Feasibility Study Report
Admiral Cleaners Site
Operable Unit No. 1
NYSDEC Site Number 401075

Prepared for

New York State Department of Environmental Conservation
625 Broadway
Albany, New York 12233

Prepared by

EA Engineering and Geology, P.C. and Its Affiliate
EA Science and Technology
Washington Station
333 West Washington Street, Suite 300
Syracuse, New York 13202
315-431-4610

February 2025
Version: REVISED FINAL
EA Project No. 16025.04

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Donald Conan — 28 February 2025

Donald Conan, P.E., P.G., Program Manager — Date
EA Engineering and Geology, P.C.

Emily Cummings — 28 February 2025

Emily Cummings, E.I.T., Project Manager — Date
EA Science and Technology

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CERTIFICATION

I, Donald Conan, certify that I am currently a NYS Registered Professional Engineer and that this Feasibility Study Report was prepared in accordance with all applicable statutes and regulations and in substantial conformance with the DER Technical Guidance for Site Investigation and Remediation (DER-10) and that all activities were performed in full accordance with the DER-approved work plan and any DER-approved modifications.

28 February 2025

Donald Conan, P.E., P.G. — Date
New York State Professional Engineer No. 75666

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LIST OF ACRONYMS AND ABBREVIATIONS

°C	Degrees Celsius
%	Percent
ARAR	Applicable or relevant and appropriate requirement
ASTM	American Society for Testing and Materials
AWQS	Ambient water quality standard
bgs	Below ground surface
BTEX	Benzene, toluene, ethylbenzene, and xylene
CCR	Construction Completion Report
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COC	Contaminant of concern
CSM	Conceptual site model
CVOC	Chlorinated volatile organic compound
DCE	Dichloroethene
DER	Division of Environmental Remediation
DNAPL	Dense non-aqueous phase liquid
DPT	Direct-push technology
EA	EA Engineering and Geology, P.C. and its affiliate EA Science and Technology
E.I.T.	Engineer-in-Training
EPA	U.S. Environmental Protection Agency
ERH	Electrical resistance heating
FS	Feasibility study
ft	Foot (feet)
ft^2	Square foot (feet)
GAC	Granular activated carbon
GHG	Greenhouse gas
GRA	General response action
IC	Institutional control
in.	Inch(es)
IRM	Interim Remedial Measure
ISCO	In situ chemical oxidation
ISCR	In situ chemical reduction
LNAPL	Light non-aqueous phase liquid

LIST OF ACRONYMS AND ABBREVIATIONS (*continued*)

MCL	Maximum contaminant level
MNA	Monitored natural attenuation
NAPL	Non-aqueous phase liquid
No.	Number
NPDES	National Pollutant Discharge Elimination System
NYCRR	New York Code of Rules and Regulations
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
OU	Operable unit
PCE	Tetrachloroethene
P.E.	Professional Engineer
PES	Precision Environmental Services, Inc.
PFAS	Per- and polyfluoroalkyl substances
PFOA	Perfluorooctanoic acid
PFOS	Perfluorooctanesulfonic acid
P.G.	Professional Geologist
PPE	Personal protective equipment
RA	Remedial alternative
RAO	Remedial action objective
RI	Remedial investigation
SCG	Standard, Criteria, and Guidance
SCO	Soil cleanup objective
SPDES	State Pollutant Discharge Elimination System
SVI	Soil vapor intrusion
TCE	Trichloroethene
TCH	Thermal conduction heating
UST	Underground storage tank
VC	Vinyl chloride
VOC	Volatile organic compound
WA	Work assignment
yd^3	Cubic yard(s)

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1. INTRODUCTION

EA Engineering and Geology, P.C. and its affiliate EA Science and Technology (EA), under Contract to the New York State Department of Environmental Conservation (NYSDEC) (Work Assignment [WA] D009806-04) were tasked to perform a remedial investigation (RI) and feasibility study (FS) for Operable Units (OUs) 1 and 2 at the Admiral Cleaners site (NYSDEC Site Number [No.] 401075) located in the city of Watervliet, Albany County, New York (**Figure 1-1**). The site is listed as a Class 2 site in the State Registry of Inactive Hazardous Waste Sites (State Superfund sites), which implies the site represents a significant threat to public health or the environment, and action is required. The hazardous waste material disposed at the site and the resulting primary contaminants of concern (COCs) are chlorinated solvents related to dry cleaning operations, particularly tetrachloroethene (PCE), trichloroethene (TCE), and *cis*-1,2-dichloroethene (DCE). This FS report has been prepared as part of the current WA to evaluate, develop, and select potential remedial actions to be implemented at OU-1 of the Admiral Cleaners site.

1.1 PURPOSE AND SCOPE

This FS report was prepared to develop and evaluate alternatives for remedial action, determine which alternative is the most protective of public health and the environment, and conforms to relevant and appropriate Standards, Criteria, and Guidance (SCGs) for OU-1 at the Admiral Cleaners site.

This FS Report was prepared in accordance with the most recent versions of the Guidance for Conducting Remedial Investigations and Feasibility Studies under Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (U.S. Environmental Protection Agency [EPA] 1988) and Division of Environmental Remediation (DER)-10, Technical Guidance for Site Investigation and Remediation (NYSDEC 2010a).

1.2 REPORT ORGANIZATION

This FS report presents the overall approach and details of potential remedial actions to be performed in response to the findings of the RI. The report is organized as follows:

- **Section 1** provides a description of the site background including site history and physical characteristics of the site.

- **Section 2** provides a summary of the RI, Interim Remedial Measure (IRM) activities, and exposure assessment.

- **Section 3** provides a description of the development of remedial action objectives (RAOs) for the site.

- **Section 4** presents a description of general response actions.

- **Section 5** identifies and evaluates different remedial technologies that could be used at the site.

- **Section 6** presents the scope and development of possible remedial actions.

- **Section 7** discusses the cost evaluation of the alternatives presented in the FS.

- **Section 8** analyzes and compares the alternatives presented in the FS and offers recommendations for further action.

- **Section 9** identifies potential climate change vulnerabilities and green remediation measures to be considered in remedy selection.

1.3 SITE BACKGROUND

The following subsections provide a brief discussion of the site background for the Admiral Cleaners site.

1.3.1 Site Location

The site is located at 617 19th Street, Watervliet, Albany County, New York (**Figure 1-2**), between 6th Avenue and 7th Avenue. The parcel has approximately 45 feet (ft) of frontage on 19th Street (on the south side of the site) and a depth of approximately 100 ft. It previously included a vacant brick and concrete block commercial building. The on-site building was demolished during an IRM, and a chain-link fence was installed around the perimeter of the site in May 2020 as described further in Section 2.2. The site is located in an urban area with mixed commercial and residential use. The site is bordered by an unoccupied residential building to the west, a mixed-use building containing a commercial day care and residences to the east, and residences to the north.

1.3.2 Site History

The Admiral Cleaners building was constructed in 1950 and was used as a dry-cleaning facility until 2013. During its operation, the facility used PCE as a cleaning solvent. In 2007, the NYSDEC issued a Consent Order, ordering the facility to obtain required owner/manager and operator dry-cleaning certifications. In November 2008, a third-party inspection indicated that the PCE concentration in the facility's dry-cleaning machine was 845 parts per million, more than double the limit of 300 parts per million published in 6 New York Code of Rules and Regulations (NYCRR) 232.2-4 (a)(5). The NYSDEC performed a follow-up inspection in February 2009, discovering that the facility had failed to comply with the 2007 Consent Order and had not performed the mandatory remedy within the required timeframe following the 2008 inspection. The NYSDEC also found evidence of improper disposal of PCE-contaminated wastes. A second Consent Order was issued in April 2009 to address the violations noted in the 2009 inspection. Dry-cleaning operations ceased in 2013 due to continued violations of environmental regulations.

The site was then operated as a dry-cleaning drop shop, where garments were brought in and sent to be dry cleaned at another local facility until 2017. A limited investigation was performed in April 2016 as part of a potential real estate transaction. The investigation identified gasoline-related volatile organic compounds (VOCs) and chlorinated VOCs (CVOCs) in soil, groundwater, and sub-slab soil vapor at the site. The NYSDEC was notified of the findings and the site was listed in the NYSDEC Registry of Inactive Hazardous Waste Disposal Sites as a Class 2 site in August 2017.

1.3.3 Operable Units

In May 2021, the Admiral Cleaners site was divided into two OUs. OU-1 encompasses on-site media including surface and subsurface soil, overburden groundwater, and bedrock groundwater. On-site media is considered the media within the 617 19th Street Watervliet, New York property boundary, tax parcel number 32.50 4 28.0000. OU-1 also includes directly adjacent off-site soil. OU-2 includes off-site groundwater (overburden and bedrock). The focus of this FS is OU-1. A separate decision document will be issued for OU-2 in the future. The property outline is illustrated on **Figure 1-2**.

1.3.4 Physiography

The Admiral Cleaners site is located on the U.S. Geological Survey, Troy South, New York, 7.5-minute topographic quadrangle map, dated 2019. The site is located in the northern Hudson River Valley, within the Hudson-Mohawk Lowlands Physiographic Province (Fenneman and Johnson 1946). The Hudson-Mohawk province, which divides the Catskills Mountains province to the west from the Taconic Mountains province to the east, is characterized as a generally flat-lying floodplain just above sea-level to a long north-south running ridge cut into by small tributary creeks (Backhaus et al. 2020). The site is relatively flat with an elevation of approximately 36 to 38 ft above mean sea level based on a survey completed 10 January 2022.

1.3.5 Regional and Site Geology

The distribution of unconsolidated lithologic units (overburden) in this portion of the Troy South quadrangle is consistent with a full glacial cycle (Backhaus et al. 2020). A diamicton (glacial till) is found throughout much of this area and was deposited beneath the Hudson Lobe of the Laurentide ice sheet. The formation and fluctuations of Glacial Lake Albany and floods from Glacial Lake Iroquois eroded out the modern-day Hudson Channel. This erosion wiped out most the glaciolacustrine deposits in this channel and exposed bedrock within the channel. Today, this channel has a few outcrops of bedrock in this quadrangle but is mainly alluvium and wetlands within the modern-day floodplain from the Late Pleistocene to the Holocene today (Backhaus et al. 2020).

Soil boring logs from the RI indicate a high degree of heterogeneity of lithologic materials at the site. Overburden thickness ranges between approximately 5 and 15 ft below ground surface (bgs). The near-surface materials generally consist of a layer anthropogenic fill (a mixture of gravel, sand, silt, clay and concrete or brick fragments) and/or native Hudson River valley alluvium (fine- and coarse-grained) ranging between 2 and 5 ft thick (potentially greater in some locations).

This uppermost unit often overlies an intermediate interval of green/brown to gray clay and/or silt with occasional sandy lenses and traces of angular gravel. This intermediate unit ranges between approximately 2 and 10 ft thick and is interpreted as re-deposited glacial sediments from the former glacial Lake Albany. At some boring locations, the fine-grained sediments extended to bedrock; at others, it was underlain by up to 2 ft of silty sand and gravel deposits, which may represent glacial till or weathered bedrock.

The predominant bedrock unit in the study area, an organic rich black shale with minor mudstone and sandstone components. The area west of the Hudson River encompassing Watervliet is underlain by bedrock also referred to as the Cohoes Melange (Kidd et al. 1995) which has highly variable stratigraphic sequence and thickness.

Depth to bedrock at the site (inferred from direct-push technology [DPT] refusal in soil borings) ranged between 5 and 15 ft bgs, but more typically occurred between 8 and 12 ft bgs (**Figure 1-3**). The hard shale observed in rock cores at the site contains thin dark gray interbeds and lenses of sandstone or siltstone with calcite veins throughout and occasional pyrite precipitates. The unit has been intensely folded and slightly metamorphosed to slate in some areas. Bedrock at the site is highly fractured at steep angles, typically between 40-50 degrees from horizontal with occasional higher angle fractures. Based on the topography of the bedrock surface, the site appears to overlie an incised bedrock trough, oriented from southwest to northeast. This feature may represent the subsurface extent of the scoured bedrock channel or channel network associated with Dry River and/or Gas House Creek, tributaries to the Hudson River. These tributaries were diverted to storm sewers through the city of Watervliet. Although site-specific borings logs indicate that the trough is not a buried channel aquifer (due to absence of continuous lens of coarse-grained material), its orientation may influence groundwater flow direction within the sediments that comprise the water table aquifer.

The regional tectonic fabric predominantly includes south-southwest to north-northeast lineaments associated with the bedrock folding and faulting (Bartosh et al. 1977). These lineaments commonly align with many major stream channels in the region, indicating a strong structural control of drainage networks and surface water features.

1.3.6 Regional and Site Hydrogeology

Groundwater in the Watervliet area occurs in unconsolidated sediments (overburden) and in the underlying bedrock. The overburden aquifers are typically either unconfined (water table) aquifers within alluvial or shallow glacial sediments or buried channel aquifers within incised pre-glacial bedrock valleys, which may be under artesian conditions (Heisig 2002; Waller 1983). Within the bedrock aquifer, groundwater flow is primarily regulated by the degree of fracturing (secondary porosity) due to the relatively low primary porosity. Fracture density, orientation, aperture, and interconnectedness of the discrete fracture network influence the hydraulic conductivity and groundwater flow direction in the bedrock aquifer. In the Watervliet area, bedrock groundwater flow is generally to the southeast toward the Hudson River, a regional discharge area (Williams and Paillet 2002).

As observed during the RI (EA 2022a), the shallowest groundwater at the site (water table aquifer) is encountered between approximately 4 to 6 ft bgs. This aquifer primarily resides within the coarse-grained / glacial sediment deposits. The hydraulic conductivity and permeability of the aquifer materials is inferred to be highly variable due to the lithologic heterogeneity (variable grain sizes and degrees of compaction). Groundwater potentiometric surface maps created from RI sampling and gauging events suggest potential for different groundwater flow paths based on high or low water table conditions. Variability in surface conditions, seasonality, and precipitation may be influencing flow patterns in the water table aquifer, sometimes leading to convergent groundwater flow in the vicinity of MW-06R and MW-05R, other times mimicking the regional flow pattern from northwest to southeast. Based on the limited spatial distribution of the monitoring well locations at the site and seasonality, groundwater flow direction appears variable, however, primary flow direction in the overburden is inferred toward the Hudson River.

The observed bedrock groundwater flow direction in locations near Admiral Cleaners was to the south-southeast, similar to the overburden and regional groundwater flow directions. Generally, the approximate groundwater elevations were similar to those of overburden monitoring wells, indicating the likelihood of hydraulic interconnectivity between the overburden and bedrock aquifers.

The nearest surface water feature is the Hudson River, located approximately 0.5-mile east of the site. Surface water runoff not captured by the city of Watervliet stormwater system infiltrates through the overburden into the shallow aquifer.

1.3.7 Water Supply

The source of water for the City of Watervliet Water System is the Watervliet Reservoir, located approximately 13 miles east of the site in the town of Guilderland. The reservoir has a capacity of 1.7 billion gallons of water and is the primary source of drinking water for residents in the area (City of Watervliet 2019). The Admiral Cleaners site is not within this watershed.

The primary aquifers in the region are the Schenectady and Clifton Park aquifers located northwest of the Albany area. Primary aquifers are defined by the NYSDEC as “highly productive aquifers presently utilized as a source of water supply by major municipal water supply systems” (NYSDEC 2021). Given the location of the municipal water supply aquifers, it is not expected that groundwater contamination at the Admiral Cleaners site will affect public drinking water supply as the primary aquifers are located upgradient from the site.

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2. SUMMARY OF REMEDIAL INVESTIGATION, INTERIM REMEDIAL MEASURES, PILOT STUDY AND EXPOSURE ASSESSMENT

An RI (EA 2022a) was conducted from December 2017 through January 2022 at the on-site area to characterize site-related contamination in site soil, groundwater, and soil vapor. The objectives were to identify the source area of subsurface contaminants of potential concern, determine the nature and extent of contamination resulting from historical site operations as a dry-cleaning facility, and to evaluate potential exposure pathways. The following sections describe the site activities, conceptual site model, and migration pathways. Further details on specific field activities are discussed in the RI.

2.1 CONCEPTUAL SITE MODEL

A conceptual site model (CSM) provides the framework for identifying and quantifying known and unknown COCs in the environment at a site. Based on the data collected during the RI, the following narrative outlines the CSM. A graphical representation of the CSM is shown on **Figure 2-1**.

2.1.1 Source Area Release Mechanism

The Admiral Cleaners site historically operated as a dry cleaning facility, and operational and/or disposal activities of chlorinated solvents occurred at the site. Analytical data collected during the RI suggests that two different dry cleaning fluids may have been used: PCE and Stoddard solvent. In addition, heating oil was released at the site.

Release to the soil and groundwater potentially occurred through:

- Direct disposal to the ground surface at the rear of the building (near MW-07R)
- Poor housekeeping practices (e.g., floor spills infiltrating through the slab)
- Release to the subsurface through dry cleaning equipment and/or underground storage tanks (USTs) in poor condition.

The source area identified during the RI consists of:

- The disposal area immediately north of the former building (suspected PCE dense non-aqueous phase liquid [DNAPL] and other dry cleaning solvents)
- The compromised North and South USTs (suspected PCE DNAPL)
- The compromised heating oil UST and transmission lines (benzene, toluene, ethylbenzene, and xylene [BTEX] light non-aqueous phase liquid [LNAPL])

The high concentrations of PCE in monitoring well MW-07R and liquids contained within the south conical UST are indicative of DNAPL, although DNAPL was not directly observed during the RI. As DNAPL poured directly on surface soils, PCE would have traveled downward through the vadose zone to saturated soils and bedrock under the force of gravity. DNAPL released to the subsurface through the leaking conical bottom USTs would have been released directly into the saturated zone. DNAPLs are understood to migrate even through low permeability soils due to their low viscosity and high density. DNAPL migration will cease when its saturation in soil has been decreased, and distribution becomes discontinuous. The discontinuous; and therefore immobile, DNAPL can remain in soil for extended periods of time. As the overburden at Admiral Cleaners has a higher primary porosity than the underlying bedrock where transport is largely through bedrock fractures (secondary porosity), released DNAPL may have pooled near the overburden/bedrock interface.

The heating oil UST and surrounding impacted soil were removed during IRM No. 2; however, documentation samples indicate that BTEX contamination remains in subsurface soil, and LNAPL is observed in monitoring wells and the recovery well installed during IRM No. 2. Side wall documentation sampling locations are illustrated on **Figure 2-2**. Remaining subsurface soil contamination is shown on **Figure 2-3**.

With the removal of the three USTs during IRM No. 2, a portion of the source was removed; however, additional source area contamination remains on-site. Upgradient areas of site-related contamination have also been identified at the adjacent 621 19th Street property, which may have occurred through poor housekeeping practices of the former Admiral Cleaners operations or through diffusion from the source area.

2.1.2 Known or Suspected Contaminants

The COCs and environmental media affected by the site are summarized below:

- Overburden Groundwater:
    - CVOCs: PCE and its breakdown products including TCE, *cis*-1,2-DCE, *trans*-1,2-DCE, 1,1-dichloroethene, and vinyl chloride (VC)
    - BTEX compounds: 1,2,4-trimethylbenzene and 1,3,5-trimethylbenzene
- Bedrock Groundwater:
    - CVOCs: PCE and its breakdown products including TCE, *cis*-1,2-DCE, *trans*-1,2-DCE, 1,1-dichloroethene, and VC
- Surface Soil:
    - Metals: Arsenic, chromium, copper, lead, and mercury
- Subsurface Soil:

  - CVOCs: PCE, *cis*-1,2-DCE, and TCE
  - BTEX compounds: ethylbenzene, m,p-xylene, o-xylene, 1,2,4-trimethylbenzene, and 1,3,5-trimethylbenzene

- Soil Vapor:
  - CVOCs: PCE, TCE, *cis*-1,2-DCE, and 1,1,1-trichloroethane

2.1.3 Migration and Exposure Pathways

COCs migrate in the environment through:

- Transport in groundwater
- Volatilization from groundwater to soil vapor
- Desorption/leaching from overburden soil into overburden and shallow bedrock groundwater.

The overall groundwater flow direction in overburden and bedrock is from northwest to southeast, although the overburden flow direction is somewhat variable due to surficial drainage/infiltration patterns and/or subsurface geologic features. The extent of COC impacts in soil and overburden groundwater is largely limited to the site and the adjacent property to the west. The COCs were confirmed in bedrock groundwater on-site, but additional investigation is needed to define their extent in bedrock groundwater off-site. The extent of COC impacts due to soil vapor intrusion (SVI) is limited to the site, and no further action is required at off-site properties in relation to potential SVI from site related COCs. However, soil vapor is impacted by site related COCs both on-site and in the vicinity of the site from volatilization from impacted groundwater.

Based on the above, the following potential human exposure routes for COCs under the current conditions were identified:

- Inhalation of volatized COCs from soil vapor on-site or from contaminated groundwater and/or soil in the vicinity of the site, if encountered during subsurface work
- Dermal contact and/or accidental ingestion of contaminated soil and groundwater if encountered during subsurface work in the vicinity of the site.

2.2 INTERIM REMEDIAL MEASURES

2.2.1 IRM No. 1 – Site Building Demolition

The on-site structure was a physical obstacle to performing subsurface investigation (e.g., drilling) activities and demolition was necessary to complete RI/FS activities. Furthermore, the structure was determined to be a hazard to public safety by the city of Watervliet. Demolition was conducted by Precision Environmental Services, Inc. (PES) of Ballston Spa, New York, who are a standby remedial construction contractor for NYSDEC. PES subcontracted Jackson Demolition of Schenectady, New York, to complete the building demolition. IRM No. 1 activities were completed from 4 to 11 May 2020 and included structural shoring; demolition of the site building; perimeter air monitoring for dust, VOCs, and asbestos during demolition; adjacent structure monitoring during demolition; site restoration; and installation of security fencing. Demolition debris including general debris, steel, and asbestos containing materials were removed from the site on 7 and 8 May 2020. Asbestos-containing material was handled and removed with the building debris under a Department of Labor variance. Further details can be found in the Construction Completion Report (CCR) for IRM No. 1, which EA prepared and submitted to the NYSDEC in January 2021 (EA 2021a).

2.2.2 IRM No. 2 – Underground Storage Tank Removal

Three USTs were discovered on-site under the building slab. Two of the USTs were conical bottom tanks associated with the former dry-cleaning operations used to store chlorinated and petroleum-based dry-cleaning solvents (EA 2022b). The third UST previously stored heating oil. Removal of the USTs occurred between February and March 2021 and was performed by PES. Contaminated soil surrounding the three tanks was excavated and disposed off-site. The approximate extent of excavation and tank locations are illustrated on **Figure 2-2**. Two bio-diffusers were installed in the excavation bottom and a collection pipe (12-inch [in.] perforated high-density polyethylene pipe) was installed where LNAPL was observed in the southeast portion of the excavation. The excavation was subsequently backfilled with washed No. 1 stone to 3 in. below surrounding grades. The remaining annular space was filled with a 3-in. thick layer of top course asphalt. Further information regarding IRM No. 2 is discussed in Section 4 and presented in the IRM No. 2 CCR (EA 2022b).

2.3 GROUNDWATER TREATMENT PILOT STUDY

Using the bio-diffusers installed in the IRM No. 2 excavation, EA conducted a pilot study to test the effectiveness of a remedial substrate. The substrate selected for the pilot study was CarBstrate™ by ETEC, a highly soluble, nutrient amended carbohydrate, dry-powdered product to enhance microbial growth and dechlorination of VOCs. On 20 July 2021, EA added approximately 300 gallons of substrate solution to the bio-diffusers. The powdered CarBstrate™ was mixed with water at a rate of 300 pounds CarBstrate™ to 150 gallons of potable water.

Groundwater sampling was performed before and after placement of the CarBstrate™ to monitor changes in VOC concentrations and monitored natural attenuation (MNA) parameters in nine selected monitoring wells: MW-01, MW-09, MW-07R, MW-06R, MW-05/05R, MW-04/04R, MW-21, MW-22, and MW-12. In January 2023, EA authored and submitted a Pilot Study Report Memorandum summarizing pilot study activities and results (EA 2023) and concluded that there was strong evidence that anaerobic PCE degradation was occurring on-site following the pilot study. However, the limited nature of the substrate application limited effectiveness at inducing complete dechlorination. Accumulation of PCE daughter products, particularly DCE and VC, indicate that dechlorination is stalling. It was recommended that additional effectiveness could be achieved through more targeted application of nutrient amendments and addition of Dehalococcoides.

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3. DEVELOPMENT OF REMEDIAL ACTION OBJECTIVES

The objectives for the remedial program have been established through the remedy selection process stated in 6 NYCRR Part 375. The goal for the remedial program is to restore the site to pre-disposal conditions to the extent feasible. At a minimum, the remedy shall eliminate or mitigate all significant threats to public health and the environment presented by the contamination identified at the site through the proper application of scientific and engineering principles. The RAOs for this site are:

Groundwater

RAOs for Public Health Protection:

- Prevent ingestion of groundwater with contaminant levels exceeding drinking water standards.

- Prevent contact with, or inhalation of volatiles, from contaminated groundwater.

RAOs for Environmental Protection:

- Restore ground water aquifer to pre-disposal/pre-release conditions, to the extent practicable.

- Remove the source of ground or surface water contamination.

Soil

RAOs for Public Health Protection:

- Prevent ingestion/direct contact with contaminated soil.

- Prevent inhalation of or exposure from contaminants volatilizing from contaminants in soil.

RAOs for Environmental Protection:

- Prevent migration of contaminants that would result in groundwater or surface water contamination.

Soil Vapor

RAOs for Public Health Protection:

- Mitigate impacts to public health resulting from existing, or the potential for, soil vapor intrusion into buildings at the site.

3.1 MEDIA CLEANUP GOALS

The media cleanup goals for soil and groundwater are based on New York State SCGs, the site-specific exposure assessment, COCs, site characteristics, and feasible actions. The COCs for soil and groundwater at OU-1 at the Admiral Cleaners site identified during the RI are chlorinated solvents, specifically PCE and its breakdown compounds TCE, *cis*-1,2-DCE, *trans*-1,2-DCE, 1,1-DCE and VC, and BTEX compounds ethylbenzene, m,p-xylene, o-xylene, 1,2,4-trimethylbenzene, and 1,3,5-trimethylbenzene. These analytes have been detected in site subsurface soil and groundwater. In addition, on-site groundwater and on-site subsurface soil have PCE concentrations exceeding applicable SCO values (i.e., Unrestricted Use SCOs, Restricted Residential SCOs, Protection of Groundwater SCOs, Class GA groundwater standards, and the 2017 New York State Department of Health [NYSDOH] Air Guideline Values). These goals can be achieved by either removing the soil and groundwater contamination or preventing impacts to human or ecological receptors via ingestion/direct contact with impacted soil and groundwater.

3.2 EXTENT OF IMPACT TO ENVIRONMENTAL MEDIA

The following sections briefly summarize the environmental impacts identified in OU-1 at the Admiral Cleaners site. The impacts associated with the environmental media are based on laboratory analytical results in relation to the SCGs. The focus of the following summaries and conclusions are aimed at defining the nature and extent of COC impacts within the site and assessing the available data for use in defining RAOs and screening remedial action alternatives during the FS process.

3.2.1 Surface Soil

Surface soil results indicate elevated metal concentrations at all sample locations, often in exceedance of one or more SCOs. Metal concentrations are distributed and not thought to be associated with former site activities; however, they are still considered COCs due to the frequency of exceedances of SCGs. Additionally, concentrations of VOCs, semivolatile organic compounds, and pesticides exist at the site in the near surface (0 to 2 ft bgs) but were determined not be COCs in surface soil (EA 2022a).

The approximate extent of surface soil metal contamination is shown on **Figure 3-1**. A total of 1,200 square feet (ft^2) of on-site surface soil contains concentrations of arsenic, iron, mercury, lead, copper, cadmium, chromium, nickel, and zinc exceeding unrestricted use SCOs. Iron, mercury, and lead concentrations exceed residential use SCOs in some of the surface soil sample locations.

3.2.2 Subsurface Soil

Subsurface soil detections of semivolatile organic compounds, pesticides, and polychlorinated biphenyls were all below the Residential Use SCOs and are not considered COCs. In subsurface soil, arsenic, chromium, iron, and manganese had significant frequencies of exceedances of Residential Use SCOs but were determined not to be site related COCs.

VOC concentrations in subsurface soil material at and adjacent to the site are elevated. Subsurface soil samples containing PCE and TCE concentrations in exceedance of SCOs were predominantly collected from below the northwest portion of the building, in the vicinity of the USTs, and adjacent to the north of the building's exterior, the suspected source area for dry cleaning chemicals. Additionally, petroleum related LNAPL, staining, and strong odors were observed at multiple locations in these areas. PCE was detected in exceedance of Residential Use SCO in 16 of 63 (approximately 25 percent [%]) subsurface soil samples collected during the RI.

The approximate extent of soil that exceeds SCOs is shown on **Figure 3-2**. The deepest soil with VOCs exceeding SCOs was collected from a depth of 15 ft bgs. The approximate volume of impacted on-site soil is 1,250 cubic yards (yd^3) across an area of approximately 3,400 ft^2. This estimate considers the varying bedrock surface on-site and includes all soil containing VOCs identified as COCs exceeding the unrestricted use SCOs.

3.2.3 Overburden Groundwater

VOC concentrations in overburden groundwater at and adjacent to the site are also elevated. Groundwater samples containing PCE, TCE, *cis*-1,2-DCE, *trans*-1,2-DCE, and VC in concentrations in exceedance of NYSDEC ambient water quality standard (AWQS) were predominantly collected from below the building in the vicinity of the USTs, and adjacent to the north of the building's exterior, the suspected disposal area for dry cleaning chemicals. Other VOCs considered COCs based on frequency of exceedance of AWQS are 1,1-dichloroethene, 1,2,4-trimethylbenzene, and 1,3,5-trimethylbenzene. The approximate extent of groundwater that exceeds NYSDEC AWQS is shown on **Figures 3-3, 3-4, and 3-5**. The areal extent of the groundwater plume on-site covers approximately 47% of the 0.17 acres. The vertical extent of the plume that has been identified is approximately 15.5 ft bgs.

Additionally, the per- and polyfluoroalkyl substances (PFAS) perfluorooctanesulfonic acid (PFOS) and perfluorooctanoic acid (PFOA) were detected in exceedance of the Final Ambient Water Quality Guidance Values (2.7 and 6.7 parts per trillion, respectively) in overburden groundwater samples. 1,4-dioxane was detected in exceedance of the Final Ambient Water Quality Guidance Value (0.35 parts per billion) in 7 out of 12 samples collected from overburden groundwater (approximately 58%). PFOS, PFOA, and 1,4-dioxane are not considered site-related contaminants or COCs. It is not anticipated that PFAS and 1,4-dioxane will drive remedy development and selection, but continued monitoring of these contaminants will be considered in this FS.

3.2.4 Bedrock Groundwater

VOCs PCE, TCE, *cis*-1,2-DCE, *trans*-1,2-DCE, 1,1-DCE, and VC exceeded AWQS in bedrock groundwater samples. PFOA and PFOS were detected in exceedance of the maximum contaminant level (MCL) in all bedrock groundwater samples. PFAS are not considered site-related contaminants, but continued monitoring will be considered in the FS.

3.2.5 Vapor Intrusion

In the 2022 RI (EA 2022a) it was recommended that no further action was required for on-site and off-site areas with regards to SVI. There are currently no buildings located in OU-1 and therefore no current concern for SVI. If in the future a new structure is located in OU-1, SVI from site-related COCs will have to be evaluated and considered.

3.3 POTENTIALLY APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Applicable or relevant and appropriate requirements (ARARs) are local, state, and federal regulations, including environmental laws and regulations that are used in the selection of remedial alternatives (RAs), as well as other non-environmental laws and regulations, such as the Occupational Safety and Health Act. New York State ARARs will supersede all other ARARs unless there is a more stringent federal or local standard. The development and evaluation of RAs presented in Section 6 includes a comparison of alternative site remedies to ARARs. The recommended remedial action for the site must satisfy all ARARs unless specific waivers have been granted.

EPA defines "applicable" and "relevant and appropriate" in the revised National Contingency Plan, codified at 40 Code of Federal Regulations (CFR) 300.5 as follows:

- ***Applicable Requirements***—substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstances at a CERCLA site.

- ***Relevant and Appropriate Requirements***—standards of control that address problems or situations sufficiently similar to those encountered at a CERCLA site that their use is well suited to the particular site.

To determine whether a requirement is relevant and appropriate, characteristics of the RA, the hazardous substances present, and the physical characteristics of the site must be compared to those addressed in the statutory or regulatory requirement. In some cases, a requirement may be relevant, but not appropriate. In other cases, only part of a requirement will be considered relevant and appropriate. When it has been determined that a requirement is both relevant and appropriate, the requirement must be complied with to the same degree as if it were applicable (EPA 1988).

ARARs for remedial action alternatives at the Admiral Cleaners site can be generally classified into one of the following three functional groups: chemical, action, or location specific.

To be considered materials (e.g., federal/state criteria, advisories, and guidance values) are non-promulgated advisories or guidance issued by federal or state government, which are not legally binding; and therefore, do not have the status of potential ARARs:

- Federal criteria, advisories, and guidance documents

- State of New York criteria, advisories, and guidance documents.

Federal and state guidance documents or criteria that are not generally enforceable, but are advisory, do not have the status of potential ARARs. Guidance documents or advisories to be considered in determining the necessary level of cleanup for protection of human health or the environment may be used where no specific ARARs exist for a chemical or situation, or where such ARARs are not sufficient to afford protection.

Federal and state requirements for soil, groundwater, and air were considered to determine if they were ARARs, based on site characteristics, site location, and the alternatives considered. The following sections summarize the specific federal, state, and local ARARs for the remedial actions that may be taken at the Admiral Cleaners site, and for the types of technologies that will be developed into RAs. As identified at the beginning of Section 3, groundwater and soil are the focus of the FS at the Admiral Cleaners site; in addition, the contaminants of concern identified during the RI consist of chlorinated solvents, specifically PCE and its breakdown compounds TCE and 1,2-DCE. Thus, each of the following ARARs has been chosen for its potential applicability or relevance and appropriateness.

3.3.1 Chemical-Specific Applicable or Relevant and Appropriate Requirements

Chemical-specific requirements are established health- or risk-based numerical values or methodologies that establish cleanup levels or discharge limits in environmental media for specific substances or pollutants. Cleanup standards for impacted groundwater are defined in the NYSDEC AWQS with SCGs specified based on drinking water standards (NYSDEC 1998).

3.3.2 Action-Specific Applicable or Relevant and Appropriate Requirements

Action-specific ARARs set controls or restrictions on the design, implementation, and performance levels of activities related to the management of hazardous substances, pollutants, or contaminants. The potential action specific ARARs are included in the following tables.

Federal Action-Specific ARARS

Requirement	Rationale
Clean Water Act NPDES 40 CFR Part 122 The NPDES establishes permitting requirements, technology-based limitations and standards, control of toxic pollutants, and monitoring of effluents to assure discharge permit conditions and limits are not exceeded. Applicable if groundwater will be extracted from ground and discharged.	Applicable if groundwater will be extracted from ground and discharged.
Safe Drinking Water Act (National Primary and Secondary Drinking Water Regulations) (42 U.S.C. 300f, 40 CFR Part 141, 40 CFR Part 143) The Safe Drinking Water Act provides a national framework to ensure the quality and safety of drinking water. The primary standards establish MCLs and MCL goals for chemical constituents in drinking water. Secondary standards pertain primarily to the aesthetic qualities of drinking water.	The removal action is being conducted to reduce chemical concentrations in soil and groundwater, with a goal of meeting cleanup levels at the property boundary.
Clean Air Act, as Amended (42 U.S.C. 7401) The Clean Air Act is a comprehensive law, which is designed to regulate any activities that affect air quality and provides the national framework for controlling air pollution. The National Primary and Secondary Ambient Air Quality Standards (40 CFR Part 50) set standards for ambient pollutants which are regulated within a region. The National Emissions Standards for Hazardous Air Pollutants (40 CFR Part 61) establishes numerical standards for hazardous air pollutants.	The Clean Air Act will be required if any remediation alternatives produce air emissions.
Resource Conservation and Recovery Act Provides the governing regulations for owners and operators of hazardous waste treatment, storage, and disposal facilities; and for the generators and transporters of hazardous waste.	All waste generated during the removal action will be characterized and handled per Resource Conservation and Recovery Act regulations.
Occupational Safety and Health Act (29 CFR 1910) Establishes the worker health and safety requirements for operations at hazardous waste sites.	Site activities will be conducted under appropriate Occupational Safety and Health Act standards.
Rules for Transport of Hazardous Waste (49 CFR 107, 171) The U.S. Department of Transportation establishes requirements for packaging, handling, and manifesting hazardous waste.	Any hazardous waste generated during site activities will be characterized as needed to determine packaging, handling, and transport requirements.

Notes:
NPDES = National Pollutant Discharge Elimination System

State Action-Specific ARARS

Requirement	Rationale
NYSDEC Environmental Remediation Programs. 6 NYCRR Part 375 This program applies to the development and implementation of remedial programs for environmental restoration sites.	Site cleanup will be conducted in accordance with 6 NYCRR Part 375.
NYSDEC CP-51/Soil Cleanup Guidance. This policy provides the framework and procedures for the selection of soil cleanup levels appropriate for each of the remedial programs in the NYSDEC DER.	Details when Protection of groundwater SCOs are applied to soil results.
Solid Waste Management Facilities. 6 NYCRR Part 360 Provides standards and regulations for permitting and operating solid waste management facilities.	These regulations will be followed for off-site treatment and disposal of hazardous waste.
Waste Transporter Permits. NYCRR Part 364 Provides standards and regulations for waste transporters.	
Land Disposal Restrictions. 6 NYCRR Part 376	
Hazardous Waste Management System. 6 NYCRR Part 370, 371, 372, 373, 375 Provides standards and regulations for the state hazardous waste management system, identification and listing of hazardous wastes, and provides standards, regulations, and guidelines for the manifest system, as well as additional standards for generators, transporters, and facilities.	
New York State Department of Transportation Rules for Hazardous Materials Transport. 49 CFR, Parts 107, 171.1-500. Addresses requirements for marking, manifesting, handling, and transport of hazardous materials; applicable if off-site treatment or disposal of wastes is required.	
Water Quality Regulations for Surface Waters and Groundwater. 6 NYCRR Part 700-706 Provides standards, regulations, and guidelines for the protection of waters within the state.	Water discharged from the site will comply with this guidance.
Implementation of NPDES Program in New York State. 6 NYCRR Part 750-757 Provides regulations regarding the SPDES program.	A SPDES permit may be required depending on selected remedial action.
Permits and Registration (Air). 6 NYCRR Part 201 Describes permits and registration requirements	Permit or registration may be required depending on selected remedial action.
Air Quality Standards. 6 NYCRR Part 257 Air quality standards are designed to provide protection from the adverse health effects of air contamination; and they are intended further to protect and conserve the natural resources and environment.	All substantive requirements of the state air pollution control regulations will be followed during implementation of the remedial action.
NYSDEC CP-49/Climate Change and NYSDEC Action. Provides general directions to all Divisions, Offices and Regions within the NYSDEC regarding the responsibilities related to incorporating climate change considerations and outlines procedures for compliance with specific provisions of the Climate Leadership and Community Protection Act of 2019 and Community Risk and Resilience Act of 2014.	NYSDEC is required to incorporate climate change and green remediation in all aspects of activities, decision making, remediation, and planning

State Action-Specific ARARS

Requirement	Rationale
NYSDEC DER-31 / Green Remediation This document provides concepts and techniques of green remediation and guidance on how to apply them to DER's remedial programs,	

Notes:
SPDES = State Pollutant Discharge Elimination System

3.3.3 Location-Specific Applicable or Relevant and Appropriate Requirements

Location-specific ARARs must be considered when developing alternatives because these types of ARARs may affect or restrict remedial activities. Generally, location-specific requirements serve to protect the individual site characteristics, resources, and specific environmental features.

The potential location specific ARARs are included in the following table.

Location-Specific ARARS

Requirement	Rationale
Land development standards, stormwater and surface water regulations, and clearing and grading requirements.	Local permits are required depending on the selected remedial action.
Building permits and building codes.	

4. GENERAL RESPONSE ACTIONS

In general, remedial technologies fit into one or more categories of general response action (GRA). GRAs are generic, medium-specific, remedial actions that will satisfy the RAOs discussed in Section 3. GRAs may include no action, institutional controls (ICs), containment, removal, treatment, disposal, monitoring, or a combination of multiple technologies. The development of RAs for this FS begins with the identification of GRAs that can meet RAOs. These GRAs are then screened based on their effectiveness, implementability, and cost, and developed into RAs to address all contaminated media at the site. The GRAs for groundwater at the Admiral Cleaners site (including no action, MNA, containment, removal, and treatment) are detailed in the following sections.

4.1 NO ACTION

The no action alternative is included to be used as the baseline alternative against which the effectiveness of all other RAs is judged.

4.2 MONITORED NATURAL ATTENUATION

For groundwater contaminated with CVOCs, MNA consists of monitoring groundwater contaminant concentration trends and natural attenuation parameters. Natural attenuation with monitoring allows natural processes to achieve site-specific remedial objectives without enhancement or aggressive treatment. The natural attenuation processes in such a remedial approach include the physical, chemical, or biological processes under favorable aquifer conditions functioning to reduce the mass, toxicity, mobility, volume, and concentration of contaminants in the groundwater. Natural attenuation processes that could occur include biodegradation (aerobic or anaerobic), abiotic transformation (e.g., hydrolysis), adsorption, dispersion, or dilution.

4.3 INSTITUTIONAL CONTROLS

Site management, also known as ICs, involves the placement of restrictions on the use of property that limits human or environmental exposure, provides notice to any individual who might come in contact with the site, or prevents actions that would interfere with the effectiveness of a remedial program, or with the effectiveness and/or integrity of site management activities at or pertaining to a site.

4.4 CONTAINMENT

Containment strategies consist of technologies that would limit or block movement of contaminants off-site. Containment strategies include:

- Slurry Wall: Slurry walls are subsurface barriers that consist of vertically excavated trenches filled with slurry. The slurry, usually a mixture of bentonite and water, hydraulically shores the trench to prevent collapse and retards groundwater flow.

- Groundwater pump and treat: Groundwater is pumped from wells within the contaminated zone to an above-grade treatment system prior to treatment and discharge.

- Contaminated soil can be contained by installing a cover over the contaminated material. A cover may consist of soil, concrete, asphalt, or a combination of cover types depending on site use.

4.5 REMOVAL (OFF-SITE TREATMENT)

Physical removal of impacted soil would be conducted by excavation, using standard construction equipment (i.e., excavators) to remove material from the ground and load it into transport mechanisms (i.e., trucks) for off-site treatment or disposal. Removal of non-aqueous phase liquid (NAPL) can be conducted using equipment such as a belt skimmer or sorbent pads in monitoring and extraction wells; NAPL and sorbent pads would be containerized and disposed of off-site.

4.6 IN SITU TREATMENT

Treatment subjects contaminants in groundwater and/or soil to processes that alter their state, transform them to innocuous forms, or immobilize them. Treatment can be performed either in situ or ex situ. Due to site space constraints, ex situ treatment is likely not feasible; only in situ treatment options are potentially applicable. There are several in situ treatment technologies for groundwater, including some that can also address NAPL when applied appropriately, that include:

- Enhanced bioremediation: The activity of naturally occurring microbes is stimulated by introducing water-based solutions into contaminated groundwater to enhance in situ biological degradation of organic contaminants. Nutrients, oxygen, or other amendments may be used to enhance biodegradation. This can be effective in NAPL reduction.

- In situ chemical oxidation (ISCO): ISCO can be achieved through injection of an oxidizing agent such as ozone or permanganate into the contaminated material, or physical mixing of soil with the oxidizing agent. Because the contaminants are treated and not volatilized, vapor does not need to be managed. ISCO can be effective in NAPL reduction as well, though requires multiple rounds of injections.

- In situ chemical reduction (ISCR): ISCR is achieved through injection of reducing agents such as zero valent iron into the contaminated material. ISCR can be effective in DNAPL reduction.

- Enhanced reductive dechlorination: Direct-push methods would be used to inject amendments/reagents into the contaminated groundwater to break down the COCs.

- Activated carbon injection: Direct-push methods would be used to inject liquid activated carbon to sorb dissolved phase COCs; this would be combined with hydrogen release compound and a microbial component to maximize contact of contaminants with treatment media.

- Electrical resistive heating (ERH)/thermal conductive heating (TCH) involves the transfer of energy into the subsurface and recovery of volatile and semivolatile organic contaminants. This technology can be used to address contamination that is not amenable to excavation, such as at depth or below the water table. Contaminants in soil and groundwater become volatized due to high temperatures. Resulting vapors can be extracted from the subsurface and are treated in above ground treatment systems. ERH can be effective in NAPL reduction and mobilization and can be combined with other technologies (such as enhanced bioremediation or pump and treat) for effective treatment.

- Groundwater treatment via Passive Reactive Barrier: These barriers allow the passage of water while prohibiting the horizontal movement of contaminants by employing such agents as chelators (ligands selected for their specificity for a given metal), sorbents, microbes, and others. These barriers are installed below grade perpendicular to groundwater flow. They treat the contaminated groundwater as it flows off-site so that the site contaminates are unable to migrate off-site.

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5. IDENTIFICATION AND SCREENING OF TECHNOLOGIES

The potentially applicable technologies based on the GRAs identified earlier in Section 4 are screened using the process defined in DER-10, Technical Guidance for Site Investigation and Remediation (NYSDEC 2010a). Three preliminary screening criteria (i.e., effectiveness, implementability, and cost) were used to screen the remedial technologies identified earlier for each media of concern. The screening process is summarized in **Table 5-1**.

5.1 SCREENING CRITERIA

5.1.1 Effectiveness

This criterion is a measure of the ability of an option to: (1) reduce toxicity, mobility, or volume of contamination, (2) minimize residual risks, (3) afford long-term protection, (4) comply with ARARs, (5) minimize short-term impacts, and (6) achieve protectiveness in a limited duration. Technologies that offer significantly less effectiveness than other proposed technologies may be eliminated from the alternative development process. Options that do not provide adequate protection of human health and environment, likewise, may be eliminated from further consideration.

5.1.2 Implementability

Implementability is a measure of the technical feasibility and availability of the option and administrative feasibility of implementing it (e.g., obtaining permits for off-site activities, rights-of-way, or construction). Options that are technically or administratively infeasible or that would require equipment, specialists, or facilities that are not available within a reasonable period, may be eliminated from further consideration.

5.1.3 Cost

Qualitative relative costs for implementing the remedy are considered. Technologies that cost more to implement, but that offer no benefit in effectiveness or implementability over other technologies, may be excluded from the alternative development process.

5.2 SCREENING SUMMARY

The results of the technology screening are summarized in Sections 5.2.1 and 5.2.2. Section 5.2.1 discusses technologies that were not retained for further analysis, and the reasons for exclusion. Section 5.2.2 lists technologies that were retained for further analysis as individual components in RAs. The screening is presented in greater detail in **Table 5-1**.

5.2.1 Technologies Not Retained for Further Analysis

From the list of technologies potentially applicable for remediation of the chemicals and media of concern at this site, numerous technologies were excluded from further consideration because they were considered ineffective, not implementable at this site, or too costly relative to the other alternatives under consideration. The reasons for exclusion are detailed below:

- Slurry walls will not treat contaminated groundwater and when implemented alone, do not prevent the further contamination of groundwater. Slurry walls can only alter the groundwater flow direction and may require pumping of groundwater off-site to maintain hydraulic control of the site; therefore, they are considered ineffective for remediation of groundwater.

- Groundwater pump and treat would prevent off-site migration of COCs; however, groundwater pump and treat systems are not effective at treating source areas resulting in excessive long-term operations and maintenance. Additionally, yields from groundwater sampling events have shown that the ability to extract overburden groundwater is limited, so may not effectively address impacts in overburden groundwater.

- Treatment of on-site groundwater contamination via a passive reactive barrier was not retained because it would not accommodate the planned future residential use of the property.

- ISCO via ozone injections were removed from consideration due to proximity of other structures and utilities. This alternative would require an intensive monitoring program to ensure no adverse impacts of ozone outside the target treatment area.

5.2.2 Technologies Retained for Further Analysis

Technologies that passed through screening and are retained and combined to create RA for the site are listed below for each medium of concern.

The list of remedial technologies considered in this FS for soil and groundwater include:

- No action will be retained for further consideration in this FS as required by DER-10.

- ICs such as land use restrictions to limit human and environmental exposure were retained due to low cost and ease of implementation.

- Natural attenuation by natural subsurface processes, such as dilution, volatilization, biodegradation, adsorption, and chemical reactions with subsurface materials, are allowed to reduce contaminant concentrations to levels that do not exceed NYSDEC SCGs. MNA is retained to be applied in combination with other technologies.

- Containment of contaminated soil using a cover such as asphalt pavement to physically prevent contact with COCs. This was retained for potential combination with other technologies.

- ISCO could reduce the mass of CVOCs in groundwater, given favorable conditions. It was retained as a potential alternative for treatment of CVOCs and LNAPL in overburden soil, vadose zone, and shallow overburden groundwater only. It would need to be used in conjunction with another technology for treatment of deeper overburden and bedrock groundwater. ISCO treatment was not selected for deeper overburden and bedrock groundwater due to the potential for treatment compounds to oxidize existing minerals into insoluble precipitates. This reaction was observed during a corrective action completed at the Watervliet Arsenal, which is within a half-mile of the site and has a similar bedrock composition and the same COCs. The interaction with the sodium permanganate and the rock matrix, specifically the reduced sulfur (i.e., pyrite), resulted in insoluble precipitates, which significantly limited the effectiveness of the permanganate injections (Malcolm Pirnie 2008).

- ISCR would promote the degradation of COCs through reductive dechlorination. It was retained to be applied with other technologies.

- Removal of contaminated soil through excavation and off-site disposal.

- Enhanced in situ bioremediation of organic contaminants involving introduction of water-soluble solutions into contaminated groundwater to stimulate the activity of naturally occurring microbes.

- Physical extraction of LNAPL via mechanical means using either a belt skimmer, sorbent pads, or bailers.

- ERH/TCH involves the injection of energy (in the form of heat) into the contaminated subsurface soil and groundwater and recovery of volatile and semi-volatile organic contaminants to be treated ex situ.

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6. SCOPING AND DEVELOPMENT OF REMEDIAL ALTERNATIVES

Scoping and development of RAs for the FS was completed based on correspondence between EA and the NYSDEC. EA performed the alternative comparison in accordance with DER-10 (NYSDEC 2010a) and the EPA publication Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (EPA l540lG-891004) (EPA 1988). The results of the technology screening process were summarized in **Table 5-1** and the Technology Screening Memorandum prepared and submitted to the NYSDEC on 24 August 2021 (EA 2021b). Following further discussions with NYSDEC and EA, the Technology Screening Memorandum was revised and submitted to NYSDEC on 28 October 2022 (EA 2022c). The screening of alternatives was designed to provide a basis for the overall assessment of applicable technologies based on impacted media within OU-1 identified at the site during the RI.

Based on the technology review and screening, seven RAs have been developed for the remediation of contamination found on the site. Each of the site-specific RAs developed in the following paragraphs incorporate technologies which address the media requiring remediation (soil and groundwater) at the site. These alternatives include readily available technologies, which have been proven to be effective at similar sites with CVOC contamination in groundwater and soil. Surface soil metal contamination and PFAS groundwater contamination will also be considered during the alternative evaluation at the request of the NYSDEC. A summary of the components of each alternative can be found in **Table 6-1.**

The selected alternatives consist of the following:

- ***Alternative 1***—No Further Action
- ***Alternative 2*—**No Further Action with Site Management
- ***Alternative 3***— High Temperature In Situ Thermal Remediation
- ***Alternative 4***—Enhanced Bioremediation with Cover System
- ***Alternative 5***— Soil Removal and Enhanced Bioremediation
- ***Alternative 6***—Low Temperature In Situ Thermal Remediation with Enhanced Bioremediation.
- ***Alternative 7***—In Situ Chemical Oxidation and Reduction.

6.1 ALTERNATIVE 1: NO FURTHER ACTION

The No Further Action alternative recognizes the remediation of the site completed by the IRM(s). This alternative leaves the site in its present condition and does not provide any additional protection of the environment.

6.2 ALTERNATIVE 2: NO FURTHER ACTION WITH SITE MANAGEMENT

The No Further Action with Site Management alternative recognizes the remediation of the site completed by the IRM(s) and that Site Management is necessary to confirm the effectiveness of the IRM. This alternative maintains engineering controls which were part of the IRM and includes institutional controls, in the form of an environmental easement and Site Management Plan, necessary to protect public health and the environment from contamination remaining at the site following the IRMs.

6.3 ALTERNATIVE 3: HIGH TEMPERATURE IN SITU THERMAL REMEDIATION

High temperature thermal remediation can be conducted using one of two methods. TCH involves heating narrow diameter steel pipes to hundreds of degrees Celsius (°C). The heat that radiates into the subsurface soil and overburden groundwater to heat and volatilize the contaminants. ERH is a thermal remediation method that employs a grid of electrodes over the site embedded in the overburden soil and shallow bedrock. The electrodes apply an electric current to the soil. The soil resists the electric current in turn heating the surrounding media to the boiling point of water.

For both methods, the resulting vapor is then extracted from the subsurface through co-located vertical extraction wells. The extracted vapors and steam are condensed and treated using a granular activated carbon (GAC) filtration system installed on-site on grade.

To protect against back diffusion of residual contamination that might not be addressed through TCH/ERH, a follow-on treatment to stimulate enhanced bioremediation is proposed. Due to the nature of TCH/ERH, the population of subsurface microbes would be reduced if not eliminated. Substrates, microbes, and/or electron amendment would be introduced into the subsurface to address remaining contamination.

High temperature in situ thermal remediation would conceptually be implemented using TCH as described below and as shown on **Figure 6-1**:

- Surface soil (0 to 2 ft bgs) impacted with metals would be removed from the site for off-site disposal. The estimated quantity for on-site soil removal due to metal contamination is 100 yd^3. The heating of the subsurface soil can increase viscosity of various metals causing them to descend into the subsurface soil. Clean fill meeting the requirements of 6 NYCRR Part 375-6.7(d) will be used to replace the excavated soil and establish design grades at the site.

- Existing monitoring wells on-site would be decommissioned and replaced as appropriate with new monitoring wells with stainless-steel piping and screen following the completion of the thermal remediation.

- Treatment wells and co-located vertical extraction wells would be installed within the contaminated zone down to a maximum depth of 15 ft bgs in a 15-ft grid.

- Power sufficient for system operation (500 kilowatts) would be installed at the site.

- A trailer-mounted treatment system including blower, GAC treatment vessels, piping, and all required controls would be delivered and installed on-site.

- A vapor barrier would be placed over the injection/extraction well field.

- Remediation activities are expected to take up to 6 months to reach SCGs.

- Verification sampling during remediation would consist of groundwater and soil sampling via soil borings for VOC analysis. It is assumed that two rounds of verification sampling would be conducted. Recovered vapor would also be sampled.

- Following completion of remediation, the system equipment would be demobilized from the site, treatment wells would be decommissioned, and the spent carbon would be disposed of off-site and is expected to be disposed of as hazardous waste.

- To protect against back diffusion of contaminants from the fractured bedrock groundwater network, additional substrates, microbes, and/or electron acceptors would be injected into the reinstalled monitoring wells and via DPT injection points following the completion of the thermal remediation.

- Groundwater samples would be collected from 8 monitoring wells (both overburden and bedrock) quarterly for the first 2 years and annually thereafter to evaluate the effectiveness of the remedy. Monitoring is estimated to be conducted for 30 years.

Special considerations to protect surrounding buildings and utilities include an offset of 5 ft or the installation of cold-water injection points (for TCH) between wells and the structures or utilities of concern. For this alternative, it is assumed that appropriate spacing could be maintained to prevent impacts to the building to the west of the site or nearby utilities south or east of the site.

6.4 ALTERNATIVE 4: ENHANCED BIOREMEDIATION WITH SOIL COVER SYSTEM

For this alternative, enhanced bioremediation of contaminated groundwater would be implemented through the addition of substrates, microbes, and/or electron acceptors to the groundwater through temporary injection points. Surface soil (0-2 ft) metal contamination exceeding Unrestricted Use SCOs would be excavated and disposed off-site. Clean fill meeting the requirements of 6 NYCRR part 375-6.7(d) will be imported to replace the excavated soil and establish design grades at the site.

Pre-design activities to refine the in situ enhanced bioremediation approach would include:

- Sampling for microbes present in site overburden and bedrock groundwater

- Evaluation of fractures in bedrock

- Overburden and bedrock groundwater sampling for VOCs and MNA parameters.

- Bench scale pilot test of remedial substrates. CarBstrate™ was applied as a Pilot Test during IRM No. 2 (Section 2.2.2) and there was strong evidence that anaerobic PCE degradation was occurring on-site following the pilot study. However, additional testing may be warranted to determine appropriate dosing and bacterial amendments needed to reach complete dechlorination.

Alternative 4 would be implemented as follows and as shown on **Figure 6-2**:

- Surface soil (0 to 2 ft bgs) impacted with metals contamination would be removed from the site for off-site disposal. The estimated quantity for on-site soil removal due to metals contamination is approximately 100 yd^3. Clean fill meeting the requirements of 6 NYCRR part 375-6.7(d) will be imported to replace the excavated soil and establish design grades at the site.

- The selected bioremediation amendment would be applied via the 2 existing application points and additional DPT injection points. The conceptual injection layout includes 32 points spaced in a 12 ft grid to target contamination from 5 ft bgs into fractured bedrock until refusal, which is expected to be 5 ft into weathered bedrock. The targeted treatment zone is currently the full extent of the site excavation prior to backfill.

- The existing concrete building slab and asphalt will remain in place and serve as a cover system, preventing exposure to contamination beneath.

- Groundwater samples would be collected from 8 monitoring wells (both overburden and bedrock quarterly for the first 2 years and annually thereafter to evaluate the effectiveness of the remedy. Monitoring is estimated to be conducted for 30 years.

Institutional controls would be employed with this alternative as there would still be contaminated soil present on-site below the asphalt, concrete, and soil covers. Institutional controls would involve the placement of a restriction on the use of property that limits human or environmental exposure, provides notice to any individual who might encounter the site, or prevents actions that would interfere with the effectiveness of a remedial program, or with the effectiveness and/or integrity of site management activities at or pertaining to a site. ICs for this alternative would likely include groundwater use restrictions, deed restrictions, and restrict development to Restricted-Residential Use.

6.5 ALTERNATIVE 5: SOIL REMOVAL AND ENHANCED BIOREMEDIATION

This alternative consists of excavation and off-site disposal of contaminated source areas, including grossly contaminated soil, as defined in 6 NYCRR Part 375-1.2(u) and soils which exceed the protection of groundwater soil cleanup objectives (PGWSCOs), as defined by 6

NYCRR Part 375-6.8 for those contaminants found in site groundwater above standards. Approximately 1,680 yd^3 of contaminated soil will be removed from the site. Clean fill meeting the requirements of 6 NYCRR Part 375-6.7(d) will be imported to replace the excavated soil and establish design grades at the site. Dust and stormwater runoff control measures will be employed to minimize any short term impacts associated with excavation.

This alternative consists of removal and off-site disposal of contaminated overburden soil that exceeds Protection of Groundwater SCOs for COCs. This alternative would aim to remove contaminated soil from the ground surface down to the competent bedrock, inclusive of weathered bedrock (thickness of approx. 1 ft across site). Depth to competent rock is between 8 to 15 ft bgs (EA 2022a); this is illustrated on **Figure 6-3**. In situ enhanced bioremediation would be used to treat contaminated groundwater.

Pre-design activities to refine the in situ enhanced bioremediation approach would include:

- Sampling for microbes present in site overburden and bedrock groundwater
- Evaluation of fractures in bedrock
- Overburden and bedrock groundwater sampling for VOCs and MNA parameters
- Bench scale pilot test of remedial substrates. CarBstrate™ was applied as a Pilot Test during IRM No. 2 (Section 2.2.2) and there was strong evidence that anaerobic PCE degradation was occurring on-site following the pilot study. However, additional testing may be warranted to determine appropriate dosing and bacterial amendments needed to reach complete dechlorination.

In addition, a structural evaluation would be conducted to identify excavation means and methods required to protect adjacent structures that would be incorporated into the design. A separate structural inspection of surrounding structures would be necessary pre- and post-excavation to evaluate and document the condition of structures to determine if additional precautions should be taken prior to excavation activities.

Alternative 5 would be implemented as follows and as shown on **Figure 6-3**:

- A utility locator would be brought to the site prior to excavation to locate known underground utilities. This information would be utilized to either re-route these utilities outside the remediation area or to accommodate their locations and future anticipated maintenance. This should only be necessary in off-site areas where excavation may extend based on confirmation sampling to reach desired SCOs as the utilities on-site have already been disconnected during IRM No. 1 and IRM No. 2 (EA 2021a; EA 2022b).
- Some of the removal area is covered by the former building slab, footers, and asphalt; this material will be saw cut and broken up for off-site disposal.

- Six existing monitoring wells would be decommissioned prior to excavation.

- Excavation and structural support, as identified during pre-design investigation activities, would be installed prior to or during excavation.

- Approximately 1,680 yd^3 of soil and weathered bedrock would be excavated and disposed of off-site under this alternative to the extent practicable. This volume includes CVOC contaminated soil and weathered bedrock down to competent bedrock, metals contaminated soil down to 2 ft bgs in areas without CVOC contamination, and additional volume for contingency.

- Soil below 4 ft bgs is assumed to be hazardous, based on characterization sampling conducted during IRM. No. 2. Soil above 4 ft bgs will need to be characterized before disposal to ensure that it is transported to an appropriate disposal facility.

- Prior to backfilling the excavation, samples would be collected to document if cleanup goals are met or if contamination remains.

- The selected bioremediation amendment would be applied to the excavation prior to backfill. Injection piping would be installed across the bottom of the excavation (perforated pipe and a riser for future applications).

- Clean fill meeting the requirements of 6 NYCRR Part 375-6.7(d) will be used to replace the excavated soil and establish design grades at the site. Approximately 1,680 yd^3 of clean fill would need to be transported to the site.

- New overburden and bedrock monitoring wells would be installed following restoration to replace the decommissioned wells.

- Groundwater samples would be collected from 8 monitoring wells (both overburden and bedrock) quarterly for the first 2 years and annually thereafter to evaluate the effectiveness of the remedy. Monitoring is estimated to be conducted for 30 years.

6.6 ALTERNATIVE 6: LOW TEMPERATURE IN SITU THERMAL REMEDIATION WITH ENHANCED BIOREMEDIATION

Low temperature thermal remediation involves heating the treatment area to a lower temperature than high temperature thermal remediation (35°C to 40°C) coupled with application of an in situ bioremediation amendment to produce anaerobic conditions to enhance microbial growth. Amendment would conceptually be applied using DPT in the same spacing as Alternative 3. TCH heating methods would conceptually be employed at the same spacing as Alternative 5. This thermal approach would not require any extraction wells or treatment systems on- or off-site. Only a small power control unit that would provide the subsurface heating would be installed on-site.

Pre-design activities to refine the in situ enhanced bioremediation aspect of this alternative approach would include:

- Sampling for microbes present in site bedrock groundwater
- Evaluation of fractures in bedrock
- Bench scale pilot test including injection radius of influence (CarBstrate™ was applied during the IRM No. 2 (Section 2.2.2); and there was strong evidence that anaerobic PCE degradation was occurring on-site following the pilot study. However, additional testing may be warranted to determine appropriate dosing and bacterial amendments needed to reach complete dechlorination.

Low temperature in situ thermal remediation with enhanced bioremediation would be implemented as follows and as shown on **Figure 6-4**:

- Surface soil (0 to 2 ft bgs) impacted with metals contamination would be removed from the site for off-site disposal. The estimated quantity for on-site soil removal due to metals contamination is 100 yd^3. Clean fill meeting the requirements of 6 NYCRR Part 375-6.7(d) will be used to replace the excavated soil and establish design grades at the site.
- The selected bioremediation amendment would be applied via the 2 existing application points and additional DPT injection points. The conceptual injection layout includes 32 points spaced in a 12 ft grid to target contamination from 5 ft bgs into fractured bedrock until refusal, which is expected to be 5 ft into weathered bedrock. The targeted treatment zone is currently the full extent of the site excavation prior to backfill.
- Treatment wells would be installed within the contaminated zone down to a maximum depth of 15 ft bgs in a 15 ft grid.
- Power sufficient for system operation (100 kilowatts) would be installed at the site.
- A small power control unit would be delivered and installed on-site to regulate the temperature of the thermal treatment.
- Remediation activities are expected to take up to 2 years to reach SCGs.
- Verification sampling during remediation would consist of groundwater and soil sampling via soil borings for VOC analysis. It is assumed that four rounds of verification sampling would be conducted.
- Following completion of remediation, the equipment would be demobilized from the site, and the treatment wells would be decommissioned.

- Groundwater samples would be collected from 8 monitoring wells (both overburden and bedrock) quarterly for the first 2 years and annually thereafter to evaluate the effectiveness of the remedy. Monitoring is estimated to be conducted for 30 years.

6.7 ALTERNATIVE 7: IN SITU CHEMICAL OXIDATION AND REDUCTION

In this alternative, VOC contamination of groundwater, saturated soil, and vadose zone soil would be addressed through a combination of ISCO and ISCR technologies; surface soil contaminated with metals exceeding Unrestricted Use SCOs would be excavated and disposed off-site. Remaining soil and groundwater to approximately 8 ft bgs would be treated with an ISCO amendment to oxidize and treat VOCs and LNAPL. The remaining depth would be treated with an ISCR amendment to treat VOCs via reductive dechlorination.

Pre-design activities to refine the ISCO/ISCR approach would include:

- Evaluation of fractures in bedrock.

- Overburden and bedrock groundwater sampling for VOCs, metals, and geochemical parameters.

- Bench scale pilot test of remedial substrates for ISCO and ISCR to determine the best product and dosing required to reduce COC concentrations below SCOs.

Alternative 7 would be implemented as follows and as shown on **Figure 6-5**:

- Existing concrete slab and asphalt would be saw cut and broken up for off-site disposal.

- Surface soil (0 to 2 ft bgs) impacted with metals contamination would be removed from the site for off-site disposal. The estimated quantity for on-site soil removal due to metals contamination is approximately 100 yd^3. Clean fill meeting the requirements of 6 NYCRR Part 375-6.7(d) will be used to replace the excavated soil and establish design grades at the site. Application of ISCO on the off-site property (621 19^{th} Street) and border of 621 19^{th} Street property would be conducted via direct-push injection. The conceptual spacing of injections would be 10 ft.

- Application of ISCO within remaining contaminated areas on-site would be conducted via soil mixing. ISCO mixing would be applied to shallow overburden contamination, down to approximately 8 ft bgs. It is assumed two applications of ISCO product will be needed to address pooled LNAPL on-site.

- Groundwater and soil samples would be collected every three months during the remedial action to evaluate effectiveness of the treatments and to determine whether additional injections are necessary.

- Following completion of ISCO treatment, soil mixing with Portland Cement would be performed to stabilize the area of ISCO soil mixing. It is assumed the top 2 ft of material will need to be removed to accommodate bulking of material following Portland amendment and mixing. Soil material removed will be disposed off-site as non-hazardous waste.

- Several months following completion of ISCO treatments and once LNAPL has been confirmed to no longer be present at the site, ISCR treatment would be performed via DPT to address deeper overburden and shallow bedrock groundwater beginning at 8 ft bgs and extending to approximately 15 ft bgs. The conceptual spacing of injections would be 10 ft.

- Clean fill meeting the requirements of 6 NYCRR Part 375-6.7(d) will be used to replace the excavated soil and establish design grades at the site. Groundwater samples would be collected from 8 monitoring wells (both overburden and bedrock) quarterly for the first 2 years and annually thereafter to evaluate the effectiveness of the remedy. Monitoring is estimated to be conducted for 30 years.

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7. COSTING AND EVALUATION CRITERIA

7.1 COST ASSUMPTIONS

Cost assumptions were prepared for each alternative using EPA's Guide to Developing and Documenting Cost Estimates during the FS (EPA 2000). The net present value of the project costs was estimated using a discount rate of 3%. The cost assumptions were calculated using the most common products, and application methods available for a RA. The EPA guidance was used in conjunction with DER-10 Technical Guidance for Site Investigation and Remediation (NYSDEC 2010a).

Cost estimates were prepared for each alternative based on the assumptions detailed in Section 6. **Appendix A** shows the detailed cost estimates developed. A summary of the costs for all alternatives is provided in **Table 7-1**.

7.2 EVALUATION CRITERIA

The criteria to which potential RAs are compared (and used during this detailed analysis) are defined in 6 NYCRR Part 375 (NYSDEC 2006) and are listed below:

- Overall protectiveness of public health and the environment
- Conformance to SCGs
- Long-term effectiveness and permanence
- Reduction in toxicity, mobility, or volume of contamination through treatment
- Short-term impacts and effectiveness
- Implementability
- Cost-effectiveness
- Land use
- Community acceptance.

A description of the criteria and how alternatives are evaluated against them follows.

Overall Protectiveness of Public Health and the Environment—This criterion is an overall evaluation of each alternative's ability to protect public health and the environment.

Conformance to SCGs—Compliance with SCGs addresses whether a remedy would meet environmental laws, regulations, and other standards and criteria. The SCGs were presented in Section 3.

Long-Term Effectiveness and Permanence—This criterion evaluates the long-term effectiveness of the Ras after implementation. If wastes or treated residuals remain on-site after the recommended remedy has been implemented, the following items are evaluated: (1) magnitude of the remaining risks, (2) adequacy of the engineering and/or ICs intended to limit the risk, and (3) reliability of these controls.

Reduction of Toxicity, Mobility, or Volume of Contamination through Treatment—The degree to which the alternative permanently reduces the toxicity, mobility, or volume of hazardous substances including the adequacy of the alternative in destroying the hazardous substances, reduction or elimination of hazardous substance releases and sources of releases, degree of irreversibility of waste treatment process, and characteristics and quantity of treatment residuals generated. Preference is given to alternatives that permanently and significantly reduce the toxicity, mobility, or volume of the wastes at the site.

Short-Term Impacts and Effectiveness—Evaluation of the short-term effectiveness for an alternative includes consideration of the risk to human health, and the environment associated with the alternative during construction and implementation, and the effectiveness of measures that will be taken to manage such risks. Impacts from RA implementation include vehicle traffic, temporary relocation of residences/buildings, temporary closure of public facilities, odor, open excavations, green remediation, and sustainability; and noise, dust, and safety concerns associated with extensive heavy equipment activity. The greatest short-term risk to human health is related to safety and general construction activity.

Implementability—The technical and administrative feasibility of implementing each alternative is evaluated. Technical feasibility includes the difficulties associated with construction of the remedy and the ability to monitor its effectiveness. For administrative feasibility, the availability of the necessary personnel and materials is evaluated along with potential difficulties in obtaining specific operating approvals, access for construction, ICs, and so forth.

Cost-Effectiveness—Capital costs and annual operation, maintenance, and monitoring costs are estimated for each alternative and compared on a present worth basis. Although cost-effectiveness is the last balancing criterion evaluated, where two or more alternatives have met the requirements of the other criteria, it can be used as the basis for the final decision.

Land Use—The current and anticipated future use of the site will be considered. Land use must comply with applicable zoning laws and maps.

Community Acceptance—Public comments will be considered after the close of the public comment period.

Green Remediation—All remediation and construction activities pose an environmental impact from vehicle usage, chemical and materials manufacture, sampling activities, and laboratory analysis. The alternatives were evaluated using guidance provided in DER-31 and include a range of environmental impacts. Excavation would have the greatest environmental impact due to the heavy vehicle usage to excavate and transport contaminated materials off-site. Generally, in situ remediation technologies can be completed more sustainably than removal/ex situ processes. The MNA sub-alternatives rely on natural processes, which are viewed favorably by DER-31.

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8. DETAILED ANALYSIS OF ALTERNATIVES AND RECOMMENDATIONS

The purpose of this FS was to develop, screen, and evaluate potential Ras for the Admiral Cleaners site. Remedies were identified and screened in accordance with EPA and NYSDEC guidance. The comparison of alternatives and recommendations are described below and summarized in **Table 8-1**.

Seven alternatives were developed in this FS, as identified below:

- ***Alternative 1***—No Further Action
- ***Alternative 2—***No Further Action with Site Management
- ***Alternative 3***— High Temperature In Situ Thermal Remediation
- ***Alternative 4***—Enhanced Bioremediation with Cover System
- ***Alternative 5***—Soil Removal and Enhanced Bioremediation
- ***Alternative 6***—Low Temperature In Situ Thermal Remediation with Enhanced Bioremediation.
- ***Alternative 7***—In Situ Chemical Oxidation and Reduction.

8.1 COMPARISON OF ALTERNATIVES

The first two evaluation criteria are termed threshold criteria and must be satisfied for an alternative to be considered for selection. The remaining six primary balancing criteria are used to compare the positive and negative aspects of each of the remedial strategies.

8.1.1 Overall Protection of Public Health and the Environment

This criterion is an overall evaluation of each alternative’s ability to protect public health and the environment.

Alternative 1 does not fulfill this criterion since there is no action involved. Alternative 2 would offer some protection to public health with ICs but will not physically remove risk of exposure to contamination. Alternatives 3, 5, 6, and 7 fulfill this criterion by removing or treating contaminated media exceeding SCGs. Alternative 4 fulfills this criterion by treating contaminated groundwater exceeding SCGs, removing contaminated surface soils exceeding SCGs, and containing contaminated subsurface soil under a cover system.

8.1.2 Standards, Criteria, and Guidance

Compliance with SCGs addresses whether a remedy will meet environmental laws, regulations, and other standards and criteria.

Alternatives 1 and 2 will not fulfill this criterion. Alternatives 3, 5, 6, and 7 will fulfill this criterion by removing or treating contaminated media. Alternative 4 will fulfill this criterion by removing a portion of contaminated media, treating groundwater contamination, and containing contaminated media on-site under a cover system.

8.1.3 Long-Term Effectiveness and Permanence

This criterion evaluates the long-term effectiveness of the RAs after implementation. If fill or treated residuals remain on-site after the recommended remedy has been implemented, the following items are evaluated: (1) the magnitude of the remaining risks, (2) the adequacy of the engineering and/or ICs intended to limit the risk, and (3) the reliability of these controls.

Alternative 1 will not provide long-term effectiveness or permanence. Alternative 2 will not provide long-term effectiveness or permanence for addressing surface soil contamination. It has the potential to have long-term effectiveness and permanence to address groundwater contamination but only after further investigation and evaluation is performed, and the timeframe to achieve permanence may be impractical. Alternatives 3, 5 and 7 will fulfill this criterion for remediation of soil contamination in a short period of time; however, Alternative 5 and 7 will require further investigation to determine the timeframe of the groundwater contamination remediation. Alternatives 5 and 7 will have a longer timeframe of reaching SCGs than Alternative 3 and will require long-term groundwater monitoring to confirm effectiveness. Alternatives 4 and 6 will fulfill this criterion over a longer period of time than Alternatives 3, 5 and 7 for both soil and groundwater remediation, but will require monitoring to ensure long-term effectiveness.

Given that site COCs are present within low-permeability zones (e.g., on-site bedrock and overburden silts/clays), back diffusion of residual contamination from low-permeability zones to high-permeability zones is of concern. In situ treatment via bioremediation or chemical reduction is proposed in Alternatives 3 through 7 to mitigate back diffusion and guard against recontamination.

8.1.3.1 Long-Term Environmental Impacts

This criterion evaluates the long-term environmental impacts, following remedial construction activities. This includes greenhouse gas (GHG) emissions and landfill space occupied by RA-derived waste. While there are immediate impacts of direct GHG emissions to the area surrounding the site, long-term impacts of off-site and indirect GHG emissions goes beyond the duration of remedial construction when GHGs are compounded in the atmosphere, contributing to climate change. Both on-site and off-site emissions of GHGs are considered in this discussion.

Alternative 1 does not have any environmental impacts associated with remedial work.

Alternative 2 will have minimal environmental impacts as it will generate nominal waste via contaminated personal protective equipment (PPE) and groundwater sampling waste that will take up minimal landfill space.

Alternative 4 will generate a moderate amount of landfill waste in the form of excavated surface soil, contaminated PPE and sampling waste. Direct GHG emissions resulting from equipment use (e.g., DPT rig for injection, and earth-moving equipment), transportation and disposal of excavated soil, and delivery/installation of cover materials will occur on-site but will likely be less than on-site and off-site GHG emissions generated in Alternative 4. Surface soils will likely be disposed off-site as non-hazardous waste.

Alternative 5 will generate the most landfill-destined waste of all alternatives. All removed soil must be taken to an appropriate landfill, which will include a hazardous waste landfill. Transportation to a hazardous landfill will generate more off-site GHG emissions than disposal in a non-hazardous landfill as the round trip distance between the site and disposal facility will be greater. Additionally, direct and indirect GHG emissions will be generated through use and operation of earthmoving equipment, waste disposal transportation, and transportation of backfill materials.

Alternatives 3 and 6 have substantial long-term environmental impacts via their power demand. Alternative 6 has longer sustained electrical usage than Alternative 3 but demands less power. Alternative 3 will have a higher power demand for a shorter duration than Alternative 6. Both alternatives will generate significant indirect GHGs through electricity and power generation; manufacturing assembly, and of remedy components (e.g., treatment trailers, well materials). Alternatives 3 and 6 will generate a minimal amount of landfill waste during groundwater sampling and PPE. Alternative 3 will generate more long-term landfill waste due to the GAC filters used during groundwater treatment that may need to be disposed of as hazardous waste. Alternative 3 will also require metals contaminated soil be disposed of at non-hazardous facility.

Alternative 7 will have moderate amounts of landfill-destined waste compared to the other alternatives. The demolished concrete slab and excavated surface soil will be transported and disposed off-site, likely in a non-hazardous landfill. Waste generated from Alternative 7 will also take the form of PPE and sampling waste. It will also have on-site direct GHG emissions resulting from equipment use (e.g., DPT rig for injections and earth moving equipment), transportation and disposal of soil and concrete waste, and delivery/installation of restoration materials.

8.1.4 Reduction of Toxicity, Mobility, or Volume of Contamination

Preference is given to alternatives that permanently and significantly reduce the toxicity, mobility, or volume of contamination at the site.

Alternative 1 will not reduce toxicity, mobility, or volume of on-site contamination. No remedy is implemented in this alternative. Alternative 2 will not reduce toxicity, mobility, or volume of on-site surface soil contamination, but further investigation and evaluation will need to be performed to confirm the degree and rate of reduction for groundwater contamination. Alternative 5 will reduce toxicity and volume of contamination on-site through soil removal and in situ treatment of groundwater. Alternative 4 will reduce the toxicity and volume of the groundwater contamination through in situ treatment; reduce toxicity and mobility of surface soil metal contamination through mechanical removal and reduce mobility of subsurface soil contaminants through cover system. Alternatives 3 and 6 will reduce toxicity and volume of contamination on-site through in situ treatment of soil and groundwater. However, Alternatives 3 and 6 may temporarily increase the mobility of NAPL contamination as increasing temperature reduces viscosity of NAPLs. Alternative 7 will reduce the toxicity, volume, and mobility of soil and groundwater contamination through in situ treatment, and mechanical removal of surface soil contamination.

8.1.5 Short-Term Impacts and Effectiveness

This criterion evaluates the potential short-term adverse impacts of the remedial action upon the community, the workers, and the environment during the construction and/or implementation. The length of time needed to achieve the remedial objectives is also estimated and compared against the other alternatives.

Alternative 1 has no short-term impacts because no remedial action is proposed in this alternative.

Alternative 2 will have short-term impacts to site workers during groundwater sampling; risks can be minimized with site-specific health and safety controls, including the use of appropriate PPE.

Alternative 3 will have minimum short-term impacts to site workers during installation of remedial technology. Risks associated with these activities can be minimized with site-specific health and safety controls, including the use of appropriate PPE. A small amount of direct GHG emissions will be generated during remedy installation activities in the form of heavy machinery exhaust on-site.

Alternatives 4, 5, and 7 will have short-term impacts to the public and construction workers during excavation of site, through the generation of dust and possible exposure to volatizing COCs; these effects can be reduced through the implementation of standard dust mitigation construction practices and utilizing odor/vapor control measures. Workers can potentially be exposed to impacted media during excavation activities involved in Alternatives 4, 5, and 7. Risks can be minimized by implementing health and safety controls, including the use of appropriate PPE. Alternatives 4, 5, and 7 will have short-term impacts to the environment in the form of direct GHG emissions during transport of materials to and from the site and direct emissions from heavy equipment exhaust during excavation activities.

Alternatives 4 and 6 will have minimal short-term impacts to site workers during injections, well installation, and/or groundwater sampling. Risks associated with these activities can be minimized with site-specific health and safety controls, including the use of appropriate PPE. A smaller amount of direct GHG emissions than Alternatives 5 and 7 will be generated during remedy installation activities in the form of heavy machinery exhaust on-site.

8.1.6 Implementability

This criterion evaluates the technical and administrative feasibility of implementing each alternative.

All alternatives are generally implementable and have been used nationally. Alternatives 3, 5, and 7 pose challenges due to the proximity of residences, utilities, and other structures surrounding property. The need to maintain the structural integrity of neighboring residences/structures may limit the extent Alternatives 3, 5, and 7 can be implemented. Meaning, size of excavation area, treatment area, etc., may need to be reduced to prevent negative impacts to neighboring structures. Similarly, additional protective measures (e.g., shoring) may need to be employed for Alternatives 3, 5 and 7 to be effective, causing increases in total cost. Space constraints due to the size of the site will be a challenge for many alternatives including Alternatives 4, 5, and 7 due to the limited space for heavy machinery during large excavation activities. Space constraints will also be a concern for Alternatives 3 and 6 while installing required extraction wells, surface piping, and treatment system components.

8.1.7 Cost-Effectiveness

This criterion evaluates estimated capital costs, as well as annual operation, maintenance, and monitoring costs, on a present-worth basis.

Alternative 1 is the least expensive, but is also the least effective, as no remedial action would take place. Alternative 3 is the most expensive but also potentially the most effective at remediating groundwater and soil contamination at the same time. Alternatives 4 and 5 are also effective in remediating groundwater and soil and are less expensive than Alternatives 3, 6, and 7. Alternative 6 and 7 are the second and third most expensive, respectively, but would be effective in remediating groundwater. Alternative 2 is the second least expensive alternative but also the second least effective.

8.1.8 Land Use

Alternative 1 has no land use restrictions due to no actions being taken administratively or otherwise. Alternatives 2 and 4 will have land use restrictions such as deed restrictions (e.g., residential, commercial, or industrial use) or groundwater use restrictions since contamination in subsurface soil and groundwater will remain on-site. Alternatives 3, 5, 6 and 7 may be able to achieve unrestricted land use following remedial activities.

8.1.9 Community Acceptance

This criterion evaluates concerns of the community regarding the investigation and the evaluation of alternatives. The Admiral Cleaners site remedial approach has not been presented to the community for comment at this point.

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9. CLIMATE RESILIENCY AND GREEN REMEDIATION

9.1 CLIMATE CHANGE VULNERABILITY ASSESSMENT

Increases in both the severity and frequency of storms/weather events, an increase in sea level elevations along with accompanying flooding impacts, shifting precipitation patterns and wide temperature fluctuations, resulting from global climate change and instability, have the potential to significantly impact the performance, effectiveness, and protectiveness of a given site and associated remedial systems. A list of possible climate change sensitivity and vulnerabilities associated with remedial activities at sites in general, is presented in **Table 9-1.**

Vulnerability assessments provide information so that the site and associated remedial systems are prepared for the impacts of the increasing frequency and intensity of severe storms/weather events and associated flooding. The site is outside of the 100-year flood zone but would be impacted by increased precipitation. The site is currently not paved and increased precipitation would result in infiltration can also cause possible dilution of the contaminants in an area as they are mobilized and moved to other areas (Maco et al. 2018). The water table could be impacted by drought and could result in dry monitoring wells and additional monitoring wells would need to be installed. A further evaluation of the site's vulnerability is recommended in the design phase.

9.2 GREEN REMEDIATION EVALUATION

NYSDEC's DER-31 Green Remediation (NYSDEC 2011) requires that green remediation concepts and techniques be considered during all stages of the remedial program with the goal of improving the sustainability of the cleanup and summarizing the net environmental benefit of any implemented green technology. It is intended to be a holistic approach, which improves the sustainability of the cleanups by promoting the use of more sustainable practices and technologies. Such practices and technologies are, e.g., less disruptive to the environment, generate less waste, increase reuse and recycling, and emit fewer pollutants, including GHGs, to the atmosphere. Green remediation concepts may be considered in the selection of the remedial action and incorporated into the design phase. A list of best management practices and opportunities to employ green remediation strategies across all presented alternatives is provided below (American Society for Testing and Materials [ASTM] International 2014):

- Reuse of existing structures for in situ treatment:
  - Existing subsurface infrastructure installed during IRM No. 2 and monitoring wells may be utilized for further injections in Alternative 4.
- Use of recycled, reused, and/or regenerated products:
  - May utilize regenerated GAC in place of virgin GAC material in Alternative 3.
  - Use of recycled concrete material in place of virgin backfill materials.
  - Reuse/recycling of steel electrodes deployed for Alternative 3 at project completion.

  - Use of biodegradable and/or recycled seed matting if soil cover is installed.
  - Use of dedicated groundwater sampling equipment (e.g., tubing) that can be reused across multiple sampling events.
  - Recycle of non-usable/spent equipment/materials at completion of construction.
  - Use of recycled/refurbished 55-gallon drums to containerize investigative derived waste (i.e., purge water and soil cuttings).
- Use of on-site and/or local materials/services:
  - Could contract local paving company in the immediate vicinity of the site. A local paving contractor was utilized for IRM No. 2.
  - Use of local supplies for backfill and site restoration.
  - Use of local laboratory to reduce transportation/shipping impacts.
- Steam clean and/or use of biodegradable detergents for equipment decontamination:
  - This practice could be employed across all alternatives where there will be soil disturbance and sampling of environmental media.
- Selection of bioremediation oxidants/reagent with lower environmental impact
- Minimize land disturbance:
  - Co-location of electrodes and recovery wells for Alternative 3.
  - Limit excavation areas to areas supported by analytical results, no overcutting of excavation area beyond limits of analytical data.
- Use of DPT or sonic drilling to reduce generation of soil cuttings needing to be disposed off-site.
- Install erosion control measures to capture sediment runoff.
- Use of permeable materials for site cover to maximize infiltration.
- Discharge of condensate generated in Alternative 3 to publicly owned treatment works.
- Purchase of renewable energy credits/certificates to power and/or off set remedial activities.

- Implement engine idling reduction plan.

- Establish green requirements and tracking system during remedial action.

A comprehensive evaluation of green remediation strategies will be conducted after remedy selection.

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Tables

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Table 5-1. Technology Screening Matrix

Technology	Process Description	Effectiveness in Addressing RAOs	Implementability	Key Factors	Cost	Status
No Action						
No Action	NA	Ineffective	Easily implemented	NA	None	Retain per NCP
Institutional Controls/Engineer Controls						
Institutional Controls	Land use restrictions	Effective for human health risk RAOs associated with contact of groundwater.	Easily implemented	Requires regulatory and public acceptance of restricted/diminished resource use. To be combined with additional technology to limit future site use scenarios.	Low	Retain for potential combination with other technologies.
Cover System	Physically cover site to prevent contact with contaminated media	Effective for human health risk RAOs associated with contact of soil and groundwater. Ineffective in source control.	Easily implemented	Requires regulatory and public acceptance of restricted/diminished resource use. To be combined with additional technology to limit future site use scenarios.	Low	Retain for potential combination with other technologies; will not meet requirements for Unrestricted Use or Residential Use scenarios
Removal						
On-site Soil Excavation	Physical removal of impacted soil in the vadose zone.	Effective for human health risk RAOs associated with contact of site soil.	Moderately difficult	Requires regulatory and public acceptance of restricted/diminished resource use; Potential to remove soil in the vadose zone; Would potentially need excavation support that would accommodate the site's space limitations.	Moderate	Retain for potential combination with other technologies.
Physical NAPL Extraction	Physical extraction of NAPL using equipment such as a belt skimmer or sorbent pads placed in monitoring and extraction wells	Effective for removal of NAPL depending on geology of overburden soils. Would not be effective for remediation of dissolved CVOCs in groundwater.	Easily implemented	Potential to remove NAPL from groundwater; recovery may be slow due to silty clay soils.	Low	Retain for potential combination with other technologies
In situ Biological Treatment						
Enhanced Biodegradation	The activity of naturally occurring microbes is stimulated by introducing nutrients or other amendments, into contaminated groundwater to enhance in situ biological degradation of organic contaminants.	Effective for risk based RAOs and source control. Effective at similar sites.	Small scale bioremediation was implemented as a Pilot Test during IRM No. 2; Multiple injection locations will need to be assessed for larger application. Treatability data is currently being collected. There is evidence of biodegradation in some areas of the site, though it is not consistent.	Pilot Test as part of Interim Remedial Measure No. 2 currently being conducted for treatability testing; Will require additional microbial/groundwater geochemistry assessment; Would potentially require multiple injections/amendments.	Low to Moderate	Retain for potential combination with other technologies.
Natural Attenuation	Natural subsurface processes - such as dilution, volatilization, biodegradation, adsorption, and chemical reactions with subsurface materials – are allowed to reduce contaminant concentrations to levels that do not exceed NYSDEC guidance.	Ineffective in short-term but potentially effective in the long-term, dependent on addressing the source.	Easily Implemented	Source reduction prior to implementation; Would require other technologies to be successful.	Low	Retain for potential combination with other technologies.

Technology	Process Description	Effectiveness in Addressing RAOs	Implementability	Key Factors	Cost	Status
Containment						
Slurry Wall	Subsurface barriers consist of vertically excavated trenches filled with slurry. The slurry, usually a mixture of bentonite and water, hydraulically shores the trench to prevent collapse and retards ground water flow.	Effectively addresses migration of onsite impacted water. Additionally, may not be effective in bedrock groundwater.	Potentially easy to implement to confine overburden groundwater migration given shallow depth to bedrock; however, difficult to implement in bedrock.	Will not address reduction of contaminant mass and would require long-term groundwater monitoring. Without additional technology will limit use of site.	High	Not Retained
Groundwater Pump and Treat	Ground water is pumped from wells within the contaminated zone to an above-grade treatment system prior to discharge. Pump and treat are one of the most used groundwater remediation technologies at contaminated sites.	Effective for risk based RAOs and partially effective for source control.	Easily implemented. Groundwater extraction wells would be required to be installed.	High capital investment and high long term treatment system operation cost; Insufficient overburden groundwater flow rate.	High	Not Retained
Passive/Reactive Treatment Walls	These barriers allow the passage of water while prohibiting the movement of contaminants by employing such agents as chelators (ligands selected for their specificity for a given metal), sorbents, microbes, and others.	Effectively addresses migration of onsite impacted water, however, is not effective for source reduction.	Difficult to implement due to the depth of the confining unit and impacted bedrock.	Will not address reduction of contaminant mass and would require long-term groundwater monitoring.	Moderate	Not Retained
In situ Physical/Chemical Treatment						
In Situ Chemical Oxidation Injection	Injection of oxidizing agent to break down COCs.	Effective for risk based RAOs and source control.	Easily implemented. Groundwater injection can be performed using temporary points or permanent wells.	Would be unable to implement in bedrock due to presence of pyrite and other minerals in fractures. Reviewed FS and pilot tests from other nearby site with similar COCs and bedrock geology. At these sites, oxidizing agents caused clogging of pore spaces in aquifer due to precipitation of minerals. Potentially feasible for treatment of overburden. Requires treatability testing and baseline groundwater geochemistry assessment. Distribution of product through injection expected to be limited due to fine-grained soils. Expected to require multiple injections/amendments.	Moderate	Retained for combination with other technologies.
In Situ Chemical Oxidation through Soil Mixing	Mixing of soil with oxidizing agent to break down COCs and NAPL.	Effective for risk based RAOs in overburden soil and source control.	Moderately difficult to implement due to space constraints.	Effective for overburden soil, NAPL, and overburden groundwater; however, would not be effective to treat bedrock groundwater due to pyrite that is present in bedrock fractures. Would require multiple applications to achieve remediation goals. Requires treatability testing and baseline groundwater geochemistry assessment.	Moderate to High	Retain for potential combination with other technologies.
Activated Carbon-Based Remedial Technology	Injection of liquid activated carbon to sorb dissolved phase COCs, often combined with hydrogen release compound and microbial component to maximize contact of contaminants with treatment media.	Effective for risk based RAOs and downgradient migration control.	Easily implemented. Groundwater injection can be performed using temporary points or permanent wells. Wells would need to be installed in bedrock.	Injection points may need to be tightly spaced for adequate coverage. Fine grained soils and fractured bedrock will likely limit radius of influence. Will not be effective remediating high concentrations of COCs and/or NAPL. Most effective in treating dissolved plume.	Moderate	Retain for potential combination with other technologies.
In Situ Chemical Reduction through Injections	Reductant such as zero valent iron is injected into the subsurface to promote degradation of COCs through reductive dechlorination.	Effective for risk based RAOs in overburden soils and shallow bedrock.	Easily implemented. Groundwater injection can be performed with temporary points or permanent wells. Wells would need to be installed to inject into bedrock.	Effective for dissolved contaminants in overburden and bedrock groundwater. Injection points would need to be tightly spaced for adequate coverage due to fine grained soils and limited radius of influence in fractured bedrock.	Moderate	Retain for potential combination with other technologies

Technology	Process Description	Effectiveness in Addressing RAOs	Implementability	Key Factors	Cost	Status
Ozone Injections	Ozone is injected into the subsurface to break down COCs through oxidation.	Effective for risk based RAOs and source control.	Easily implementable with minor construction.	System design (wells/conveyance/system components) must account for corrosive nature of ozone in the process stream. Would require an intensive monitoring program to ensure no side effects of ozone outside the target treatment area. Could negatively impact utilities in close proximity to treatment area.	Moderate to High	Not Retained
Thermal	The application of heat to the soil and groundwater to destroy or volatize the organic contaminants. As the contaminants change into gases they can be captured and contained for ex situ treatment.	Effective for risk based RAOs and source control.	Easily implementable with minor construction; Would require ex situ treatment/containment of contaminants.	Extremely rapid form of remediation; Would address LNAPL and DNAPL product in soil, as well as overburden and bedrock groundwater; Nearby properties and utilities require protection from heat.	High	Retained

Notes:
COC = Contaminant of concern
DNAPL = Dense non-aqueous phase liquid
FS = Feasibility study
IRM = Interim remedial measure
LNAPL – Light non-aqueous phase liquid
NA = Not applicable
NAPL = Non-aqueous phase liquid
NCP = National Contingency Plan
No. = Number
NYSDEC = New York State Department of Environmental Conservation
RAO = Remedial action objective

Table 6-1. Alternatives Summary

Soil and Groundwater							
	Alternative 1	**Alternative 2**	**Alternative 3**	**Alternative 4**	**Alternative 5**	**Alternative 6**	**Alternative 7**
	No Further Action	**No Further Action with Site Management**	**High Temperature In Situ Thermal Remediation**	**Enhanced Bioremediation with Soil Cover System**	**Soil Removal and Enhanced Bioremediation**	**Low Temperature In Situ Thermal Remediation with Enhanced Bioremediation**	**In situ Chemical Oxidation and Reduction**
Size and Configuration of Process Options	No further action.	Long-term monitoring and periodic sampling of site groundwater for VOCs. Regular long-term monitoring of the site will track changes in contaminant migration off-site.	Surface soil down to 2 ft bgs impacted with mercury would be removed from the site for off-site disposal. Heating of the subsurface soil would increase mercury's viscosity, causing descent further into the subsurface soil. Clean common fill from an off-site source would be used to return the shallow excavation area to surrounding grades. Existing monitoring wells on-site would be decommissioned and replaced with new stainless steel piping and screen. Treatment wells and co-located vertical extraction wells would be installed within the contamination zone down to a maximum depth of 15 ft. bgs. Power sufficient for system operation would be installed at the site. A trailer mounted treatment system including blower, GAC treatment vessels, piping and all required controls would be delivered and installed on-site. A vapor barrier would be placed over the injection/extraction well fields. Verification sampling during remediation would consist of groundwater and soil sampling. System equipment would be demobilized on-site after remediation and treatment wells decommissioned. An enhanced bio remediation amendment would be injected into the newly installed replacement wells and in the subsurface via DPT in areas as needed to guard against back diffusion from the fractured bedrock. Groundwater samples would be collected from 8 monitoring wells annually for the first 2 years and annually thereafter.	Approximately 32 injection points would be install onsite with a 12 ft spacing. DPT would be used to apply injectate in the contaminated zone from 5 ft. bgs to bedrock/refusal. A cover system would be installed over the site to prevent migration or contact with contaminated soil. A cover system consisting of clean fill and other materials would be put in place over the site's surface soil. Groundwater samples would be collected from 8 monitoring wells quarterly for the first 2 years and annually thereafter to measure the concentration of VOCs and evaluate effectiveness of the treatment.	Approximately 1,680 cy of soil and weathered bedrock would be excavated and disposed of off-site. Samples would be collected to document if cleanup goals are met prior to backfilling the excavation. Injection piping would be installed and CarBstrate would be injected in to the subsurface to treat the contaminated groundwater. The excavated area would be backfilled with granular material below the water table, common backfill above to water table and 6 inches of topsoil to the surrounding grade. Approximately 1,680 cy of clean fill would need to be transported to the site. Groundwater samples would be collected from 8 monitoring wells quarterly for the first year and annually thereafter to measure VOC concentrations and evaluate effectiveness of treatment.	Low temperature in situ thermal remediation with enhanced bioremediation would be implemented. DPT would be used to apply injectate in the contaminated zone from 5 ft. bgs to bedrock/refusal. Treatment wells would be installed within the contaminated zone down to a maximum depth of 15 ft. bgs in a 15 ft. grid. Power sufficient for system operation would be installed at the site. Small power control unit would be delivered and installed onsite. Verification sampling would consist of groundwater and soil sampling via soil borings for VOC analysis. Four rounds of verification sampling would be conducted. Following completion of remediation, equipment would be demobilized from the site and treatment wells would be decommissioned.	ISCO and ISCR would be used in situ to treat soil and groundwater contamination. Site surface soil contamination would be excavated and disposed off-site. ISCO treatments would be applied using soil mixing to an approximate depth of 8 ft bgs. ISCO substrate would also be applied through DPT in off-site areas and in areas adjacent to 621 19th Street building. It is assumed two treatments of ISCO will be needed. Deeper contamination in soil and groundwater from approximately 8 ft bgs to 15 ft bgs will be treated with ISCR injections using DPT. The area of soil mixing will require stabilization with Portland cement, and the area will be restored to have positive site drainage. Groundwater samples would be collected from 8 monitoring wells quarterly for the first 2 years and annually thereafter to measure VOC concentration and evaluate effectiveness of the remediation.
Time for Remediation	NA	NA	12 months	3 months	8 months	24 months	24 months
Spatial Requirements	NA	Sitewide	Sitewide	Sitewide	Sitewide (with the addition of some soil removal to the west of the site)	Sitewide	Sitewide
Options for Disposal	NA	NA	Minimal amount of landfill waste from groundwater sampling and contaminated PPE. Approximately 100 cy of surface soil will also need to be disposed of in an appropriate landfill.	Generation of minimal landfill waste from groundwater sampling and contaminated PPE.	All removed soil must be taken to an appropriate landfill which will include hazardous and non hazardous waste landfills. PPE waste will be generate but at a minimal amount.	Minimal amount of landfill waste generated during groundwater sampling and PPE.	Soil from surface soil excavation will need to be disposed of at an appropriate landfill. Additionally, concrete slab materials and soils required to be removed to accommodate stabilization with Portland cement will be disposed off-site. Additional waste streams include PPE and waste from groundwater sampling.
Substantive Technical Permit Requirements	NA	Property surveys and approval by property owners are required for monitoring. Where approval cannot be obtained, NYSDEC may employ environmental notices.	Property surveys and approval by property owners are required for monitoring. Where approval cannot be obtained, NYSDEC may employ environmental notices. A permit will be needed for the treated air discharge from the treatment system.	Property surveys and approval by property owners are required for monitoring. Where approval cannot be obtained, NYSDEC may employ environmental notices.	Access agreements and associated permits needed for soil removal. Property surveys and approval by property owners are required for monitoring. Where approval cannot be obtained, NYSDEC may employ environmental notices.	Property surveys and approval by property owners are required for monitoring. Where approval cannot be obtained, NYSDEC may employ environmental notices. A permit will be needed for the treated air discharge from the treatment system.	Property surveys and approval by property owners are required for monitoring. Where approval cannot be obtained, NYSDEC may employ environmental notices.
Limitations or Other Factors Necessary to Evaluate Alternatives	NA	None	Special considerations to protect surrounding buildings and utilities include and offset of 5 ft or the installation of cold-water injection points between wells and the structures or utilities of concern. Appropriate spacing could be maintained to prevent impacts to the building to the west of the site or nearby utilities in the sidewalk south or the road to the east.	Additional PDI would need to be conducted to confirm that this alternative will be effective in remediating the contaminated soil and groundwater in a practical time frame.	Additional PDI would need to be conducted to confirm that this alternative will be effective in remediating the contaminated soil and groundwater in a practical time frame. Adjacent properties and structures limit the extent of excavation practicable and therefore may not be able to remove all contaminated soil.	Additional PDI would need to be conducted to confirm that this alternative will be effective in remediating the contaminated soil and groundwater in a practical time frame. Availability and cost of electrical demand needs to be further evaluated at the site.	Additional PDI would need to be conducted to confirm that this alternative will be effective in remediating the contaminated soil and groundwater in a practical time frame. Utility locator brought to adjacent properties to the west to locate known underground utilities or other obstructions that prove problematic during injection activities Additional structural evaluation would need to be conducted to prevent impacts to adjacent properties. Structures to the immediate west of the site may bound the extent of the remedy.
Public Impacts	NA	Will offer some protection to public health with ICs, but will not physically remove risk of exposure to contamination.	Treatment may impact nearby utilities if not properly protected. Noise during installation and treatment may become a nuisance if not properly monitored and accounted for.	Minimal short-term impacts to site workers during injections, well installation and/or groundwater sampling.	Short-term impacts to the public and construction workers during excavation of site, through the production of dust, noise and potential volatilized COC exposure. Workers can potentially be exposed to impacted media during excavation activities involved. These effects can be reduced through the implementation of standard dust and vapor mitigation construction practices, and through workers utilizing appropriate PPE.	Minimal short-term impacts to site workers during injections, well installation and/or groundwater sampling. Treatment may impact nearby utilities if not properly protected. Noise during installation and treatment may become a nuisance if not properly monitored and accounted for.	Short-term impacts to the public and construction workers during excavation of site, through the production of dust, noise and potential volatilized COC exposure. Workers can potentially be exposed to impacted media during excavation activities involved. These effects can be reduced through the implementation of standard dust and vapor mitigation construction practices, and through workers utilizing appropriate PPE.
Beneficial and/or Adverse Impacts on Fish and Wildlife Resources	No impacts associated with remedial work.	No impacts associated with remedial work.	No impacts associated with remedial work.	No impacts associated with remedial work.	No impacts associated with remedial work.	No impacts associated with remedial work.	No impacts associated with remedial work.
Net Present Worth	$0.00	$385,300	$4,265,200	$1,337,600	$3,322,500	$3,619,300	$3,419,800

Notes:
bgs = Below ground surface
cy = Cubic yard
DPT = Direct push technologies
ft = Foot (feet)
GAC = Granular activated carbon
LTM = Long term monitoring
MNA = Monitored natural attenuation
NA = Not applicable
NYSDEC = New York State Department of Environmental Conservation
PDI = Predesign investigation
PPE = Personal protective equipment
PRB = Passive reactive barrier
SCG = Standard, criteria, and guidance
VOC = Volatile organic compound

Table 7-1. Alternatives Cost Summary

Alternative	Description	Capital Cost	Construction Time (months)	Annual Costs	Total Cost with Contingency (Capital + LTM)
1	No Further Action	$ -	0	$0/$0	$ -
2	No Further Action with Site Management	$ 18,000	0	Yrs 1-30: $13,109	$ 385,300
3	High Temperature In Situ Thermal Remediation	$ 3,645,700	12	Yrs 1-2: $62,762 Yrs 3-30: $15,879	$ 4,265,200
4	Enhanced Bioremediation with Cover Sytem	$ 718,100	3	Yrs 1-2: $62,762 Yrs 3-30: $15,879	$ 1,337,600
5	Soil Removal and Enhanced Bioremediation	$ 2,703,000	8	Yrs 1-2: $62,762 Yrs 3-30: $15,879	$ 3,322,500
6	Low Temperature In Situ Thermal Remediation with Enhanced Bioremediation	$ 2,999,800	24	Yrs 1-2: $62,762 Yrs 3-30: $15,879	$ 3,619,300
7	In Situ Chemical Oxidation and Reduction	$ 2,800,300	24	Yrs 1-2: $62,762 Yrs 3-30: $15,879	$ 3,419,800

Notes:
LTM = Long-term monitoring
Yrs = Years

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Table 8-1. Alternatives Evaluation Summary

Overburden Groundwater and Subsurface Soil							
	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7
	No Further Action	No Further Action with Site Management	High Temperature In Situ Thermal Remediation	Enhanced Bioremediation with Soil Cover System	Soil Removal and Enhanced Bioremediation	Low Temperature In Situ Thermal Remediation with Enhanced Bioremediation	In Situ Chemical Oxidation and Reduction
(1) Overall Protection of the Public Health and the Environment							
	There is no reduction of risk with this alternative. The exposure pathways would continue to pose unacceptable risk to all receptors.	Would offer some protection to public health with ICs but will not physically remove risk of exposure to contamination	Reduces potential for human and ecological contact and migration of contaminants through complete removal of contaminates in exceedances of SCGs in soil and groundwater via in situ thermal remediation.	The potential for an exposure pathway via surface contact is eliminated via cap above the consolidated material. Would protect from potential exposure to contaminated groundwater by permanently destroying the site contaminants by enhanced bioremediation in high concentration groundwater areas. Groundwater monitoring is included.	Reduces potential for contact and migration of contaminants through removal of contaminated soil exceeding UU SCOs from the site to the extent practicable. Groundwater contamination would be remediated by in situ enhanced bioremediation.	Protective of groundwater and soil by permanently destroy the site contaminants by enhanced bioremediation in high concentration groundwater areas. Groundwater monitoring is included. Exposure to groundwater is prevented by institutional controls until SCGs are met.	Reduces potential for human and ecological contact and migration of contaminants through removal and treatment of soil and groundwater.
(2) Standards, Criteria and Guidance							
	Does not meet SCG criterion.	Does not meet SCG criterion.	Anticipated meet UU SCOs for on-site soil and groundwater SCGs.	Will meet SCGs for soil through containment. Will meet groundwater SCGs over time; may require additional treatment, to be determined through long-term monitoring.	Anticipated to meet UU SCOs for soil and groundwater SCGs after treatment.	Will meet UU SCOs for on-site surface soil through removal. Anticipated to meet SCGs for groundwater and saturated soil over time.	Will meet UU SCOs for on-site surface soil through removal. Anticipated to meet Residential SCOs in subsurface soil through treatment. Will meet groundwater SCGs over time through treatment.
(3) Long-Term Effectiveness and Permanence							
Effective as long-term remediation	This alternative will not provide long-term effectiveness or permanence. This alternative offers no controls.	Will be least effective as it does not involve removal, immobilization or containment of impacted materials.	Will permanently remove contaminants from soil and groundwater. Will effectively reduce exposure and prevent transport. Small risk of back diffusion from the fractured bedrock network that will be treated with enhanced bioremediation following thermal remediation. Effectiveness to be monitored via periodic groundwater sampling during and following implementation.	Will effectively reduce exposure and prevent contaminant transport. Effectiveness to be monitored via long-term inspection of cap condition, as well as groundwater sampling during and following implementation.	Will permanently remove contaminants from soil and groundwater. Will effectively address exposure and prevent transport. Small risk of back diffusion from the fractured bedrock network that will be treated with enhanced bioremediation. Effectiveness to be monitored via periodic groundwater sampling during and following implementation.	Will effectively reduce exposure and prevent transport. Effectiveness to be monitored via long-term sampling of groundwater during and following implementation.	Will effectively reduce exposure and prevent transport. Effectiveness to be monitored via long-term sampling of groundwater during and following implementation.
Long-term Environmental Impacts	No Long-term Environmental impacts.		Contaminated PPE will be generated and will take up minimal landfill space. GHG emissions will be generated by heavy machinery and transport vehicles. This alternative will have a high power demand.	Contaminated PPE will be generated and will take up minimal landfill space. GHG emissions will be generated by heavy machinery and transport vehicles.	Contaminated soil and PPE will be generated as a waste and will take up landfill space (hazardous and non-hazardous). GHG emissions will be generated by heavy machinery and transport vehicles.	This alternative will have a high power demand over a period of a few years. GHG emissions will be generated by heavy machinery and transport vehicles.	Contaminated soil and PPE will be generated as a waste and will take up landfill space, though less than other alternatives. GHG emissions will be generated by heavy machinery and transport vehicles.
(4) Reduction of Toxicity, Mobility, or Volume of Contamination							
Amount of Hazardous Materials Destroyed, Treated, or Removed	None	None	Alternative will result in permanent removal of hazardous materials on-site via in situ treatment of groundwater and soil. Treatment will be permanent.	Alternative will result in permanent reduction in volume, toxicity, and mobility of contaminants through in situ treatment for groundwater in high concentration areas. Treatment of groundwater will be permanent and will remove contaminants from groundwater.	Hazardous materials would be removed and disposed of at a permitted facility. Soil exceeding UU SCOs will be removed under this alternative.	Alternative will result in permanent reduction in volume, toxicity, and mobility of contaminants through in situ treatment for groundwater in high concentration areas. Treatment of groundwater will be permanent.	Alternative will result in permanent reduction in volume, toxicity, and mobility of contaminants through physical removal and in situ treatment for groundwater in high concentration areas. Treatment of groundwater will be permanent.
Degree of Expected Reductions in Toxicity, Mobility, or Volume	None	Volume and toxicity may be reduced over time due to natural degradation, which would be monitored over time.	Will reduce the toxicity, volume and mobility of contamination via in situ treatment of soil and groundwater simultaneously. Bioremediation would reduce the toxicity, volume and mobility of contamination that may be mobilized due to backdiffusion.	Will reduce the toxicity and volume of contamination via in situ treatment of groundwater.	Will reduce the toxicity, volume and mobility of contamination via soil removal and disposal in permitted facilities that use measures to reduce or eliminate the risk of toxic mobility. Bioremediation would reduce the toxicity, volume and mobility of contamination of the overburden groundwater.	Will reduce the toxicity and volume of contamination via in situ treatment of groundwater.	Will reduce the toxicity, volume and mobility of contamination via soil removal and disposal in permitted facilities that use measures to reduce or eliminate the risk of toxic mobility. ISCO/ISCR would reduce the toxicity, volume and mobility of contamination of the overburden soil groundwater.
Irreversible Treatment?	Not applicable	No	Yes	Yes	Yes	Yes	Yes
Residuals Remaining After Treatment?	Yes	No in situ treatment applied to subsurface soil or groundwater.	No soil above UU SCOs on-site or contaminated perched groundwater will remain on-site, there is the possibility of recontamination from back diffusion from the fracture bedrock network, enhanced bioremediation injections are included to address this concern. Groundwater monitoring is included to evaluate the reduction.	The remainder of the plume would reduce in volume and toxicity in groundwater over time due to natural attenuation. Groundwater monitoring is included to evaluate the reduction.	No soil above UU SCOs on-site will remain on-site after treatment. The remainder of the overburden plume would reduce in volume and toxicity in groundwater over time due to enhanced biological degradation. Groundwater monitoring is included to evaluate the reduction.	The remainder of the plume would reduce in volume and toxicity in groundwater over time due to natural attenuation. Groundwater monitoring is included to evaluate the reduction.	No surface soil above UU SCOs would remain on-site. The groundwater plume and subsurface soils would reduce volume and toxicity over time through oxidation and reduction mechanisms. Groundwater monitoring is included to evaluate the reduction.

Table 8-1. Alternatives Evaluation Summary

Overburden Groundwater and Subsurface Soil							
	Alternative 1	**Alternative 2**	**Alternative 3**	**Alternative 4**	**Alternative 5**	**Alternative 6**	**Alternative 7**
	No Further Action	**No Further Action with Site Management**	**High Temperature In Situ Thermal Remediation**	**Enhanced Bioremediation with Soil Cover System**	**Soil Removal and Enhanced Bioremediation**	**Low Temperature In Situ Thermal Remediation with Enhanced Bioremediation**	**In Situ Chemical Oxidation and Reduction**
(5) Short-Term Impact and Effectiveness							
Community Protection	There is no action; and therefore, no additional risk to the community.	No short-term impact to community; not effective in short-term.	Increased short-term risks to the public during treatment system installation activities. These risks can be reduced with site specific health and safety controls.	There is limited potential exposure to contamination during injection, well installation, or sampling to the community. Cover system would ensure no exposure of soil to community.	Increased short-term risks to the public during excavation activities and transport of equipment and materials to and from site. Dust/residuals will be produced during excavation activities. These can be mitigated through standard construction practices and site-specific HASP and CAMP.	There is limited potential exposure to contamination during injection, well installation, or sampling to the community.	Increased short-term risks to the public during excavation and soil mixing activities and transport of equipment and materials to and from site. Dust/residuals will be produced during intrusive activities. These can be mitigated through standard construction practices and site-specific HASP and CAMP.
Worker Protection	There is no action; and therefore, no workers will be present on site.	There is limited potential exposure of workers to contamination during well installation (if needed) and groundwater sampling. These risks can be minimized with site specific health and safety controls, including the use of appropriate PPE.	Workers can potentially be exposed to contaminated media during installation of treatment system and groundwater monitoring. Work around heavy equipment carries potential risk for workers. These risks can be minimized with site specific health and safety controls, including the use of appropriate PPE.	Workers can potentially be exposed to contaminated media during injections and groundwater monitoring. Work around heavy equipment carries potential risk for workers. These risks can be minimized with site specific health and safety controls, including the use of appropriate PPE.	Workers can potentially be exposed to contaminated media during excavation and mixing activities. Work around heavy equipment carries potential risk for workers. These risks can be minimized with site specific health and safety controls, including the use of appropriate PPE.	Workers can potentially be exposed to contaminated media during installation of treatment system and groundwater monitoring. Work around heavy equipment carries potential risk to workers. These risks can be minimized with site specific health and safety controls, including the use of appropriate PPE.	Workers can potentially be exposed to contaminated media during excavation and mixing activities. Work around heavy equipment carries potential risk for workers. These risks can be minimized with site specific health and safety controls, including the use of appropriate PPE.
Short-term Environmental Impacts	There are no short-term impacts associated with this alternative.	There are no short-term impacts associated with this alternative.	This alternative will require a high power demand for less than a year. A small amount of uncontaminated water will also be generated and added to the city's sewer system. Heavy machinery and transport vehicles will generate exhaust during construction activities.	Heavy machinery and transport vehicles will generate exhaust during construction activities.	Heavy machinery and transport vehicles will generate exhaust during construction activities.	Heavy machinery and transport vehicles will generate exhaust during system installation and removal activities.	Heavy machinery and transport vehicles will generate exhaust during construction activities.
Estimate Time Until Action Complete (Field Construction Time)	No action taken	No construction activities	12 months	3 months	8 months	24 months	24 months
(6) Implementability							
Ability to Construct and Operate	Not applicable	Alternative requires no remedial action. No construction or operation required.	Thermal technology can be implemented and has been used nationally. Able to be implemented with specialty contractor and appropriate equipment.	Cover system can be implemented and has been used nationally. Material for cover system is readily available. Treatment chemicals for groundwater are commercially available. Able to be implemented with specialty contractor and appropriate equipment.	Excavation and disposal alternatives can be implemented and have been used nationally. Treatment chemicals for groundwater are commercially available. Construction challenges will be in form of limited working space on-site and proximity to surrounding properties.	Thermal technology can be implemented and has been used nationally. Able to be implemented with specialty contractor and appropriate equipment. Treatment chemicals for groundwater are commercially available.	Excavation and soil mixing alternatives are implemented and used nationally. The ISCO/ISCR treatment chemicals are commercially available. Construction challenges will be in form of limited working space on-site and proximity to surrounding properties.
Monitoring Requirements	Not applicable	Regular groundwater monitoring would be required. Institutional Controls would need to be verified periodically.	Temperature and pressure monitoring to track subsurface heating, pneumatic, and hydraulic control by specialty contractor. Vapor and liquid treatment system monitoring for mass removal and discharge compliance by specialty contractor. Groundwater will be periodically sampled and analyzed to monitor effectiveness of the remedy.	Initial evaluation of MNA parameters is recommended. Groundwater will be periodically sampled and analyzed to monitor effectiveness of the remedy. Cover system must be inspected periodically.	Initial evaluation of MNA parameters is recommended. Soil shall be sampled and analyzed to confirm removal of impacted area. Groundwater will be periodically sampled and analyzed to monitor effectiveness of the remedy.	Initial evaluation of MNA parameters is recommended. Temperature and pressure monitoring to track subsurface heating, pneumatic, and hydraulic control by specialty contractor. Vapor and liquid treatment system monitoring for mass removal and discharge compliance by specialty contractor. Groundwater will be periodically sampled and analyzed to monitor effectiveness of the remedy.	Initial evaluation of geochemical parameters and soil oxygen demand. Initial groundwater monitoring for pre-construction conditions is recommended. Soil shall be sampled and analyzed to confirm removal of impacted area. Groundwater samples would be collected from monitoring wells to measure effectiveness of treatment.
Availability of Equipment and Specialists	Not applicable	Not applicable	Equipment and specialists are available for the implementation of all of these technologies.				
Ability to Obtain Approvals and Coordinate with Other Agencies	Not applicable	Not applicable	Ability to obtain approvals and coordinate with other agencies assumed to be possible.				

Table 8-1. Alternatives Evaluation Summary

Overburden Groundwater and Subsurface Soil							
	Alternative 1	**Alternative 2**	**Alternative 3**	**Alternative 4**	**Alternative 5**	**Alternative 6**	**Alternative 7**
	No Further Action	**No Further Action with Site Management**	**High Temperature In Situ Thermal Remediation**	**Enhanced Bioremediation with Soil Cover System**	**Soil Removal and Enhanced Bioremediation**	**Low Temperature In Situ Thermal Remediation with Enhanced Bioremediation**	**In Situ Chemical Oxidation and Reduction**
(7) Cost Effectiveness							
Cost	**$0**	**$385,300**	**$4,265,200**	**$1,337,600**	**$3,322,500**	**$3,619,300**	**$3,419,800**
(8) Land Use							
	Not applicable	Restricted	Unrestricted	Restricted	Unrestricted	Restricted	Restricted
(9) Community Acceptance							
	TBD						

Notes:
ARARs = Applicable or Relevant and Appropriate Requirements
CAMP = Community Air Monitoring Plan
GHG = Greenhouse gas
HASP = Health and Safety Plan
ISCO = In situ chemical oxidation
ISCR = In situ chemical reduction
MNA = Monitored natural attenuation
PPE = Personal protective equipment
ppm = Part(s) per million
PRB = Passive reactive barrier
SCG = Standard, criteria, and guidance
SCO = Soil Cleanup objective
TBD = To be determined
UU = Unrestricted use

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Table 9-1. Possible Climate Change Impacts on Remediation

Climate Impact	Secondary Effect	Relevant remediation effect
Altered precipitation pattern	Wetter: Flooding, storms, more runoff	• Mobilization of contaminants (e.g., from vadose zone to groundwater) → Higher contaminant concentration/export, overpowering significant degradation rate in groundwater zone could remove natural protective barriers or cause infill subsidence in low-lying areas
		• Dilution → Lower contaminant concentration/export
		• Damage to capping systems
	Drier: Drought	• Oxidation of soils
		• Increased volatility
		• Less dilution → Higher contaminant concentration/export
		• Reduced mobilization → Higher contaminant persistence (higher contaminant concentration/export)
		• Insufficient water for remediation; Overuse of groundwater
		• Possible enhanced natural attenuation, expedited contaminant removal
	Altered salinity	• Altered degradation rates (physical, microbial)
Extreme weather	Scour (wind/wave action; surface water flow velocity)	• Damage to site integrity, capping systems
	Flooding	• Possible dilution (lower contaminant concentration/export), or compromised site with mixing or loss of contaminated materials, damage to capping systems
	Extreme heat	• Increased volatility → Mobilization of contaminants from site through soil and air
		• Changes in use of site by wildlife
		• Melting permafrost → Mobilization of contaminants from site through water, soil, and air
	Freezing conditions	• Damage to capping systems and in situ stabilization systems
Extreme weather: Fire	Increased use of fire retardants	• Spread of contaminants
	Damage to site infrastructure	• Loss of function of remediation systems
Decreasing pH		• Increased availability, mobilization, toxicity
		• Increased sensitivity of species due to pH stress
		• Altered transformation rates
Increasing temperature	Altered transformation or degradation	• Increased or decreased toxicity
	Decreased dissolved oxygen/anoxic conditions	• Altered transformation, decreased species resilience
	Increased species heat stress and associated conditions	• Increased sensitivity to contaminants
Human impact and responses	Vulnerable communities commonly comprised of low socioeconomic and minority populations	• Cardiopulmonary illness; Food, water, and vector-borne diseases • Loss of homes, drinking water, and livelihoods; Mental health consequences and stress
Source: Maco et al. 2018.		

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Figures

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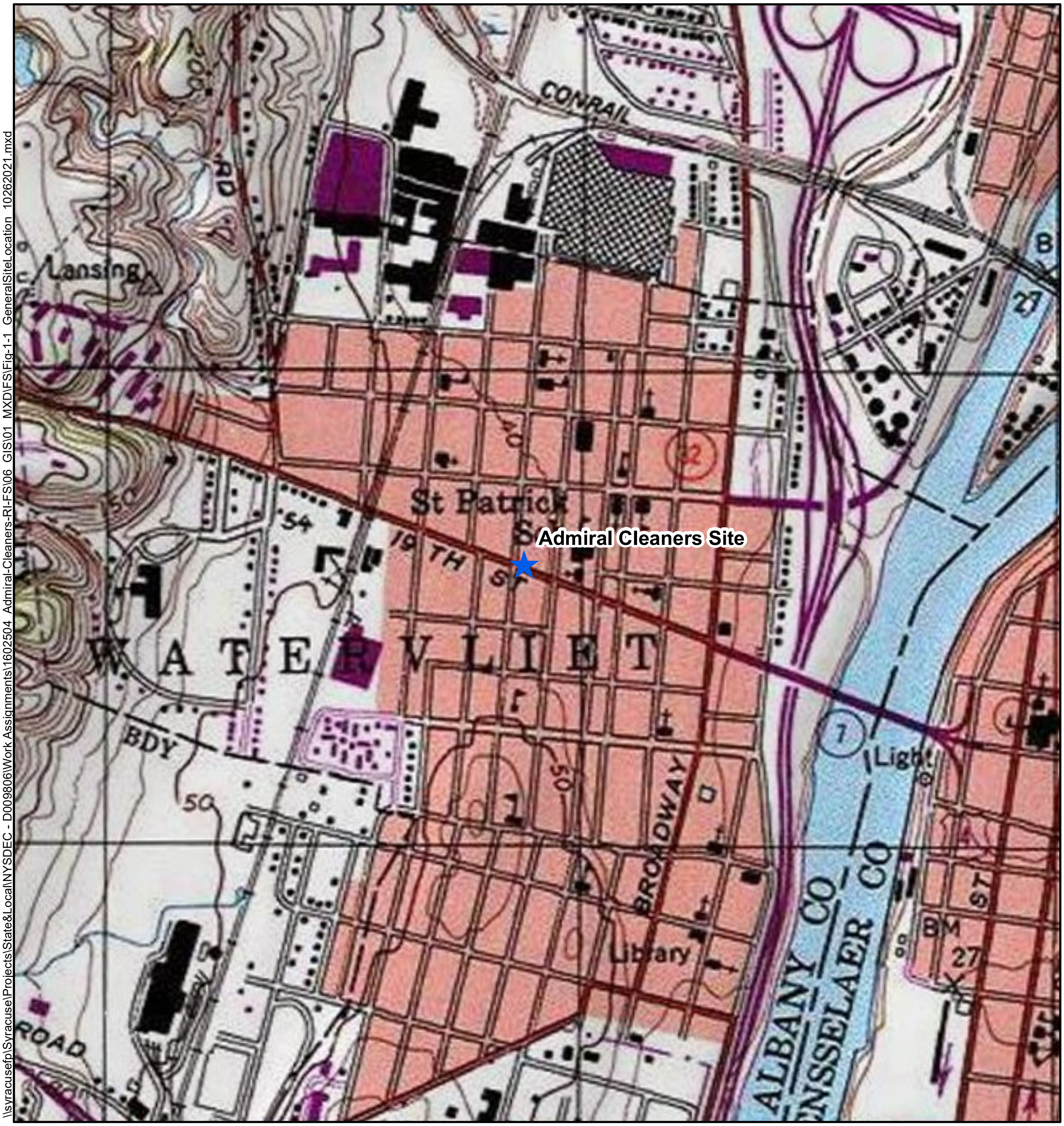

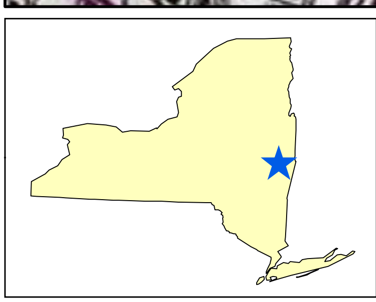

Legend

★ Site Location

0 500 1,000
Feet

N

Figure 1-1
General Site Location
Feasibility Study Report
Admiral Cleaners
Watervliet, NY

Map Date: 5/1/2023
Projection: NAD 1983 State Plane New York East FIPS 3101 Feet

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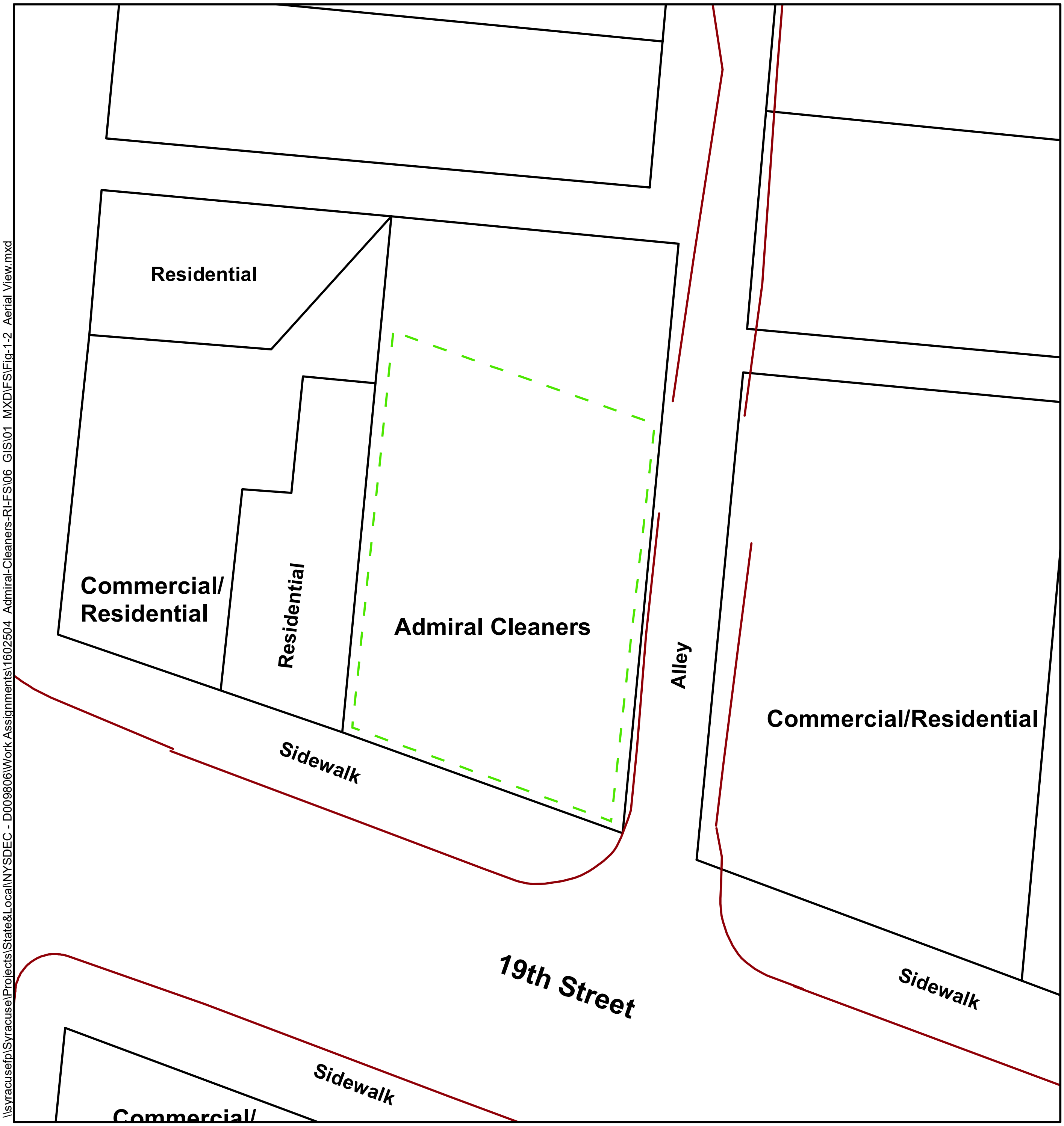

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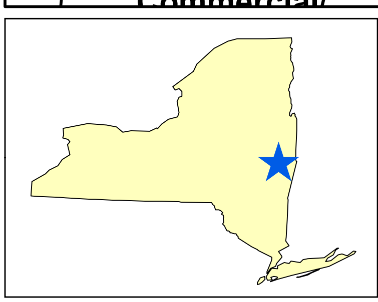

Legend

- Concrete Slab Outline
- Edge of Pavement
- Property Boundaries
- Site Location

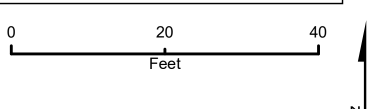

Figure 1-2
Site Map and Surrounding Area
Feasibility Study Report
Admiral Cleaners
Watervliet, NY

Map Date: 5/1/2023
Projection: NAD 1983 State Plane New York East FIPS 3101 Feet

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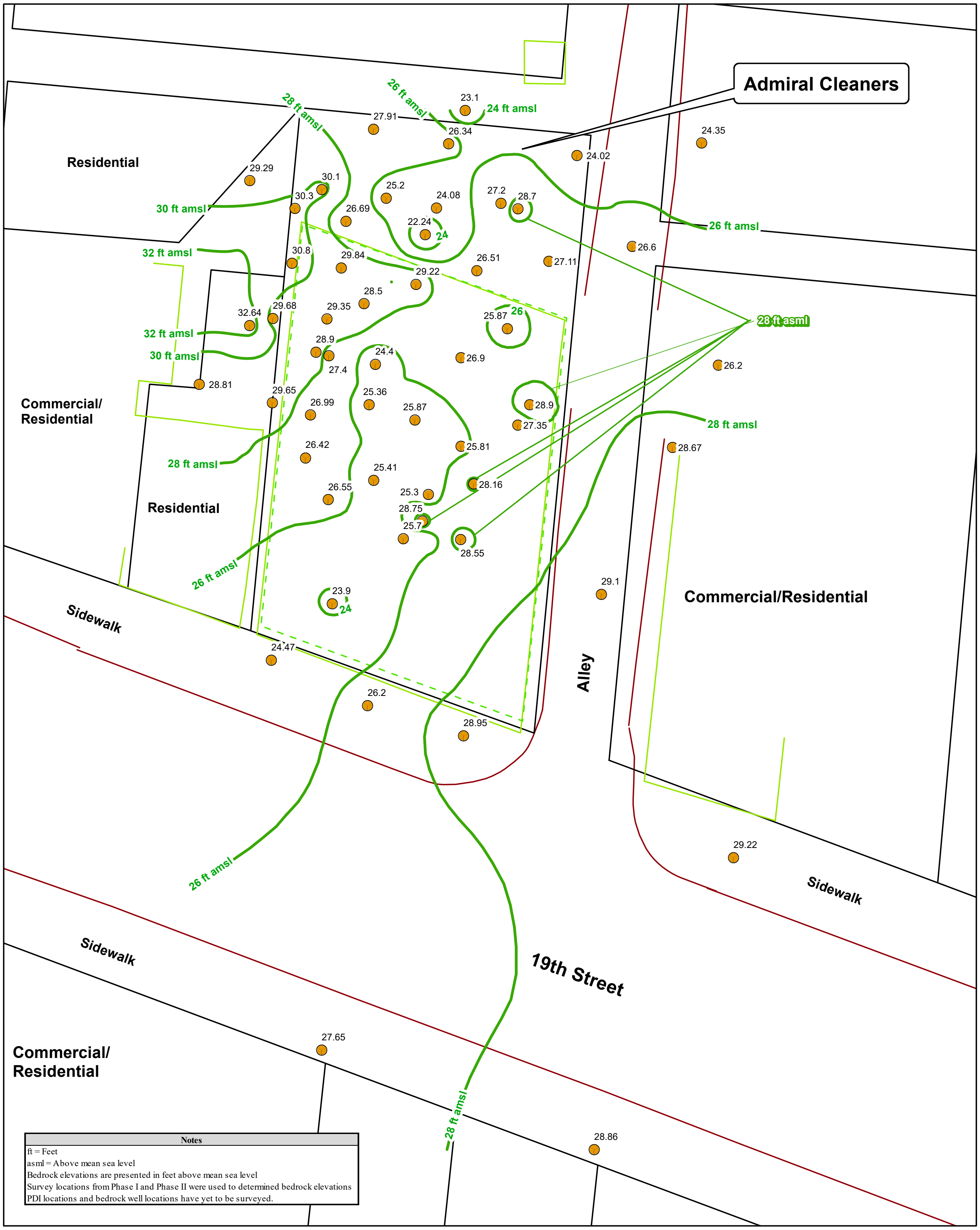
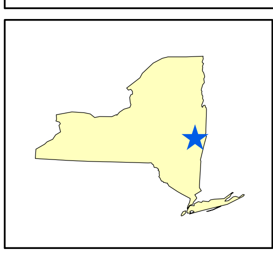


Notes
ft = Feet
asml = Above mean sea level
Bedrock elevations are presented in feet above mean sea level
Survey locations from Phase I and Phase II were used to determined bedrock elevations
PDI locations and bedrock well locations have yet to be surveyed.

G:\Projects\State&Local\NYSDEC - D009806\Work Assignments\1602504_Admiral-Cleaners-RI-FS\06_GIS\01_MXD\FS\Fig-1-3_BedrockContours11x17- Feb 2022.mxd



Legend

- Soil Boring Locations
- Bedrock Elevation Contour
- Concrete Slab Outline
- Property Boundaries
- Edge of Pavement
- Site Location

0 10 20
Feet

N

Figure 1-3
Interpreted Top of Bedrock Surface Map
Feasibility Study Report
Admiral Cleaners
Watervliet, Albany County, New York

Map Date: 2/9/2022
Source: ESRI, 2011
Projection: NAD 1983 State Plane New York East FIPS 3101 Feet

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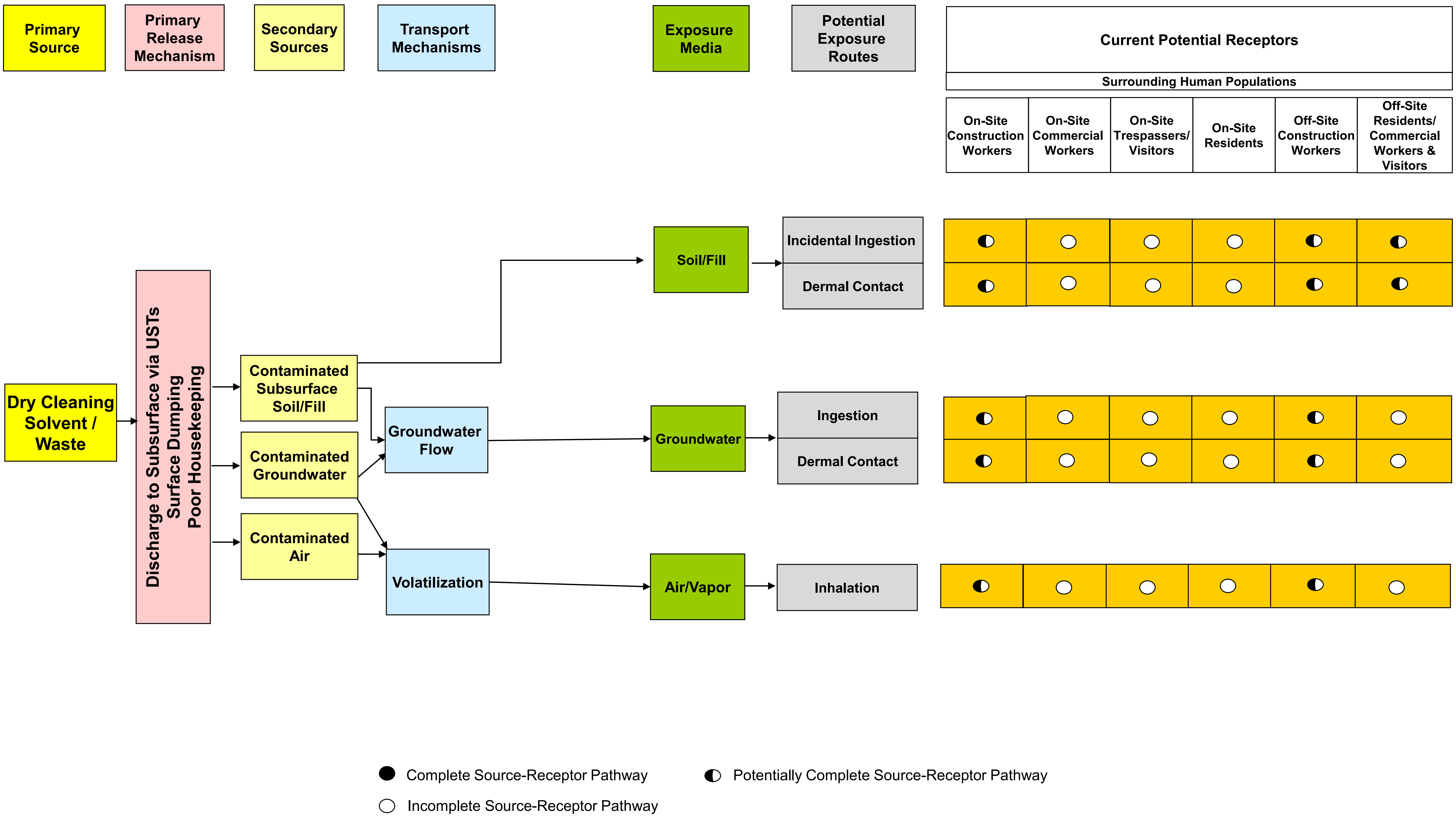

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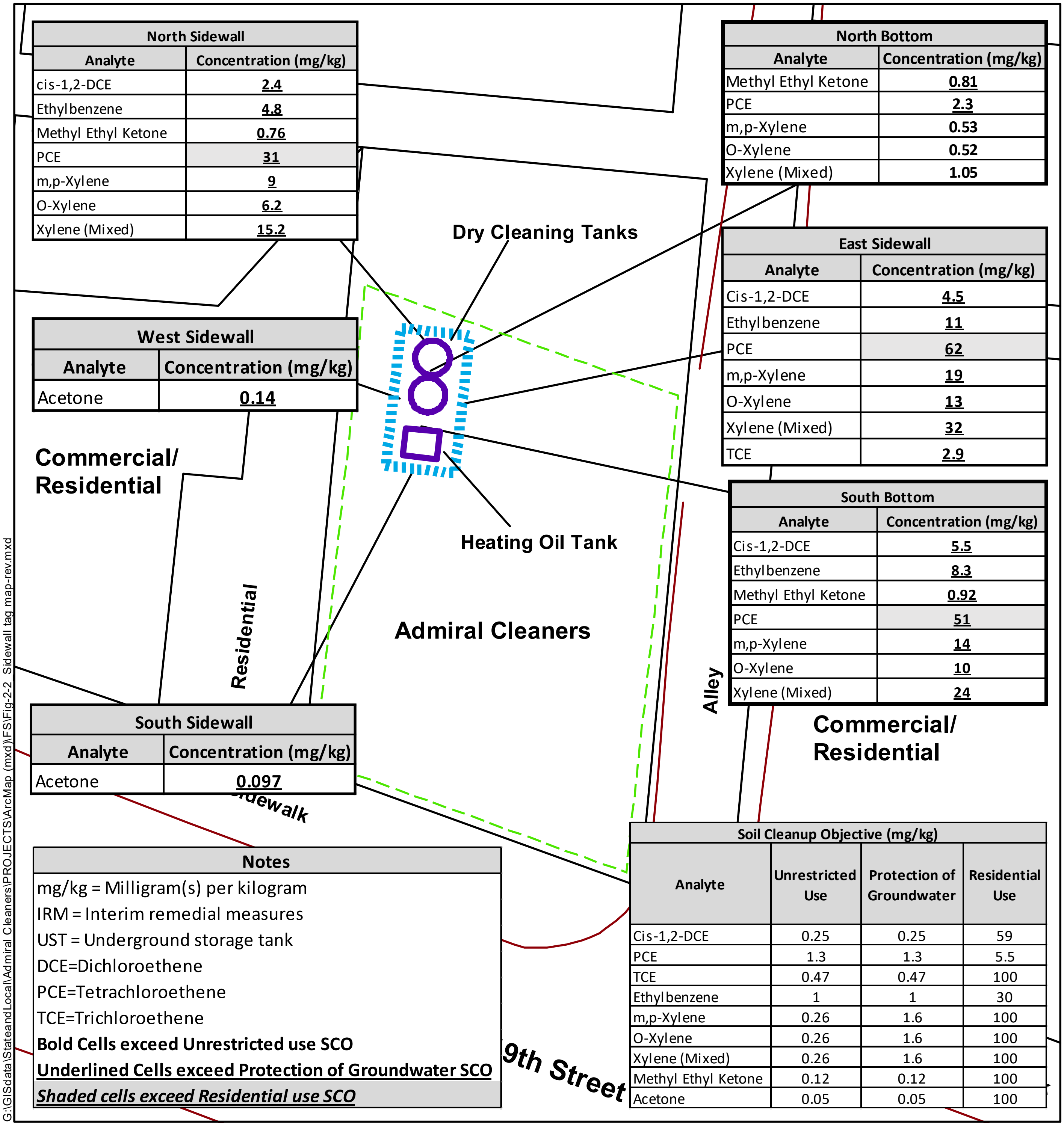
ADMIRAL CLEANERS (401075)
FEASIBILITY STUDY REPORT
WATERVLIET, NEW YORK

FIGURE 2-1
Conceptual Site Model

PROJECT MGR:	DATE:	EA PROJECT NO:
EGC	June 2022	16025.04



North Sidewall	
Analyte	Concentration (mg/kg)
cis-1,2-DCE	2.4
Ethylbenzene	4.8
Methyl Ethyl Ketone	0.76
PCE	31
m,p-Xylene	9
O-Xylene	6.2
Xylene (Mixed)	15.2

West Sidewall	
Analyte	Concentration (mg/kg)
Acetone	0.14

South Sidewall	
Analyte	Concentration (mg/kg)
Acetone	0.097

North Bottom	
Analyte	Concentration (mg/kg)
Methyl Ethyl Ketone	0.81
PCE	2.3
m,p-Xylene	0.53
O-Xylene	0.52
Xylene (Mixed)	1.05

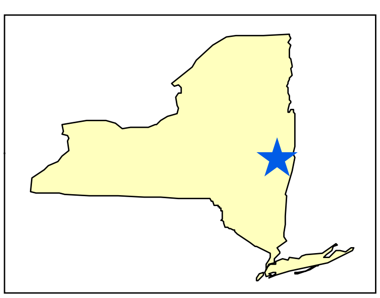
East Sidewall	
Analyte	Concentration (mg/kg)
Cis-1,2-DCE	4.5
Ethylbenzene	11
PCE	62
m,p-Xylene	19
O-Xylene	13
Xylene (Mixed)	32
TCE	2.9

South Bottom	
Analyte	Concentration (mg/kg)
Cis-1,2-DCE	5.5
Ethylbenzene	8.3
Methyl Ethyl Ketone	0.92
PCE	51
m,p-Xylene	14
O-Xylene	10
Xylene (Mixed)	24

Soil Cleanup Objective (mg/kg)			
Analyte	Unrestricted Use	Protection of Groundwater	Residential Use
Cis-1,2-DCE	0.25	0.25	59
PCE	1.3	1.3	5.5
TCE	0.47	0.47	100
Ethylbenzene	1	1	30
m,p-Xylene	0.26	1.6	100
O-Xylene	0.26	1.6	100
Xylene (Mixed)	0.26	1.6	100
Methyl Ethyl Ketone	0.12	0.12	100
Acetone	0.05	0.05	100

Notes

mg/kg = Milligram(s) per kilogram
IRM = Interim remedial measures
UST = Underground storage tank
DCE=Dichloroethene
PCE=Tetrachloroethene
TCE=Trichloroethene
Bold Cells exceed Unrestricted use SCO
Underlined Cells exceed Protection of Groundwater SCO
Shaded cells exceed Residential use SCO



Legend

- IRM No. 2 Excavation
- Concrete Slab Outline
- USTs
- Edge of Pavement
- Property Boundaries
- Site Location

0 15 30
Feet

N

Figure 2-2
IRM No. 2 Excavation and Sidewall Exceedances
Feasibility Study Report
Admiral Cleaners
Watervliet, NY

Map Date: 1/9/2024
Projection: NAD 1983 State Plane New York East FIPS 3101 Feet

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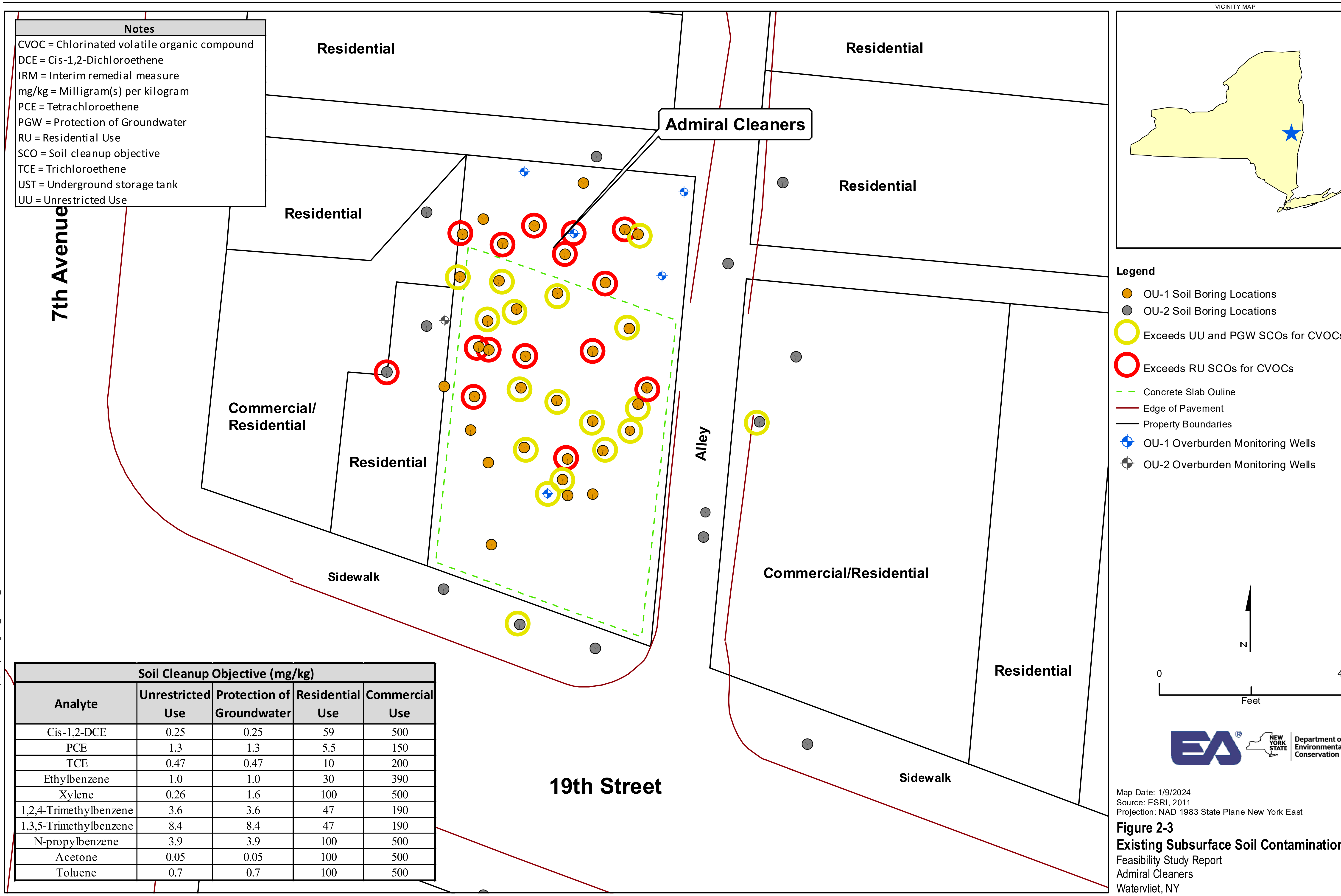
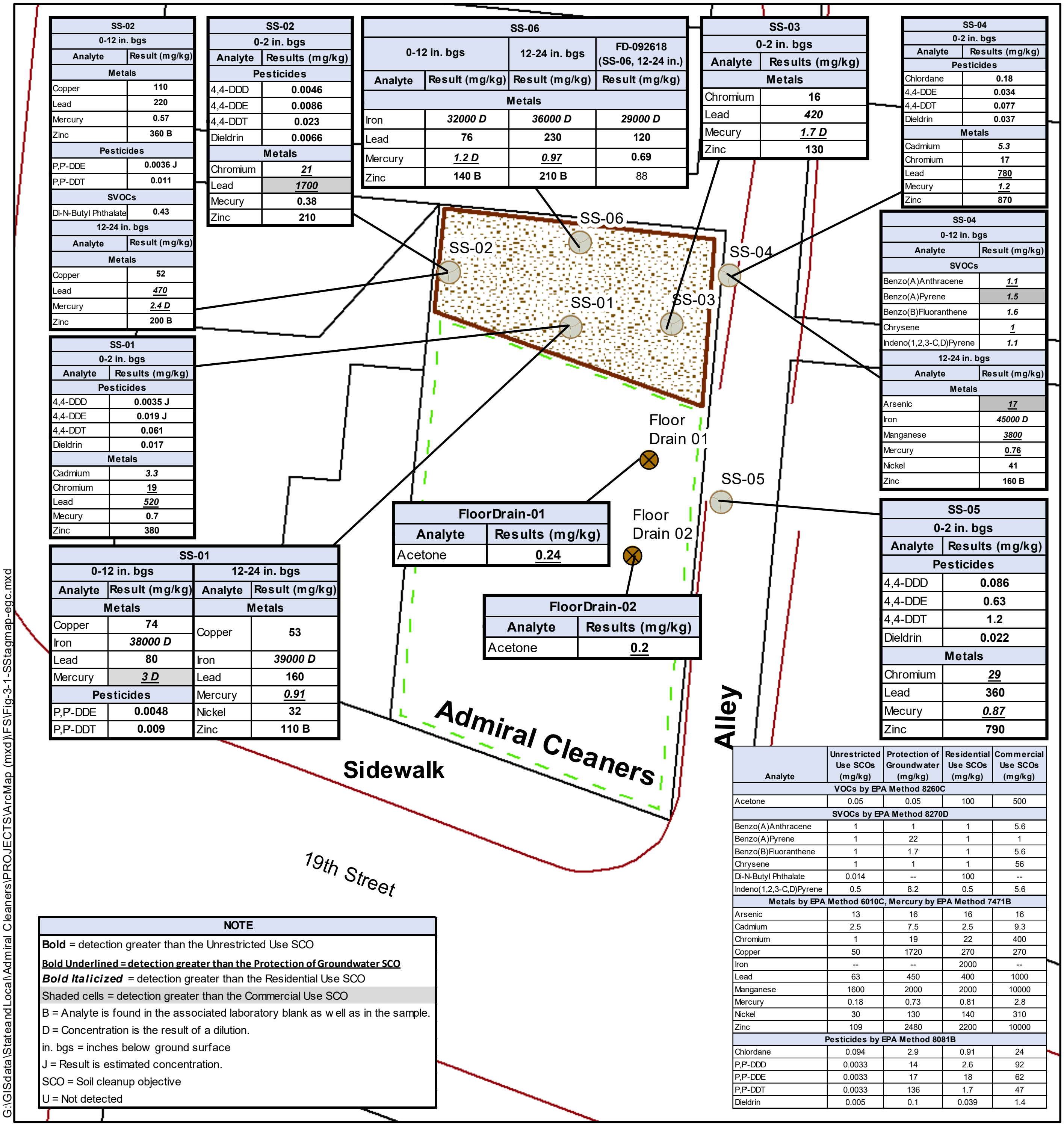


Soil Cleanup Objective (mg/kg)				
Analyte	Unrestricted Use	Protection of Groundwater	Residential Use	Commercial Use
Cis-1,2-DCE	0.25	0.25	59	500
PCE	1.3	1.3	5.5	150
TCE	0.47	0.47	10	200
Ethylbenzene	1.0	1.0	30	390
Xylene	0.26	1.6	100	500
1,2,4-Trimethylbenzene	3.6	3.6	47	190
1,3,5-Trimethylbenzene	8.4	8.4	47	190
N-propylbenzene	3.9	3.9	100	500
Acetone	0.05	0.05	100	500
Toluene	0.7	0.7	100	500

Map Date: 1/9/2024
Source: ESRI, 2011
Projection: NAD 1983 State Plane New York East

Figure 2-3
Existing Subsurface Soil Contamination
Feasibility Study Report
Admiral Cleaners
Watervliet, NY



SS-02	
0-12 in. bgs	
Analyte	**Result (mg/kg)**
Metals	
Copper	**110**
Lead	**220**
Mercury	**0.57**
Zinc	**360 B**
Pesticides	
P,P'-DDE	**0.0036 J**
P,P'-DDT	**0.011**
SVOCs	
Di-N-Butyl Phthalate	**0.43**
12-24 in. bgs	
Analyte	**Result (mg/kg)**
Metals	
Copper	**52**
Lead	***470***
Mercury	***2.4 D***
Zinc	**200 B**

SS-02	
0-2 in. bgs	
Analyte	**Results (mg/kg)**
Pesticides	
4,4-DDD	**0.0046**
4,4-DDE	**0.0086**
4,4-DDT	**0.023**
Dieldrin	**0.0066**
Metals	
Chromium	***21***
Lead	***1700***
Mecury	**0.38**
Zinc	**210**

SS-06			
	0-12 in. bgs	**12-24 in. bgs**	**FD-092618 (SS-06, 12-24 in.)**
Analyte	**Result (mg/kg)**	**Result (mg/kg)**	**Result (mg/kg)**
Metals			
Iron	***32000 D***	***36000 D***	***29000 D***
Lead	**76**	**230**	**120**
Mercury	***1.2 D***	***0.97***	**0.69**
Zinc	**140 B**	**210 B**	88

SS-03	
0-2 in. bgs	
Analyte	**Results (mg/kg)**
Metals	
Chromium	**16**
Lead	***420***
Mecury	***1.7 D***
Zinc	**130**

SS-04	
0-2 in. bgs	
Analyte	**Results (mg/kg)**
Pesticides	
Chlordane	**0.18**
4,4-DDE	**0.034**
4,4-DDT	**0.077**
Dieldrin	**0.037**
Metals	
Cadmium	***5.3***
Chromium	**17**
Lead	**780**
Mecury	***1.2***
Zinc	**870**

SS-04	
0-12 in. bgs	
Analyte	**Result (mg/kg)**
SVOCs	
Benzo(A)Anthracene	***1.1***
Benzo(A)Pyrene	***1.5***
Benzo(B)Fluoranthene	***1.6***
Chrysene	***1***
Indeno(1,2,3-C,D)Pyrene	***1.1***
12-24 in. bgs	
Analyte	**Result (mg/kg)**
Metals	
Arsenic	***17***
Iron	***45000 D***
Manganese	***3800***
Mercury	**0.76**
Nickel	**41**
Zinc	**160 B**

SS-01	
0-2 in. bgs	
Analyte	**Results (mg/kg)**
Pesticides	
4,4-DDD	**0.0035 J**
4,4-DDE	**0.019 J**
4,4-DDT	**0.061**
Dieldrin	**0.017**
Metals	
Cadmium	***3.3***
Chromium	***19***
Lead	***520***
Mecury	**0.7**
Zinc	**380**

SS-01			
0-12 in. bgs		**12-24 in. bgs**	
Analyte	**Result (mg/kg)**	**Analyte**	**Result (mg/kg)**
Metals		**Metals**	
Copper	**74**	Copper	**53**
Iron	***38000 D***	Iron	***39000 D***
Lead	**80**	Lead	**160**
Mercury	***3 D***	Mercury	***0.91***
Pesticides		Nickel	**32**
P,P'-DDE	**0.0048**	Zinc	**110 B**
P,P'-DDT	**0.009**		

FloorDrain-01	
Analyte	**Results (mg/kg)**
Acetone	**0.24**

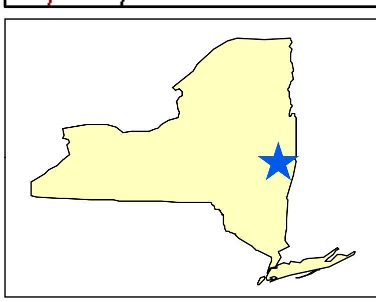
FloorDrain-02	
Analyte	**Results (mg/kg)**
Acetone	**0.2**

SS-05	
0-2 in. bgs	
Analyte	**Results (mg/kg)**
Pesticides	
4,4-DDD	**0.086**
4,4-DDE	**0.63**
4,4-DDT	**1.2**
Dieldrin	**0.022**
Metals	
Chromium	***29***
Lead	**360**
Mecury	***0.87***
Zinc	**790**

Analyte	Unrestricted Use SCOs (mg/kg)	Protection of Groundwater (mg/kg)	Residential Use SCOs (mg/kg)	Commercial Use SCOs (mg/kg)
VOCs by EPA Method 8260C				
Acetone	0.05	0.05	100	500
SVOCs by EPA Method 8270D				
Benzo(A)Anthracene	1	1	1	5.6
Benzo(A)Pyrene	1	22	1	1
Benzo(B)Fluoranthene	1	1.7	1	5.6
Chrysene	1	1	1	56
Di-N-Butyl Phthalate	0.014	--	100	--
Indeno(1,2,3-C,D)Pyrene	0.5	8.2	0.5	5.6
Metals by EPA Method 6010C, Mercury by EPA Method 7471B				
Arsenic	13	16	16	16
Cadmium	2.5	7.5	2.5	9.3
Chromium	1	19	22	400
Copper	50	1720	270	270
Iron	--	--	2000	--
Lead	63	450	400	1000
Manganese	1600	2000	2000	10000
Mercury	0.18	0.73	0.81	2.8
Nickel	30	130	140	310
Zinc	109	2480	2200	10000
Pesticides by EPA Method 8081B				
Chlordane	0.094	2.9	0.91	24
P,P'-DDD	0.0033	14	2.6	92
P,P'-DDE	0.0033	17	18	62
P,P'-DDT	0.0033	136	1.7	47
Dieldrin	0.005	0.1	0.039	1.4

NOTE

Bold = detection greater than the Unrestricted Use SCO
Bold Underlined = detection greater than the Protection of Groundwater SCO
Bold Italicized = detection greater than the Residential Use SCO
Shaded cells = detection greater than the Commercial Use SCO
B = Analyte is found in the associated laboratory blank as well as in the sample.
D = Concentration is the result of a dilution.
in. bgs = inches below ground surface
J = Result is estimated concentration.
SCO = Soil cleanup objective
U = Not detected



0 20 40
Feet

N

Legend

Surface Soil Sample Locations
Floor Drain Samples
Surface Soil Contamination
Concrete Slab Outline
Edge of Pavement
Property Boundaries
Site Location

Figure 3-1
Surface Soil and Floor Drain Sample Exceedances
Feasibility Study Report
Admiral Cleaners
Watervliet, NY

Map Date: 1/9/2024
Projection: NAD 1983 State Plane New York East FIPS 3101 Feet

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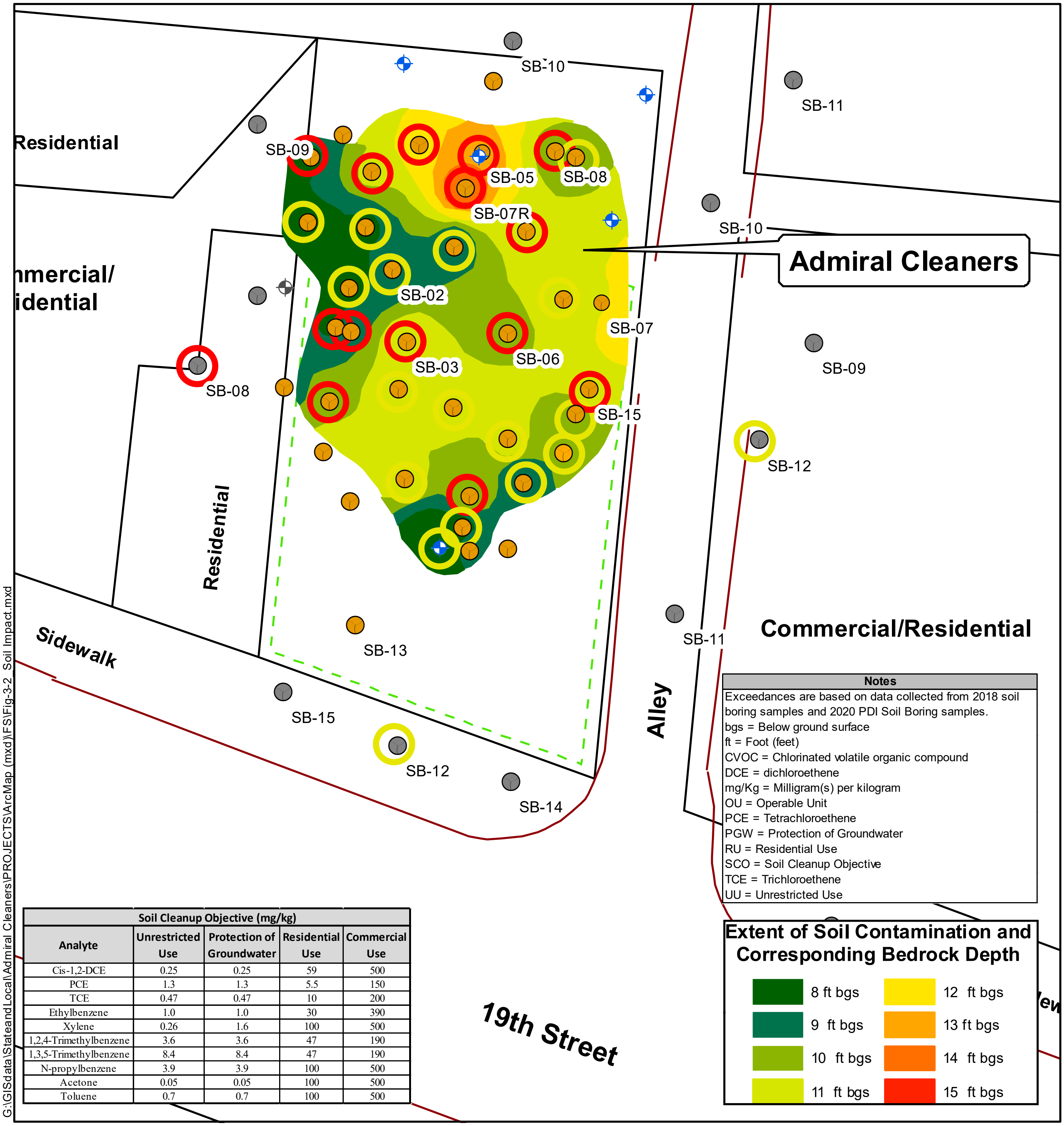


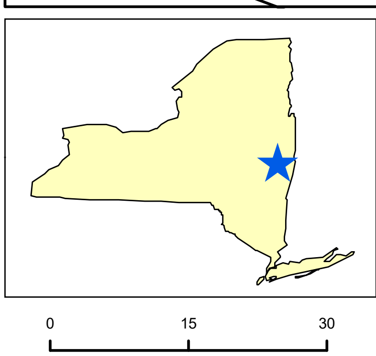
Analyte	Soil Cleanup Objective (mg/kg) Unrestricted Use	Protection of Groundwater	Residential Use	Commercial Use
Cis-1,2-DCE	0.25	0.25	59	500
PCE	1.3	1.3	5.5	150
TCE	0.47	0.47	10	200
Ethylbenzene	1.0	1.0	30	390
Xylene	0.26	1.6	100	500
1,2,4-Trimethylbenzene	3.6	3.6	47	190
1,3,5-Trimethylbenzene	8.4	8.4	47	190
N-propylbenzene	3.9	3.9	100	500
Acetone	0.05	0.05	100	500
Toluene	0.7	0.7	100	500

Notes

Exceedances are based on data collected from 2018 soil boring samples and 2020 PDI Soil Boring samples.
bgs = Below ground surface
ft = Foot (feet)
CVOC = Chlorinated volatile organic compound
DCE = dichloroethene
mg/Kg = Milligram(s) per kilogram
OU = Operable Unit
PCE = Tetrachloroethene
PGW = Protection of Groundwater
RU = Residential Use
SCO = Soil Cleanup Objective
TCE = Trichloroethene
UU = Unrestricted Use

Extent of Soil Contamination and Corresponding Bedrock Depth

8 ft bgs	12 ft bgs
9 ft bgs	13 ft bgs
10 ft bgs	14 ft bgs
11 ft bgs	15 ft bgs



Legend

- Phase 1 Monitoring Wells
- OU-1 Soil Boring Locations
- OU-2 Soil Boring Locations
- Exceeds UU and PGW SCO for CVOCs
- Exceeds RU SCOs for CVOCs
- Concrete Slab Outline
- Edge of Pavement
- Property Boundaries
- Site Location

N

Figure 3-2
Extent of Soil Exceeding Soil Clean Up Objectives Operable Unit 1

Feasibility Study Report
Admiral Cleaners
Watervliet, NY

Map Date: 1/10/2024
Projection: NAD 1983 State Plane New York East FIPS 3101 Feet

New York State Department of Environmental Conservation
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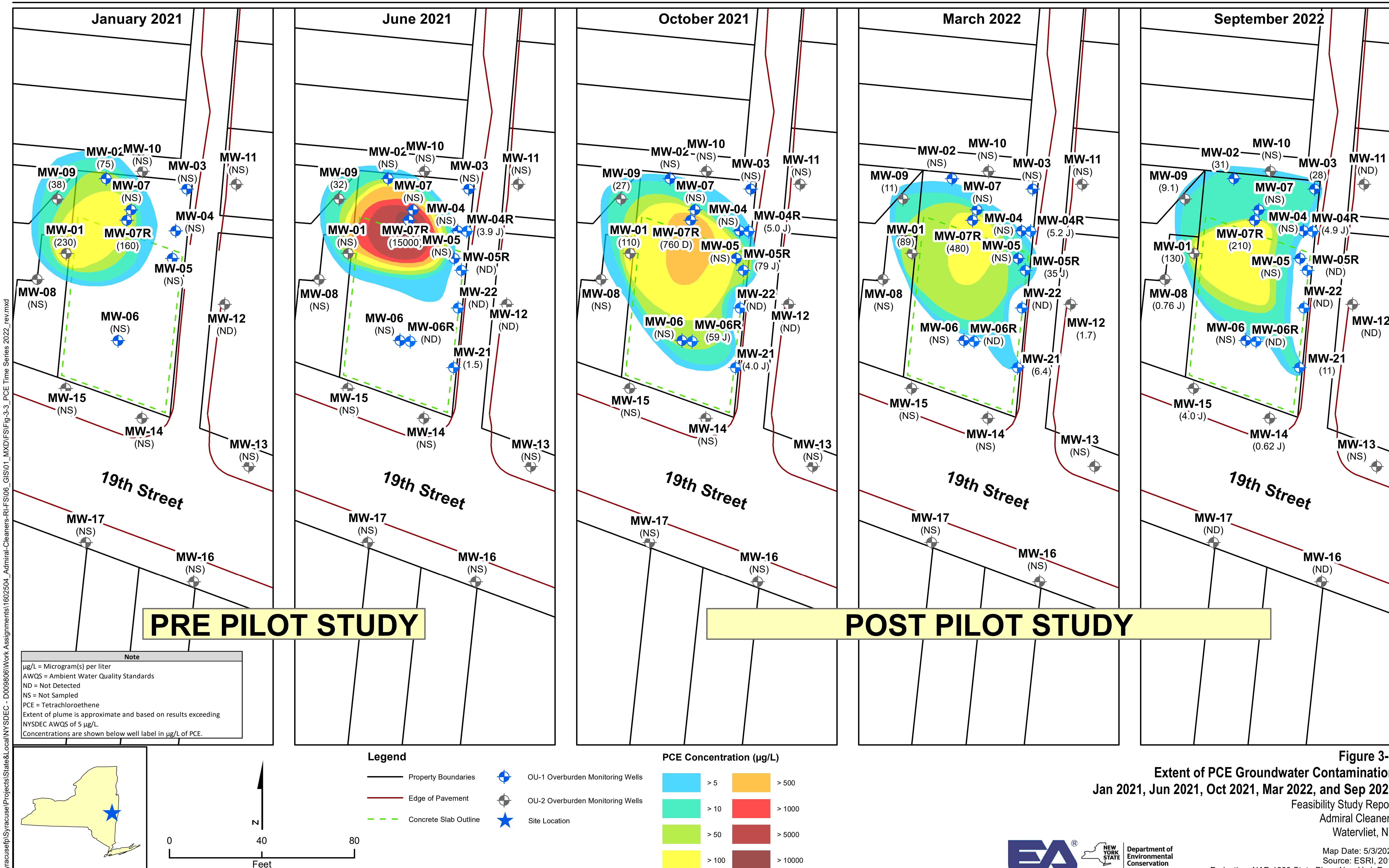

January 2021
MW-02 (75)
MW-10 (NS)
MW-09 (38)
MW-03 (NS)
MW-11 (NS)
MW-07 (NS)
MW-04 (NS)
MW-01 (230)
MW-07R (160)
MW-05 (NS)
MW-08 (NS)
MW-06 (NS)
MW-12 (ND)
MW-15 (NS)
MW-14 (NS)
MW-13 (NS)
19th Street
MW-17 (NS)
MW-16 (NS)
June 2021
MW-02 (NS)
MW-10 (NS)
MW-09 (32)
MW-03 (NS)
MW-11 (NS)
MW-07 (NS)
MW-04 (NS)
MW-04R (3.9 J)
MW-01 (NS)
MW-07R (15000)
MW-05 (NS)
MW-05R (ND)
MW-08 (NS)
MW-22 (ND)
MW-12 (ND)
MW-06 (NS)
MW-06R (ND)
MW-21 (1.5)
MW-15 (NS)
MW-14 (NS)
MW-13 (NS)
19th Street
MW-17 (NS)
MW-16 (NS)
October 2021
MW-02 (NS)
MW-10 (NS)
MW-09 (27)
MW-03 (NS)
MW-11 (NS)
MW-07 (NS)
MW-04 (NS)
MW-04R (5.0 J)
MW-01 (110)
MW-07R (760 D)
MW-05 (NS)
MW-05R (79 J)
MW-08 (NS)
MW-22 (ND)
MW-12 (ND)
MW-06 (NS)
MW-06R (59 J)
MW-21 (4.0 J)
MW-15 (NS)
MW-14 (NS)
MW-13 (NS)
19th Street
MW-17 (NS)
MW-16 (NS)
March 2022
MW-02 (NS)
MW-10 (NS)
MW-09 (11)
MW-03 (NS)
MW-11 (NS)
MW-07 (NS)
MW-04 (NS)
MW-04R (5.2 J)
MW-01 (89)
MW-07R (480)
MW-05 (NS)
MW-05R (35 J)
MW-08 (NS)
MW-22 (ND)
MW-12 (1.7)
MW-06 (NS)
MW-06R (ND)
MW-21 (6.4)
MW-15 (NS)
MW-14 (NS)
MW-13 (NS)
19th Street
MW-17 (NS)
MW-16 (NS)
September 2022
MW-02 (31)
MW-10 (NS)
MW-09 (9.1)
MW-03 (28)
MW-11 (ND)
MW-07 (NS)
MW-04 (NS)
MW-04R (4.9 J)
MW-01 (130)
MW-07R (210)
MW-05 (NS)
MW-05R (ND)
MW-08 (0.76 J)
MW-22 (ND)
MW-12 (ND)
MW-06 (NS)
MW-06R (ND)
MW-21 (11)
MW-15 (4.0 J)
MW-14 (0.62 J)
MW-13 (NS)
19th Street
MW-17 (ND)
MW-16 (ND)
PRE PILOT STUDY
POST PILOT STUDY
Note
µg/L = Microgram(s) per liter
AWQS = Ambient Water Quality Standards
ND = Not Detected
NS = Not Sampled
PCE = Tetrachloroethene
Extent of plume is approximate and based on results exceeding
NYSDEC AWQS of 5 µg/L.
Concentrations are shown below well label in µg/L of PCE.
N
0
40
80
Feet
Legend
Property Boundaries
Edge of Pavement
Concrete Slab Outline
OU-1 Overburden Monitoring Wells
OU-2 Overburden Monitoring Wells
Site Location
PCE Concentration (µg/L)
> 5
> 10
> 50
> 100
> 500
> 1000
> 5000
> 10000
Figure 3-3
Extent of PCE Groundwater Contamination
Jan 2021, Jun 2021, Oct 2021, Mar 2022, and Sep 2022
Feasibility Study Report
Admiral Cleaners
Watervliet, NY
NEW YORK STATE
Department of Environmental Conservation
Map Date: 5/3/2023
Source: ESRI, 2011
Projection: NAD 1983 State Plane New York East
\\syracusefp\Syracuse\Projects\State&Local\NYSDEC - D009806\Work Assignments\1602504_Admiral-Cleaners-RI-FS\06_GIS\01_MXD\FS\Fig-3-3_PCE Time Series 2022_rev.mxd

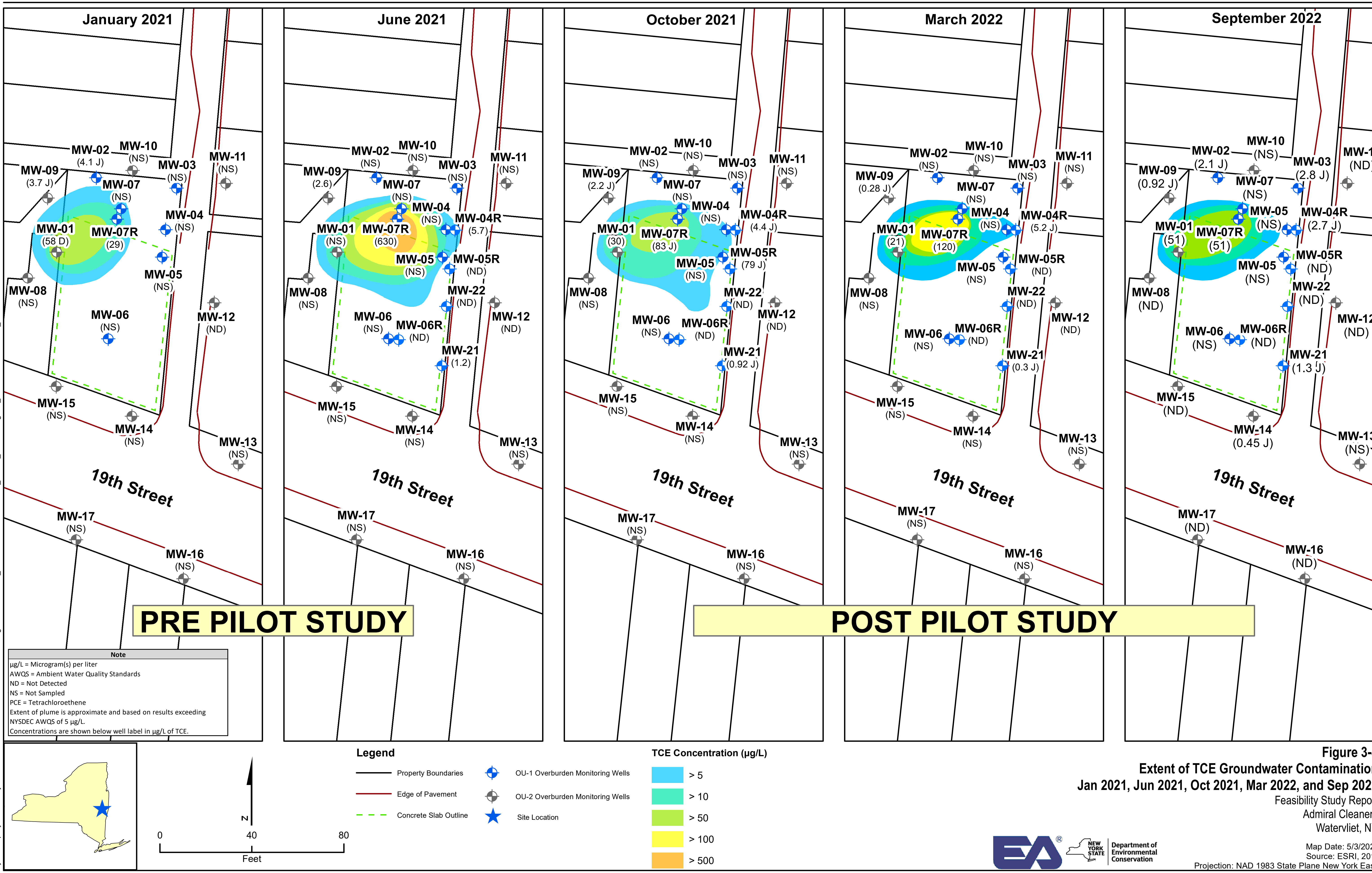


Figure 3-4
Extent of TCE Groundwater Contamination
Jan 2021, Jun 2021, Oct 2021, Mar 2022, and Sep 2022
Feasibility Study Report
Admiral Cleaners
Watervliet, NY

Map Date: 5/3/2023
Source: ESRI, 2011
Projection: NAD 1983 State Plane New York East

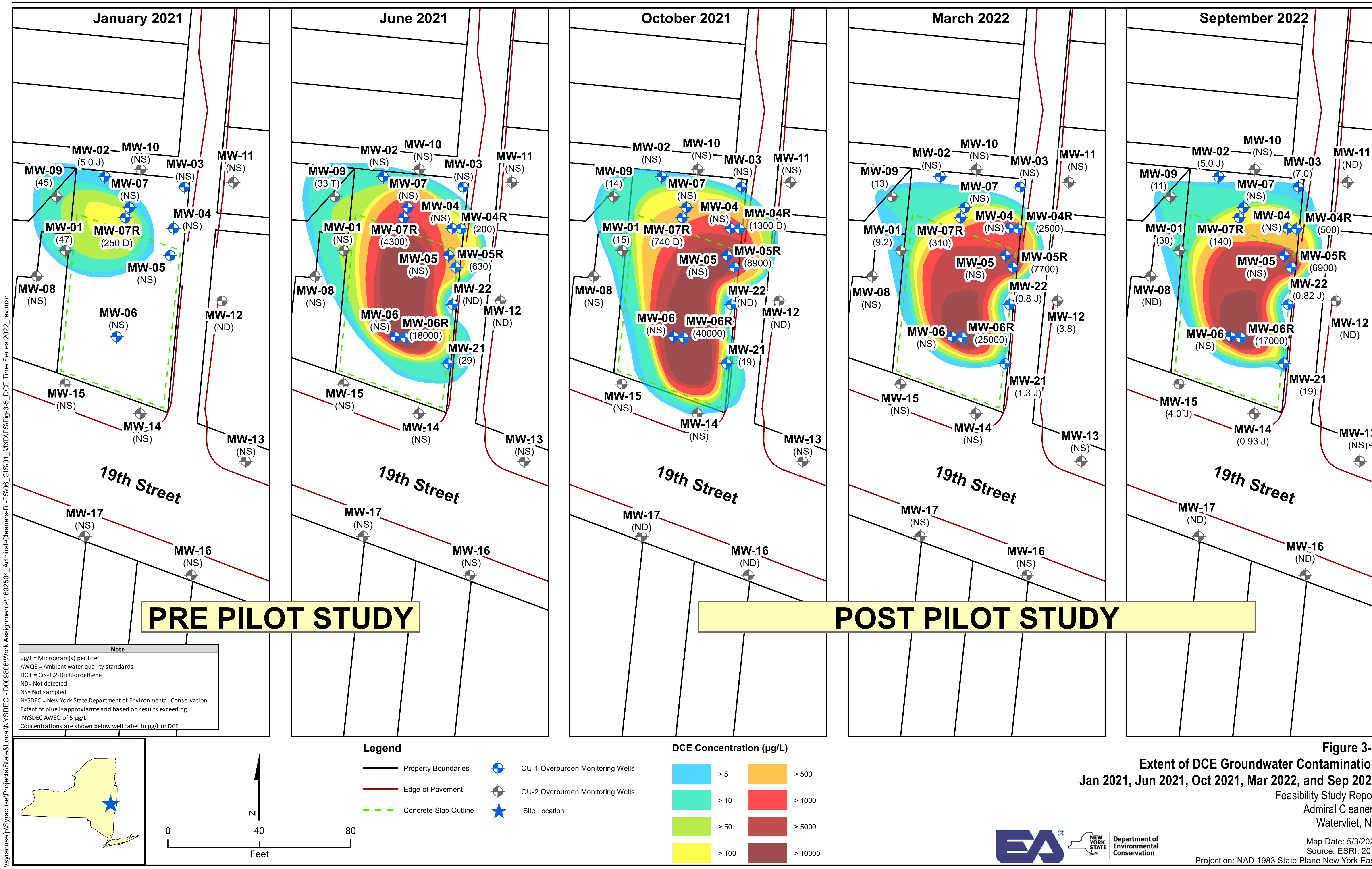
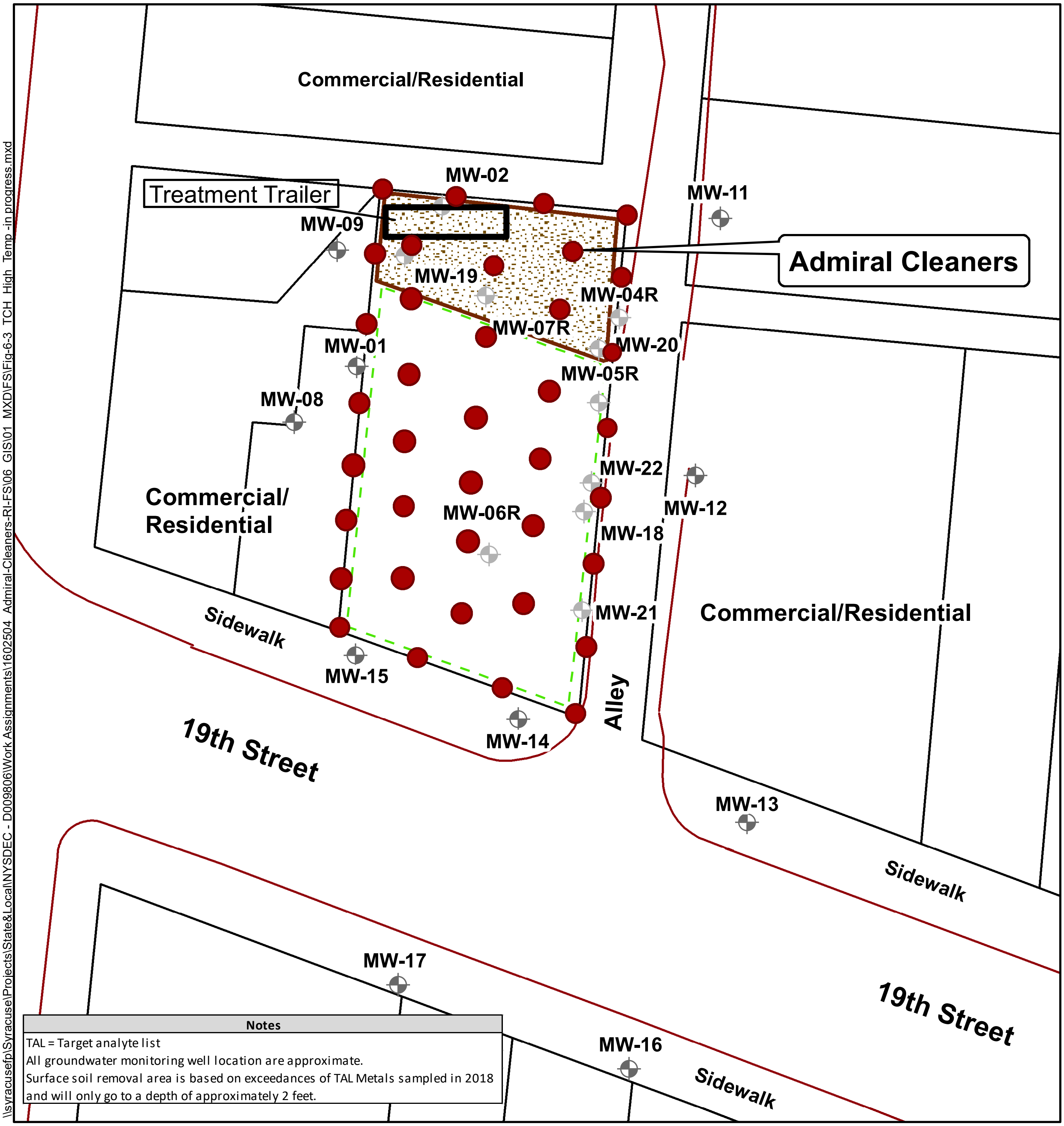


Figure 3-5
Extent of DCE Groundwater Contamination
Jan 2021, Jun 2021, Oct 2021, Mar 2022, and Sep 2022
Feasibility Study Report
Admiral Cleaners
Watervliet, NY



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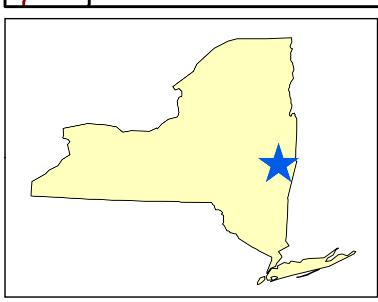


0 20 40
Feet

Legend

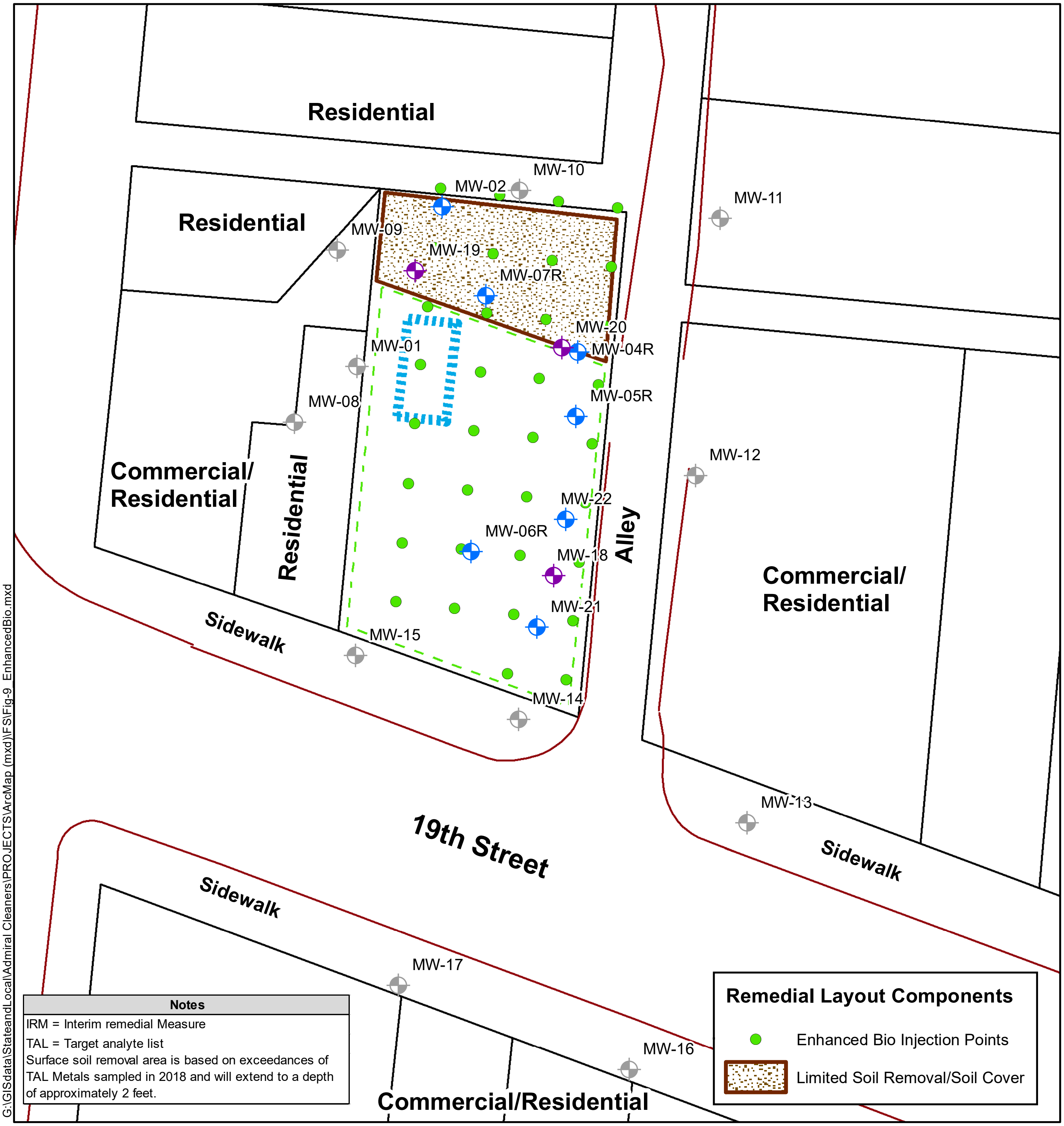
- OU-2 Overburden Monitoring Well
- Proposed OU-1 Decommissioned Well
- Concrete Slab Outline
- Surface Soil Excavation
- Edge of Pavement
- Property Boundaries
- Thermal Heating Wells
- Site Location

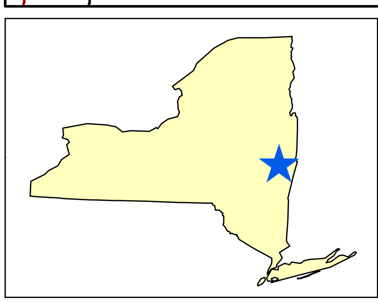
N

Figure 6-1
Alternative 3
Remedial Layout
Feasibility Study Report
Admiral Cleaners
Watervliet, NY

Map Date: 5/3/2023
Projection: NAD 1983 State Plane New York East FIPS 3101 Feet

New York State Department of Environmental Conservation





0 20 40
Feet

Legend

- OU-1 Overburden Monitoring Wells
- OU-2 Overburden Monitoring Wells
- Bedrock Monitoring Wells
- Concrete Slab Outline
- Edge of Pavement
- Property Boundaries
- IRM No.2 Excavation
- Site Location

N

Figure 6-2
Alternative 4
Remedial Layout
Feasibility Study Report
Admiral Cleaners (Site No. 401075)
Watervliet, Albany County, NY

Map Date: 2/19/2025
Projection: NAD 1983 State Plane New York East FIPS 3101 Feet

NEW YORK STATE OF OPPORTUNITY | Department of Environmental Conservation

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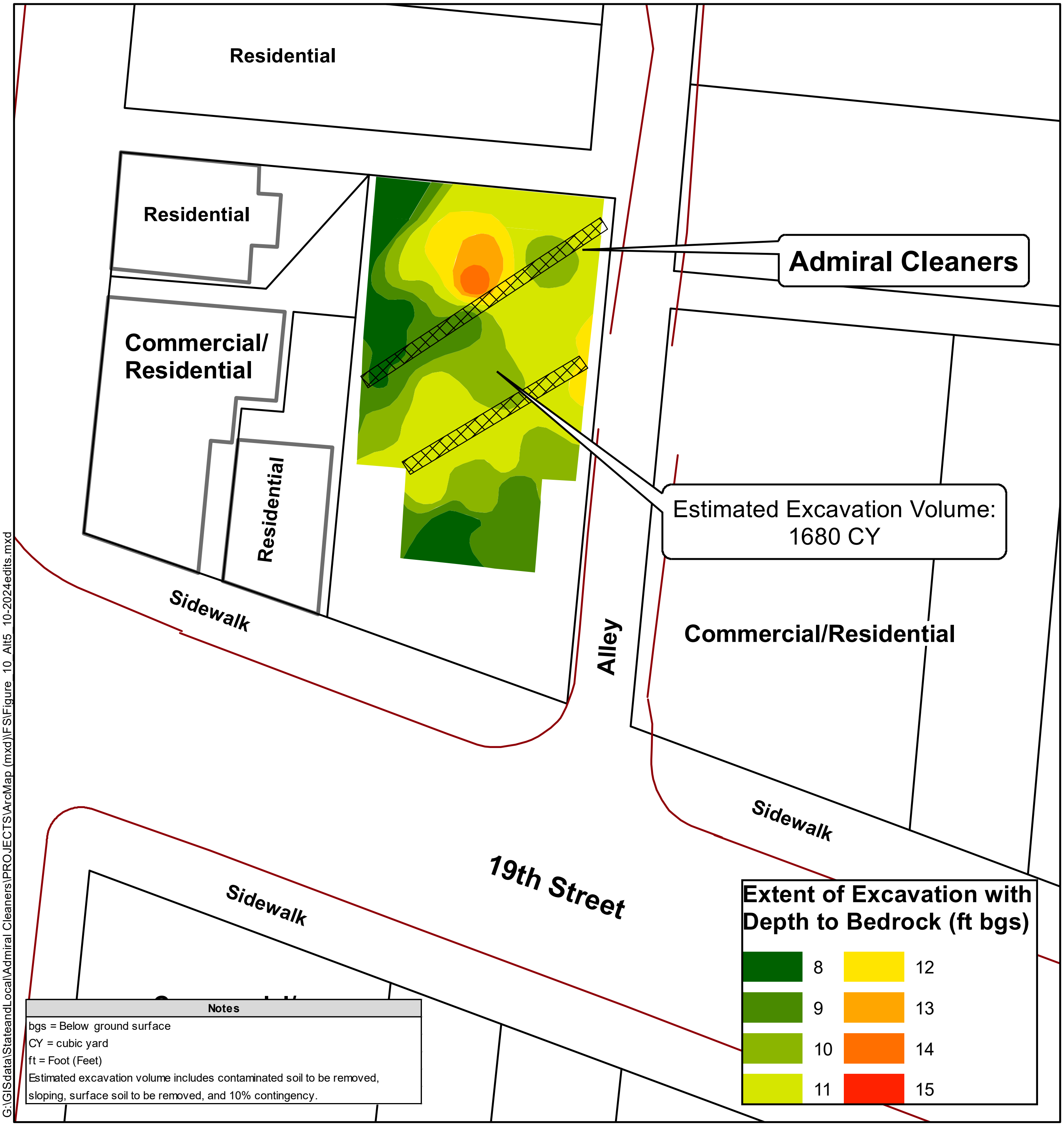

Notes
bgs = Below ground surface
CY = cubic yard
ft = Foot (Feet)
Estimated excavation volume includes contaminated soil to be removed, sloping, surface soil to be removed, and 10% contingency.

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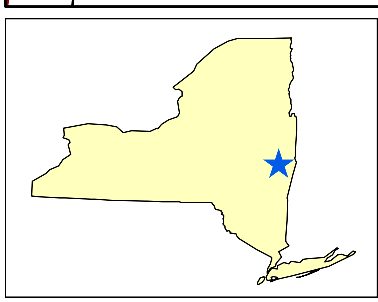
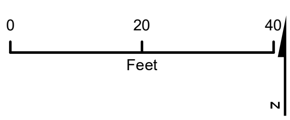




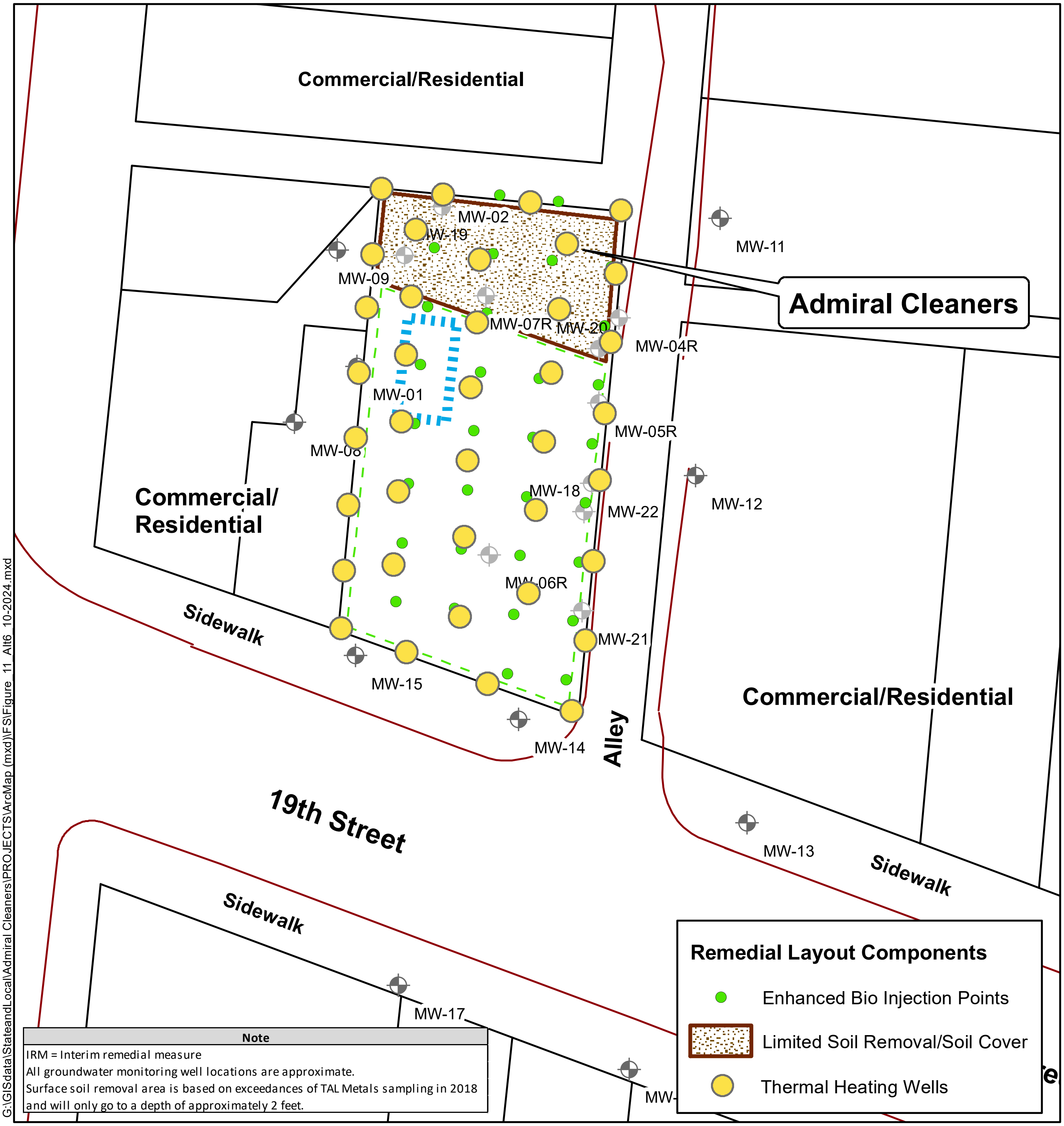
Legend

- Concrete Slab Outline
- Edge of Pavement
- Property Boundaries
- Building Foundation Outline
- Proposed Biodiffusers
- Site Location

Figure 6-3
Alternative 5
Remedial Layout
Feasibility Study Report
Admiral Cleaners (Site No. 401075)
Watervliet, Albany County, NY

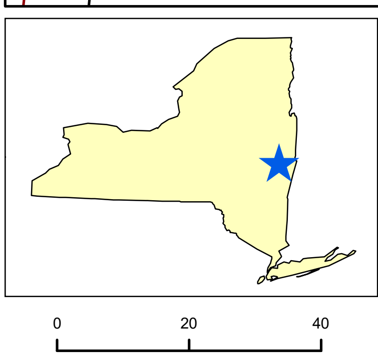
Map Date: 2/27/2025
Projection: NAD 1983 State Plane New York East FIPS 3101 Feet

NEW YORK STATE OF OPPORTUNITY | Department of Environmental Conservation



Note

IRM = Interim remedial measure
All groundwater monitoring well locations are approximate.
Surface soil removal area is based on exceedances of TAL Metals sampling in 2018 and will only go to a depth of approximately 2 feet.



Legend

- OU-2 Overburden Monitoring Well
- OU-1 Proposed Decommissioned Well
- Concrete Slab Outline
- Edge of Pavement
- Property Boundaries
- IRM No. 2 Excavation
- Site Location

N

Figure 6-4
Alternative 6
Remedial Layout
Feasibility Study Report
Admiral Cleaners (Site No. 401075)
Watervliet, Albany County, NY

Map Date: 2/19/2025
Projection: NAD 1983 State Plane New York East FIPS 3101 Feet

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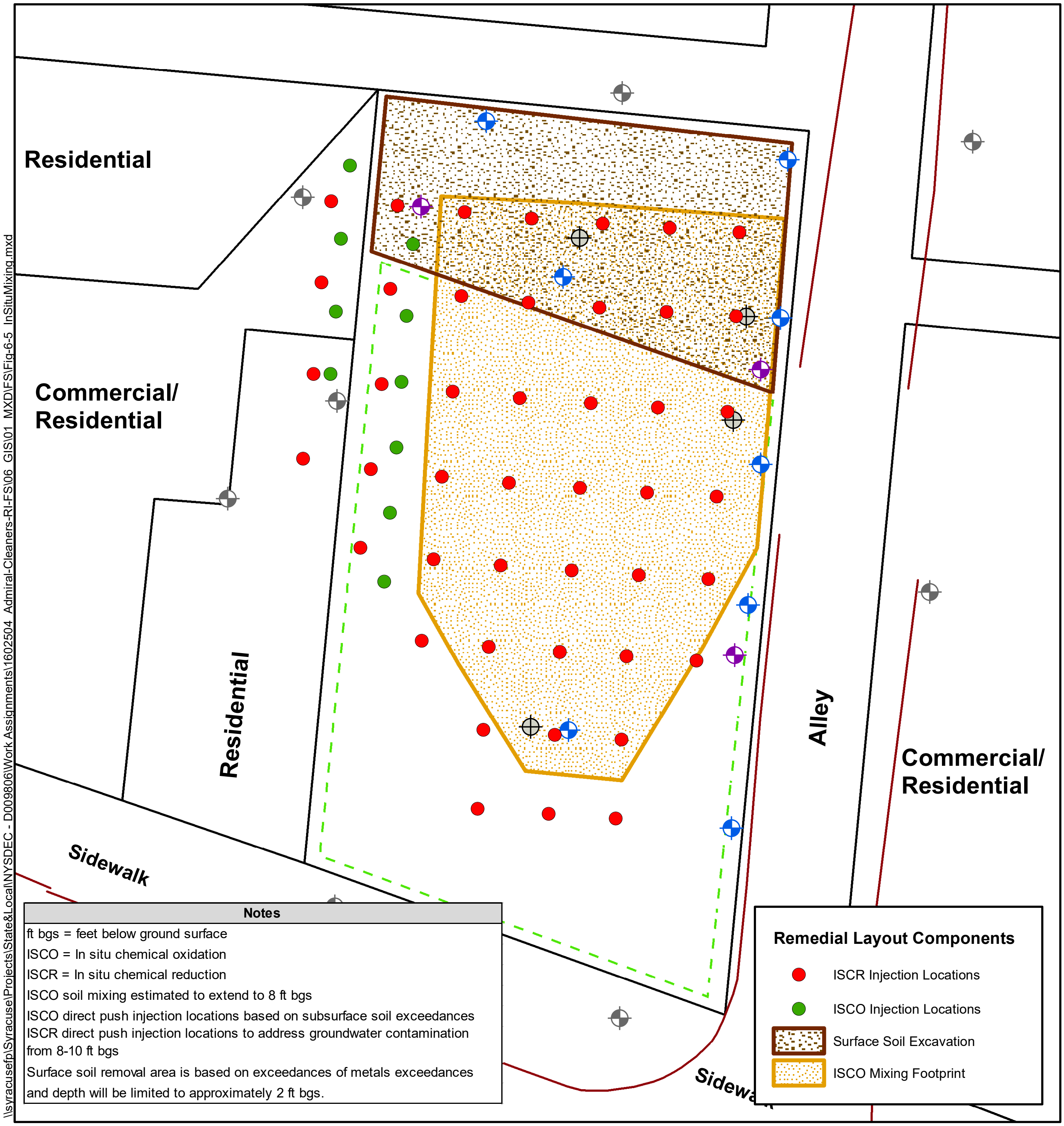

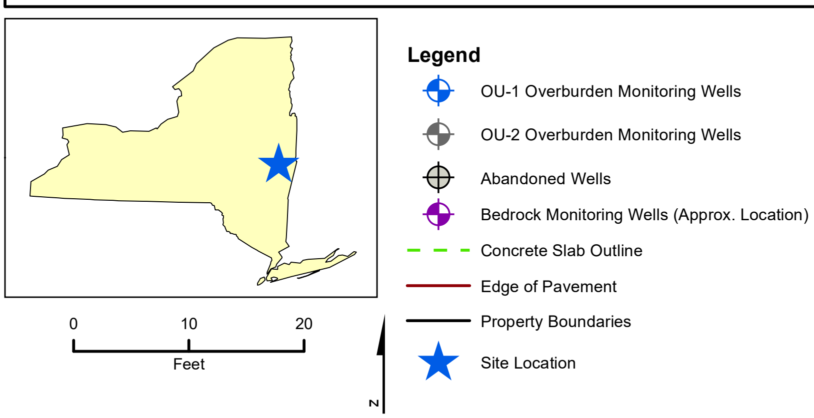

Figure 6-5
Alternative 7
Remedial Layout
Feasibility Study Report
Admiral Cleaners
Watervliet, NY

Map Date: 5/3/2023
Projection: NAD 1983 State Plane New York East FIPS 3101 Feet

NEW YORK STATE Department of Environmental Conservation

Appendix A

Alternative Cost Estimates

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Feasibility Study Cost Estimate
Alternative 2 - Site Management with Long Term Monitoring
Admiral Cleaners Site
Site Number 401075

City of Watervliet, Albany County, New York

Payment Item Number	Description	Estimated Quantity	Unit	Unit Price	**$ Total Cost**
Site Management					
101	Lawyer Fees	1	LS	$5,000.00	$5,000
102	Site Surveys	1	LS	$10,000.00	$10,000
SITE MANAGEMENT TOTAL					**$15,000**
Contingency		20%	-		$3,000
SITE MANAGEMENT TOTAL WITH CONTINGENCY					**$18,000**
Long Term Monitoring - Annual					
201	Mobilization/Demobilization	1	Event	$1,500.00	$1,500
202	Grab Samples	1	LS	$1,072.88	$1,073
203	Lab Analyses for VOCs	11	EA	$60.00	$660
204	Lab Analyses for PFAS	11	EA	$263.00	$2,893
205	Validation	22	EA	$219.00	$4,818
206	Shipping	1	LS	$150.00	$150
207	Reporting	1	Event	$200.00	$200
ANNUAL MONITORING TOTAL					**$13,109**
10 YEAR MONITORING TOTAL (NPV)					**$119,622**
30 YEAR MONITORING TOTAL (NPV)					**$306,073**
Contingency		20%	-		$61,215
MONITORING TOTAL WITH CONTINGENCY (NPV)					**$367,300**
TOTAL ESTIMATED ALTERNATIVE COST WITH CONTINGENCY					***$385,300***

Feasibility Study Cost Estimate
Alternative 3 - High Temperature In Situ Thermal Remediation
Admiral Cleaners Site
Site Number 401075

City of Watervliet, Albany County, New York

Payment Item Number	Description	Estimated Quantity	Unit	Unit Price	**$ Total Cost**
Mobilization, Demobilization, and Site Preparation					**$581,100**
101	Mobilization/Demobilization	20.0%	-	-	$379,053
102	Insurance	0.64%	-	-	$12,130
103	Performance Bond	2.50%	-	-	$47,382
104	Permitting	1	LS	$10,000.00	$10,000
105	Baseline Sampling	1	LS	$15,000.00	$15,000
106	Work Plan Preparation	1	LS	$10,000.00	$10,000
107	Survey/Boundaries & Markers	1	Day	$6,000.00	$6,000
108	Utility Locator	1	Day	$3,000.00	$3,000
109	Office Trailer	1	EA	$12,499.73	$12,500
110	Power Drop and Transformer Installation (500kW)	1	LS	$40,000.00	$40,000
111	Geotextile for Construction Entrance	111	SY	$0.77	$86
112	Stone for Construction Entrance	19	LCY	$26.88	$498
113	Site Services	180	Day	$150.00	$27,000
114	Install Silt Fence	300	LF	$3.64	$1,092
115	Install Hay Bales	300	LF	$1.10	$330
116	Health & Safety	30	Day	$500.00	$15,000
117	Well Abandonment	90	LF	$21.75	$1,958
Treatment					**$1,665,800**
201	Dust Monitoring	1	MO	$6,820.00	$6,820
202	Dust Control	30	Day	$1,159.85	$34,796
203	Surface Soil Metal Contamination Excavation	100	BCY	$35.00	$3,500
204	Load Contaminated Material	100	BCY	$2.20	$220
205	Waste Characterization Sampling	2	EA	$935.00	$1,870
206	Transport and Dispose Contaminated Material	124	Tons	$82.00	$10,194
207	Thermal Treatment	1	LS	$1,390,000.00	$1,390,000
208	Utility Cost	1	LS	$210,000.00	$210,000
209	Verification Sampling	56	EA	$23.87	$1,337
210	Drill Rig Mobilization for Verification Sampling	2	EA	$3,500.00	$7,000
211	Geoprobe and Drill Crew for Verification Sampling	2	Day	$3,000.00	$6,000
212	Laboratory Analysis for VOCs in Water	16	EA	$60.00	$960
213	Laboratory Analysis for VOCs in Soil	40	EA	$72.00	$2,880
214	Laboratory Analysis for VOCs in Vapor	76	EA	$255.00	$19,380
215	Sample Shipping	2	LS	$150.00	$300
Restoration					**$87,000**
301	Procure & Deliver Backfill Material	119	BCY	$60.00	$7,143
302	Haul Backfill	158	LCY	$17.74	$2,809
303	Place Backfill	158	LCY	$1.55	$245
304	Compact Backfill	100	ECY	$1.41	$141
305	Procure & Deliver Topsoil	24	BCY	$93.78	$2,251
306	Haul Topsoil	27	LCY	$17.74	$473
307	Spread Topsoil	27	LCY	$2.68	$71
308	Fine Grade, Fertilize, and Seed Disturbed Area	144	SY	$4.29	$618

Feasibility Study Cost Estimate
Alternative 3 - High Temperature In Situ Thermal Remediation
Admiral Cleaners Site
Site Number 401075

City of Watervliet, Albany County, New York

Payment Item Number	Description	Estimated Quantity	Unit	Unit Price	**$ Total Cost**
309	Driller Mobilization for MW Installation	1	EA	$3,500.00	$3,500
310	Monitoring Well Installation	200	LF	$70.00	$14,000
311	Monitoring Well Pad Installation	8	EA	$325.00	$2,600
312	Restoration Survey	1	LS	$1,000.00	$1,000
313	Enhanced Bioremediation of Groundwater	1	LS	$24,003.00	$24,003
314	Geoprobe for injections	5	Days	$2,725.00	$13,625
315	Soft dig to 5 ft at injection points	5	EA	$625.00	$3,125
316	Oversight Labor & Equipment	100	HRS	$113.14	$11,314
CONSTRUCTION TOTAL					**$2,333,900**
	Contingency	20%	-	-	$466,780
CONSTRUCTION TOTAL WITH CONTINGENCY					**$2,800,700**
Engineering and Construction Management					**$845,000**
NA	Engineering Design & Bid Support	1	LS	$500,000.00	$500,000
NA	Construction Oversight	7	MO	$45,000.00	$315,000
NA	Final Engineering Report	1	LS	$30,000.00	$30,000
TOTAL OF CAPITAL COSTS (INCLUDING CONTINGENCY) AND ENGINEERING COSTS					**$3,645,700**
Long Term Monitoring - Annual					
401	Mobilization/Demobilization	1	Event	$1,500.00	$1,500
402	Sampling Labor and Equipment	1	LS	$3,000.00	$3,000
403	Lab Analyses for VOCs	11	EA	$60.00	$660
404	Lab Analyses for MNA Parameters	8	EA	$263.00	$2,104
405	Lab Analyses for PFAS	11	EA	$219.00	$2,409
406	Validation	22	EA	$48.00	$1,056
407	Shipping	1	LS	$150.00	$150
408	Reporting	1	Event	$5,000.00	$5,000
ANNUAL MONITORING TOTAL					**$15,879**
YEAR 1-2 MONITORING TOTAL (NPV)					**$125,524**
10 YEAR MONITORING TOTAL (NPV)					**$246,164**
30 YEAR MONITORING TOTAL (NPV)					**$516,168**
	Contingency	20%	-		$103,234
MONITORING TOTAL WITH CONTINGENCY (NPV)					**$619,500**
TOTAL ESTIMATED ALTERNATIVE COST WITH CONTINGENCY					***$4,265,200***

Feasibility Study Cost Estimate
Alternative 4 - Enhanced Bioremediation with Soil Cover System
Admiral Cleaners Site
Site Number 401075
City of Watervliet, Albany County, New York

Payment Item Number	Description	Estimated Quantity	Unit	Unit Price	**$ Total Cost**
Mobilization and Site Preparation					**$199,300**
101	Mobilization/Demobilization	10.0%	-	-	$33,798
102	Insurance	0.64%	-	-	$2,003
103	Performance Bond	2.50%	-	-	$7,825
104	Permitting	1	LS	$10,000	$10,000
105	Pre-Design Investigation	1	LS	$70,000	$70,000
106	Work Plan Preparation	1	LS	$10,000	$10,000
107	Survey/Boundaries & Markers	1	Day	$6,000	$6,000
108	Utility Locator	1	Day	$3,000	$3,000
109	Office Trailer	1	EA	$12,499.73	$12,500
110	Temporary Electricity Setup	1	LS	$3,078.08	$3,078
111	Geotextile for Construction Entrance	111	SY	$0.77	$86
112	Stone for Construction Entrance	19	LCY	$26.88	$498
113	Site Services	60	Day	$150.00	$9,000
114	Install Silt Fence	300	LF	$3.64	$1,092
115	Install Hay Bales	300	LF	$1.10	$330
116	Health & Safety	60	Day	$500.00	$30,000
Treatment					**$131,200**
201	Dust Monitoring	1	MO	$6,820.00	$6,820
202	Dust Control	30	Day	$1,159.85	$34,796
203	Enhanced Bioremediation	1	LS	$89,500.00	$89,500
Excavation					**$25,000**
301	Surface Soil Metal Contamination Excavation	100	BCY	$35.00	$3,500
302	Load Contaminated Material	100	BCY	$2.20	$220
303	Waste Characterization Sampling	3	EA	$935.00	$2,805
304	Transport and Dispose Contaminated Material	178	Tons	$82.00	$14,563
305	Confirmation Sampling	20	EA	$23.87	$477
306	Lab Analysis for Metals	20	EA	$120.00	$2,400
307	Excavation Survey	1	EA	$1,000.00	$1,000
Restoration					**$26,200**
401	Procure & Deliver Backfill Material	120	CY	$60.00	$7,200
402	Place Backfill Material	120	CY	$2.68	$322
403	Compact Backfill	120	CY	$1.41	$169
404	Regrading Area	133	SY	$5.00	$667
405	Procure & Deliver Topsoil	2	CY	$93.78	$226
406	Spread Topsoil	2	CY	$2.68	$6
407	Fine Grade, Fertilize, and Seed Disturbed Area	144	SY	$4.29	$620
408	Drilling Mobilization/Demobilization	1	EA	$3,500.00	$3,500
409	Replacement Monitoring Well Drilling	150	LF	$42	$6,300
410	Replacement Monitoring Well PVC Casing Install	150	LF	$28	$4,200
411	Replacement Monitoring Well Pad Construction	6	EA	$325	$1,950
412	Restoration Survey	1	LS	$1,000.00	$1,000
CONSTRUCTION TOTAL					**$381,700**

Feasibility Study Cost Estimate
Alternative 4 - Enhanced Bioremediation with Soil Cover System
Admiral Cleaners Site
Site Number 401075
City of Watervliet, Albany County, New York

Payment Item Number	Description	Estimated Quantity	Unit	Unit Price	**$ Total Cost**
	Contingency	20%	-		$76,340
CONSTRUCTION TOTAL WITH CONTINGENCY					**$458,100**
Engineering and Construction Management					**$260,000**
NA	Engineering Design & Bid Support	1	LS	$130,000.00	$130,000
NA	Construction Oversight	1	LS	$100,000.00	$100,000
NA	Final Engineering Report	1	LS	$30,000.00	$30,000
TOTAL OF CAPITAL COSTS (INCLUDING CONTINGENCY) AND ENGINEERING COSTS					**$718,100**
Long Term Monitoring - Annual					
501	Mobilization/Demobilization	1	Event	$1,500.00	$1,500
502	Sampling	1	LS	$3,000.00	$3,000
503	Lab Analyses for VOCs	11	EA	$60.00	$660
504	Lab Analyses for MNA Parameters	8	EA	$263.00	$2,104
505	Lab Analyses for PFAS	11	EA	$219.00	$2,409
506	Validation	22	EA	$48.00	$1,056
507	Shipping	1	LS	$150.00	$150
508	Reporting	1	Event	$5,000.00	$5,000
ANNUAL MONITORING TOTAL					**$15,879**
YEAR 1-2 MONITORING TOTAL (NPV)					**$125,524**
10 YEAR MONITORING TOTAL (NPV)					**$246,164**
30 YEAR MONITORING TOTAL (NPV)					**$516,168.14**
	Contingency	20%	-		$103,234
MONITORING TOTAL WITH CONTINGENCY (NPV)					**$619,500**
TOTAL ESTIMATED ALTERNATIVE COST WITH CONTINGENCY					***$1,337,600***

Feasibility Study Cost Estimate
Alternative 5 - Soil Removal and Enhanced Bioremediation
Admiral Cleaners Site
Site Number 401075
City of Watervliet, Albany County, New York

Payment Item Number	Description	Estimated Quantity	Unit	Unit Price	$ Total Cost
Mobilization and Site Preparation					**$533,300**
101	Mobilization/Demobilization	20.0%	-	-	$257,545
102	Insurance	0.64%	-	-	$8,241
103	Performance Bond	2.50%	-	-	$32,193
104	Permitting	1	LS	$10,000	$10,000
105	Pre-Design Investigation	1	LS	$60,000	$60,000
106	Work Plan Preparation	1	LS	$10,000	$10,000
107	Survey/Boundaries & Markers	1	Day	$6,000	$6,000
108	Utility Locator	1	Day	$3,000	$3,000
109	Office Trailer	1	EA	$12,499.73	$12,500
110	Temporary Electricity Setup	1	LS	$3,078.08	$3,078
111	Geotextile for Construction Entrance	111	SY	$0.77	$86
112	Stone for Construction Entrance	19	LCY	$26.88	$498
113	Site Services	75	Day	$1,500.00	$112,500
114	Install Silt Fence	300	LF	$3.64	$1,092
115	Install Hay Bales	300	LF	$1.10	$330
116	Health & Safety	30	Day	$500.00	$15,000
117	Well Abandonment	52	LF	$21.75	$1,141
Treatment					**$881,000**
201	Dust Monitoring	1	MO	$6,820.00	$6,820
202	Dust Control	30	Day	$1,159.85	$34,796
203	Cut Concrete Slab	70	LF	$290.87	$20,361
204	Transport and Dispose of Concrete	81	Tons	$82.00	$6,642
205	Excavate Contaminated Soil	1,680	BCY	$35.00	$58,800
206	Load Contaminated Soil	1,680	BCY	$2.20	$3,696
207	Excavation Survey	1	LS	$1,000.00	$1,000
208	Waste Characterization Sampling	6	EA	$935.00	$5,610
209	Transport and Dispose Hazardous Soil	1,568	Tons	$375.00	$588,000
210	Transport and Dispose Non-Hazardous Soil	1,120	Tons	$82.00	$91,840
211	Confirmation Sampling	20	EA	$23.87	$477
212	Lab Analyses for VOCs	20	EA	$60.00	$1,200
213	Enhanced Bioremediation for Groundwater	1	LS	$52,100.00	$52,100
214	Trench boxes (2x 8' by 16' boxes)	2	MO	$4,784.40	$9,569
Restoration					**$171,500**
301	Procure & Deliver Backfill Material	1,680	CY	$60.00	$100,800
302	Haul Backfill	2,234	LCY	$17.74	$39,638
303	Place Backfill	2,234	LCY	$1.55	$3,463
304	Compact Backfill	1,680	CY	$1.41	$2,369
305	Backfill Survey	1	LS	$1,000.00	$1,000
306	Procure & Deliver Topsoil	65	CY	$93.78	$6,078
307	Haul Topsoil	72	LCY	$17.74	$1,276
308	Spread Topsoil	72	LCY	$2.68	$193
309	Fine Grade, Fertilize, and Seed Excavation Area	389	SY	$4.29	$1,668
310	Driller Mobilization for MW Installation	1	EA	$3,500.00	$3,500
311	Monitoring Well Installation	150	LF	$70	$10,500
312	Restoration Survey	1	LS	$1,000.00	$1,000
313	Monitoring Well Pad Installation	6	EA	$325.00	$1,950
CONSTRUCTION TOTAL					**$1,585,800**
	Contingency	20%	-		$317,160
CONSTRUCTION TOTAL WITH CONTINGENCY					**$1,903,000**
Engineering and Construction Management					**$800,000**
NA	Engineering Design & Bid Support	1	LS	$500,000.00	$500,000
NA	Construction Oversight	6	MO	$45,000.00	$270,000
NA	Final Engineering Report	1	LS	$30,000.00	$30,000

Feasibility Study Cost Estimate
Alternative 5 - Soil Removal and Enhanced Bioremediation
Admiral Cleaners Site
Site Number 401075

City of Watervliet, Albany County, New York

Payment Item Number	Description	Estimated Quantity	Unit	Unit Price	**$ Total Cost**
TOTAL OF CAPITAL COSTS (INCLUDING CONTINGENCY) AND ENGINEERING COSTS					**$2,703,000**
Long Term Monitoring - Annual					
401	Mobilization/Demobilization	1	Event	$1,500.00	$1,500
402	Sampling	1	LS	$3,000.00	$3,000
403	Lab Analyses for VOCs	11	EA	$60.00	$660
404	Lab Analyses for MNA Parameters	8	EA	$263.00	$2,104
405	Lab Analyses for PFAS	11	EA	$219.00	$2,409
406	Validation	22	EA	$48.00	$1,056
407	Shipping	1	LS	$150.00	$150
408	Reporting	1	Event	$5,000.00	$5,000
ANNUAL MONITORING TOTAL					**$15,879**
YEAR 1-2 MONITORING TOTAL (NPV)					**$125,524**
10 YEAR MONITORING TOTAL (NPV)					**$246,164**
30 YEAR MONITORING TOTAL (NPV)					**$516,168**
Contingency		20%	-		$103,234
MONITORING TOTAL WITH CONTINGENCY (NPV)					**$619,500**
TOTAL ESTIMATED ALTERNATIVE COST WITH CONTINGENCY					***$3,322,500***

Feasibility Study Cost Estimate
Alternative 6 - Low Temperature In Situ Thermal Remediation with Enhanced Bioremediation
Admiral Cleaners Site
Site Number 401075
City of Watervliet, Albany County, New York

Payment Item Number	Description	Estimated Quantity	Unit	Unit Price	**$ Total Cost**
Mobilization and Site Preparation					**$863,900**
101	Mobilization/Demobilization	20.0%	-	-	$285,541
102	Insurance	0.64%	-	-	$9,137
103	Performance Bond	2.50%	-	-	$35,693
104	Permitting	1	LS	$10,000.00	$10,000
105	Pre Design Investigation	1	LS	$70,000	$70,000
106	Work Plan Preparation	1	LS	$10,000.00	$10,000
107	Survey/Boundaries & Markers	1	Day	$6,000	$6,000
108	Utility Locator	1	Day	$3,000	$3,000
109	Office Trailer	1	EA	$12,499.73	$12,500
110	Power Drop and Transformer Installation (100kW)	1	LS	$40,000.00	$40,000
111	Geotextile for Construction Entrance	111	SY	$0.77	$86
112	Stone for Construction Entrance	19	LCY	$26.88	$498
113	Site Services	730	Day	$500.00	$365,000
114	Install Silt Fence	300	LF	$3.64	$1,092
115	Install Hay Bales	300	LF	$1.10	$330
116	Health & Safety	30	Day	$500.00	$15,000
Treatment					**$879,700**
201	Dust Monitoring	1	MO	$6,820.00	$6,820
202	Dust Control	30	Day	$1,159.85	$34,796
203	Surface Soil Metal Contamination Excavation	100	BCY	$5.19	$519
204	Load Contaminated Material	100	BCY	$2.20	$220
205	Waste Characterization Sampling	2	EA	$935.00	$1,870
206	Transport and Dispose Contaminated Material	124	Tons	$82.00	$10,194
207	Thermal Treatment	1	LS	$660,000.00	$660,000
208	Utility Cost	1	LS	$60,000.00	$60,000
209	Enhanced Bioremediation	1	LS	$89,500.00	$89,500
210	Verification Sampling	72	EA	$23.87	$1,719
211	Drill Rig Mobilization for Verification Sampling	4	EA	$3,500.00	$14,000
212	Geoprobe and Drill Crew for Verification Sampling	4	Day	$3,000.00	$12,000
213	Laboratory Analysis for VOCs - Water	32	EA	$60.00	$1,920
214	Laboratory Analysis for VOCs - Soil	40	EA	$72.00	$2,880
215	Sample Shipping	4	LS	$150.00	$600

Feasibility Study Cost Estimate
Alternative 6 - Low Temperature In Situ Thermal Remediation with Enhanced Bioremediation
Admiral Cleaners Site
Site Number 401075
City of Watervliet, Albany County, New York

Payment Item Number	Description	Estimated Quantity	Unit	Unit Price	**$ Total Cost**
Restoration					**$14,500**
301	Procure & Deliver Backfill	119	BCY	$60.00	$7,143
302	Haul Backfill	158	LCY	$17.74	$2,809
303	Place Backfill	158	LCY	$1.55	$245
304	Compact Backfill	100	ECY	$1.41	$141
305	Procure & Deliver Topsoil	22	BCY	$93.78	$2,084
306	Haul Topsoil	25	LCY	$17.74	$438
307	Spread Topsoil	25	LCY	$2.68	$66
308	Fine Grade, Fertilize, and Seed Disturbed Area	133	SY	$4.29	$572
310	Restoration Survey	1	LS	$1,000.00	$1,000
CONSTRUCTION TOTAL					**$1,758,100**
	Contingency	20%	-	-	$351,620
CONSTRUCTION TOTAL WITH CONTINGENCY					**$2,109,800**
Engineering and Construction Management					**$890,000**
NA	Engineering Design & Bid Support	1	LS	$500,000.00	$500,000
NA	Construction Oversight	8	MO	$45,000.00	$360,000
NA	Final Engineering Report	1	LS	$30,000.00	$30,000
TOTAL OF CAPITAL COSTS (INCLUDING CONTINGENCY) AND ENGINEERING COSTS					**$2,999,800**
Long Term Monitoring - Annual					
401	Mobilization/Demobilization	1	Event	$1,500.00	$1,500
402	Sampling Labor and Equipment	1	LS	$3,000.00	$3,000
403	Lab Analyses for VOCs	11	EA	$60.00	$660
404	Lab Analyses for MNA Parameters	8	EA	$263.00	$2,104
405	Lab Analyses for PFAS	11	EA	$219.00	$2,409
406	Validation	22	EA	$48.00	$1,056
407	Shipping	1	LS	$150.00	$150
408	Reporting	1	Event	$5,000.00	$5,000
ANNUAL MONITORING TOTAL					**$15,879**
YEAR 1-2 MONITORING TOTAL (NPV)					**$125,524**
10 YEAR MONITORING TOTAL (NPV)					**$246,164**
30 YEAR MONITORING TOTAL (NPV)					**$516,168**
	Contingency	20%	-		$103,234
MONITORING TOTAL WITH CONTINGENCY (NPV)					**$619,500**
TOTAL ESTIMATED ALTERNATIVE COST WITH CONTINGENCY					***$3,619,300***

Feasibility Study Cost Estimate
Alternative 7 - ISCO & ISCR
Admiral Cleaners Site
Site Number 401075
City of Watervliet, Albany County, New York

Payment Item Number	Description	Estimated Quantity	Unit	Unit Price	$ Total Cost
Mobilization and Site Preparation					**$238,300**
101	Insurance	0.64%	-	-	$2,049
102	Permitting	1	LS	$20,000	$20,000
103	Pre-Design Investigation	1	LS	$70,000	$70,000
104	Work Plan Preparation	1	LS	$10,000	$10,000
105	Surveying and Record Drawing	1	LS	$37,000	$37,000
106	Utility Locator	1	Day	$3,000	$3,000
107	Office Trailer	1	EA	$12,499.73	$12,500
108	Temporary Electricity Setup	1	LS	$3,078.08	$3,078
109	Geotextile for Construction Entrance	111	SY	$0.77	$86
110	Stone for Construction Entrance	19	LCY	$26.88	$498
111	Site Services	90	Day	$150.00	$13,500
112	Install Silt Fence	500	LF	$4.20	$2,100
113	Install Hay Bales	1	LF	$890.00	$890
114	Cut and remove concrete slab	500	LS	$1.30	$650
115	Waste Characterization Sampling and Analysis-Debris	1	LS	$11,000.00	$11,000
116	Transport and Dispose of Concrete	81	Tons	$85.00	$6,885
117	Health & Safety	90	Day	$500.00	$45,000
Treatment					**$1,303,300**
	ISCO Injections				**$29,200**
201	Mobilization	1	LS	$1,500.00	$1,500
202	Dust Monitoring	1	LS	$1,159.85	$1,160
203	Dust Control	3	Day	$290.87	$873
204	RegenOx Part A	680	lb	$3.83	$2,604
205	RegenOx Part B	240	lb	$3.83	$919
206	Air Knife/Hand Clearance to 5-ft bgs	6	EA	$345.00	$2,070
207	Day Rate for DPT injection	3	Day	$5,600.00	$16,800
208	Support equipment including trucking of a min. 2,500 gallon of solution	3	Day	$403.00	$1,209
209	Injection Borehole Abandonment	60	LF	$1.75	$105
210	Standby time	1	LS	$375.00	$375
211	Demobilization	1	LS	$1,500.00	$1,500
	ISCO Mixing				**$701,800**
301	Mobilization	1	LS	$138,000.00	$138,000
302	Community Air Monitoring Plan Implementation	3	Months	$6,800.00	$20,400
303	Decommissioning wells	4	EA	$1,700.00	$6,800
304	Odor/Vapor Control Products-Rusmar Foam	72	Drum	$601.00	$43,272
305	Odor/Vapor Control Products-BioSolve Solution	2	Drum	$2,750.00	$5,500
306	InSitu Treatment	300	CY	$259.00	$77,700
307	RegenOx Part A (Application 1)	22,280	lb	$3.83	$85,321
308	RegenOx Part B (Application 1)	7,440	lb	$3.83	$28,491
309	Mobilization	1	LS	$85,500.00	$85,500
310	RegenOx Part A (Application 2)	22,280	lb	$3.83	$85,321
311	RegenOx Part B (Application 2)	7,440	lb	$3.83	$28,491
312	Perfmorance and Payment Bonds	1	LS	$71,500.00	$71,500
313	Closeout Documents and Submittals	1	LS	$25,500.00	$25,500
	ISS				**$485,000**
401	Mobilization	1	LS	$85,500.00	$85,500
402	ISS Start-Up Phase and Curing/Evaluation Period	1	LS	$37,000.00	$37,000
403	Pre-characterization Sampling and Analysis	4	EA	$1,250.00	$5,000
404	Post-ISS Excavation of ISS Swell and Onsite Management of Excavated Material	150	CY	$37.00	$5,550
405	ISS-Full-scale implementation (12% reageant mixture)	500	CY	$418.00	$209,000
406	Waste Characterization Sampling and Analysis-Soil	4	EA	$705.00	$2,820
407	Soil, ISS Swell, Comingled Debris: Transportation and Disposal	400	Ton	$61.00	$24,400
408	Demobilization	1	LS	$112,000.00	$112,000
409	Closeout Documents and Submittals	1	LS	$3,700.00	$3,700
	ISCR Injections				**$87,300**
501	Mobilization	1	LS	$1,500.00	$1,500
502	S-MicroZVI	1,500	lb	$13.01	$19,510
503	3-D Microemulsion	800	lb	$6.80	$5,437

Feasibility Study Cost Estimate
Alternative 7 - ISCO & ISCR
Admiral Cleaners Site
Site Number 401075
City of Watervliet, Albany County, New York

Payment Item Number	Description	Estimated Quantity	Unit	Unit Price	$ Total Cost
504	Bio-Dechlor Inoculum Plus	18	liters	$227.70	$4,099
505	Day Rate for DPT injection	9	Day	$5,600.00	$50,400
506	Support equipment including trucking of a min. 2,500 gallon of solution	9	Day	$403.00	$3,627
507	Injection Borehole Abandonment	440	LF	$1.75	$770
508	Standby time	1	LS	$375.00	$375
509	Demobilization	1	LS	$1,500.00	$1,500
	Treatment Monitoring				**$28,200**
601	Sampling Labor and Equipment	4	Event	$3,000.00	$12,000
602	Lab Analyses for VOCs-Aqueous	32	EA	$60.00	$1,920
603	Lab Analyses for VOCs-Non-Aqueous	32	EA	$72.00	$2,304
604	Lab Analyses for Performace Monitoring Parameters-Aqueous	32	EA	$203.00	$6,496
605	Lab Analyses for SVOCs-Non-Aqueous	32	EA	$150.00	$4,800
606	Shipping	4	Event	$150.00	$600
Excavation					**$25,000**
701	Pre-ISS Excavation (Areas subject to remediation) and Onsite Management of Excavated Material	100	BCY	$35.00	$3,500
702	Surface Soil Metal Contamination Excavation	100	BCY	$2.20	$220
703	Load Contaminated Material	3	EA	$935.00	$2,805
704	Waste Characterization Sampling	178	Tons	$82.00	$14,596
705	Transport and Dispose Contaminated Material	20	EA	$23.87	$477
706	Confirmation Sampling	20	EA	$120.00	$2,400
707	Lab Analysis for Metals	1	EA	$1,000.00	$1,000
Restoration					**$34,600**
801	Procure & Deliver Backfill Material	0	CY	$60.00	$0
802	Backfilling and Compaction of Clean Fill	0	CY	$60.00	$0
803	Pavement Site Cover (Within ISS Footprint)	280	SY	$83.00	$23,240
804	Replacement Monitoring Well Drilling	120	LF	$42	$5,040
805	Replacement Monitoring Well PVC Casing Install	120	LF	$28	$3,360
806	Replacement Monitoring Well Pad Construction	6	EA	$325	$1,950
807	Restoration Survey	1	LS	$1,000.00	$1,000
CONSTRUCTION TOTAL					**$1,629,400**
	Contingency	20%	-		$325,880
CONSTRUCTION TOTAL WITH CONTINGENCY					**$1,955,300**
Engineering and Construction Management					**$845,000**
NA	Engineering Design & Bid Support	1	LS	$500,000.00	$500,000
NA	Construction Oversight	7	Months	$45,000.00	$315,000
NA	Final Engineering Report	1	LS	$30,000.00	$30,000
TOTAL OF CAPITAL COSTS (INCLUDING CONTINGENCY) AND ENGINEERING COSTS					**$2,800,300**
Long Term Monitoring - Per Event					
901	Mobilization	1	Event	$1,500.00	$1,500
902	Sampling	1	LS	$3,000.00	$3,000
903	Lab Analyses for VOCs	11	EA	$60.00	$660
904	Lab Analyses for MNA Parameters	8	EA	$263.00	$2,104
905	Lab Analyses for PFAS	11	EA	$219.00	$2,409
906	Validation	22	EA	$48.00	$1,056
907	Shipping	1	LS	$150.00	$150
908	Reporting	1	Event	$5,000.00	$5,000
MONITORING TOTAL PER EVENT					**$15,879**
YEAR 1-2 MONITORING TOTAL (NPV)					**$125,524**
10 YEAR MONITORING TOTAL (NPV)					**$246,164**
10 YEAR MONITORING TOTAL (NPV)					**$516,168**
	Contingency	20%	-		$103,234
MONITORING TOTAL WITH CONTINGENCY (NPV)					**$619,500**
TOTAL ESTIMATED ALTERNATIVE COST WITH CONTINGENCY					***$3,419,800***

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