs:	**$1,710,000**
Long-Term Groundwater Monitoring					
Groundwater monitoring - labor	Assume two people for one week of sampling (80 hours), 20 hours for planning and mobilization, and 16 hours for data validation.	Hour	116	$141.42	$16,405
Sampling supplies	Includes rental equipment (low-flow pumps and tubing, water level meters, turbidity meters, multi-parameter water quality meter), and disposable equipment (gloves, nylon rope, etc.). Sampling to be conducted once every five quarters.	EA	1	$2,828.47	$2,828
Travel costs	Assume two truck rentals for one week.	Day	10	$110.00	$1,100
Analytical Services	Subcontracted. Includes analysis for VOCs (EPA 8260C).	Sample	46	$67.70	$3,114
Subtotal					$23,448
				Long-Term Groundwater Monitoring Event Subtotal:	$23,448
				10% Legal, administrative, engineering fees:	$2,345
				15% Contingencies:	$3,869
				Long-Term Groundwater Monitoring Event Total:	**$29,700**
				10-Year Present Value of Long-Term Groundwater Monitoring Event Costs:	**$373,582**
3-Year Costs					
Periodic Review Reporting	Performed once every three years; costs included are for the additional effort beyond annual reporting.	LS	1.00	$16,377.33	$16,377
Subtotal					$16,377
				3-Year Cost Subtotal:	$16,377
				10% Legal, administrative, engineering fees:	$1,638
				15% Contingencies:	$2,702
				3-Year Cost Total:	**$20,800**
				10-Year Present Value of 3-Year Costs:	**$59,000**

2025 Total Present Value of Costs $2,515,000

Table A-2: Preliminary Cost Estimate for Alternative 2: Groundwater Monitoring with Monitored Natural Attenuation
Mr. C's Dry Cleaner's Site, East Aurora, New York

Item Description	Comment	Unit	Quantity	Unit Cost	Cost
Capital Costs					
Treatment System Decommissioning					
System Decommissioning	Capital costs along with Option D costs; see Table A-4 for cost breakdown	LS	1	$48,414.88	$48,415
Subtotal					$48,415
				Capital Cost Subtotal:	$48,415
				10% Legal, administrative, engineering fees:	$4,841
				15% Contingencies:	$7,988
				Capital Cost Total:	**$61,300**
Annual Costs					
SSDS annual inspection and reporting	Assume 3 hours per system (includes inspection and associated office work)	EA	12	$466.89	$5,603
OM&M	OM&M for monitoring well network and SSDS systems	Year	1	$23,152.14	$23,152
Annual Reporting	Publication of an annual report detailing groundwater sampling analysis results	LS	1	$3,727.83	$3,728
Subtotal					$28,755
				Annual Cost Subtotal:	$28,755
				10% Legal, administrative, engineering fees:	$2,875
				15% Contingencies:	$4,745
				Annual Cost Total:	**$36,375**
				10-Year Present Value of Annual Costs:	**$281,000**
Long-Term Groundwater Monitoring					
Groundwater monitoring - labor	Assume two people for one week of sampling (80 hours), 20 hours for planning and mobilization, and 16 hours for data validation.	Hour	116	$141.42	$16,405
Sampling supplies	Includes rental equipment (low-flow pumps and tubing, water level meters, turbidity meters, multi-parameter water quality meter), and disposable equipment (gloves, nylon rope, etc.). Sampling to be conducted once every five quarters.	EA	1	$2,828.47	$2,828
Travel costs	Assume two truck rentals for one week.	Day	10	$110.00	$1,100
Analytical Services	Subcontracted. Includes analysis for VOCs (EPA 8260C).	Sample	46	$67.70	$3,114
Subtotal					$23,448
				Long-Term Groundwater Monitoring Event Subtotal:	$23,448
				10% Legal, administrative, engineering fees:	$2,345
				15% Contingencies:	$3,869
				Long-Term Groundwater Monitoring Event Total:	**$29,700**
				10-Year Present Value of Long-Term Groundwater Monitoring Event Costs:	**$373,582**

Alternative 2: Groundwater Monitoring with Monitored Natural Attenuation

3-Year Costs					
Periodic Review Reporting	Performed once every three years	LS	1.00	$11,272.17	$11,272
Subtotal					$11,272
				3-Year Cost Subtotal:	$11,272
				10% Legal, administrative, engineering fees:	$1,127
				15% Contingencies:	$1,860
				3-Year Cost Total:	**$14,300**
				10-Year Present Value of 3-Year Costs:	**$41,000**

2025 Total Present Value of Costs $757,000

Assumptions:

1. Present value cost based on annual/periodic costs over: 10 years
2. Present value of costs assumes 5% annual interest rate.
3. CPI for 2025 is 21.27%

Table A-3: Preliminary Cost Estimate for Alternative 3: Groundwater Monitoring with In-Situ Remediation
Mr. C's Dry Cleaner's Site, East Aurora, New York

Item Description	Comment	Unit	Quantity	Unit Cost	Cost
Capital Costs					
Construction Management (2.5% of total capital cost)	Includes submittals, reporting, permitting, subcontract management	LS	1	$8,978.67	$8,979
Construction Oversight	Assume 1 week work duration for injections	Day	5	$965.00	$4,825
Treatment System Decommissioning					
System Decommissioning	Capital costs along with Option D costs; see Table A-4 for cost breakdown	LS	1	$48,414.88	$48,415
Injection Pilot Test work plan					
Plan development	Plan will outline the preferred option (in-situ chemical reduction or bioremediation)	LS	1	$15,000.00	$15,000
Site Preparation					
Decontamination Pad	Construction and removal of decon pad (including labor and materials)	LS	1	$855.56	$856
Temporary fence	Chain link industrial	LF	200	$9.23	$1,846
In-Situ Chemical Reduction/Bioremediation Amendment Injections					
Injection cost	Cost per CF of plume, includes mob/demob, drilling, oversight, and injection	CF	82,328	$3.00	$246,985
In-Situ Treatment Summary Report	Includes reporting costs additional to the typical annual report	LS	1	$5,000.00	$5,000
Post-injection Sampling					
Groundwater monitoring - labor	Assume two people for one week of sampling (80 hours), 20 hours for planning and mobilization, and 16 hours for data validation.	Hour	116	$141.42	$16,405
Sampling supplies	Includes rental equipment (low-flow pumps and tubing, water level meters, turbidity meters, multi-parameter water quality meter), and disposable equipment (gloves, nylon rope, etc.). Sampling to be conducted once every five quarters.	EA	1	$2,828.47	$2,828
Travel costs	Assume two truck rentals for one week.	Day	10	$110.00	$1,100
Analytical Services	Subcontracted. Includes analysis for VOCs (EPA 8260C).	Sample	46	$67.70	$3,114
Site Restoration					
Surveying Crew	2-person crew and equipment, 8hr/day	Day	2	$1,637.17	$3,274
Restoration seeding	Kentucky Bluegrass; hydroseeding w/ mulch and fertilizer (material, labor, equipment)	SY	356	$0.89	$317
Asphalt driveway repair	hot-mix asphalt				
Binder	2" thick	SY	356	$16.86	$6,002
Wearing course	1" thick	SY	356	$8.93	$3,179
Subtotal					$368,126
Maintenance Injections					
Year 6 Reinjection at source	Present value of initial injection to occur after 5 years of monitoring	LS	1	$331,000	$331,000
In-Situ Treatment Summary Report	Includes reporting costs additional to the typical annual report	LS	1	$5,000	$5,000
Subtotal					$336,000
				Capital Cost Subtotal:	$704,126
	10% Legal, administrative, engineering fees, construction management:				$70,413
				15% Contingencies:	$116,181
				Total Capital Cost:	**$891,000**

Alternative 3: Groundwater Monitoring with In-Situ Remediation

Annual Costs					
SSDS annual inspection and reporting	Assume 3 hours per system (includes inspection and associated office work)	EA	12	$466.89	$5,603
OM&M	OM&M for monitoring well network and SSDS systems	Year	1	$23,152.14	$23,152
Annual Reporting	Publication of an annual report detailing groundwater sampling analysis results	LS	1	$3,727.83	$3,728
Subtotal					$28,755
				Annual Cost Subtotal:	$28,755
				10% Legal, administrative, engineering fees:	$2,875
				15% Contingencies:	$4,745
				Annual Cost Total:	**$36,375**
				10-Year Present Value of Annual Costs:	**$281,000**
Long-Term Groundwater Monitoring					
Groundwater monitoring - labor	Assume two people for one week of sampling (80 hours), 20 hours for planning and mobilization, and 16 hours for data validation.	Hour	116	$141.42	$16,405
Sampling supplies	Includes rental equipment (low-flow pumps and tubing, water level meters, turbidity meters, multi-parameter water quality meter), and disposable equipment (gloves, nylon rope, etc.). Sampling to be conducted once every five quarters.	EA	1	$2,828.47	$2,828
Travel costs	Assume two truck rentals for one week.	Day	10	$110.00	$1,100
Analytical Services	Subcontracted. Includes analysis for VOCs (EPA 8260C).	Sample	46	$67.70	$3,114
Subtotal					$23,448
				Long-Term Groundwater Monitoring Event Subtotal:	$23,448
				10% Legal, administrative, engineering fees:	$2,345
				15% Contingencies:	$3,869
				Long-Term Groundwater Monitoring Event Total:	**$29,700**
				10-Year Present Value of Long-Term Groundwater Monitoring Event Costs:	**$373,582**
3-Year Costs					
Periodic Review Reporting	Performed once every three years	LS	1.00	$11,272.17	$11,272
Subtotal					$11,272
				3-Year Cost Subtotal:	$11,272
				10% Legal, administrative, engineering fees:	$1,127
				15% Contingencies:	$1,860
				3-Year Cost Total:	**$14,259**
				10-Year Present Value of 3-Year Costs:	**$41,000**

2025 Total Present Value of Costs $1,587,000

Assumptions:

1. Present value cost based on annual/periodic costs over:	10	years
2. Present value of costs assumes 5% annual interest rate.		
3. CPI for 2025 is	21.27%	
Injection plume area (assume 3% of 2024 PCE plume area)	82,328	CF
Historical cost index - Buffalo		
2025	308	
2019	234	

Table A-4: Cost Estimates for Decommissioning the Pump-and-Treat System
Mr. C's Dry Cleaner's Site, East Aurora, New York

Item Description	Comment	Unit	Quantity	Unit Cost	Cost
Capital Costs					
Treatment System Garage Decommissioning					
Downgrade electrical system	Change electrical system from 420 V to 220 V.	LS	1	$10,000.00	$10,000
Remove and dispose of EQ tank, furniture, and non-reusable items - labor	Assume one supervisor and two field technicians for two days.	Hour	16	$260.00	$4,160
Remove and dispose of EQ tank, furniture, and non-reusable items - transportation & disposal	Assume disposal facility is 50 miles away.	LS	1	$1,558.56	$1,559
Transportation of items to be kept by NYSDEC	Assume storage facility is 50 miles away, 1 trip. For labor assume two field technicians for one day.	LS	1	$1,913.90	$1,914
				Capital Cost Subtotal	**$17,632**
Piping Removal					
Option A: Full removal everywhere					
Traffic Control & Asphalt Removal					
Labor	Assume one flagger directing traffic, assume 20 LF removed per hour and 10 LF restored per hour	Hr	153	$96.70	$14,839
Traffic cones	2' tall reflective traffic cones, 1/four ft of work area, both sides of work area	LF	3,358	$5.28	$17,730
Barrier tape	Polyethylene barricade tape, 7mil, 3" wide, 300' long roll	LF	3,358	$0.04	$127
Steel plate	Steel roadway plate 1" thick, 8'x20' - weekly rental	Week	4	$1,687.60	$6,750
Asphalt sawcut	Asphalt saw cut, up to 3" thick	LF	3,550	$2.39	$8,485
Asphalt disposal	Assume 5 mile haul to recycling facility	CY	66	$20.07	$1,319
Manhole removal					
Excavation	Trench excavation 6-10' deep, 3/4 CY excavator, common earth, trench box	BCY	114	$11.75	$1,337
Haul to Stockpile	Common earth, 80HP loader, 300' haul	LCY	142	$5.31	$755
Removal	Remove existing catch basin or manhole, excluding excavation and hauling	Each	8	$563.50	$4,508
Demolition	Demolition of manhole, cast in place, 4-8' deep, excluding excavation	SF of Face	1,280	$26.33	$33,702
Disposal	Assume 5 mile haul to recycling facility	CY	12	$20.07	$238
Manhole backfill					
Material	Assume run of crusher stone to fill manhole	Ton	57	$13.74	$782
Transportation	16.5 Cy truck, cycle hauling 25min wait, 40 MPH, 10 mile cycle	LCY	47	$7.60	$360
Placement (imported material and existing)	Sand and gravel, 80HP loader, 300' haul	LCY	190	$4.73	$897
Compaction	Walk behind vibrating plate tamper, 12" lifts, 2 passes, 21" wide	BCY	152	$1.31	$199

PVC pipe removal & backfill					
Excavation	Trench excavation 4-6' deep, 1/2 CY excavator, common earth, trench box	BCY	797	$13.83	$11,021
Haul to Stockpile	Common earth, 80HP loader, 300' haul	LCY	996	$5.31	$5,289
Pipe demolition	Plastic pipe and fittings, 6-8" diameter	LF	1,793	$4.50	$8,069
Pipe disposal	2 dumpsters, 40 CY capacity, weekly rental, 1 dump/week	Week	4	$1,700.00	$6,800
Backfill - replacement of excavated material	Common earth, 80HP loader, 300' haul	LCY	996	$5.31	$5,289
Compaction	Walk behind vibrating plate tamper, 12" lifts, 2 passes, 21" wide	BCY	797	$1.31	$1,044
Paving					
Subbase Material	Assume 3" run of crusher stone	Ton	54	$13.74	$738
Asphalt hauling	16.5 Cy truck, cycle hauling 25min wait, 40 MPH, 10 mile cycle	LCY	90	$7.60	$681
Binder	Binder course, 2" thick, includes compaction	SY	430	$16.86	$7,250
Topcoat	Wearing course, 1" thick, includes compaction	SY	430	$8.93	$3,840
Grass area repair					
Topsoil: Material and transport	Screened topsoil, assume 6" thick, includes delivery	LCY	5	$54.30	$287
Topsoil: Placement	Sandy clay and loam, 80HP loader, 300' haul	LCY	5	$4.86	$26
Sodding	1" deep bluegrass sod, level ground, 1,000 SF	SF	228	$0.75	$172
Watering	Assume 1/day for 2 weeks for establishment. 2hrs/day, common laborer	LS	1	$1,472.00	$1,472
				Piping Option A Subtotal	**$144,005**
Option B: Removal everywhere except roadways (i.e. in parking lots & grassy areas)					
Traffic Control					
Traffic cones	2' tall reflective traffic cones, 1/four ft of work area, both sides of work area	LF	1,312	$5.28	$6,927
Barrier tape	Polyethylene barricade tape, 7mil, 3" wide, 300' long roll	LF	1,312	$0.04	$50
Steel plate	Steel roadway plate 1" thick, 8'x20' - week rental	Week	3	$843.80	$2,531
Asphalt sawcut	Asphalt saw cut, up to 3" thick	LF	1,504	$2.39	$3,595
Asphalt disposal	Assume 5 mile haul to recycling facility	CY	28	$20.07	$559
Manhole removal					
Excavation	Trench excavation 6-10' deep, 3/4 CY excavator, common earth, trench box	BCY	114	$11.75	$1,337
Haul to Stockpile	Common earth, 80HP loader, 300' haul	LCY	142	$5.31	$755
Removal	Remove existing catch basin or manhole, excluding excavation and hauling	Each	8	$563.50	$4,508
Demolition	Demolition of manhole, cast in place, 4-8' deep, excluding excavation	SF of Face	1,280	$26.33	$33,702
Disposal	Assume 5 mile haul to recycling facility	CY	12	$20.07	$238

Manhole backfill					
Material	Assume 2" run of crusher stone	Ton	57	$13.74	$782
Transportation	16.5 Cy truck, cycle hauling 25min wait, 40 MPH, 10 mile cycle	LCY	47	$7.60	$360
Placement (imported material and existing)	Sand and gravel, 80HP loader, 300' haul	LCY	190	$4.73	$897
Compaction	Walk behind vibrating plate tamper, 12" lifts, 2 passes, 21" wide	BCY	152	$1.31	$199
PVC pipe removal					
Excavation	Trench excavation 4-6' deep, 1/2 CY excavator, common earth, trench box	BCY	342	$13.83	$4,733
Haul to Stockpile	Common earth, 80HP loader, 300' haul	LCY	428	$5.31	$2,272
Pipe demolition	Plastic pipe and fittings, 6-8" diameter	LF	770	$4.50	$3,465
Pipe disposal	2 dumpsters, 40 CY capacity, weekly rental, 1 dump/week	Week	3	$1,700.00	$5,100
Backfill - replacement of excavated material	Common earth, 80HP loader, 300' haul	LCY	428	$5.31	$2,272
Compaction	Walk behind vibrating plate tamper, 12" lifts, 2 passes, 21" wide	BCY	342	$1.31	$448
Paving					
Subbase Material	Assume 3" run of crusher stone	Ton	25	$13.74	$348
Asphalt hauling	16.5 Cy truck, cycle hauling 25min wait, 40 MPH, 10 mile cycle	LCY	34	$7.60	$257
Binder	Binder course, 2" thick, includes compaction	SY	203	$16.86	$3,417
Topcoat	Wearing course, 1" thick, includes compaction	SY	203	$8.93	$1,810
Grass area repair					
Topsoil: Material and transport	Screened topsoil, assume 6" thick, includes delivery	LCY	5	$54.30	$287
Topsoil: Placement	Sandy clay and loam, 80HP loader, 300' haul	LCY	5	$4.86	$26
Sodding	1" deep bluegrass sod, level ground, 1,000 SF	SF	228	$0.75	$172
Watering	Assume 1/day for 2 weeks for establishment. 2hrs/day, common laborer	LS	1	$1,472.00	$1,472
		Piping Option B Subtotal			**$82,517**
Option C: Full Removal of Manholes					
Traffic Control					
Labor	Assume one flagmen directing traffic, assume 0.5 manholes removed per hour, 0.5 manholes restored per hour	Hr	32	$96.70	$3,094
Traffic cones	2' tall reflective traffic cones, 1/four ft of work area, both sides of work area	LF	80	$5.28	$422
Barrier tape	Polyethylene barricade tape, 7mil, 3" wide, 300' long roll	LF	80	$0.04	$3
Steel plate	Steel roadway plate 1" thick, 8'x20' - week rental	Week	2	$421.90	$844
Asphalt sawcut	Asphalt saw cut, up to 3" thick	LF	192	$2.39	$459
Asphalt disposal	Assume 5 mile haul to recycling facility	CY	4	$20.07	$71

Manhole removal					
Excavation	Trench excavation 6-10' deep, 3/4 CY excavator, common earth, trench box	BCY	114	$11.75	$1,337
Haul to Stockpile	Common earth, 80HP loader, 300' haul	LCY	142	$5.31	$755
Removal	Remove existing catch basin or manhole, excluding excavation and hauling	Each	8	$563.50	$4,508
Demolition	Demolition of manhole, cast in place, 4-8' deep, excluding excavation	SF of Face	1,280	$26.33	$33,702
Disposal	Assume 5 mile haul to recycling facility	CY	12	$20.07	$238
Manhole backfill					
Material	Assume 2" run of crusher stone	Ton	57	$13.74	$782
Transportation	16.5 Cy truck, cycle hauling 25min wait, 40 MPH, 10 mile cycle	LCY	47	$7.60	$360
Placement (imported material and existing)	Sand and gravel, 80HP loader, 300' haul	LCY	190	$4.73	$897
Compaction	Walk behind vibrating plate tamper, 12" lifts, 2 passes, 21" wide	BCY	152	$1.31	$199
PVC pipe plug					
PVC pipe end cap	6" PVC end cap, assume 2 pipes per manhole	Each	16	$9.32	$149
Labor	Install end caps, 4/hr	Hr	4	$113.65	$455
Pipe Solvent	Clean & glue capped area	Each	1	$37.05	$37
Paving					
Asphalt hauling	16.5 Cy truck, cycle hauling 25min wait, 40 MPH, 10 mile cycle	LCY	9	$7.60	$72
Binder	Binder course, 2" thick, includes compaction	SY	57	$16.86	$959
Topcoat	Wearing course, 1" thick, includes compaction	SY	57	$8.93	$508
		Piping Option C Subtotal			**$49,852**
Option D: Remove manholes to depth of piping, grout & seal all piping					
Traffic Control					
Labor	Assume one flagmen directing traffic, assume 0.5 manholes removed per hour, 0.5 manholes restored per hour	Hr	32	$96.70	$3,094
Traffic cones	2' tall reflective traffic cones, 1/four ft of work area, both sides of work area	LF	80	$5.28	$422
Barrier tape	Polyethylene barricade tape, 7mil, 3" wide, 300' long roll	LF	80	$0.04	$3
Steel plate	Steel roadway plate 1" thick, 8'x20' - week rental	Week	2	$421.90	$844
Asphalt sawcut	Asphalt saw cut, up to 3" thick	LF	192	$2.39	$459
Asphalt disposal	Assume 5 mile haul to recycling facility	CY	4	$20.07	$71

Manhole removal					
Manhole top demolition	Demolition top 8", precast manhole, 4-6' diameter	Each	8	$281.52	$2,252
Manhole demolition to 4 feet below ground surface	Demolition of manhole, cast in place, 4-8' deep, excluding excavation - 3.25'	SF of Face	416	$26.33	$10,953
Debris Disposal	2 dumpsters, 40 CY capacity, weekly rental, 1 dump/week	Week	2	$1,700.00	$3,400
Pipe and manhole grouting					
Flowable fill material	1000 psi structural flowable fill - ash, cement, aggregate, sand, delivered	CY	30	$123.61	$3,663
Flowable fill placement	Pumped flowable fill - into piping and filling manhole	CY	30	$113.84	$3,373
Backfill - stone for asphalt subbase					
Material	Assume 2" run of crusher stone	Ton	28	$13.74	$391
Transportation	16.5 Cy truck, cycle hauling 25min wait, 40 MPH, 10 mile cycle	LCY	24	$7.60	$180
Placement (imported material and existing)	Sand and gravel, 80HP loader, 300' haul	LCY	24	$4.73	$112
Compaction	Walk behind vibrating plate tamper, 12" lifts, 2 passes, 21" wide	BCY	19	$1.31	$25
Paving					
Asphalt hauling	16.5 Cy truck, cycle hauling 25min wait, 40 MPH, 10 mile cycle	LCY	9	$7.60	$72
Binder	Binder course, 2" thick, includes compaction	SY	57	$16.86	$959
Topcoat	Wearing course, 1" thick, includes compaction	SY	57	$8.93	$508
				Piping Option D Subtotal	**$30,782**

Notes/Assumptions	**Quantity**	**Unit**	
Asphalt - parking lot piping	656	LF	
Asphalt - road piping	1023	LF	
Grass/Soil piping	114	LF	
Number of Manholes	8	Each	Assumed no manholes in the road
Depth of piping (ft)	6	LF	
Pipe trench width assumed	2	LF	
Asphalt thickness assumed	0.25	LF	
Assume extra LF per manhole of asphalt to cut	24	LF	
volume (assumes 4x4x8))	14.22	CY	
deep manhole)	160	SF	
(assumed 4' wide, 3.5' deep manhole)	52	SF	
thick cast in place	1.48	CY	
Pipe trench excavation volume assumed (per LF, 6ft deep)	0.44	CY/LF of pipe	
Manhole volume (4x4x8) (for backfilling area)	4.74	CY	
Manhole volume (4x4x4) (for backfilling area Option D)	2.37	CY	
Stone and Soil swell factor (BCY -> LCY)	1.25		
Stone density assumed	1.5	ton/CY	
Flowable fill volume - piping - total	13.04	CY	Assumed 6-inch pipe diameter
Flowable fill volume - manholes (assuming internal volume is 3.5'x4'x4' and rest of manhole is stone backfill and topsoil/asphalt	2.07	CY each	
Assume duration - option A	4	week	
Assume duration - option B	3	week	
Assume duration - option C	2	week	
Assume duration - option D	2	week	