Feasibility Study

Former George A. Robinson & Company, Inc. Site
477 Whitney Road
Perinton, New York
Site # 828065
Work Assignment #D009804-19.1

February 2025

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February 7, 2025

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I, Daniel J. Loewenstein, certify that I am currently a NYS registered professional engineer and that this 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).

Daniel J. Loewenstein, P.E.,
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Acronyms and Abbreviations

amsl	above mean sea level
Arcadis	Arcadis of New York, Inc.
bgs	below ground surface
CAMP	Community Air Monitoring Plan
cis-1,2-DCE	cis-1,2-dichloroethene
Class GA Standard	New York State Class GA Groundwater Standard
CLCPA	Climate Leadership and Community Protection Act
cm/s	centimeter per second
COC	constituent of concern
DAC	disadvantaged community
DER	Division of Environmental Remediation
DPT	direct push technology
DNAPL	dense non-aqueous phase liquid
EDR	Environmental Data Records
EJScreen	Environmental Justice Screening and Mapping Tool
FS	Feasibility Study
GHG	greenhouse gas
gpm	gallons per min
ISCO	in-situ chemical oxidation
ITRC	Interstate Technology and Regulatory Council
LTM	long-term monitoring
µg/L	microgram per liter
$\mu g/m^3$	microgram per cubic meter
mg/kg	milligram per kilogram
MNA	monitored natural attenuation
ng/L	nanograms per liter
MiHpT	membrane interface probe/hydraulic profiling tool
MIP	membrane interface probe
NYCRR	New York Codes, Rules and Regulations
NYSDEC	New York State Department of Environmental Conservation

NYSDOH	New York State Department of Health
OM&M	operation, maintenance, and monitoring
OSHA	Occupational Safety and Health Administration
PAH	polycyclic aromatic carbon
PCE	tetrachloroethene
PEJA	Potential Environmental Justice Area
PFAS	per- and polyfluoroalkyl substances
PFOA	perfluorooctanoic acid
PFOS	perfluorooctanesulfonic acid
ppb	part per billion
ppm	part per million
ppt	pert per trillion
%	percent
PPE	personal protection equipment
PRAP	Proposed Remedial Action Plan
PRB	permeable reactive barrier
RAO	Remedial Action Objective
RI	Remedial Investigation
ROD	Record of Decision
SAT2	Site Assessment Team 2
SCG	Standards, Criteria, and Guidance
SCO	Soil Cleanup Objective
SCR	Site Characterization Report
site	Former George A. Robinson & Company, Inc. (Site #828065) located at 477 Whitney Road in the Town of Perinton, Monroe County, New York
SVI	soil vapor intrusion
TAL	target analyte list
TCE	trichloroethene
TCL	target compound list
USEPA	United States Environmental Protection Agency
VOC	volatile organic compound
ZVI	zero valent iron

1 Introduction

On behalf of the New York State Department of Environmental Conservation (NYSDEC), Arcadis of New York, Inc. (Arcadis) has prepared this Feasibility Study (FS) Report for the George A Robinson & Company, Inc. site (Site #828065), located in the Town of Perinton, Monroe County, New York (the "site") (**Figures 1-1 and 1-2**). This FS evaluates potential remedial alternatives for the site based on the evaluation criteria listed in the *NYSDEC Division of Environmental Remediation Technical Guidance for Site Investigation and Remediation* (DER-10) (NYSDEC 2010a). Following approval of this FS and selection of a preferred remedial alternatives for the site, the NYSDEC will issue a Proposed Remedial Action Plan (PRAP) for public comment. Following the public comment period, the NYSDEC will issue a Record of Decision (ROD) for the site.

The FS was performed under NYSDEC State Division of Environmental Remediation Standby Engineering Services Contract Work Assignment No. D009804-19.1 in accordance with the following: the NYSDEC's DER-10 (NYSDEC 2010a); the NYSDEC's guidance on presumptive remedies as defined in 6 New York Codes, Rules and Regulations (NYCRR) Part 375; the NYSDEC's DER program policy for Presumptive/Proven Remedial Technologies (DER-15); the NYSDEC's DER program policy for Green Remediation (DER-31) (NYSDEC 2010b); and other appropriate NYSDEC and United States Environmental Protection Agency (USEPA) guidance (e.g., USEPA 2008b, 2009, 2010).

1.1 Site Location and Background

The 13.67-acre site is located at 477 Whitney Road in the Town of Perinton, Monroe County, New York **(Figure 1-1**). The ground surface of the site is composed of unmaintained grassy fields, maintained lawn areas, wooded and brush covered areas, recessed lagoons, some asphalt pavement, and several buildings. The eastern two-thirds of the site is relatively flat. The western third of the site slopes gently to the west/southwest toward a ravine beyond the site fence where surface water drains to an unnamed tributary of the Irondequoit Creek. Ten (10) wood-frame buildings, some of which are used for the active manufacturing business, are currently present onsite. The site is fenced, and access is controlled by a locking entrance gate (**Figure 1-2**). Active site operations include metal parts manufacturing by Robinson Tools , LLC. The site is accessed via Whitney Road.

The site was originally part of the 48-acre John Case Farm. In 1930, 12 acres of the farm were sold to the Rochester Fireworks Company owned by Mr. George Robinson. The Rochester Fireworks Company manufactured fireworks in the 1930s and flares for the United States Navy during World War II (USEPA 2006). The Robinson Company started metal fabrication and manufacturing operations at the site in the mid-1950s. Processes included electroplating, anodizing, chemical conversion of aluminum, and mechanical finishing. Search warrant investigations at the site in 2005 revealed that substantial amounts of waste trichloroethene (TCE) had been disposed of on the property at two locations: directly west of Building 101 and at the western corner of the property (**Figure 1-2**). Also, process wastewater that contained heavy metals, hexavalent chromium, and cyanide was discharged to multiple lagoons at the western side of the site. Two lagoons and one settling pond are still present at the western portion of the site, adjacent to Buildings 52 and 64 (**Figure 1-2**). Process water was presumably discharged to ground surface in these areas during historical site processes.

The site is located in a mixed residential-commercial/light industrial area and is bordered by railroad, residential, commercial, and light industrial properties (**Figure 1-3**). The area around the site is a developing rural/suburban area. The property immediately east of the site has one commercial building and a parking area. To the north and across Whitney Road from the site are five mixed commercial/industrial properties comprised of three light industrial facilities and two commercial structures. Residential properties, a wooded ravine, and an unnamed tributary to Irondequoit Creek are located west of the site. CSX railroad tracks aligned generally east-west are located immediately south of the site. Further south are residential properties on Midvale Drive and a public use trail between Midvale Drive and the Irondequoit Creek. The nearest residential area to the site is approximately 0.1 miles south, on the northern side of Midvale Drive (**Figure 1-3**). This residential area and the residential area northwest of the site are serviced by municipal water supply. The Midvale Drive area is also serviced by public (County) sewer.

According to the Climate Leadership and Community Protection Act (CLCPA), disadvantaged communities (DACs) are identified based on a combination of environmental, economic, and health criteria. An evaluation was conducted to determine the proximity of the site to a DAC and whether the proposed remediation places a disproportionate burden on a DAC. Based upon this evaluation, The site is located more than 0.5 mile (approximately 1.2 miles) from a DAC; therefore, further DAC analysis is not required.

CLCPA defines Potential Environmental Justice Area (PEJA) communities as U.S. Census block groups of 250 to 500 households that met or exceeded at least one of the following statistical thresholds in the Census:

- •At least 52.42% of the population in an urban area reported themselves to be members of minority groups
- •At least 26.28% of the population in a rural area reported themselves to be members of minority groups
- •At least 22.82% of the population in an urban or rural area had household incomes below the federal poverty level

An evaluation was conducted to determine the proximity of the site to PEJA communities. There are two census block groups within a 0.5 mile of the site that are identified as PEJA communities, one in the Town of Perinton and one in the Village of Fairport. Property residents located within both tracts are within proximity to the site and have the potential to be impacted by an increase in exposure of potential pollutants that may be produced during remediation operations. The census block groups identified as PEJA communities are as follows:

Census Block Group 360550119014

Census Block Group 360550119014 consists of a portion of the Town of Perinton located east of the site. The factors that contribute PEJA identification in this block group include:

- Percentage of Population in an Urban Area Below Poverty Level: 35.13%

Census Block Group 360550118006

Census Block Group 360550118006 consists of a portion of the Village of Fairport located southeast of the site. The factors that contribute PEJA identification in this block group include:

- Percentage of Population in an Urban Area Below Poverty Level: 23.45%

1.2 Site Geology/Hydrogeology

The site is in the Eastern Lake Section of the Central Lowlands physiographic province. A majority of the Central Lowlands province was glaciated during Pleistocene times. The Eastern Lakes Section is covered by relatively young glacial till (Pirkle 1977). Soils in the vicinity of the site are comprised of lacustrine silt and clay and till formations (Cadwell and Muller 1986). Regional studies of the underlying aquifer indicate that overburden in the area is estimated to be approximately 50 to 60 feet thick, with upper layers composed of alternating silt, clay, and fine sand underlain by coarser sand and gravel deposits. Bedrock beneath the overburden is reported to be relatively flat bedded limestone and dolostone of the Upper Silurian Lockport Group (Fisher and Rickard 1970).

Soil borings were advanced to depths up to 68 feet below ground surface (bgs) during previous investigations at the site. Geology beneath the site is variable, but generally consists of one to five feet of fill material (soil mixed with trace to little asphalt and/or concrete) overlying approximately 10 to 40 feet of lacustrine deposits composed primarily of interbedded fine sand, silt, and clay. A USEPA site investigation in 2005 (see Section 1.3.2) documented that fill material from the regrading of Whitney and Baird Roads was used to backfill two of the four the lagoons (USEPA 2006). The lacustrine deposits overlie approximately 10 to 20 feet of till. Below the till, clayey silt and silty clay layers transition to silty sand (in the vicinity of MW-3D and MW-5) at approximately 49 to 58 feet bgs or sandy gravel (in the vicinity of MW-4) at approximately 51 feet bgs. There are discontinuous sand and gravel deposits overlying the till unit throughout the site. With the exception of location MW-10, till was not observed in borings south of the site. Bedrock was not encountered during previous investigation activities at the site.

Groundwater elevation data collected in October 2019 are shown on **Figure 1-4** and in August 2022 are shown on **Figure 1-5**. Potentiometric contours based on these data show groundwater at the site generally flowing southwest towards Thomas Creek and west towards the unnamed tributary. Thomas Creek and the unnamed tributary both discharge to Irondequoit Creek, which is located approximately 1,300 feet west of the site (**Figure 1-3**). Groundwater flow velocity at the site is variable due to varying lithology as shown in the schematic cross sections shown in **Figures 1-6 through 1-9**.

Hydraulic conductivity tests were conducted as part of previous investigations (see Section 1.3.4) at monitoring wells screened in three hydrogeologic formations: shallow and intermediate silty sand, intermediate sand and gravel, and deep fine sand or sand and gravel with silt and clay. Hydraulic conductivity at the shallow-screened (and one intermediate-screened) wells ranged from 8.5×10^{-5} to 3.3×10^{-4} centimeters per second (cm/sec) with a geometric mean of 1.4×10^{-4} cm/sec. Hydraulic conductivity at the intermediate-screened wells ranged from 1.3×10^{-3} to 7.7×10^{-3} cm/sec with a geometric mean of 1.8×10^{-3} cm/sec. Hydraulic conductivity at the deep-screened wells ranged from 1.0×10^{-3} to 2.6×10^{-3} cm/sec with a geometric mean of 1.6×10^{-3} cm/sec.

1.3 Environmental Investigations at the Site

Initial environmental investigations at the site were performed between 1986 and 2008. These investigations included soil sampling by NYSDEC in 1986, a site inspection by the USEPA in 2005, and site characterization by Arcadis (on behalf of NYSDEC) in 2008. A Remedial Investigation (RI) was subsequently conducted by Arcadis to evaluate: the nature and extent of target compound list (TCL) volatile organic compounds (VOCs), hexavalent chromium, and target analyte list (TAL) metals in soil, sediment, groundwater, and surface water on- and off-site; the potential for soil vapor intrusion (SVI) into on-site buildings and off-site properties as a result of former site activities; and the nature and extent of per- and polyfluoroalkyl substances (PFAS) in on-site soil and on-and off-site groundwater. These investigations are summarized in the following subsections.

1.3.1 1986 Soil Sampling

In 1986, the NYSDEC collected soil samples from various areas at the site. Elevated concentrations of chlorinated solvents and metals were detected in soil samples collected near Buildings 73 and 202 and in a sediment sample from a historical wastewater lagoon. These data led to the site being listed on the State's registry of inactive hazardous waste sites. The listing was challenged in court by the property owner at the time and the site was subsequently removed from the State's registry of inactive hazardous sites as mandated by the State Supreme Court.

1.3.2 2005 Site Inspection

In June 2005, representatives of the USEPA Region 2 Site Assessment Team 2 (SAT2) collected samples to further investigate potential impacts to on- and off-site soil. Laboratory results for surface and subsurface soil samples detected elevated concentrations of chromium (1,800 parts per million [ppm]), copper (380 ppm), nickel (170 ppm), lead (220 ppm), and zinc (3,600 ppm). Samples collected in June 2005 by the USEPA documented a release to surface water in the unnamed tributary to Irondequoit Creek adjacent to the northern and western boundary of the site, as indicated by analytical results of sediment samples. Concentrations of zinc (320 ppm) and cis-1,2-dichloroethene (cis-1,2-DCE) (170 parts per billion [ppb]) were present in sediment samples collected from this location. In August 2006, Weston Solutions, Inc. prepared a Site Inspection Prioritization Report for the USEPA (USEPA 2006) summarizing sampling activities and analytical data collected during the SAT2 Site Inspection.

1.3.3 2008 Site Characterization

In November 2008, Arcadis completed a Site Characterization Report (SCR) under NYSDEC Work Assignment # D-004439-7 following several field sampling activities (Malcolm Pirnie 2008). The SCR included sample collection and laboratory analysis of subsurface soils, lagoon sediments, and soil vapor to evaluate on- and off-site conditions, as well as use of membrane interface probe (MIP) boring data to determine areas where source material could potentially be located. Results from the investigation showed that solvent contamination was present in site soil and had impacted groundwater quality. Following the SCR, the site was again listed in the State's registry of inactive hazardous sites as a Class 2 site in 2009.

Data presented in the Site Inspection Prioritization Report and in the SCR, indicated that constituents of potential concern at the site are VOCs (TCE and cis-1,2-DCE) and metals, primarily chromium (hexavalent and trivalent), cadmium, copper, iron, and zinc.

1.3.4 2019-2023 Remedial Investigation

Between October 2019 and August 2022, Arcadis performed the first phase of the RI to further characterize the nature and extent of TCE, cis-1,2-DCE, hexavalent chromium, and other heavy metals associated with former parts manufacturing and metal plating operations at the site. The potential for migration of constituents of concern (COCs) and the potential for vapor intrusion on- and off-site were also evaluated during this phase. Groundwater samples were also collected and analyzed for PFAS and 1,4 dioxane. Phase 1 RI activities included:

- Review of site files and documents, and an Environmental Data Records (EDR) report;
- Site survey;
- Geophysical survey;
- Surface soil, sediment, groundwater, and surface water sampling;
- Groundwater monitoring well installation;
- MIP/hydraulic profiling tool (MiHPT) borings;

- Direct-push soil borings (soil and groundwater grab sampling);
- SVI study (indoor air and sub-slab vapor sampling at on-site and off-site locations);
- Groundwater hydraulic conductivity assessment; and
- Fish and Wildlife Resource Impact Analysis.

In July 2023, Arcadis completed the second phase of the RI, designed to further characterize the nature and extent of PFAS in soil based on groundwater data collected during the first mobilization of the RI as well as previous site operations and use. A total of 36 soil samples were collected and submitted for laboratory analysis of PFAS.

Data collected during the RI were compared to the following standards to identify site COCs:

- Analyte concentrations in soil samples were compared to 6 NYCRR Part 375 Commercial Use Soil Cleanup Objectives (SCOs) or, for PFAS, with *Protection of Groundwater Guidance Values in accordance with Sampling, Analysis, and Assessment of Per- and Polyfluoroalkyl Substances (PFAS) Under NYSDEC's Part 375 Remedial Programs* (NYSDEC 2023).
- Analyte concentrations in sediment samples were compared to Class A and Class C Sediment Guidance Values in accordance with *Screening and Assessment of Contaminated Sediment* (NYSDEC 2014).
- Analyte concentrations in groundwater sample results were compared to the NYSDEC Class GA Groundwater Quality Criteria (Class GA Standard) or, for PFAS, to the NYSDEC ambient water quality guidance values. 1,4-dioxane concentrations were compared to the Class GA guidance value.
- Analyte concentrations in surface water were compared to the New York State Class A Type H(WS) Surface Water Standard (Class A Standard) listed in the New York State Division of Water *Technical and Operational Guidance Series* version 1.1.1. Type H(WS) standards are for protection of surface water as a source of drinking water. The Class A Standard was selected for screening of surface water analytical results as a very conservative assumption due in part to lack of availability of standards for human health exposure for the water body classes sampled in the RI.
- SVI study results were compared to the matrices presented in the New York State Department of Health (NYSDOH) *Final Guidance for Evaluating Soil Vapor Intrusion in the State of New York* dated October 2006 and with revisions in May 2017.

The following COCs were identified in site soil and groundwater:

- COCs identified for surface soil were polycyclic aromatic carbons (PAHs) (benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene and indeno(1,2,3-cd)pyrene), cadmium, chromium, copper, lead, nickel, zinc, and PFAS (perfluorooctanesulfonic acid [PFOS]).
- COCs identified for subsurface soil were tetrachloroethene (PCE), benzo(a)pyrene, cadmium, chromium, copper, lead, nickel, and PFAS (PFOS).
- COCs identified for groundwater were TCE, cis-1,2-DCE, iron, magnesium, manganese, PFAS (PFOS and perfluorooctanoic acid [PFOA]).

VOCs were present in indoor air and sub-slab vapor samples collected at on-site Building 102. No COCs were identified for surface water or sediment.

The RI identified two potential source areas for the COCs at the site: Building 101 and adjacent historical settling pond to the west; and Building 64 and the adjacent historical settling pond and wastewater lagoons to the west.

The highest metals concentrations in site soil were detected in unsaturated soil samples collected from historical settling ponds/lagoons west of Building 64 and in the vicinity of the historical settling pond west of Building 101. The highest PFAS concentrations in soil were detected in unsaturated soil samples collected from historical settling ponds or in soils at the perimeter of Building 64.

The highest chlorinated VOC concentrations in groundwater were detected in shallow groundwater in historical settling ponds/lagoons west of Building 64, at the eastern perimeter of Building 64, and in the vicinity of Building 101. TCE concentrations in shallow groundwater samples collected during the RI indicated that residual separate-phase product is likely present, although it was not observed in groundwater or soil during the RI or previous investigations. The highest PFAS concentrations in groundwater were detected in shallow groundwater east of Building 64.

The PAHs identified as COCs were sporadically detected at concentrations greater than their respective Commercial Use SCOs in sediment and soil samples. These constituents are commonly found in urban sourced fill or associated with asphalt materials and are not considered to be associated with a spill or release at the site.

The RI Report provides additional details of the RI activities and findings (Arcadis 2023). The nature and extent of primary COCs at the site are summarized in the following section of this FS Report.

2 Conceptual Site Model

The primary COCs at the site are TCE, cis-1,2-DCE, metals, and PFAS. **Figures 2-1 and 2-2** show metals and PFAS (represented by PFOS) exceedances in soil, respectively. **Figures 2-3 through 2-5** show VOC, metals, and PFAS exceedances in groundwater, respectively. The nature and extent of these COCs are discussed in the following subsections.

2.1 Potential Source Areas

COCs are present in site soil and groundwater as a result of historical metal fabrication and manufacturing operations. The RI identified two potential source areas: Building 101 and the adjacent historical settling pond to the west; and Building 64 and the adjacent historical settling pond and wastewater lagoons to the west. Concentrations of COCs in site media are consistent with historical releases of chlorinated solvent, metals, and PFAS occurring adjacent to Buildings 52, 64, and 101. Additionally, discoloration has been observed in soil samples collected from the settling pond and wastewater lagoon areas, and sheens have been observed on saturated soil samples collected from the perimeter of Building 101 (Arcadis 2023).

2.1.1 Building 101 and Settling Pond

Elevated concentrations of TCE and cis-1,2-DCE were detected in shallow groundwater samples collected at the perimeter of Building 101. During initial site characterization activities in 2008, TCE was detected in a groundwater sample collected immediately downgradient of Building 101 at a concentration of 210,000 micrograms per liter (µg/L) (Malcolm Pirnie 2008). This concentration exceeds 1 percent (%) of the solubility of TCE (14,720 µg/L), indicating the potential presence of dense non-aqueous phase liquid (DNAPL), although DNAPL was not observed during either the site characterization or recent RI activities. TCE was detected downgradient of Building 101 in monitoring wells PZ-4 and MW-2 at concentrations of 280 µg/L and 620 µg/L, respectively, in August 2022 (**Figure 2-3**). The characterization of VOCs in groundwater below Building 101 is unknown because investigation below the building was not practicable due to access/structural design concerns; however, based upon groundwater samples collected from its perimeter, groundwater concentrations below the building are potentially elevated. Elevated concentrations of metals (cadmium, copper, lead, and nickel) were also detected in soil samples collected at the perimeter of Building 101 and in the approximate area of the historical settling pond immediately west of Building 101. Elevated concentrations of manganese, cadmium, arsenic, and chromium were detected in groundwater samples.

2.1.2 Building 64, Historical Settling Pond, and Wastewater Lagoon Area

COCs at concentrations that exceeded their respective soil and groundwater standards were identified in the vicinity of Building 64. COCs were detected in samples collected to the east at the perimeter of the building, as well as to the west in the area of a historical settling pond and lagoons. TCE in groundwater at monitoring well MW-3S, located on the upgradient perimeter of Building 64, was detected at a concentration of 67,000 µg/L, in August 2022 (**Figure 2-3**). This result exceeded 1% of the solubility of TCE, indicating the potential presence of DNAPL near MW-3S. PFOS was detected at 3,000 nanograms per liter (ng/L) in the sample collected from monitoring well MW-3S (**Figure 2-5**), which exceeded the NYSDEC human health criteria of 2.7 ng/l (i.e., parts per trillion [ppt]) for PFOS by three orders of magnitude. Given that Well MW-3S is located directly upgradient of Building 64, elevated concentrations of TCE and PFAS well above standards are likely present in the groundwater beneath this building. The highest reported detections of TCE and PFAS in groundwater samples collected during the RI were in the sample collected from monitoring well MW-3S.

2.2 Impacted Media

2.2.1 Soil

Soil at the site is impacted by VOCs, metals, and PFAS, both in the vadose and saturated zones. Only one soil sample, collected between 7.5 and 8 feet bgs at SB-134 (located east of Building 101), contained PCE at a concentration that exceeded both its protection of groundwater criterion and commercial SCO. Other soil samples with elevated VOC concentrations exceeded only protection of groundwater criteria. These samples were collected from locations around Buildings 52, 64, 73, and Building 101, as well as at the two northern wastewater lagoons. Metals concentrations in samples collected the vicinity of the former settling ponds and the southernmost wastewater lagoon exceeded commercial SCOs. Soil samples with PFAS concentrations that exceeded protection of groundwater criteria were also concentrated around Buildings 52, 64, 73, and 101.

2.2.2 Soil Vapor

Soil vapor beneath Building 102 is impacted by VOCs, specifically TCE. TCE concentrations that exceeded NYSDOH mitigation guidance values were reported in samples collected during 2018, 2021, and 2023 SVI investigations. No other onsite buildings were identified to have SVI concerns.

2.2.3 Groundwater

Groundwater at the site is impacted by VOCs (primarily TCE), metals, and PFAS. TCE concentrations above the NYSDEC Class GA standard were observed at the highest concentrations in samples collected from locations around Building 52, 64, 73, and 101. TCE-impacted groundwater was observed to extend offsite to a groundwater seep located approximately 700 feet south of the site (SW-8-SEEP on **Figure 2-3**). Metals at concentrations that exceeded the NYSDEC Class GA standard in groundwater included: arsenic at various locations throughout the site; cadmium in the vicinity of the settling pond southeast of Building 101; and total and hexavalent chromium in the southeast corner of the site. Groundwater impacted with PFAS was detected throughout the site, with the highest concentrations in the sample collected from MW-3S, located adjacent to Building 64.

2.3 COC Migration

The extent of COCs in soil, groundwater, indoor air, and sub-slab vapor indicates that the primary mode of migration from source areas was through dissolved-phase COC migration in the direction of groundwater flow. Concentrations of primary COCs decrease hydraulically downgradient of the potential source areas. COCs appear to have migrated through the mostly fine-grained lacustrine deposits (interbedded very fine sand, silt, and clay) to the top of till. TCE and cis-1,2-DCE that were detected in lower concentrations were in deeper groundwater than in shallow groundwater, indicating that the dense till is acting as a semi-confining layer.

2.4 Potential Exposure Pathways

A qualitative human health exposure pathway assessment was performed as part of the RI to identify both potential human receptor populations that may be exposed to media of concern at or in the vicinity of the site and potential exposure pathways and routes of exposure. The RI concluded that potential exposure pathways at the site primarily exist for those who could come in contact with groundwater and/or subsurface soil. Construction and utility workers could be exposed to subsurface soils during excavations via dermal contact, incidental ingestion, and inhalation of vapors and soil particulates. Complete groundwater exposure pathways for construction and utility workers include dermal contact, incidental ingestion, and inhalation of vapors. The RI also identified a complete exposure pathway via SVI and inhalation of indoor air in on-site Building 102 in the absence of engineering controls. COCs were detected in the sample from groundwater seep SW-8-SEEP (**Figure 2-3**); however, COCs were not detected in surface water samples collected from the receiving water body. Therefore, no complete exposure pathways to site COCs exists for this surface water or sediment.

3 Remedial Action Objectives and Evaluation Criteria

The RI identified the nature and extent of COCs, with exception of the southeastern extent of the COC-impacted shallow groundwater that extends from Building 101. However, the presumed sources and migration of COCs and exposure pathways were identified and the results from the RI provide sufficient data to evaluate potential remedial alternatives for the site.

The remedial goal for the site is restoration to pre-release conditions, to the extent feasible, given the existing and potential future land use and the presence of historical fill. At this time, the end use of the property is not known. It is expected to either be commercial land use or, potentially in the future, restricted residential land use.

3.1 Remedial Action Objectives

The Remedial Action Objectives (RAOs) for impacted media are listed below. Generally, these RAOs may be achieved by minimizing the:

- Magnitude and extent of COCs in impacted media;
- Migratory potential of the COCs; and
- Potential for human exposure to site-related COCs in impacted media.

3.1.1 Soil

The RAOs for soil are:

RAOs for Human Health Protection

- Prevent ingestion/direct contact with COC-impacted soil.
- Prevent inhalation exposure to COCs volatilizing from soil.

RAOs for Environmental Protection

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

3.1.2 Soil Vapor

The RAOs for soil vapor are:

RAOs for Human Health Protection

- Mitigate impacts to human health resulting from existing, or the potential for, SVI into occupied buildings.

3.1.3 Groundwater

The RAOs for groundwater are:

RAOs for Human Health Protection

- Prevent ingestion of groundwater with COC concentrations that exceed drinking water standards.
- Prevent contact with, or inhalation of, COCs volatilizing from contaminated groundwater.

RAOs for Environmental Protection

- Restore groundwater to pre-disposal/pre-release conditions, to the extent practicable.
- Remove the source(s) of COCs to groundwater.
- Prevent the discharge of COCs in groundwater to offsite surface water.

3.2 Evaluation Criteria

In accordance with DER-10 (NYSDEC 2010a), the remedial measure alternatives developed in this FS will be screened based on an evaluation of the following threshold criteria:

- Overall Protection of Human Health and the Environment; and
- Compliance with Standards, Criteria, and Guidance (SCGs).

The remedial alternatives will also be screened against the following balancing criteria:

- Long-Term Effectiveness and Permanence;
- Reduction of Toxicity, Mobility, and Volume;
- Short-Term Effectiveness;
- Implementability;
- Cost Effectiveness;
- Land Use; and
- Green and Sustainable Remediation in accordance with DER-31 (NYSDEC 2010b).

As stated in DER-10, the community acceptance criterion is evaluated after public review of the remedy selection process as part of the final DER selection/approval of a remedy for a site. As such, community acceptance of the remedial alternatives will not be evaluated in this FS Report.

3.2.1 Overall Protection of Human Health and the Environment

This criterion serves as a final check to assess whether each alternative meets the requirements that are protective of human health and the environment. The overall assessment of protection is based on a composite of factors assessed under the other evaluation criteria. The evaluation focuses on how a specific alternative achieves protection over time and how site risks are reduced. The analysis includes how each CPOC is to be eliminated, reduced, or controlled for each alternative.

3.2.2 Compliance with Standards, Criteria, and Guidance

This evaluation assesses how each alternative complies with 6 NYCRR Part 375 Unrestricted Use SCOs, 6 NYCRR Part 375 Protection of Groundwater SCOs, NYSDEC Class GA Standard, and the guidelines set forth in the NYSDOH October 2006 *Final Guidance for Evaluating Soil Vapor Intrusion in the State of New York*.

COC	Unrestricted Use SCO or Guidance (mg/kg)	Commercial Use SCO or Guidance (mg/kg)	Protection of Groundwater Guidance Value (mg/kg)	NYSDEC Class GA Standard or Guidance Value (µg/L)	NYSDEC Ambient Water Guidance Value (ng/L)	NYSDOH Air Guideline Value (µg/m3)
PCE	1.3	150	1.3	5	NA	30
TCE	0.47	200	0.47	5	NA	2
cis-1,2-DCE	0.25	500	0.25	5	NA	Na
Cadmium	2.5	9.3	7.5	5	NA	NA
Copper	50	270	1,720	200	NA	NA
Lead	63	1,000	450	25	NA	NA
Nickel	30	310	130	100	NA	NA
Zinc	109	10,000	2,480	2,000	NA	NA
PFOA	0.00066	0.50	0.0008	NA	6.7	NA
PFOS	0.00088	0.44	0.0001	NA	2.7	NA

Abbreviations:
$\mu g/m^3$: microgram per cubic meter
µg/L: microgram per liter
mg/kg: milligram per kilogram
NA: not applicable
ng/L: nanogram per liter

3.2.3 Long-Term Effectiveness and Permanence

This evaluation criterion addresses the results of a remedial alternative in terms of its permanence and quantity/nature of waste or residual remaining at the site after response objectives have been met. The primary focus of this evaluation is the extent and effectiveness of the controls that may be required to manage the waste or residual remaining at the site and operating system necessary for the remedy to remain effective. The factors being evaluated include the permanence of the remedial alternative, magnitude of the remaining risk, adequacy of controls used to manage residual waste, and reliability of controls used to manage residual waste.

3.2.4 Reduction of Toxicity, Mobility, and Volume

This evaluation criterion assesses the remedial alternative’s use of the technologies that permanently and significantly reduce toxicity, mobility, or volume of the hazardous wastes as their principal element. The NYSDEC’s policy is to give preference to alternatives that eliminate significant threats at the site through destruction of toxic contaminants, reduction of the total mass of toxic contaminants, irreversible reduction in the contaminants mobility, or reduction of the total volume of contaminated media. This evaluation includes: the amount of the hazardous materials that would be destroyed or treated; the degree of expected reduction in toxicity, mobility, or volume measured as a percentage; the degree to which the treatment would be irreversible; and the type and quantity of treatment residuals that would remain following treatment.

3.2.5 Short-Term Effectiveness

This evaluation criterion assesses the effects of the alternative during the construction and implementation phase. Alternatives are evaluated with respect to the effects on human health and the environment during implementation of the remedial action. The aspects evaluated include: protection of the community during remedial actions; environmental impacts as a result of remedial actions; time until the remedial response objectives are achieved; and protection of workers during the remedial action.

3.2.6 Implementability

This criterion addresses the technical and administrative feasibility of implementing an alternative and the availability of various services and materials required during its implementation. The evaluation includes: feasibility of construction and operation; the reliability of the technology; the ease of undertaking additional remedial action; monitoring considerations; activities needed to coordinate with other offices or agencies; availability of adequate off-site treatment, storage, and disposal services; availability of equipment; and availability of services and materials.

3.2.7 Cost Effectiveness

Cost estimates are prepared and evaluated for each alternative. The cost estimates include: capital costs; operation, maintenance, and monitoring (OM&M) costs; and future closeout costs. A cost sensitivity analysis is performed, which includes the following factors: effective life of the remedial action; OM&M costs; duration of the cleanup; volume of contaminated material; other design parameters; and discount rate. Cost estimates developed at the detailed analysis of alternatives phase of a FS generally have an expected accuracy range of -30% to +50% (USEPA 2000).

3.2.8 Land Use

This criterion assesses the current, intended, and reasonably anticipated future use of the site and its surroundings, as it relates to an alternative or remedy, when unrestricted levels would not be achieved (NYSDEC 2010a).

3.2.9 Green and Sustainable Remediation

This criterion evaluates the effect that the remedial alternative has on the environment and the sustainability of the alternative. The USEPA's *Consideration of Greener Cleanup Activities in the Superfund Cleanup Process* Memorandum (USEPA 2016) recommends approaches for regional remedial Superfund programs to consider throughout the remedy selection process and encourages regions to consider conducting a footprint analysis throughout the cleanup process.

A qualitative green remediation assessment was performed to serve as a differentiator in the evaluation of the proposed alternatives. The evaluation includes consideration of green remediation metrics to achieve an optimal solution which considers environmental effects of the proposed disposal options. The green and sustainable remediation principles considered herein are consistent with the following agency policies, practices, and strategies:

- NYSDEC DER-31 Green Remediation program policy (NYSDEC 2010b).
- USEPA Region 2 Clean & Green Policy (USEPA 2010).
- USEPA Principles for Green Clean-ups (USEPA 2009).

- The USEPA's Green Remediation: Best Management Practices for Excavation and Surface Restoration (USEPA 2008b).
- Interstate Technology Regulatory Council (ITRC) Sustainable Resilient Remediation guidance (ITRC 2021).
- USEPA Climate Adaptation Plans (USEPA 2021).
- USEPA Region 2 Climate Adaptation Implementation Plan (USEPA 2022).

A qualitative green remediation assessment was conducted for each of the alternatives relative to the five core elements of green remediation developed by the USEPA as defined in their *Principles for Greener Clean-up* issued in August 2009 (USEPA 2009). In addition, the USEPA technology primer titled *Green Remediation: Incorporating Sustainable Environmental Practices into Remediation of Contaminated Sites* (USEPA 2008b) was referenced in developing the below understandings of these core elements. Two additional elements (resilience and social impacts) were also considered. The resultant seven core green remediation elements used in this evaluation are described below:

1. **Energy requirements** include direct fuel consumption for both mobile and stationary sources and the purchase of commercial energy. Mobile sources can include heavy equipment or trucks and stationary sources can include equipment and facilities used for OM&M activities.
2. **Air emissions** include particulates and greenhouse gas (GHG) emissions generated from mobile and stationary sources.
3. **Water requirements and impacts on water resources** include the consideration of water use from potable sources, reused water, or recovered water generated onsite from excavation dewatering. Impacts on water resources can include how stormwater is handled on site, how the remedial alternative affects groundwater supply and quality, and whether or not water is permanently added to or removed from the watershed.
4. **Land and ecosystem impact** considers the overall footprint of the alternative and relevant changes in the cover system and how those changes affect stormwater generation. Furthermore, this metric considers the impact of the remedy implementation, including installation and operation of the cover system, on flora and fauna habitats.
5. **Material consumption and waste generation** considers material throughput of the system during every stage of the project, including temporary and permanent materials.
6. **Resilience** considers the effect on each alternative of the site's susceptibility to extreme weather events, including flooding, sea level rise, extreme precipitation, extreme temperatures, and high winds.
7. **Social impacts** examine the anticipated effects of each alternative on community stakeholders. Considerations included short- and long- term disruptions (traffic, noise, visual) and physical effects such as dust production. The USEPA Environmental Justice Screening and Mapping Tool (EJScreen) was used to better customize analysis of this element to the community around the site (USEPA 2023). The EJScreen results indicated that Monroe County is at or below most state and national indicators for pollution exposure; this status was considered when evaluating the remedial alternatives. The EJScreen Community Report is provided in **Appendix A**.

Each alternative was ranked as High, Medium, or Low sustainability based on a comprehensive evaluation of the core elements.

Green and sustainable remediation considerations were evaluated for major site activities that differentiated each of the alternatives. Components that were shared between all six alternatives (Section 4.1) were not evaluated because they were not relevant to the comparison of the alternatives.

A quantitative sustainability assessment for the selected proposed remedial alternatives evaluation was also conducted, using USEPA's SiteWise™ Tool for Green and Sustainable Remediation. The assessment includes a quantitative assessment of GHG emissions; energy use (total energy use and electricity from renewable and non-renewable sources); air emissions of criteria pollutants (total emissions and onsite emissions), including nitrogen oxide, sulfur oxide, and particulate matter; water consumption; resource consumption and waste generation (landfill space and top soil consumption); and worker safety (risk of fatality, injury and lost hours). Metric quantification was completed for activities conducted onsite and transportation associated with movement of materials, waste, and workers to and from the site. The evaluation is provided in **Appendix B**.

3.3 Identification and Screening of Technologies

General response actions, which may be effective remedies for the remediation of soil, soil vapor, and/or groundwater at the site, and remedial technologies are identified and screened in **Tables 3-1 through 3-3** for soil, soil vapor, and groundwater, respectively. Remedial alternatives are identified and evaluated relative to multiple criteria in **Tables 3-4 through 3-6** for soil, soil vapor, and groundwater, respectively.

In-situ technologies for treatment of chlorinated VOCs have been implemented over several decades, and design and implementation principals are well established. In contrast, in situ solutions for management of PFAS in soil and groundwater are limited and in the early stages of development. Legacy sites with existing groundwater extraction and treatment systems can implement ex-situ PFAS treatment through addition of carbon or resin adsorption systems. An alternative approach to groundwater extraction and ex-situ treatment that has been developed more recently is an adaptation of activated carbon technology for injection into the subsurface. When emplaced in the aquifer, PFAS (and chlorinated VOCs) sorb to the activated carbon as groundwater migrates through the injection area. While the use of activated carbon technology in ex-situ applications is well understood, field testing of in-situ applications remains at the small-scale or pilot testing stage, with long term-effectiveness therefore unknown. Because the in-situ performance of this activated carbon technology relies upon direct contact between PFAS in groundwater and the activated carbon, a thorough understanding of the conceptual site model and achieving uniform in-situ distribution of the activated carbon throughout the target treatment area are critical to the technology's effectiveness. Also, the mix of constituents present in groundwater must be well understood because sorption of PFAS to activated carbon will be impacted by other constituents that also sorb to activated carbon (i.e., chlorinated VOCs) and thus "compete" for sorption capacity. Because of the relative newness of this in-situ approach, the long-term performance, and in particular the potential for desorption over time, is not well understood. While not originally implemented for mitigation of PFAS in groundwater, activated carbon injection has been performed at PFAS-impacted sites in New York, primarily in the Brownfields Cleanup Program, and at Federal sites. Overall, however, in-situ PFAS treatment technologies do not have the record of remedial success that has been established for other in-situ and ex-situ technologies evaluated for this FS.

4 Remedial Alternatives Analysis

Remedial alternatives were developed and evaluated for COCs in onsite and offsite media. The following subsections summarize the common components assumed for each remedial alternative and then describe the specifics of each proposed remedial alternative.

4.1 Components Common to Each Remedial Alternative

Each remedial alternative evaluated for the site (excluding the No Action alternative) is anticipated to include the following components:

- Demolition of Buildings 52, 64, and 73;
- Vapor intrusion mitigation in Building 102;
- Institutional Controls;
- Site Management Plan; and
- Long-Term Monitoring (LTM) of onsite and downgradient offsite groundwater quality.

Extraction from and/or injection into site media are also components common to each remedial alternative evaluated for the site (excluding the No Action alternative). To support development and analysis of site-specific alternatives, data from the RI were used to develop estimates of potential extraction and injection rates for site media in target injection/extraction areas.

Target injection/extraction areas would be generally aligned with the shallow groundwater flow direction in and downgradient of source areas under and/or around Buildings 52, 64, 73, and 101. As shown on the site geology cross-sections (**Figures 1-7 through 1-9**), saturated thickness above the glacial till in these areas ranges between approximately 12 and 27 feet. To optimize operational flow rates, extraction wells and injection points for remedial alternatives would be screened in the coarser sand and gravel deposits beneath the site, with anticipated screen intervals up to approximately 10 feet in length within the shallow groundwater zone. A screened interval of 10 feet located entirely within the coarser sand and gravel deposits has been assumed for the purposes of FS cost estimation.

As presented in the RI Report (Arcadis 2023) and summarized in Section 1.2, hydraulic conductivity values from slug tests at shallow-screened (and one intermediate-screened) site wells ranged from 8.5×10^{-5} cm/sec to 3.3×10^{-4} cm/sec with a geometric mean of 1.4×10^{-4} cm/sec. Using this geometric mean and a pseudo steady state, 365-day evaluation, the Theis solution (Reed 1980) estimated the maximum sustained extraction rate for a well screened across 10 feet of coarser sand and gravel deposits beneath the site as approximately 5 gallons per minute (gpm). Based on this evaluation, a well spacing of approximately 140 feet would provide effective groundwater capture between extraction wells.

The approach provided in USEPA's *A Systematic Approach for Evaluation of Capture Zones at Pump and Treat Systems* (USEPA 2008a) was used to estimate the total extraction rate required to provide effective capture of impacted site groundwater. Additional information considered in this evaluation was the site groundwater elevation (which ranges between 368 and 406 feet above mean sea level [amsl]; **Figures 1-4 and 1-5**) and groundwater hydraulic gradient in the area of Buildings 52, 64, 73, and 101. The latter was estimated between 0.023 and 0.042 foot/foot using *3PE: A Tool for Estimating Groundwater Flow Vectors* (Beljin et al. 2014). This tool provided by USEPA generated estimated extraction rates for prevention off-site migration of impacted site groundwater that ranged between 50 and 100 gpm. For the purpose of FS design and costing, a total extraction rate of approximately 60 gpm was used, requiring installation of at least 12 extraction wells. The infiltration/injection rate into target site media was estimated at 2 gpm, or 40% of the maximum sustained extraction rate based on industry standard.

4.2 Proposed Remedial Alternatives

Based on the site characteristics, technology screening, and in consultation with the NYSDEC, the following remedial alternatives are considered to be potentially applicable to address site COCs in soil and groundwater:

Alternative 1: No Action

Alternative 2: Return to Pre-Disposal Conditions

Alternative 3: Source Soil Excavation, Soil Treatment, and Groundwater Treatment

Alternative 4: Source Soil Excavation and Groundwater Treatment

Alternative 5: Partial Source Soil Excavation and Prevention of Off-site Migration

Alternative 6: Partial Source Soil Excavation, Cover, and Prevention of Off-site Migration

This section presents an analysis of each proposed remedial alternatives evaluated against the criteria described in Section 3.2. The active remediation alternatives (Alternatives 2 through 6) focus on addressing COCs in soil and groundwater. Because the PAHs identified as COCs in site media are commonly found in urban sourced fill or associated with asphalt materials and not considered to be associated with a spill or release at the site, PAHs in soil and groundwater are not specifically addressed in the remedial alternatives presented below.

4.3 Remedial Alternatives Evaluation

4.3.1 Alternative 1: No Action

The No Action alternative, by definition, involves no institutional controls, environmental monitoring, or remedial action, and therefore, includes no technological barriers. In accordance with DER-10 (NYSDEC 2010a), this alternative serves as a baseline, defining the minimum steps that would be taken at the site in the absence of any type of action directed at the existing contamination. The site buildings would remain in their current states.

Alternative 1 would include abandoning the 20 monitoring wells and piezometers (referred to collectively herein as wells) installed during the remedial investigations, which are depicted on **Figure 4-1** and listed below:

- MW-1
- MW-2
- MW-3S
- MW-3D
- MW-4
- MW-5
- MW-6S
- MW-6D
- MW-7
- MW-8
- MW-9
- MW-10
- MW-11
- MW-12
- MW-13
- MW-14
- PZ-1
- PZ-2
- PZ-3
- PZ-4

4.3.1.1 Overall Protection of Human Health and the Environment

Alternative 1 would not be protective of human health and the environment because soil and groundwater containing COCs at concentrations greater than applicable soil and groundwater standards would remain at the site. Although the nearest receptors are supplied with public drinking water and are prohibited from using groundwater as a source of potable water, potential exposure to contaminated soil and groundwater by site workers and/or visitors would remain.

4.3.1.2 Compliance with Standards, Criteria, and Guidance

Alternative 1 would not meet the SCGs because contamination would persist at concentrations greater than standards/guidelines in soil and groundwater.

4.3.1.3 Long-Term Effectiveness and Permanence

Alternative 1 would not meet the SCGs over the long term because contamination would persist at concentrations greater than standards/guidelines in soil and groundwater.

4.3.1.4 Reduction of Toxicity, Mobility, and Volume

Alternative 1 would not reduce the toxicity or mobility of the contaminants; however, the volume of contamination may be reduced over the long term through natural attenuation and/or off-site migration.

4.3.1.5 Short-Term Effectiveness

Community Protection

Standard protection measures for mitigation of environmental impacts and nuisance conditions would be implemented during well abandonment.

Worker Protection

Implementation of this alternative would be undertaken using standard procedures for worker protection, including the establishment of a health and safety plan, which would outline the appropriate protective measures that should be undertaken during subsurface activities in the affected area.

Environmental Impacts

Implementation of this alternative would not be expected to create adverse environmental impacts.

Time Required to Implement

This alternative would require less than one year to implement.

4.3.1.6 Implementability

The No Action alternative can be easily implemented but would not be compliant with NYSDEC regulations/policy.

4.3.1.7 Cost

The capital and present value costs for Alternative 1 are summarized in **Table 4-1** and detailed in **Appendix C (Table C-1)**. There are no OM&M costs for this alternative.

- Capital Costs: The probable capital cost of Alternative 1 related solely to abandonment of wells is estimated at $110,000.
- Present Value Cost: The present value for this alternative is estimated at $110,000.

4.3.1.8 Land Use

The No Action alternative would not achieve criteria for the current or anticipated future (i.e., commercial or restricted residential) land use for the site.

4.3.1.9 Green and Sustainable Remediation

An evaluation of Alternative 1 against the seven core green remediation elements defined in Section 3.2.9 is provided below. However, since the alternative would not meet the SCGs overall this alternative is not considered sustainable.

- **Energy Requirements:** The energy usage associated with Alternative 1 would be minimal and would primarily include fuel consumption by work vehicles to complete the well abandonment.
- **Air Emissions:** The air emissions associated with Alternative 1 would be minimal and would primarily include particulate and GHG emissions from vehicles commuting to and around the site.
- **Water Requirements and Impact on Water Resources:** Water requirements associated with Alternative 1 would be negligible. There would be no anticipated impacts to stormwater or groundwater supply, usage, or quality.
- **Land and Ecosystem Impact:** With the exception of short-term vehicle traffic for the well abandonment event, Alternative 1 would not have significant impacts on the ecosystem or habitats of flora and fauna.
- **Material Consumption and Waste Generation:** Materials consumed by Alternative 1 would be limited to bentonite and/or grout used to abandon the 20 existing site monitoring wells. Minimal waste would be generated under Alternative 1.
- **Resilience:** Alternative 1 would not require permanent infrastructure that would be susceptible to extreme weather events. However, this alternative leaves soil and groundwater impacts in place that could migrate in events such as floods.
- **Social Impacts:** This alternative would have minimal short- or long-term disturbances on the community in the form of noise or dust. However, migration of impacts could have an impact on the community.

Overall, Alternative 1 would have a minimal physical footprint but would not be a protective solution. A summary of this evaluation is provided in **Table 4-2**.

4.3.2 Alternative 2: Return to Pre-Disposal Conditions

In addition to the common components listed in Section 4.1, Alternative 2 includes the following elements, which are depicted on **Figure 4-2**:

- Demolition of Building 101 using standard construction and demolition techniques.
- Predesign investigation and remedial design:
  - Installation of 30 soil borings beneath and surrounding building footprints to fully delineate and characterize source soil; and
  - Remedial design of excavation.
- Excavation of vadose zone soil source areas of VOCs, PFAS, and metals (approximately 4,400 cubic yards) using standard construction techniques.
- Treatment of groundwater on and off the property containing COCs at concentrations greater than NYSDEC Class GA Standards via groundwater extraction and treatment. The main components are as follows:
  - Installation of 16 extraction wells (estimated extraction rate of up to 5 gpm at each well);
  - Design, construction, and installation of a groundwater treatment system to treat both VOC and PFAS impacts to groundwater at rates up to 80 gpm;
  - Trenching and installation of approximately 2,700 feet of subsurface piping;
  - Connection of extraction wells and subsurface piping to the treatment system;
  - Permitting, trenching, and connection for discharge of treated groundwater to the storm water management system;
  - Operation and maintenance of the extraction and treatment system for an estimated 20 years to achieve SCOs based upon source soil removal, the known site characteristics, and the COCs; and
  - Execution of a LTM program that includes semi-annual monitoring and reporting during the 20 years of extraction and treatment system operation.

4.3.2.1 Overall Protection of Human Health and the Environment

Alternative 2 would result in protection of human health and the environment. Metals and VOCs at concentrations above criteria in source soils would be eliminated via excavation and off-site disposal. PFAS and VOCs at concentrations above criteria in both on- and off-site groundwater would be reduced through groundwater extraction and treatment. LTM combined with a limited monitored natural attenuation (MNA) assessment would be used to monitor and/or further reduce contaminant concentrations over time to ensure protection of human health and the environment during implementation. Following groundwater extraction and treatment implementation, LTM/MNA would be used to evaluate decreasing COC concentrations over time.

4.3.2.2 Compliance with Standards, Criteria, and Guidance

Alternative 2 would meet soil SCGs over the short term by removing impacted soil and is expected to meet groundwater SCGs over the long term by treating impacted groundwater.

4.3.2.3 Long-Term Effectiveness and Permanence

Alternative 2 would be effective in the long term by treating remaining impacted groundwater. VOCs and metals in source soils would be removed from the site via excavation. VOCs and PFAS concentrations in groundwater would be significantly reduced over time through groundwater extraction and treatment and natural attenuation for VOCs. Following remedy implementation, concentrations of VOCs, PFAS, and metals in soil and groundwater will be reduced to low levels and show established downward trends to ensure continued compliance with NYSDEC Class GA Standard or Guidance Values.

4.3.2.4 Reduction of Toxicity, Mobility, and Volume

Alternative 2 would significantly reduce the toxicity, mobility, and volume of COCs.

VOCs in source soils would be removed from the site via excavation resulting in a significant reduction of toxicity and volume. VOCs present in on- and off-site groundwater would be removed via groundwater extraction and treated through carbon. These remedial actions would be irreversible and would result in a significant reduction in VOC mass flux from on-site source areas. Natural attenuation during and post active remedial actions would result in the destruction of VOCs over time and is irreversible.

Similar to VOCs, PFAS in both on- and off-site groundwater would be removed via extraction and treated through carbon and/or resin. This removal would be irreversible and reduce toxicity.

Metals in source soils would be removed from the site via excavation resulting in a significant reduction of toxicity and volume. Metals concentrations above criteria in groundwater are limited in area and are not widespread in off-site groundwater. This remedial alternative would result in a reduction of the flux of metals from soil into groundwater and reduce metals mobility. Source soil excavation and treatment of VOCs in groundwater is expected to result in restoration of groundwater to a more oxidized natural state over time, further lowering the mobility of metals.

4.3.2.5 Short-Term Effectiveness

Community Protection

Enhanced protection measures for mitigation of environmental impacts and nuisance conditions would be implemented during all active phases of this alternative. These measures include, but are not limited to, implementation of a community air monitoring plan (CAMP), a dust control plan, erosion and sedimentation controls, and installation of temporary fencing.

Worker Protection

Implementation of this alternative would be undertaken using enhanced procedures for worker protection, including the establishment of a health and safety plan, which would outline the appropriate protective measures that should be undertaken during on-site work. In addition, daily job briefing meetings would be held to discuss the anticipated work to be completed each day.

Environmental Impacts

Implementation of this alternative would not be expected to create adverse environmental impacts.

Time Required to Implement

This alternative would likely require approximately three years to implement the remedial construction.

4.3.2.6 Implementability

Alternative 2 would be implemented using readily available technologies; however, it would require significant clearing both onsite and offsite. This alternative would require construction of a building to house the groundwater treatment system and significant trenching both on- and off-site in challenging terrain to connect extraction wells to the system. The complex geology of the site, which comprises fine and silty sands, could pose challenges for installation and operation of extraction wells to effectively target impacted groundwater. The number of extraction wells expected to be required to capture on- and off-site groundwater is significant and would require long term operation and maintenance of installed infrastructure. Periodic redevelopment and/or replacement of extraction wells would also likely be required. This remedial alternative would require long term access to the property and access agreements for installation of off-site infrastructure and drilling beneath the rail line south of the property. This alternative would require a permit to connect to stormwater system and discharge of treated groundwater.

4.3.2.7 Cost

The capital, OM&M, and present value costs for Alternative 2 are presented in **Table 4-1** and detailed in **Appendix C (Table C-2)**. Cost projections assume that wastes generated during remedy implementation (e.g., excavated soil, decontamination water, and spent carbon) will be F listed.

- Capital Costs: The probable capital cost is estimated at $7.2 million. This cost includes demolition of on-site buildings, remedial design and predesign investigations, excavation of source soils, and installation and startup of a groundwater extraction and treatment system.
- OM&M Costs: The annual OM&M cost for this alternative is estimated at $528,000. This includes operation and maintenance of the groundwater extraction and treatment system and LTM.
- Present Value Cost: The present value for this alternative is estimated at $16.7 million. This estimate was calculated using a -1% annual discount rate based on the difference between 10-year treasury and US inflation rates.

4.3.2.8 Land Use

This alternative would return the site to pre-disposal conditions resulting in unrestricted land use.

4.3.2.9 Green and Sustainable Remediation

An evaluation of Alternative 2 against the seven core green remediation elements defined in Section 3.2.9 is provided below.

- **Energy requirements:** The energy requirements associated with Alternative 2 would be high in the short-term, specifically associated with transportation of materials and wastes and operation of heavy equipment associated with the excavation, installation of the groundwater extraction and treatment system, and building demolition. Additionally, operation of the treatment system for 20 years would create moderate long-term energy requirements. Long-term energy requirements associated with long term monitoring would be negligible.
- **Air emissions:** Short-term air emissions would include particulates and greenhouse gas emissions from transportation (personnel, materials, waste), and heavy equipment operation. Transportation and treatment of wastes would result in a high emissions footprint. Long-term air emissions would be associated with operation

of the groundwater extraction and treatment system for a 20-year period. Long term emissions associated with long-term monitoring would be negligible.

- **Water requirements and impacts on water resources:** Water use associated with the excavation and the groundwater extraction and treatment system would be minimal. While the groundwater extraction and treatment system would remove a large amount of groundwater, it would be treated and discharged to the storm sewer.
- **Land and ecosystem impact:** Alternative 2 would cause short-term disruption of the vegetation and fauna within the footprint of construction and demolition activities. However, long-term land and ecosystem impacts would be minimal after site restoration.
- **Material consumption and waste generation:** Initial material consumption would be moderate to high for Alternative 2 for the select granular fill and top soil associated with backfilling and restoration of the excavation. Waste generation would be high in the form of contaminated soil and water from the excavation, installation of the groundwater extraction and treatment system, and construction and debris waste associated with the building demolition. The long-term material consumption and waste generated by the groundwater extraction and treatment system would be moderate and include treatment media which will require change-out over the 20-year lifetime of the system.
- **Resilience:** By removing contaminated source material, Alternative 2 would reduce the potential for migration of impacts due to extreme weather events such as flooding. However, permanent infrastructure associated with the groundwater extraction and treatment system would be more susceptible to extreme weather events, which could cause damage and require repair or replacement.
- **Social impacts:** Alternative 2 would have high short-term impacts in the form of noise, traffic, and potential dust during active construction phases. However, the long-term impact of groundwater extraction and treatment would be relatively low. Alternative 2 would also mitigate the potential for future migration of impacts, which is protective of the community long-term.

Alternative 2 would have a high short-term footprint due to the extent of the active construction work and waste production, and a moderate long-term footprint. Therefore, the sustainability of this alternative is ranked as Low. A summary of this evaluation is provided in **Table 4-2**.

4.3.3 Alternative 3: Source Soil Excavation, Soil Treatment, and Groundwater Treatment

In addition to the common components listed in Section 4.1, Alternative 3 includes the following elements, which are depicted on **Figure 4-3**:

- Demolition of Building 101 using standard construction and demolition techniques.
- Predesign investigation and remedial design:
  - Installation of 30 soil borings beneath and surrounding building footprints to fully delineate and characterize soil source impacts;
  - Field injectability testing for in-situ chemical oxidation (ISCO) amendment (sodium permanganate) and colloidal carbon;
  - Design of excavation and in-situ stabilization of metals in source soils;
  - Design of ISCO injection using direct push technology (DPT); and

  - Design of colloidal carbon injection using DPT.
- Excavation of vadose zone soil source areas containing TCE at concentrations exceeding the Protection of Groundwater SCO of 0.47 mg/kg. TCE is considered the driver of VOC contamination in soil. The estimated excavation volume is 3,000 cubic yards.
- In-situ stabilization of vadose zone soil source areas containing metals at concentrations exceeding applicable Protection of Groundwater SCOs. In-situ stabilization involves mixing in a remedial amendment into the soil to prevent leaching of the targeted metals to groundwater. The stabilization volume is estimated to be 500 cubic yards.
- Treatment of groundwater via ISCO in source areas. ISCO injections would be performed at approximately 30 to 40 locations with DPT rigs with the following major assumptions:
  - DPT points installed over 5-foot screen intervals;
  - Injection rates of 2 gpm;
  - Injection of 2,500 gallons of 3% permanganate solution at each point;
  - Simultaneous injection into five points; two injection setups; and
  - Four-week injection program.
- Performance monitoring following ISCO application that includes the following:
  - Monthly monitoring at 12 wells; and
  - Quarterly monitoring at 12 wells.
- Follow up ISCO application in source areas. ISCO injections would be performed at approximately 20 to 30 locations with DPT rigs with the following major assumptions;
  - DPT points installed over 5-foot screen intervals;
  - Injection rates of 2 gpm;
  - Injection of 2,500 gallons of 3% permanganate solution at each point;
  - Simultaneous injection into five points; and
  - Three-week injection program.
- Treatment of PFAS in groundwater via colloidal carbon injection in three potential source areas. Colloidal carbon injections would be performed at approximately 80 to 90 locations using DPT rigs with the following major assumptions:
  - DPT points installed over 5-foot screen intervals;
  - Injection rates of 2 gpm;
  - Injection of 1,000 gallons of colloidal carbon solution at each point;
  - Simultaneous injection into five points; and
  - Five-week injection program.
- LTM for an estimated 15 years to achieve SCGs in groundwater post-ISCO and colloidal carbon injections based upon source soil/removal/stabilization, the known site characteristics, and the COCs.

Treatment of PFAS in soil is not included under this alternative because PFAS concentrations in site soil samples were below the applicable Commercial SCOs.

4.3.3.1 Overall Protection of Human Health and the Environment

Alternative 3 would result in protection of human health and the environment. Metals and VOCs at concentrations above criteria in source soils would be eliminated via excavation or, for metals, controlled via in-situ stabilization. VOCs at concentrations above criteria in site groundwater will be reduced through ISCO injections and reductions would be confirmed/tracked through post injection monitoring. PFAS concentrations in site groundwater would be reduced and controlled through injection of colloidal carbon. Off-site groundwater impacts would attenuate and/or be reduced over time due to treatment of on-site sources. LTM would be used to track COC concentrations over time to ensure protection of human health and the environment during remedial implementation and achieve/confirm PFAS, VOCs, and metals concentrations below criteria in groundwater.

4.3.3.2 Compliance with Standards, Criteria, and Guidance

Alternative 3 would meet soil and groundwater SCGs. Excavation, in-situ treatment, performance monitoring, and reporting would be conducted in compliance with federal and state requirements.

4.3.3.3 Long-Term Effectiveness and Permanence

Alternative 3 would be moderately effective in the long term by treating sources of impacted soil and groundwater. VOCs and metals in source soils would be removed from the site via excavation resulting in long-term effectiveness and permanence. Metals in source soils that remain on site would be in a stabilized form preventing/limiting further leaching to groundwater. VOCs in source area groundwater would be directly targeted and their concentrations reduced via ISCO injection. ISCO would not be effective in reducing PFAS concentrations. Rather, PFAS in source area groundwater would be bound to the colloidal carbon where distributed. The colloidal carbon will also bind VOCs and other non-target compounds naturally present organic matter. When the injected colloidal carbon is spent, it cannot be regenerated in place. Desorption of PFAS and/or other bound compounds could occur over time, reducing long-term permanence. Concentrations of VOCs and PFAS that remain in groundwater post remediation are expected to attenuate over time and/or be reduced through reduction of mass flux from treated source soils. Follow up injections of either ISCO and/or colloidal carbon may be necessary for long-term effectiveness and permanence.

4.3.3.4 Reduction of Toxicity, Mobility, and Volume

Alternative 3 would reduce the toxicity, mobility, and volume of VOCs, metals, and PFAS in on-site soil and groundwater. Off-site downgradient groundwater impacts would be reduced over time as a result of reduced mass flux from the site but not be targeted directly.

VOCs in source soils would be removed from the site via excavation resulting in a significant reduction of toxicity and volume. VOCs present in on-site source groundwater would be destroyed via ISCO application where distributed. These remedial actions would be irreversible and would result in a significant reduction in VOC mass flux from on-site source areas. Natural attenuation during and post active remedial actions would result in the destruction of VOCs over time and is irreversible.

PFAS in on-site source groundwater would be immobilized via injection of colloidal carbon. Post remediation, PFAS would remain bound to the injected carbon, reducing their mobility. This reduction would be reversible to an extent because desorption of PFAS bound to injected colloidal carbon is possible when the adsorption capacity of the injected carbon is exceeded. PFAS concentrations in off-site groundwater would decrease over time due to the reduction of mass flux from the site.

Metals in source soils would be immobilized in place via in-situ stabilization, resulting in a significant reduction of toxicity and volume. Metals concentrations above criteria in groundwater are limited in area and are not widespread in off-site groundwater. This remedial alternative would result in a reduction of the mass flux of metals from soil into groundwater and reduce metals mobility. Source soil excavation and treatment of VOCs in groundwater is expected to result in restoration of groundwater to a more oxidized natural state over time, further lowering the mobility of metals.

4.3.3.5 Short-Term Effectiveness

Community Protection

Enhanced protection measures for mitigation of environmental impacts and nuisance conditions would be implemented during all active phases of this alternative. These measures include, but are not limited to, implementation of a CAMP, a dust control plan, geotechnical monitoring of surrounding buildings, secured and ventilated chemical storage area, chemical secondary containment, erosion and sedimentation controls, and installation of temporary fencing.

Worker Protection

Implementation of this alternative would be undertaken using enhanced procedures for worker protection, including the establishment of a health and safety plan, which would outline the appropriate protective measures that should be undertaken during on-site work. In addition, daily job briefing meetings would be held to discuss the anticipated work to be completed each day. During the ISCO injection, modified Level C personal protection equipment (PPE) would be required for handling, storing, and injecting the chemical. As ISCO is injected, pressures will be monitored and recorded to avoid pressure buildups and injuries.

Environmental Impacts

Implementation of this alternative would not be expected to create adverse environmental impacts.

Time Required to Implement

It is anticipated that remedial construction for this alternative would be implemented and completed within two years.

4.3.3.6 Implementability

Alternative 3 would be implemented using readily available technologies; however, implementation would require extensive site controls. Alternative 3 utilizes standard excavation techniques and requires pilot testing and predesign investigation to design an effective treatment approach. Treatment of VOCs in groundwater via ISCO would be complicated due to the difficulty associated with the injection and distribution of oxidant into the lower permeability and heterogeneous underlying soils at the site (comprising fine and silty sands and till). Colloidal carbon injections would encounter similar distribution challenges due to the complex site geology.

4.3.3.7 Cost

The capital, OM&M, and present value costs for Alternative 3 are presented in **Table 4-1** and detailed in **Appendix C (Table C-3)**. Cost projections assume that wastes generated during remedy implementation (e.g., excavated soil, decontamination water, and water generated during LTM) will be F listed.

- Capital Costs: The probable capital cost is estimated at $6.0 million. This cost includes demolition of on-site buildings, remedial design and predesign investigations, excavation/stabilization of source soils, ISCO injection, and colloidal carbon injection.
- OM&M Costs: The annual OM&M costs is estimated at $88,000 with one-time costs of 220,000 in Year 2 and $270,000 in Year 4. This includes post-injection performance monitoring and LTM.
- Present Value Cost: The present value for this alternative is estimated at $7.7 million. This estimate was calculated using a -1% annual discount rate.

4.3.3.8 Land Use

This alternative would result in unrestricted land use for soil and restricted land use for groundwater. COCs in site soil would be addressed through excavation or in-situ treatment and their concentrations would be reduced to below Protection of Groundwater SCOs. COCs in groundwater would be addressed through in-situ treatment but their concentrations would still exceed NYSDEC Class GA Standard or Guidance Values.

4.3.3.9 Green and Sustainable Remediation

An evaluation of Alternative 3 against the seven core green remediation elements defined in Section 3.2.9 is provided below.

- **Energy Requirements:** The energy requirements associated with Alternative 3 would be high in the short-term, specifically associated with transportation of materials and wastes and operation of heavy equipment associated with the source area excavation, stabilization, building demolition, and injections. However, long-term emissions associated with monitoring would be negligible.
- **Air Emissions:** Short-term air emissions would include particulates and greenhouse gas emissions from transportation (personnel, materials, waste), and heavy equipment operation. Transportation and treatment of wastes would result in a high emissions footprint. Long-term air emissions associated with monitoring would be negligible.
- **Water Requirements and Impact on Water Resources:** Water requirements associated with Alternative 3 would be moderate in the short-term to supply the water needed for the injections. However, long term water use associated with this alternative would be minimal.
- **Land and Ecosystem Impact:** Alternative 3 would cause short-term disruption of the vegetation and fauna within the footprint of construction and demolition activities. However, long-term land and ecosystem impacts would be minimal after site restoration. Land and ecosystem impacts resulting from soil and groundwater treatment would be minimal.
- **Material Consumption and Waste Generation:** Material consumption for Alternative 3 would be high and include the select granular fill and top soil associated with backfilling and restoration of the excavation, stabilization materials for the soil mixing and injection chemicals. Waste generation would be high in the form of contaminated soil and water associated with the source area excavation and construction and debris waste

associated with the building demolition. The long-term footprint of waste and materials consumption would be minimal.

- **Resilience:** By removing contaminated source material, Alternative 3 would reduce the potential for migration of impacts due to extreme weather events such as flooding. Additionally, Alternative 3 would not require permanent infrastructure that could be susceptible to extreme weather events. Excavated areas would be restored to natural site conditions and no long-term impacts would be expected.
- **Social Impacts:** Alternative 3 would have high short-term impacts in the form of noise, traffic, and potential dust during active construction phases. However, the long-term impact would be negligible. Alternative 3 also mitigates the potential for future migration of impacts, which would be protective of the community long-term.

Alternative 3 would have a moderate to high short-term footprint due to active construction work and waste production, but a low long-term footprint. Therefore, the sustainability of this alternative is ranked as Moderate. A summary of this evaluation is provided in **Table 4-2**.

4.3.4 Alternative 4: Source Soil Excavation and Groundwater Treatment

In addition to the common components listed in Section 4.1, Alternative 4 includes the following elements, which are depicted on **Figure 4-4**:

- Demolition of Building 101 using standard construction and demolition techniques.
- Predesign investigation and remedial design:
  - Installation of approximately 30 soil borings beneath and surrounding building footprints to fully delineate and characterize soil source impacts;
  - Field injectability testing for ISCO amendment (sodium permanganate) and colloidal carbon;
  - Design of excavation;
  - Design of ISCO injection event using DPT; and
  - Design of colloidal carbon injection using DPT.
- Excavation of vadose zone soil source areas containing TCE at concentrations exceeding the Protection of Groundwater SCO of 0.47 mg/kg. TCE is considered the driver of VOC contamination in soil. The estimated excavation volume is 3,000 cubic yards.
- Excavation of vadose zone soil source areas containing metals at concentrations exceeding Protection of Groundwater SCOs. The estimated excavation volume is 500 cubic yards.
- Treatment of groundwater via ISCO in source areas. ISCO injections would be performed at approximately 30 to 40 locations with DPT rigs with the following major assumptions:
  - DPT points installed over 5-foot screen intervals;
  - Injection rates of 2 gpm;
  - Injection of 2,500 gallons of 3% permanganate solution at each point;
  - Simultaneous injection into five points; two injection setups; and
  - Four-week injection program.
- Performance monitoring following ISCO application that includes the following:

  - Monthly monitoring at 12 wells; and
  - Quarterly monitoring at 12 wells.
- Follow up ISCO application in source areas. ISCO injections would be performed at approximately 20 to 30 locations with DPT rigs with the following major assumptions;
  - DPT points installed over 5-foot screen intervals;
  - Injection rates of 2 gpm;
  - Injection of 2,500 gallons of 3% permanganate solution at each point;
  - Simultaneous injection into five points; and
  - Three-week injection program.
- Treatment of PFAS in groundwater via colloidal carbon injection in three potential source areas. Colloidal carbon injections would be performed at approximately 80 to 90 locations using DPT rigs with the following major assumptions:
  - DPT points installed over 5-foot screen intervals;
  - Injection rates of 2 gpm;
  - Injection of 1,000 gallons of colloidal carbon solution at each point;
  - Simultaneous injection into five points; and
  - Five-week injection program.
- LTM for an estimated 15 years to achieve SCOs in groundwater post-ISCO and colloidal carbon injections based upon source soil/removal/stabilization, the known site characteristics, and the COCs.

Treatment of PFAS in soil is not included under this alternative because PFAS concentrations in site soil samples were below the applicable Commercial SCOs.

4.3.4.1 Overall Protection of Human Health and the Environment

Alternative 4 would result in protection of human health and the environment. Metals and VOCs at concentrations above criteria in source soils would be eliminated via excavation and off-site disposal. VOCs at concentrations above criteria in on-site groundwater would be reduced through ISCO injections and reductions would be confirmed/tracked through post injection monitoring. PFAS concentrations in site groundwater would be reduced and controlled through placement of colloidal carbon. Off-site groundwater impacts would attenuate and/or be reduced over time due to treatment of on-site sources. LTM would be used to track COC concentrations over time to ensure protection of human health and the environment during remedial implementation and achieve/confirm PFAS, VOCs, and metals concentrations below criteria in groundwater.

4.3.4.2 Compliance with Standards, Criteria, and Guidance

Alternative 4 would meet soil and groundwater SCGs. Excavation, in-situ treatment, performance monitoring, and reporting would be conducted in compliance with federal and state requirements.

4.3.4.3 Long-Term Effectiveness and Permanence

Alternative 4 would be effective in the long term by treating sources of impacted soil and groundwater. VOCs and metals in source soils would be removed from the site via excavation resulting in long-term effectiveness and permanence. VOCs in source area groundwater would be directly targeted and their concentrations reduced via ISCO injection. ISCO would not be effective in reducing PFAS concentrations. Rather, PFAS in source area groundwater would be bound to the colloidal carbon where distributed. The colloidal carbon will also bind VOCs and other non-target compounds related to natural organic matter. When the injected colloidal carbon is spent, it cannot be regenerated in place. Desorption of PFAS and/or other bound compounds could occur over time, reducing long-term permanence. Concentrations of VOCs and PFAS that remain in groundwater post remediation are expected to attenuate over time and/or be reduced through reduction of mass flux from treated source soils. Follow up injections of either ISCO and/or colloidal carbon may be necessary for long-term effectiveness and permanence.

4.3.4.4 Reduction of Toxicity, Mobility, and Volume

Alternative 4 would reduce the toxicity, mobility, and volume of VOCs, metals, and PFAS in on-site soil and groundwater. Off-site downgradient groundwater impacts would be reduced over time as a result of reduced mass flux from the site but not be targeted directly.

VOCs in source soils would be removed from the site via excavation resulting in a significant reduction of toxicity and volume. VOCs present in on-site source groundwater would be destroyed via ISCO application where distributed. These remedial actions would be irreversible and would result in a significant reduction in VOC mass flux from on-site source areas. Natural attenuation during and post active remedial actions would result in the destruction of VOCs over time and is irreversible.

PFAS in on-site source groundwater would be immobilized via injection of colloidal carbon. Post remediation, PFAS would remain bound to the injected carbon, reducing their mobility. This reduction would be reversible to an extent because desorption of PFAS bound to the injected colloidal carbon is possible when the adsorption capacity of the injected carbon is exceeded. PFAS concentrations in off-site groundwater would decrease over time due to the reduction of mass flux from the site.

Metals in source soils would be removed from the site via excavation resulting in a significant reduction of toxicity and volume. Metals concentrations above criteria in groundwater are limited in area and are not widespread in off-site groundwater. This remedial alternative would result in a reduction of the mass flux of metals from soil into groundwater and reduce metals mobility.

Source soil excavation and treatment of VOCs in groundwater is expected to result in restoration of groundwater to a more oxidized natural state over time, further lowering the mobility of metals.

4.3.4.5 Short-Term Effectiveness

Community Protection

Enhanced protection measures for mitigation of environmental impacts and nuisance conditions would be implemented during all active phases of this alternative. These measures include, but are not limited to, implementation of a CAMP, a dust control plan, geotechnical monitoring of surrounding buildings, secured and ventilated chemical storage area, chemical secondary containment, erosion and sedimentation controls, and installation of temporary fencing.

Worker Protection

Implementation of this alternative would be undertaken using enhanced procedures for worker protection, including the establishment of a health and safety plan, which would outline the appropriate protective measures that should be undertaken during on-site work. In addition, daily job briefing meetings would be held to discuss the anticipated work to be completed each day. During the ISCO injection, modified Level C PPE would be required for handling, storing, and injecting the chemical. As ISCO is injected, pressures will be monitored and recorded to avoid pressure buildups and injuries.

Environmental Impacts

Implementation of this alternative would not be expected to create adverse environmental impacts.

Time Required to Implement

It is anticipated that remedial construction for this alternative would be implemented and completed within four years.

4.3.4.6 Implementability

Alternative 4 would be implemented using standard excavation techniques and readily available technologies, such as hollow stem auger drilling via easily maneuverable drill rigs and temporary injection system setups. Alternative 4 requires pilot testing and predesign investigation to design an effective treatment approach. Treatment of VOCs in groundwater via ISCO would be complicated due to the difficulty associated with the injection and distribution of oxidant into the lower permeability and heterogeneous underlying soils at the site (comprising fine and silty sands and till). Colloidal carbon injections would encounter similar distribution challenges due to the complex site geology.

4.3.4.7 Cost

The capital, OM&M, and present value costs for Alternative 4 are presented in **Table 4-1** and detailed in **Appendix C (Table C-4)**. Cost projections assume that wastes generated during remedy implementation (e.g., excavated soil, decontamination water, and water generated during LTM) will be managed as F-listed hazardous waste.

- Capital Costs: The capital cost is estimated at $6.3 million. This cost includes demolition of on-site buildings, remedial design and predesign investigations, excavation of source soils, ISCO injection, and colloidal carbon injection.
- OM&M Costs: The annual OM&M costs is estimated at $88,000 with one-time costs of 220,000 in Year 2 and $270,000 in Year 4. This includes post-injection performance monitoring and LTM.
- Present Value Cost: The probable net present value for this alternative is estimated at $8.1 million. This was calculated using a -1% annual discount rate.

4.3.4.8 Land Use

This alternative would result in unrestricted land use (soil) and restricted land use (groundwater). COCs in site soil would be addressed through excavation or in-situ treatment and their concentrations would be reduced to below Protection of Groundwater SCOs. COCs in groundwater would be addressed through in-situ treatment but their concentrations would still exceed NYSDEC Class GA Standard or Guidance Values.

4.3.4.9 Green and Sustainable Remediation

An evaluation of Alternative 4 against the seven core green remediation elements defined in Section 3.2.9 is provided below.

- **Energy Requirements:** The energy requirements associated with Alternative 4 would be high in the short-term, specifically associated with transportation of materials and wastes and operation of heavy equipment associated with the source area excavation, building demolition, and ISCO and colloidal carbon injections. However, long-term emissions associated with monitoring would be negligible.
- **Air Emissions:** Short-term air emissions would include particulates and greenhouse gas emissions from transportation (personnel, materials, waste), and heavy equipment operation. Transportation and treatment of wastes would result in a high emissions footprint. Long-term air emissions associated with monitoring would be negligible.
- **Water Requirements and Impact on Water Resources:** Water requirements associated with Alternative 4 would be moderate in the short-term to supply the water needed for the injections. However, long term water use associated with this alternative would be minimal. The ISCO and carbon injections would protect nearby water resources from off-site migration of impacts.
- **Land and Ecosystem Impact:** Alternative 4 would cause short-term disruption of the vegetation and fauna within the footprint of construction and demolition activities. However, long-term land and ecosystem impacts would be minimal after site restoration.
- **Material Consumption and Waste Generation:** Material consumption for Alternative 4 would be high and include select granular fill and top soil associated with backfilling and restoration of the excavation, and injection chemicals. Waste generation would be high in the form of contaminated soil and water from the source area excavation footprint, and construction and debris waste associated with the building demolition. The long-term footprint of waste and materials consumption would be minimal.
- **Resilience:** By removing contaminated source material, Alternative 4 would reduce the potential for migration of impacts due to extreme weather events such as flooding. Additionally, Alternative 4 would not require permanent infrastructure that could be susceptible to extreme weather events. Excavated areas would be restored to natural site conditions and no long-term impacts would be expected.
- **Social Impacts:** Alternative 4 would have high short-term impacts in the form of noise, traffic, and potential dust during active construction phases. However, the long-term impact would be negligible. Alternative 4 also would mitigate the potential for future migration of impacts through source area removal and injections, which would be protective of the community long-term.

Alternative 4 would have a moderate to high short-term footprint due to active construction work and waste production, but a low long-term footprint. Therefore, the sustainability of this alternative is ranked as Moderate. A summary of this evaluation is provided in **Table 4-2**.

4.3.5 Alternative 5: Partial Source Soil Excavation and Prevention of Off-site Migration

In addition to the common components listed in Section 4.1, Alternative 5 includes the following elements, which are depicted on **Figure 4-5**:

- Excavation of vadose zone soil source areas containing TCE at concentrations exceeding the Protection of Groundwater SCO of 0.47 mg/kg. TCE is considered the driver of VOC contamination in soil. The estimated excavation volume is 2,800 cubic yards.
- Excavation of vadose zone soil source areas containing metals at concentrations exceeding Protection of Groundwater SCOs. The estimated excavation volume is 500 cubic yards.
- Prevention of off-site migration of chlorinated VOC-impacted groundwater via a property boundary permeable reactive barrier (PRB) to the south of Buildings 101 and 201. For the purpose of costing and evaluation, it has been assumed that the PRB would installed using a biopolymer slurry to emplace a 20% by volume mixture of zero valent iron (ZVI). Additional site characterization activities to assess groundwater quality and lithology along the planned PRB alignment would be performed during remedial design. Site groundwater samples would also be collected for a laboratory treatability study to assess rate of degradation of VOCs specific to the ZVI-site groundwater combination. The PRB installation would be performed with the following major assumptions:
  - Length of approximately 220 feet;
  - Targeted depth of installation to 20 feet bgs; and
  - Tied into underlying till.
- Treatment of groundwater via ISCO downgradient of Building 64. The ISCO injections would be performed at approximately 20 to 30 locations with DPT rigs with the following major assumptions:
  - DPT points installed over 5-foot screen intervals;
  - Injection rates of 2 gpm;
  - Injection of 2,500 gallons of 3% permanganate solution at each point;
  - Simultaneous injection into five points; two injection setups; and
  - Three-week injection program.
- Performance monitoring following ISCO application that includes the following:
  - Monthly monitoring at 12 wells; and
  - Quarterly monitoring at 12 wells.
- Follow up ISCO application downgradient of Building 64. ISCO injections would be performed at approximately 10 to 20 locations with DPT rigs with the following major assumptions;
  - DPT points installed over 5-foot screen intervals;
  - Injection rates of 2 gpm;
  - Injection of 2,500 gallons of 3% permanganate solution at each point;
  - Simultaneous injection into five points; and
  - Three-week injection program.
- Treatment of PFAS in groundwater via colloidal carbon injection in three potential source areas. Colloidal carbon injections would be performed at approximately 80 to 90 locations using DPT rigs with the following major assumptions:
  - DPT points installed over 5-foot screen intervals;
  - Injection rates of 2 gpm;
  - Injection of 1,000 gallons of colloidal carbon solution at each point;

  - Simultaneous injection into five points; and
  - Five-week injection program.
- LTM for 20 years to achieve SCOs in groundwater post-ISCO and colloidal carbon injections and PRB installation based upon partial source soil removal, the known site characteristics, and the COCs.

Treatment of PFAS in soil is not included under this alternative because PFAS concentrations in site soil samples were below the applicable Commercial SCOs.

4.3.5.1 Overall Protection of Human Health and the Environment

Alternative 5 would result in protection of human health and the environment. Metals and VOCs at concentrations above criteria in source area soils would be eliminated via excavation. PFAS concentrations in site groundwater would be reduced and controlled through injection of colloidal carbon. VOCs at concentrations above criteria in on-site groundwater near and downgradient of Building 64 would be reduced through ISCO injections and reductions would be confirmed/tracked through post injection monitoring. Off-site migration of VOC-impacted groundwater near Building 101 would be controlled through PRBs installed at targeted areas along the property boundary. Off-site groundwater impacts would attenuate and/or be reduced over time due to removal of on-site sources. LTM would be used to track COC concentrations over time to ensure protection of human health and the environment during remedial implementation and achieve/confirm PFAS, VOCs, and metals concentrations below criteria in groundwater over time.

4.3.5.2 Compliance with Standards, Criteria, and Guidance

Alternative 5 would meet soil and groundwater SCGs. Excavation, performance monitoring, and reporting would be conducted in compliance with federal and state requirements.

4.3.5.3 Long-Term Effectiveness and Permanence

In Alternative 5, VOCs and metals in source soils would be removed from the site via excavation. Treatment of VOCs at concentrations above criteria in on-site groundwater near and downgradient of Building 64 would be reduced through ISCO injections and reductions would be confirmed/tracked through post injection monitoring. Treatment of VOCs in on-site groundwater downgradient of Building 101 would occur at the property boundary via installation of a fence line ZVI-based PRB. The PRB would prevent further off-site migration of VOCs in groundwater. VOC concentrations in off-site groundwater are expected to attenuate over time and/or be reduced through reduction of VOC mass flux off site. The effectiveness of the PRB in treating VOCs will require ongoing monitoring and potential maintenance depending upon field monitoring results.

PFAS in source area groundwater would be bound to colloidal carbon where distributed. The colloidal carbon will also bind VOCs and other non-target compounds related to naturally present organic matter. Once the injected colloidal carbon is spent, it cannot be regenerated in place. Desorption of PFAS and/or other bound compounds may occur over time, reducing long-term permanence. Concentrations of PFAS that remain in groundwater post remediation are expected to attenuate over time and/or be reduced through reduction of mass flux from treated source soils. Follow up injections of colloidal carbon may be necessary for long-term effectiveness and permanence.

4.3.5.4 Reduction of Toxicity, Mobility, and Volume

Alternative 5 would reduce the toxicity and volume of VOCs, metals, and PFAS in on-site soil and groundwater. VOCs at concentrations above criteria in on-site groundwater near and downgradient of Building 64 would be reduced through ISCO injections. On-site groundwater would further be reduced over time as a result of reduced mass flux due to excavation of source soils and immobilization by colloidal carbon. Off-site downgradient groundwater impacts near Building 101 would be reduced over time as a result of VOC treatment in the PRB and reduced mass flux from the site but not be targeted directly.

VOCs in source soils would be removed from the site via excavation resulting in a significant reduction of toxicity and volume. Chlorinated VOCs present in on-site groundwater would be destroyed by the PRBs installed at the property boundary. The permanence of treatment would be dependent upon proper design and installation of the ZVI PRBs. This remedial component would prevent off-site mass flux of chlorinated VOCs. Natural attenuation during and post active remedial actions would also result in the destruction of VOCs over time and is irreversible. Natural attenuation processes that reduce VOC concentrations in soil and groundwater can be physical, chemical, or biological and include biodegradation, dispersion, dilution, sorption, and volatilization. (EPA 1999).

PFAS in on-site source area groundwater would be immobilized via injection of colloidal carbon. Post remediation, PFAS would remain bound to the injected carbon, reducing their mobility. This reaction would be reversible to an extent because desorption of PFAS bound to the injected colloidal carbon is possible when the adsorption capacity of the injected carbon is exceeded. PFAS concentrations in off-site groundwater would decrease over time due to the reduction of mass flux from the site.

Metals in source soils would be removed from the site via excavation resulting in a significant reduction of toxicity and volume. Metals concentrations above criteria in groundwater are limited in area and are not widespread in off-site groundwater. This remedial alternative would result in a reduction of the flux of metals from soil into groundwater and reduce metals mobility. Source removal and immobilization of VOCs in source soils is expected to result in restoration of groundwater to a more oxidized natural state over time, further lowering the mobility of metals.

4.3.5.5 Short-Term Effectiveness

Community Protection

Enhanced protection measures for mitigation of environmental impacts and nuisance conditions would be implemented during all active phases of this alternative. These measures include, but are not limited to, implementation of a CAMP, a dust control plan, secured and ventilated amendment storage area, chemical secondary containment, erosion and sedimentation controls, and installation of temporary fencing.

Worker Protection

Implementation of this alternative would be undertaken using enhanced procedures for worker protection, including the establishment of a health and safety plan, which would outline the appropriate protective measures that should be undertaken during on-site work. In addition, daily job briefing meetings would be held to discuss the anticipated work to be completed each day.

Environmental Impacts

Implementation of this alternative would not be expected to create adverse environmental impacts.

Time Required to Implement

It is anticipated that remedial construction for this alternative would be implemented and completed within 5 years.

4.3.5.6 Implementability

Alternative 5 would be implemented using standard excavation techniques and readily available technologies, such as hollow stem auger drilling via easily maneuverable drill rigs and temporary injection system setups. Alternative 5 requires pilot testing and predesign investigation to design an effective treatment approach. Distribution of ISCO reagent and colloidal carbon for source treatment of VOCs (near Building 64) and PFAS would be challenging due to the difficulty associated with the injection and distribution of materials into the lower permeability and heterogeneous underlying soils at the site (comprising fine and silty sands and till). PRB installation would be achievable at the targeted depths via trenching utilizing a biopolymer slurry. Clearing of the land along the areas targeted for PRB application would be achievable. Construction of a temporary 50 foot wide platform would be required to accommodate the equipment used to install the PRB; the platform would be removed following PRB completion.

4.3.5.7 Cost

The capital, OM&M, and present value costs for Alternative 5 are presented in **Table 4-1** and detailed in **Appendix C (Table C-5).** Cost projections assume that wastes generated during remedy implementation (e.g., excavated soil, decontamination water, and water generated during LTM) will be managed as F-listed hazardous waste.

- Capital Costs: The probable capital cost to is estimated at $7.7 million This cost includes demolition of on-site buildings except for Building 101, remedial design and predesign investigations, partial excavation of source soils, ISCO injections around Building 64, colloidal carbon injections, and the installation of a PRB downgradient of Building 101.
- OM&M Costs: The annual OM&M costs is estimated at $88,000 with one-time costs of 190,000 in year 2 and $190,000 in year 4. This includes post-injection performance monitoring and LTM.
- Present Value Cost: The probable net present value for this alternative is estimated at $9.4 million. This estimate was calculated using a -1% annual discount rate.

4.3.5.8 Land Use

This alternative would not attain unrestricted land use for soil or groundwater. Site COC concentrations would continue to exceed NYSDEC Class GA Standard or Guidance Values and SCOs.

4.3.5.9 Green and Sustainable Remediation

An evaluation of Alternative 5 against the seven core green remediation elements defined in Section 3.2.9 is provided below.

- **Energy Requirements:** The energy requirements associated with Alternative 5 would be high in the short-term, specifically associated with transportation of materials and wastes and operation of heavy equipment associated with the partial source zone excavation, building demolition, ISCO and colloidal carbon injections, and PRB installation. However, long-term emissions associated with monitoring would be negligible.

- **Air Emissions:** Short-term air emissions would include particulates and greenhouse gas emissions from transportation (personnel, materials, waste), and heavy equipment operation. Transportation and treatment of wastes would result in a high emissions footprint. Long-term air emissions associated with monitoring would be negligible.
- **Water Requirements and Impact on Water Resources:** Water use associated with this alternative would be moderate in the short term to supply the water needed for injections. Long term water use associated with this alternative would be minimal. The installation of the PRB and ISCO and carbon injections would protect nearby water resources from off-site migration of impacts.
- **Land and Ecosystem Impact:** Alternative 5 would cause short-term disruption of the vegetation and fauna within the footprint of construction and demolition activities. However, long-term land and ecosystem impacts would be minimal after site restoration. The size of the excavation and retention of Building 101 would limit disruption associated with excavation activities.
- **Material Consumption and Waste Generation:** Material consumption for Alternative 5 would be moderate to high and include the select granular fill and top soil associated with backfilling and restoration of the excavation, PRB construction materials, and injection substrate. Waste generation would be moderate to high in the form of contaminated soil from the partial source excavation footprint and construction and debris waste associated with the demolition of Buildings 52, 64 and 73. The long-term footprint of waste and materials would be minimal.
- **Resilience:** By removing part of the contaminated source material, Alternative 5 would reduce the potential for migration of impacts due to extreme weather events such as flooding. Excavated areas would be restored to natural site conditions and no long-term impacts would be expected. However, Alternative 5 does not include the demolition of Building 101, or removal of the soils beneath. These areas could be vulnerable to future extreme weather conditions and could result in potential for migration of impacts.
- **Social Impacts:** Alternative 5 would have moderate to high short-term impacts in the form of noise, traffic, and potential dust during active construction and injection phases. However, the long-term impact would be negligible. Alternative 5 would reduce the potential for future migration of impacts through partial source area removal, installation of the PRB, and injections, which would be protective of the community long-term.

Alternative 5 would have a moderate to high short-term footprint due to active construction work, but a low long-term footprint. Therefore, the sustainability of this alternative is ranked as Moderate. A summary of this evaluation is provided in **Table 4-2**.

4.3.6 Alternative 6: Partial Source Soil Excavation, Cover, and Prevention of Off-site Migration

In addition to the common components listed in Section 4.1, Alternative 6 includes the following elements, which are depicted on **Figure 4-6**:

- Excavation of vadose zone soil source areas containing TCE at concentrations exceeding the Protection of Groundwater SCO of 0.47 mg/kg. TCE is considered the driver of VOC contamination in soil. The estimated excavation volume is 2,800 cubic yards.
- Installation of an engineered barrier system (i.e., a cover) over metals-impacted soil. The engineered barrier layer, also referred to as a cover system, will consist of a minimum of 12 inches of clean material, which could consist of a combination of topsoil, clean soil, clean stone, asphalt pavement, concrete-covered sidewalks, or

concrete building slabs. A demarcation layer, consisting of white geotextile or equivalent material, will be installed at the base of the engineered barrier layer to provide a visual reference separating clean material from contaminated soil. The estimated area of metals-impacted soil is 5,000 square feet.

- Prevention of off-site migration of chlorinated VOC-impacted groundwater via fenceline permeable reactive barriers (PRBs). For the purpose of costing and evaluation, it has been assumed that PRBs would be trenched in at four distinct areas of the site using biopolymer slurry to emplace a mixture of zero valent iron (ZVI). Additional site characterization activities to assess groundwater quality and lithology along the planned PRB alignments would be performed during remedial design. Site groundwater samples would also be collected for a laboratory treatability study to assess rate of degradation of VOCs specific to the ZVI-site groundwater combination. PRB installations would be performed with the following major assumptions:
  - PRB-1:
    - Length of approximately 220 feet;
    - Targeted depth of installation to 20 feet bgs; and
    - Tied into underlying till.
  - PRB-2:
    - Length of approximately 100 feet;
    - Targeted depth of installation to 35 feet bgs; and
    - Tied into underlying till.
  - PRB-3:
    - Length of approximately 220 feet;
    - Targeted interval for ZVI emplacement to 30 feet bgs; and
    - Tied into underlying till.
  - PRB-4:
    - Length of approximately 400 feet;
    - Targeted depth of installation to 25 feet bgs; and
    - Tied into underlying till.
- Treatment of PFAS in groundwater via colloidal carbon injection in three potential source areas. Colloidal carbon injections would be performed at approximately 80 to 90 locations using DPT rigs with the following major assumptions:
  - DPT points installed over 5-foot screen intervals;
  - Injection rates of 2 gpm;
  - Injection of 1,000 gallons of colloidal carbon solution at each point;
  - Simultaneous injection into five points; and
  - Five-week injection program.
- LTM for 20 years to achieve SCOs in groundwater post colloidal carbon injections and PRB installation based upon partial source soil removal, soil cover, the known site characteristics, and the COCs.

Treatment of PFAS in soil is not included under this alternative because PFAS concentrations in site soil samples were below the applicable Commercial SCOs.

4.3.6.1 Overall Protection of Human Health and the Environment

Alternative 6 would result in protection of human health and the environment. VOCs at concentrations above criteria in source area soils would be eliminated via excavation. A cover would be installed over remining soils with metals at concentrations exceeding criteria to minimize contact and further leaching to groundwater. PFAS concentrations in site groundwater would be reduced and controlled through injection of colloidal carbon. Off-site migration of VOC-impacted groundwater would be controlled through PRBs installed at targeted areas along the property boundary. Off-site groundwater impacts would attenuate and/or be reduced over time due to source area remediation. LTM would be used to track COC concentrations over time to ensure protection of human health and the environment during remedial implementation and achieve/confirm PFAS, VOCs, and metals concentrations below criteria in groundwater over time.

4.3.6.2 Compliance with Standards, Criteria, and Guidance

Alternative 6 is expected to meet soil and groundwater SCGs over the long term. Excavation, cover installation, performance monitoring, and reporting would be conducted in compliance with federal and state requirements.

4.3.6.3 Long-Term Effectiveness and Permanence

In Alternative 6, VOCs in source soils would be removed from the site via excavation resulting in a significant reduction of toxicity and volume. These excavations would also result in removal of coincident metals. Metals at concentrations that exceed criteria that remain in soil would be covered to limit contact and the potential for leaching to groundwater.

Treatment of VOCs in on-site groundwater would occur at the property boundary via installation fence line ZVI-based PRBs. These PRBs will prevent further off-site migration of VOCs in groundwater. VOC concentrations in off-site groundwater are expected to attenuate over time and/or be reduced through reduction of VOC mass flux off site. The effectiveness of the PRBs in treating VOCs will require ongoing monitoring and potential maintenance depending upon field monitoring results.

PFAS in source area groundwater would be bound to colloidal carbon where distributed. The colloidal carbon will also bind VOCs and other non-target compounds related to natural organic matter. Once the injected colloidal carbon is spent, it cannot be regenerated in place. Desorption of PFAS and/or other bound compounds may occur over time, reducing long-term permanence. Concentrations of PFAS that remain in groundwater post remediation are expected to attenuate over time and/or be reduced through reduction of mass flux from treated source soils. Follow up injections of colloidal carbon may be necessary for long-term effectiveness and permanence.

4.3.6.4 Reduction of Toxicity, Mobility, and Volume

Alternative 6 would reduce the toxicity and volume of VOCs, metals, and PFAS in on-site soil and groundwater. On-site groundwater impacts would be reduced over time as a result of reduced mass flux due to excavation of source soils, cover of remaining metals-impacted soils, immobilization by colloidal carbon but not be targeted directly. Off-site groundwater impacts would be reduced over time as a result of reduced mass flux from the site but not be targeted directly.

VOCs in source soils would be removed from the site via excavation resulting in a significant reduction of toxicity and volume. Chlorinated VOCs present in on-site groundwater would be destroyed by the PRBs installed at the property boundary. The permanence of treatment would be dependent upon proper design and installation of the

ZVI PRBs. This remedial component would result prevent off-site mass flux of chlorinated VOCs. Natural attenuation during and post active remedial actions would also result in the destruction of VOCs over time and is irreversible.

PFAS in on-site source area groundwater would be immobilized via injection of colloidal carbon. Post remediation, PFAS would remain bound to the injected carbon, reducing their mobility. This reaction would be reversible to an extent because desorption of PFAS bound to the injected colloidal carbon is possible when the adsorption capacity of the injected carbon is exceeded. PFAS concentrations in off-site groundwater would decrease over time due to the reduction of mass flux from the site.

Metals in source soils would be removed from the site via excavation (coincident with VOCs) or covered, resulting in a significant reduction of toxicity and volume. Metals concentrations above criteria in groundwater are limited in area and are not widespread in off-site groundwater. This remedial alternative would result in a reduction of the flux of metals from soil into groundwater and reduce metals mobility. Source removal and immobilization of VOCs in source soils is expected to result in restoration of groundwater to a more oxidized natural state over time, further lowering the mobility of metals.

4.3.6.5 Short-Term Effectiveness

Community Protection

Enhanced protection measures for mitigation of environmental impacts and nuisance conditions would be implemented during all active phases of this alternative. These measures include, but are not limited to, implementation of a CAMP, a dust control plan, secured and ventilated amendment storage area, chemical secondary containment, erosion and sedimentation controls, and installation of temporary fencing.

Worker Protection

Implementation of this alternative would be undertaken using enhanced procedures for worker protection, including the establishment of a health and safety plan, which would outline the appropriate protective measures that should be undertaken during on-site work. In addition, daily job briefing meetings would be held to discuss the anticipated work to be completed each day.

Environmental Impacts

Implementation of this alternative would not be expected to create adverse environmental impacts.

Time Required to Implement

It is anticipated that remedial construction for this alternative would be implemented and completed within 5 years.

4.3.6.6 Implementability

Alternative 6 would be implemented using standard excavation techniques and readily available technologies, such as hollow stem auger drilling via easily maneuverable drill rigs and temporary injection system setups. Alternative 6 requires pilot testing and predesign investigation to design an effective treatment approach. Distribution of colloidal carbon for source treatment of PFAS would be challenging due to the difficulty associated with the injection and distribution of materials into the lower permeability and heterogeneous underlying soils at the site (comprising fine and silty sands and till). PRB installation would be achievable at the targeted depths via trenching utilizing a biopolymer slurry. Clearing of the land along the areas targeted for PRB application would be achievable. PRB installation would require installation of an approximately 50 foot wide platform at each PRB wall for construction.

4.3.6.7 Cost

The capital, OM&M, and present value costs for Alternative 6 are presented in **Table 4-1** and detailed in **Appendix C (Table C-6)**. Cost projections assume that wastes generated during remedy implementation (e.g., excavated soil, decontamination water, and water generated during LTM) will be managed as F-listed hazardous waste.

- Capital Costs: The probable capital cost to is estimated at $9.3 million. This cost includes demolition of on-site buildings except for Building 101, remedial design and predesign investigations, partial excavation of source soils, engineered cover installation over remining areas with metals exceedances, colloidal carbon injection, and installation of PRBs.
- OM&M Costs: The annual OM&M costs is estimated at $88,000. This includes post-PRB installation performance monitoring and LTM.
- Present Value Cost: The probable net present value for this alternative is estimated at $10.9 million. This estimate was calculated using a -1% annual discount rate.

4.3.6.8 Land Use

This alternative would not attain unrestricted land use for soil or groundwater. Site COC concentrations would continue to exceed NYSDEC Class GA Standard or Guidance Values and SCOs.

4.3.6.9 Green and Sustainable Remediation

An evaluation of Alternative 6 against the seven core green remediation elements defined in Section 3.2.9 is provided below.

- **Energy Requirements:** The energy requirements associated with Alternative 6 would be moderate to high in the short-term, specifically associated with transportation of materials and wastes and operation of heavy equipment associated with the partial source zone excavation, building demolition, colloidal carbon injections, and installation of the PRB and cover. However, long-term emissions associated with monitoring would be negligible.
- **Air Emissions:** Short-term air emissions would include particulates and greenhouse gas emissions from transportation (personnel, materials, waste), and heavy equipment operation. Transportation and treatment of wastes would result in a moderate to high emissions footprint. Long-term air emissions associated with monitoring would be negligible.
- **Water Requirements and Impact on Water Resources:** Water use associated with this alternative would be moderate in the short term to supply the water needed for injections. The installation of the PRB and carbon injections would protect nearby water resources from offsite migration.
- **Land and Ecosystem Impact:** Alternative 6 would cause short-term disruption of the vegetation and fauna within the footprint of construction and excavation activities. However, long-term land and ecosystem impacts could persist due to the engineered cover, even after site restoration. The size of the excavation and retention of Building 101 would limit disruption.

- **Material Consumption and Waste Generation:** Material consumption for Alternative 6 would be moderate to high for the PRB and cover construction and the select granular fill and top soil associated with backfilling and restoration of the excavation, as well as the injection substrate. Waste generation would be moderate to high in the form of contaminated soil from the partial source excavation footprint. The long-term footprint of waste and materials consumption would be minimal.
- **Resilience:** By removing part of the contaminated source material, Alternative 6 would reduce the potential for migration of impacts due to extreme weather events such as flooding. Long-term impacts to surface water infiltration and flow could be present depending on the design of the cover. Alternative 6 does not include the demolition of Building 101 or removal of the soils beneath. These areas could be vulnerable to future extreme weather conditions and could result in potential for migration of impacts. The PRB does not require permanent aboveground infrastructure, however flooding of the site could impact the soil stability, making it susceptible to extreme weather events.
- **Social Impacts:** Alternative 6 would have moderate to high short-term impacts in the form of noise, traffic, and potential dust during active construction and injection phases. However, the long-term impact would be negligible. Alternative 6 would reduce the potential for future migration of impacts through partial source area removal and installation of the PRB, which would be protective of the community long-term.

Alternative 6 would have a moderate to high short-term footprint due to active construction work, but a low long-term footprint. Therefore, the sustainability of this alternative is ranked as Moderate. A summary of this evaluation is provided in **Table 4-2**.

4.4 Comparative Analysis

4.4.1 Overview

The RAOs for the site are concerned with the prevention of contact with contaminated soil and groundwater and the remediation of the affected media to pre-release conditions, Commercial SCOs, and the Class GA Standard, to the extent practicable. The alternatives presented for the site provide varying levels of remedial actions and are summarized in the table below.

Alternative	Name	Description	Likelihood of Meeting RAOs	Rating
1	No Action	Minimum steps for remediation.	Will not meet	
2	Return to Pre-Disposal Conditions	Building demolition and active groundwater remediation.	Will meet	22
3	Source Soil Excavation, Soil Treatment, and Groundwater Treatment	Building demolition, source removal, and active soil and groundwater remediation.	Potentially will meet	25
4	Source Soil Excavation and Groundwater Treatment	Building demolition, source removal, and active groundwater remediation.	Potentially will meet	25
5	Partial Source Soil Excavation and Prevention of Off-site Migration	Building demolition, limited source removal, and offsite migration prevention.	Potentially will meet	22

Alternative	Name	Description	Likelihood of Meeting RAOs	Rating
6	Partial Source Soil Excavation, Cover, and Prevention of Off-site Migration	Building demolition, limited source removal, engineering barrier system, and offsite migration prevention.	Potentially will meet	19

Alternative 1 would not be protective of human health and the environment. CPOCs would remain in soil and groundwater with no action and no infrastructure in place to monitor and track groundwater concentrations and trends over time. Alternative 1 would also not comply with SCGs. Because this No Action alternative does not meet the threshold criteria of Protection of Human Health and the Environment and Compliance with Standards, Criteria, and Guidance, it is not evaluated further in the comparative analysis or numerical rated using balancing criteria identified in Section 3.2.

Table 4-2 summarizes the numerical rating results for Alternatives 2 through 6 using the balancing criteria. Each balancing criterion was assigned a numerical rating range of 0 to 5 (non-conformance to high conformance) to rank each of Alternatives 2 through 6. The ratings were summed to assign an overall score to each alternative for overall comparison.

4.4.2 Overall Protection of Human Health and the Environment

As noted in Section 4.1.1, Alternative 1 would not be protective of human health and the environment. CPOCs would remain in soil and groundwater with no further action and no infrastructure in place to monitor and track groundwater concentrations and trends over time. Alternatives 2 through 6 would each be protective of human health and the environment. Because Overall Protection of Human Health and The Environment is a threshold criterion, it is not assigned a numerical rating range; rather it is used to deem Alternatives 2 through 6 as appropriate for further consideration and Alternative 1 as not appropriate for further consideration.

Alternatives 2 through 6 would remove source soil impacts of accessible soils above the water table with known exceedances above criteria. Direct groundwater treatment of VOCs via ISCO is included in Alternatives 3 and 4. Alternative 5 does not directly target groundwater VOCs near and downgradient of Building 101, and Alternative 6 does not directly target groundwater VOCs throughout the site. Alternative 5 prevents further migration of VOCs downgradient of Building 101 through the installation of a PRB. Alternative 6 prevents further off-site migration of VOCs in groundwater through installation of PRBs along the site boundaries. Source fixation (by adsorption) of PFAS in groundwater for these alternatives will be addressed through colloidal carbon injection. Off-site impacts in groundwater will be addressed through reduction of mass flux from Site restrictions and/or activities and use limitations, prevent exposure to groundwater with exceedances, and provide protection to human health and the environment.

4.4.3 Compliance with Standards, Criteria, and Guidance

As noted in Section 4.1.1, Alternative 1 would not comply with SCGs. Alternatives 2 through 6 would all comply with SCGs. Because Compliance with Overall Standards, Criteria, and Guidance is a threshold criterion, it is not assigned a numerical rating range; rather it is used to deem Alternatives 2 through 6 as appropriate for further consideration and Alternative 1 as not appropriate for further consideration.

4.4.4 Long-Term Effectiveness and Permanence

Alternative 2 offers a high value in long-term effectiveness and permanence and has therefore been given a score of 5. Alternative 2 directly addresses known site contaminants in soil through excavation and in groundwater through groundwater extraction and treatment. Following active remediation, on site monitoring will be conducted to ensure residual VOCs, PFAS, and metals concentrations in groundwater have either met closure criteria or have established downward concentration trends to meet remedial endpoint goals.

Alternatives 3 and 4 have been given a rating score of 4, slightly less than Alternative 2 in long-term effectiveness and permanence. PFAS located in source area groundwater would be sorbed to the injected colloidal carbon but could desorb over time resulting in some uncertainty in terms of permanence over the long term. Alternative 5 has been given the same rating score of 4 for long-term effectiveness and permanence as it has the same permanence uncertainty associated with the PFAS groundwater treatment. Alternative 6 has been assigned a rating score of 3 for long-term effectiveness as this alternative does not contain any source treatment of VOCs.

4.4.5 Reduction of Toxicity, Mobility, and Volume

Alternative 2 has been given a high rating score of 5 related to reduction of toxicity, mobility, and volume. This alternative would directly target and address COC impacts in soil and groundwater.

Alternatives 3, 4, and 5 have been given a moderate to high rating score of 4 related to reduction of toxicity, mobility, and volume. These alternatives will result in the significant reduction of toxicity, mobility, and volume of contaminants in unsaturated soils through targeted excavations. The significant reduction of toxicity, mobility, and volume of VOCs in source groundwater would be achieved through ISCO applications. PFAS source mobility in groundwater would be reduced through colloidal carbon injections. However, PFAS impacts would remain on site bound to the carbon with the potential for long-term desorption occurring over time. Off-site impacts would be addressed over time through reduction of mass flux from the site due to source removal and treatment.

Alternative 6 has been given a moderate rating score of 3 related to reduction of toxicity, mobility, and volume. It would result in the significant reduction of toxicity, mobility, and volume of contaminants in unsaturated soils through targeted excavations. PFAS source mobility in groundwater would be reduced through colloidal carbon injections. However, PFAS impacts would remain on site bound to the carbon with the potential for long-term desorption occurring over time. Reduction of on-site groundwater source VOC concentrations would not be targeted directly but rather rely on the reduction of mass flux from source areas related to excavation activities. There would still be significant concentrations remaining in groundwater and soil in the saturated soils that would continue to mobilize while attenuating. PRBs would limit further mobility of site contaminants beyond the property line and result in direct treatment of VOCs in groundwater. Off-site impacts would be addressed over time through reduction of mass flux from the site due to source removal and treatment.

4.4.6 Short-Term Effectiveness

Alternative 2 has been given a rating score of 3 for short-term effectiveness. There is manageable risk to workers and the environment during implementation and construction of this alternative related to the use of heavy equipment during soil excavation, system install and trenching, and the physical demands of the job. These risks would be managed through utility clearance, use of standard excavation techniques, following Occupational Safety and Health Administration (OSHA) standards, and implementation of run-off controls where applicable to protect against potential deleterious impacts to the environment. There are also management risks associated with the continued operation and maintenance of the treatment system post system construction and install. While manageable, the installation of extraction wells off site in heavily wooded areas will increase the risks to workers required for maintenance of this infrastructure (i.e. biological hazards such as ticks and poison ivy and traversing and working on uneven terrain).

Alternatives 3 and 4 have been given a rating score of 4 for short-term effectiveness. Similar to Alternative 2, there are manageable risks to workers and the environment during excavation activities. There are also manageable risks to worker health and the environment during implementation of ISCO and colloidal carbon injections associated mainly with the risk of exposure to the ISCO reagent, injection pressures, and colloidal carbon. This has been given a higher rating than Alternative 2 because of the smaller working footprint and overall duration of the implementation.

Alternatives 5 and 6 have also been given a rating score of 4 for short-term effectiveness. These alternatives have the same manageable risks discussed previously due to excavation and due to ISCO injections for the case of Alternative 5. There are also manageable risks to worker health and the environment during implementation of colloidal carbon injections discussed previously. They also include manageable risks during installation of the PRB walls associated with heavy equipment, installation of deep trenches, and handling of ZVI. The implementation period associated with the PRB installation is of much shorter duration than that of Alternative 2 which has been reflected in the higher score given to these alternatives.

4.4.7 Implementability

Alternative 2 has been given a low implementability rating of 2. This rating reflects the complexity of the underlying on-site geology, comprising fine and silty sands resulting in the questionable ability to effectively target the aquifer impacts through groundwater extraction, and the physical challenges of off-site implementation. Off-site access would be required to install the trenches/piping and install/operate the extraction wells in these off-site properties. Construction of the off-site infrastructure is complicated by the steeply sloping, wooded terrain located off-site. The presence of an active railway immediately south of the site is an additional complication for connection of off-site infrastructure to the on-site treatment facility (i.e. a horizontal well must be drilled beneath the railway).

Alternatives 3 and 4 have been given a moderate implementability rating of 3. The main issues related to implementability of these alternatives relates to the injection and distribution of an ISCO reagent in the challenging and complex underlying geology. Similar injection and distribution challenges would be encountered during the application of colloidal carbon for PFAS treatment.

Alternatives 5 has been given a moderate implementability rating of 3. It includes injection of colloidal carbon and carry the same implementability challenges discussed previously. Alternative 5 also includes the injection of an ISCO reagent and carries the corresponding implementability challenges. While implementable, the installation of PRBs along the property line would be complicated due to site constraints and challenging terrain. In particular, the site boundary to the south in between Building 101 and the tracks has limited space and would require significant clearing and potential removal and replacement of the fence.

Alternative 6 has been given a moderate implementability rating of 3 due to difficulties associated with installation of PRBs at the site. Depths to groundwater in the PRBs located on the western edge of the property is fairly deep requiring installation involving biopolymer slurry or other more involved methods adding to the complexity of install.

4.4.8 Cost

A comparison of the costs for each alternative is provided in **Table 4-1**. The ranking of Alternatives 2 through 6 in order of total present value cost (from lowest to highest) is shown below:

1. Alternative 3 – Source Soil Excavation, Soil Treatment, and Groundwater Treatment ($7.7 million)
2. Alternative 4 – Source Soil Excavation and Groundwater Treatment ($8.1 million)
3. Alternative 5 – Partial Source Soil Excavation and Prevention of Off-site Migration ($9.4 million)
4. Alternative 6 – Partial Source Soil Excavation, Cover, and Prevention of Off-site Migration ($10.9 million)
5. Alternative 2 – Return to Pre-Disposal Conditions ($16.7 million)

4.4.9 Land Use

Alternative 2 would return the site to pre-disposal conditions resulting in unrestricted land use and has been given a score rating of 5. Alternatives 3, 4, and 5 would attain unrestricted land use for soil by reducing COC concentrations in site soil below Protection of Groundwater SCOs; however, COC concentrations in groundwater would still exceed NYSDEC Class GA Standard or Guidance Values. Alternative 6 would not attain unrestricted land use for soil or groundwater; site COC concentrations would continue to exceed Protection of Groundwater SCOs and NYSDEC Class GA Standard or Guidance Values and SCOs.

4.4.10 Green and Sustainable Remediation

The ranking of each of Alternatives 2 through 6, in order of most sustainable to least sustainable, is shown below:

1. Alternative 6 – Partial Source Soil Excavation, Cover, and Prevention of Off-site Migration
2. Alternative 5 – Partial Source Soil Excavation and Prevention of Off-site Migration
3. Alternative 3 – Source Soil Excavation, Soil Treatment, and Groundwater Treatment
4. Alternative 4 – Source Soil Excavation and Groundwater Treatment
5. Alternative 2 – Return to Pre-Disposal Conditions

Though each alternative that meets RAOs has impacts associated with the materials needed, waste created and operation of equipment to perform the remediation, the reduced volumes associated with Alternative 6 put it slightly ahead of Alternative 5 due to the additional 10% reduction in excavation area and the relatively small area of engineered cover. Additionally, both of these alternatives have smaller overall footprints than the alternatives that include removal of Building 101.

4.5 Comparative Evaluation of Alternatives

Table 4-2 contains a summary table of the rankings given to each individual alternative including scores for each balancing criterion. If equal weight is given to each criterion, Alternatives 3 and 4 received the highest overall score of 25. The only difference between these two alternatives is that Alternative 3 incorporates in-situ stabilization of soils in place of excavation and off-site disposal in areas with only known metals exceedances (no VOCs) which lowers the overall costs slightly, leaves the treated soils on site, and lowers the quantity of soil for off-site disposal.

Alternative 5 received the next highest overall score of 22. It has a slightly higher cost than Alternatives 3 and 4 and would result in restricted use for soil and groundwater. Alternative 2 also received a score of 22. It has the highest cost of all alternatives with significant implementability challenges associated with installation. Alternative 6 received an overall score of 19 due to high costs, restricted use, and lower reduction in toxicity, mobility, and volume due to no source VOC groundwater treatment.

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Tables

Table 3-1
Preliminary Evaluation of Remedial Measure Technologies for Soil

Feasibility Study
Former George A. Robinson Company., Inc. Site
477 Whitney Road, Penfield, New York

Response Actions	Remedial Technologies	Process Options	Description	Retained: Yes or No	Decision Rationale
No Action	Not Applicable	No Action	Not Applicable	Yes	Use as a baseline for comparison to other alternatives.
Institutional Control	Not Applicable	Deed Restrictions	Deed restrictions to limit the property use and implementation of a Site Management Plan.	Yes	Minimize potential for exposure to residual concentrations in soil.
Engineering Control	Not Applicable	Access Restrictions	Place access restrictions along the property boundary (i.e., fencing and signage).	Yes	Minimize potential for exposure to residual concentrations in soil.
Engineering Control	Infiltration Control or Capping	Soil, Asphalt and Concrete Cover	Prevent direct contact and infiltration through the use of cover.	Yes	Maintaining / adding asphalt or concrete over impacted soil would eliminate contact and infiltration. May require import of materials to stabilize grassed areas prior to capping.
In Situ Treatment	Physical	Soil Flushing	Flush soil with liquid to desorb contaminants.	No	Limited effectiveness for CVOCs because of low solubilities. Ineffective in lower permeability soils and till because of distribution and injection challenges and the need to have direct contact with the contaminant mass. Requires capture, collection, and treatment of flushed liquid.
In Situ Treatment	Physical	Surfactant Flushing	Flush soil with surfactant solution to promote the desorption and solubilization of hydrophobic contaminants.	No	Does not enhance metals solubility. Ineffective in lower permeability soils and till because of distribution and injection challenges and the need to have direct contact with the contaminant mass. Requires capture, collection, and treatment of flushed liquid.
In Situ Treatment	Physical	Thermal Treatment	Subsurface heating. May require total fluids recovery, including vapor extraction and treatment of vapor stream.	Yes	Effective for CVOCs. Effective for PFAS. Ineffective for metals. May be combined with other process options.
In Situ Treatment	Chemical	Oxidation	Inject oxidizing agent to oxidize contaminants.	Yes	Effective for CVOCs. Ineffective for PFAS. Ineffective for metals. May be ineffective in lower permeability soils and till because of distribution and injection challenges and the need to have direct contact with the contaminant mass. Requires multiple injections. May be combined with other process options.
In Situ Treatment	Chemical	Stabilization/ Solidification	Treatment/fixation of soil and contaminants by mixing.	Yes	Effective for CVOCs and metals. Effective for reducing the overall mass flux of PFAS by reducing leachability to groundwater. May be ineffective in lower permeability soils and till because of distribution and injection challenges and the need to have direct contact with the contaminant mass. Likely to require demolition of Buildings 52, 64, and 101 for access.
In Situ Treatment	Biological	Enhanced Reductive Dechlorination	Inject a substrate to facilitate biodegradation of soil COCs by microorganisms.	Yes	Only effective for CVOCs in the saturated zone. Ineffective for PFAS. Ineffective for metals. May be ineffective in lower permeability soils and till because of distribution and injection challenges and the need to have direct contact with the contaminant mass. Requires multiple injections. May be combined with other process options.
In Situ Treatment	Biological	Bioventing	Add oxygen to vadose zone to stimulate aerobic microorganisms for the catabolization of contaminants.	No	Soil COCs do not have viable aerobic degradation pathways.
Removal	Excavation	Excavation	Remove soil through mechanical methods.	Yes	Effective for CVOCs, PFAS, and metals. Implementable in unconsolidated deposits and till. Likely to require demolition of Buildings 52, 64, and 101 for access. Requires dewatering and treatment of recovered water. Backfill with reactive media would mitigate soil recontamination by CVOC and/or PFAS-impacted groundwater re-entering the excavation.
Removal	Extraction	SVE	Apply a vacuum to extraction wells to enhance VOC volatilization. Recover and treat vapor.	Yes	Effective for VOCs. Ineffective for PFAS. Ineffective for metals. Limited effectiveness in low permeability soils and till. Stripping at the air/water interface would have minimal effect on VOCs in saturated soil. May be combined with other process options
Removal	Extraction	Multi-Phase Extraction	Apply a vacuum to extraction wells to enhance fluids recovery. Treat and dispose of extracted fluids.	No	Limited effectiveness in low permeability soils and till. Ineffective for PFAS.

See Notes on Page 2.

Table 3-1
Preliminary Evaluation of Remedial Measure Technologies for Soil

Feasibility Study
Former George A. Robinson Company., Inc. Site
477 Whitney Road, Penfield, New York

ARCADIS

Response Actions	Remedial Technologies	Process Options	Description	Retained: Yes or No	Decision Rationale
Ex Situ Treatment	Physiochemical	Soil Washing	Physical separation of contaminated soil from non-contaminated soil followed by chemical desorption to remove contaminants from the soil.	Yes	Effective for CVOCs, PFAS, and metals. Effectiveness is limited by the ability to achieve direct contact with the contaminant mass. Requires onsite treatment of contaminated fines and wash water prior to disposal.
	Physical	Low-Temperature Thermal Treatment	Heat soil using a conveyor and burner system to promote the volatilization of VOCs. Heat of hydration when water mixes with calcium oxide (e.g., quicklime) can also promote volatilization. Requires dedicated, access-restricted site area for treatment operations.	No	Ineffective for metals. Cost per unit volume of treated soil would make combination of thermal treatment with other ex situ process options infeasible.
		On-site Incineration	Heat soil using a conveyor and burner system to thermally oxidize VOCs. Requires dedicated, access-restricted site area for treatment operations.	No	Ineffective for PFAS. Ineffective for metals. Requires recovery and treatment of vapors. Cost per unit volume of treated soil would make combination of incineration with other ex situ process options infeasible. Lower permeability soils and till require intense mixing to effectively contact mass trapped in interior pore space.
	Chemical	Stabilization/ Solidification	Fixation of soil and contaminants by mixing. Requires dedicated, access-restricted site area for treatment operations.	Yes	Effective for CVOCs, PFAS, and metals.
		Oxidation	Oxidize contaminants	No	Ineffective for PFAS. Ineffective for metals. Requires dedicated, access-restricted site area for treatment operations.
	Biological	Land Farming	Stockpile and till soils to promote aerobic biodegradation.	No	Ineffective for contaminants that degrade under anaerobic conditions (e.g., CVOCs), PFAS, and metals.
Disposal	Disposal	On-site	Disposal or reuse of soil onsite. Generally requires treatment prior to disposal. See ex situ treatment options above.	Yes	Feasible in conjunction with other process options if onsite space available. Requires treatment of soil and approval from regulators and site owner.
		Off-site	Disposal of soil or remediation process residuals offsite.	Yes	Effective and implementable. Disposal location will depend on soil concentrations. May require pre-treatment due to land ban regulations.

Note:
Shaded cells indicate technologies not retained.

Abbreviations:
COC - constituent of concern
CVOC - chlorinated volatile organic compound
PFAS - per- and polyfluoroalkyl substances
SVE - soil vapor extraction
VOC - volatile organic compound

Table 3-2
Preliminary Evaluation of Remedial Measure Technologies for Vapor Intrusion

Feasibility Study
Former George A. Robinson Company, Inc. Site
477 Whitney Road, Penfield, New York

Response Actions	Remedial Technologies	Process Options	Description	Retained: Yes or No	Decision Rationale
No Action	Not Applicable	Not Applicable	Not Applicable	Yes	Use as a baseline for comparison to other alternatives.
Institutional Control	Not Applicable	Deed Restrictions	Deed restrictions to limit the property use and implementation of a Site Management Plan.	Yes	Minimize potential for exposure to residual concentrations.
Containment	Building Sealing	Caulking/Sealing	Seal pathways for vapor to enter building (slab, walls, etc.) through caulking, epoxy/polymer coatings, and minor concrete repair, as necessary.	Yes	Effective and implementable. Implementation requires disruption of ongoing activities in Building 102. Requires ongoing inspection to preserve effectiveness.
		Concrete	Thicken the existing concrete pad.	No	Effective and implementable. Implementation requires substantial disruption of ongoing activities in Building 102.
	Passive Barrier	Passive Barrier	Install a spray applied, polyvinyl chloride, or rubber liner during new building construction. Liner to be sealed to perimeter footings, post footings, piping and other protrusions.	No	Effective for new construction. Implementation requires demolition and reconstruction of Building 102.
Mitigation	Building Pressurization	HVAC Adjustments	Keep doors closed and adjust HVAC systems to maintain a higher pressure within the building than under the slab to prevent vapors from entering.	No	Low effectiveness and difficult to implement in aging buildings. Building 102 is not airtight. Requires modification of worker behavior to prevent doors being left open.
	Air Cleaning	Filtering of Indoor Air	Install carbon filter on HVAC systems or as stand alone units to remove volatile organic compounds from the indoor air.	No	May be ineffective at Building 102 because of building size and the large volume of indoor air to filter. Does not prevent vapors from entering the buildings.
	Passive Venting	Passive Venting	Install vent pipes from the subslab to the atmosphere.	No	Effective for new construction. May require collection and treatment of vented vapor. Implementation requires demolition and reconstruction of Building 102.
	SSDS	Individual Fans	Depressurize the subslab using inline fans to prevent vapors from entering the buildings.	Yes	Effective and implementable for minimizing potential exposure to residual concentrations.
		Centralized Systems	Depressurize the subslab using a centralized blower to prevent vapors from entering the buildings.	Yes	Effective and implementable for minimizing potential exposure to residual concentrations.
	SSVS	Individual Fans	Dilute the subslab vapors by introducing fresh air into the subslab using inlet pipes.	No	Best suited for very porous soils. Requires significant infrastructure. May increase potential for vapor intrusion.
		Centralized Systems	Dilute the subslab vapors by introducing fresh air into the subslab using inlet pipes.	No	Best suited for very porous soils. Requires significant infrastructure. May increase potential for vapor intrusion.
	SSP	Individual Fans or Centralized System	Force fresh air beneath the slab to push vapors away from the subslab.	No	Best suited for very porous soils. Requires significant infrastructure. May increase potential for vapor intrusion.
Removal	Demolition	Building Demolition	Demolish a building to remove the potential for vapor intrusion into indoor air.	No	Highly effective but has implementability challenges and high costs. Implementation would eliminate future use of Building 102 or incur additional cost for reconstruction.

Note:
Shaded cells indicate technologies not retained.

Abbreviations:
HVAC - heating ventilation and air conditioning
SSDS - subslab depressurization system
SSVS - subslab ventilation system
SSP - subslab pressurization

Table 3-3
Preliminary Evaluation of Remedial Measure Technologies for Groundwater

Feasibility Study
Former George A. Robinson Company, Inc. Site
477 Whitney Road, Penfield, New York

Response Actions	Remedial Technologies	Process Options	Description	Retained: Yes or No	Decision Rationale
No Action	Not Applicable	No Action	Not Applicable	Yes	Use as a baseline for comparison to other alternatives.
Institutional Control	Not Applicable	Deed Restrictions	Deed restrictions to limit the property use and implementation of a Site Management Plan.	Yes	Minimize potential for exposure to residual concentrations in groundwater.
Monitoring	Groundwater Monitoring	Long-Term Monitoring	Monitor groundwater quality.	Yes	Minimize potential for exposure to residual concentrations in groundwater.
		Monitored Natural Attenuation	Monitor natural attenuation parameters and groundwater quality.	Yes	Observation of degradation products indicates attenuation of some CVOCs. Ineffective as a standalone response. May be combined with other process options.
Containment	Infiltration Control or Capping	Cover	Concrete and asphalt cover to minimize infiltration.	Yes	Addition of asphalt or concrete over grassed portions of the Site would reduce infiltration. May require import of materials to stabilize grassed areas prior to capping.
	Barriers (Horizontal or Vertical)	Grout Injection	Pressure injection of grout to provide a low permeability confining unit.	Yes	Must be combined with groundwater extraction and treatment or similar technology. Requires key-in to low permeability deposits to prevent underflow. Does not prevent vertical groundwater migration within the containment area.
		Trenched Cut-off Wall	Low permeability wall to prevent horizontal migration of groundwater.	Yes	Must be combined with groundwater extraction and treatment or similar technology. Requires key-in to low permeability deposits to prevent underflow. Does not prevent vertical groundwater migration within the containment area.
		Sheet Piling	Sheet pile wall to prevent horizontal migration of groundwater.	Yes	Must be combined with groundwater extraction and treatment or similar technology. Requires key-in to low permeability deposits to prevent underflow. Does not prevent vertical groundwater migration within the containment area.
In Situ Treatment	Physical	Thermal Treatment	Subsurface heating. May require total fluids recovery, including vapor extraction and treatment of vapor stream.	No	Effective for PFAS. Ineffective for metals. May be combined with other process options.
		Permeable Reactive Barrier or Funnel and Gate	A passive treatment wall across the groundwater flow path.	No	Effective for CVOCs, PFAS, and metals with different reactive media. Requires key-in to low permeability deposits to prevent underflow.
		Air Sparging	Strip Site COCs using air injection wells.	No	Ineffective for PFAS. Ineffective for metals. Requires groundwater flow to move contaminants to the recovery area. Ineffective in lower permeability soils and till where groundwater flow may not move a large enough portion of the mass through the target area.
		In-well Air Stripping	Strip Site COCs in a dual-screened well that controls groundwater flow.	No	Ineffective for PFAS. Ineffective for metals. Requires groundwater flow to move contaminants to the recovery area. Ineffective in lower permeability soils and till where groundwater flow may not move a large enough portion of the mass through the target area.
	Chemical	Oxidation	Oxidize contaminants.	Yes	Effective for chlorinated VOCs. Ineffective for PFAS. Ineffective for metals. May be ineffective in lower permeability soils and till because of distribution and injection challenges and the need to have direct contact with the contaminant mass. Requires multiple injections. May be combined with other process options.
		Precipitation	Fixation of contaminants to soil by amendment injection.	Yes	Effective for metals. Amendment will also enhance reductive dechlorination of CVOCs. Ineffective for PFAS. May be ineffective in lower permeability soils and till because of distribution and injection challenges and the need to have direct contact with the contaminant mass. May be combined with other process options.
		Chemical Reduction	Use a reductant or reductant generating material (i.e., zero valent iron) to degrade contaminants.	Yes	Effective for CVOCs. Ineffective for PFAS. Ineffective for metals. May be ineffective in lower permeability soils and till because of distribution and injection challenges and the need to have direct contact with the contaminant mass. May be combined with other process options.

See Notes on Page 3.

Table 3-3
Preliminary Evaluation of Remedial Measure Technologies for Groundwater

Feasibility Study
Former George A. Robinson Company, Inc. Site
477 Whitney Road, Penfield, New York

Response Actions	Remedial Technologies	Process Options	Description	Retained: Yes or No	Decision Rationale
In Situ Treatment (cont.)	Biological	Enhanced Reductive Dechlorination	Inject a degradable substrate to facilitate biodegradation of groundwater COCs by microorganisms.	Yes	Effective for CVOCs. Ineffective for PFAS. Ineffective for metals. May be ineffective in lower permeability soils and till because of distribution and injection challenges and the need to have direct contact with the contaminant mass. Requires multiple injections.
Removal	Removal	Excavation/Dewatering	Remove impacted groundwater through excavation and dewatering.	Yes	Effective in areas where soil and groundwater impacts are co-located. Likely to require demolition of Buildings 52, 64, and 102 for access. Requires dewatering and ex situ treatment and disposal of extracted fluids. Has the potential to mobilize DNAPL and PFAS.
		Groundwater Extraction	Hydraulic containment through the extraction of groundwater using vertical wells.	Yes	Effective for Site groundwater COCs. Limited effectiveness in low permeability soils and till because of low achievable recovery and recharge. Requires ex situ treatment and disposal of extracted fluids. Has the potential to mobilize DNAPL and PFAS.
		Multi-Phase Extraction	Apply a moderate to high vacuum (i.e., higher than 10 mmHg) to a series of extraction wells for enhanced total fluids recovery.	No	Limited effectiveness in low permeability soils and till. Requires ex situ treatment and disposal of extracted fluids. DNAPL has not been observed to accumulate in wells.
		Groundwater Recovery Trenches	Trenches, drains and piping, used to passively collect groundwater.	Yes	Effective for Site groundwater COCs. Requires groundwater flow to move contaminants to the recovery area. Limited effectiveness for mass removal in low permeability soils and till because of low achievable recovery and recharge. Requires ex situ treatment and disposal of extracted fluids.
Ex Situ Treatment	Physical	Air Stripping	Transfer contaminants from an aqueous to a vapor phase. Off-gas may require additional treatment.	Yes	Effective and implementable technology for ex situ groundwater treatment of VOCs. Ineffective for PFAS. Ineffective for metals. May be combined with other ex situ treatment options.
		Carbon Adsorption	Remove contaminants from the aqueous or vapor phase onto activated carbon.	Yes	Effective and implementable technology for ex situ groundwater treatment of VOCs. Ineffective for PFAS. Generally ineffective for metals. May be combined with other ex situ treatment options.
		IX Adsorption	Remove contaminants from the aqueous phase onto IX resin.	Yes	Effective and implementable technology for ex situ groundwater treatment of metals. Ineffective for CVOCs. Ineffective for PFAS. May be combined with other process options.
	Chemical	UV/Chemical Oxidation	Destroy VOCs by changing the oxidation state of target contaminants using UV radiation and chemical oxidants.	No	Effective and implementable technology for ex situ groundwater treatment of CVOCs. Ineffective for PFAS. Ineffective for metals. Cost per unit volume of treated groundwater would make combination of UV/chemical oxidation with other ex situ process options infeasible.
		Precipitation	Removal of COCs from groundwater through precipitation by amendment addition	Yes	Effective for metals. Ineffective for PFAS. Amendment will also enhance reductive dechlorination of chlorinated VOCs but requires long treatment time. May be combined with other ex situ process options.
		Ozone Oxidation	Oxidize contaminants.	Yes	Effective and implementable technology for ex situ groundwater treatment of chlorinated VOCs. Ineffective for PFAS. Ineffective for metals. May be combined with other ex situ treatment options.
	Biological	Aerobic Bioreactor	Aerobic biodegradation performed in an engineered bioreactor for contaminant removal from a process stream.	No	Site COCs do not have viable aerobic degradation pathways.
		Anaerobic Bioreactor	Biodegradation in the absence of oxygen performed in an engineered bioreactor for contaminant removal from a process stream.	No	Effective and implementable technology for ex situ groundwater treatment of CVOCs. Ineffective for PFAS. Ineffective for metals. Long hydraulic retention times for complete mineralization of chlorinated ethenes require large reactor volumes.

See Notes on Page 3.

Table 3-3
Preliminary Evaluation of Remedial Measure Technologies for Groundwater

Feasibility Study
Former George A. Robinson Company, Inc. Site
477 Whitney Road, Penfield, New York

Response Actions	Remedial Technologies	Process Options	Description	Retained: Yes or No	Decision Rationale
Disposal/ Discharge	Disposal	POTW	Offsite discharge to a POTW.	Yes	Effective but may require onsite pretreatment and permits with the POTW.
		Treatment Facility	Offsite disposal of liquids to be containerized and treated by a second party.	Yes	Effective and implementable technology for ex situ groundwater treatment of site COCs.
	Reuse	Facility Use	Non-potable onsite reuse of treated groundwater.	No	No onsite use of non-potable water is occurring.
		Reinjection	Reinject treated groundwater.	Yes	Implementable in unconsolidated deposits but reinjection volume will be limited in lower permeability soils.
	Discharge	Surface Water Discharge	Discharge treated groundwater to the Thomas or Irondequoit Creeks.	Yes	Effective and implementable assuming a SPDES permit equivalency can be obtained.
		Air Discharge	Discharge from air treatment system.	Yes	Granular activated carbon or air stripper can be used to achieve regulatory air discharge standards for VOCs.

Note:
Shaded cells indicate technologies not retained.

Abbreviations:
COC - constituent of concern
CVOC - chlorinated volatile organic compound
DNAPL - dense nonaqueous phase liquid
IX - ion exchange
mmHg - millimeters of mercury
PFAS - per- and polyfluoroalkyl substances
POTW - Public Owned Treatment Works
SPDES - State Pollutant Discharge Elimination System
UV - ultraviolet
VOC - volatile organic compound

Table 3-4
Process Options Screening for Soil

Feasibility Study
Former George A. Robinson Company, Inc. Site
477 Whitney Road, Penfield, New York

Remedial Technologies	Process Options	Effectiveness Evaluation		Implementability Evaluation		Relative Cost Evaluation		Retained?	
Not Applicable	No Action	Low	No effect on soil concentrations. Effectiveness, if any, is attributed to naturally occurring processes.	High	Easily implemented.	Low	No additional costs.	Yes	Use as a baseline for comparison to other alternatives.
Not Applicable	Deed Restrictions	Low	No effect on soil concentrations. Placing deed restrictions and maintaining the Site Management Plan will reduce potential exposure to residual concentrations.	High	Easily implemented.	Low	Negligible costs.	Yes	Considered in conjunction with other process options.
	Access Restrictions	Low	No effect on soil concentrations. Limiting site access will reduce potential for exposure to residual concentrations.	High	Easily implemented.	Low	Negligible costs.	Yes	Considered in conjunction with other process options.
Infiltration Control or Capping	Impermeable Cover	Low	Use/maintain cover to prevent direct contact and rainwater infiltration. Does not limit leaching to groundwater traversing the area.	High	May require extension of impermeable cover (i.e., asphalt, concrete).	Low	Low capital and O&M costs since most surface is already covered.	Yes	Considered in conjunction with other process options.
In Situ Physical Treatment	Thermal Treatment	High	Effective for chlorinated solvents and other VOCs in saturated soil. Effective for PFAS. Ineffective for metals. Effectively reach treatment goals in a short time frame.	Moderate	Predesign sampling needed to confirm treatment area. Requires installation and maintenance of electrodes or heater wells and recovery and treatment of vapors. The density of the soil would need to be analyzed to determine spacing. Likely to require demolition of Buildings 52, 64, and 101 for access.	High	High capital cost for installation of infrastructure and off-gas capture and treatment. High O&M costs.	Yes	Considered in conjunction with other process options for metals.
In Situ Chemical Treatment	Oxidation	Moderate	Effective for CVOCs. Effective for PFAS. Ineffective for metals. Effectiveness is limited by the ability to achieve direct contact with the contaminant mass.	Moderate	Predesign sampling needed to confirm treatment area. Requires multiple injections to be effective. May experience reduced distribution and CVOC contact in till.	Moderate	Moderate capital cost and O&M costs for multiple injections using injection wells installed in close proximity in smaller treatment areas. High O&M costs for multiple injections using direct push injections in larger treatment areas.	Yes	Considered in conjunction with other process options for metals.
	Stabilization/ Solidification	High	Effective for fixing CVOCs and metals in soil but does not reduce contaminant concentrations in soil. Effective for reducing the overall mass flux of PFAS by reducing leachability to groundwater. Effectiveness is limited by the ability to achieve direct contact with the contaminant mass.	High	Predesign sampling needed to confirm treatment area. Likely to require demolition of Buildings 52, 64, and 101 for access. May be ineffective in lower permeability soils and till.	High	High capital cost for building demolition.	Yes	Poses higher cost than other considered methods and greater design/engineering challenges. Does not reduce contaminant concentrations in soil.
In Situ Biological Treatment	Enhanced Reductive Dechlorination	Moderate	Only effective for CVOCs in the saturated zone. Ineffective for PFAS. Ineffective for metals. Effectiveness is limited by the ability to achieve direct contact with the contaminant mass.	Moderate	Predesign sampling needed to confirm treatment area. Requires multiple injections to be effective. May experience reduced distribution and CVOC contact in till.	Moderate	Moderate capital cost and O&M costs for multiple injections using injection wells installed in close proximity in smaller treatment areas. High O&M costs for multiple injections using direct push injections in larger treatment areas.	Yes	Considered in conjunction with other process options for metals.
Removal	Excavation	High	Effective for mass removal in areas where DNAPL and PFAS are contributing to soil and groundwater concentrations or in shallow unsaturated soils. Replaced clean soils may become recontaminated by CVOC and/or PFAS-impacted groundwater re-entering the excavation.	Moderate/ Low	Predesign sampling needed to confirm treatment area. Likely to require demolition of Buildings 52, 64, and 101 for access. Requires active dewatering of the excavation and treatment or offsite disposal. Backfill with reactive media may be implemented to prevent recontamination by CVOC and/or PFAS-impacted groundwater entering the excavation.	High	High capital cost for building demolition. Offsite disposal of excavated material and extracted groundwater and import of backfill would be required.	Yes	Effective for all Site soil COCs. Considered in conjunction with other process options.
	SVE	Low	Effective for VOC removal from higher permeability vadose zone soil. Ineffective for PFAS. Ineffective for metals.	Low/ Moderate	Not easily implementable in lower permeability soil and till.	High	High capital cost to install SVE wells in close proximity in larger treatment areas. Moderate to high operations and maintenance costs.	No	High cost and lower effectiveness in comparison to other process options.

See Notes on Page 2.

Table 3-4
Process Options Screening for Soil

Feasibility Study
Former George A. Robinson Company, Inc. Site
477 Whitney Road, Penfield, New York

Remedial Technologies	Process Options	Effectiveness Evaluation		Implementability Evaluation		Relative Cost Evaluation		Retained?	
Ex Situ Physiochemical Treatment	Soil Washing	High	Effective for CVOCs, PFAS, and metals. Effectiveness is limited by the ability to achieve direct contact with the contaminant mass. Requires on-site treatment of contaminated fines and wash water prior to disposal.	Low	Requires a high degree of certainty and optimization of the volume of soil requiring treatment and may be less amenable to a field pilot scale trial than other ex situ technologies.	Moderate /High	Cost dependent on the extent of ex situ treatment required. If excavation extends beyond 20 feet below ground surface, this technology becomes cost prohibitive.	Yes	Considered in conjunction with other process options for shallow soil.
Ex Situ Chemical Treatment	Stabilization/ Solidification	High	Effective for CVOCs, PFAS, and metals. Effectiveness is limited by the ability to achieve direct contact with the contaminant mass.	Low/ Moderate	Implementable. Requires the use of a pug mill and addition of water to create plasticity in tight clays.	High	High capital cost for soil excavation and backfill. Not all of the material would be used as backfill so disposal would be required.	No	High capital cost and difficult Implementability in comparison to other process options. Does not reduce contaminant concentrations in soil.
Disposal	On-site	Moderate	Requires onsite soil treatment prior to disposal.	Low/ Moderate	Requires treatment of soil and approval from regulators and site owner for implementation. Requires available onsite space for staging and treatment.	Moderate	Cost dependent on the extent of ex situ treatment required.	Yes	Considered in conjunction with removal process options.
	Off-site	High	Removes the contaminants from the site.	Moderate	Used in conjunction with excavation. Requires coordination and acceptance of material at an offsite location.	Moderate/ High	Cost dependent on the classification of the soil for disposal and the level of required pre-treatment.	Yes	Considered in conjunction with removal process options.

Note:
Shaded cells indicate technologies not retained.

Abbreviations:
COC - constituent of concern
CVOC - chlorinated volatile organic compound
DNAPL - dense nonaqueous phase liquid
O&M - operation and maintenance
PFAS - per- and polyfluoroalkyl substances
SVE - soil vapor extraction
VOC - volatile organic compound

Table 3-5
Process Options Screening for Vapor Intrusion

Feasibility Study
Former George A. Robinson Company, Inc. Site
477 Whitney Road, Penfield, New York

Remedial Technologies	Process Options	Effectiveness Evaluation		Implementability Evaluation		Relative Cost Evaluation		Retained for Consideration	
Not Applicable	No Action	Low	No effect on VOC concentrations in soil vapor or indoor air. Effectiveness, if any, is attributed to naturally occurring processes.	High	Easily implemented.	Low	No additional costs.	Yes	Use as a baseline for comparison to other alternatives.
Not Applicable	Deed Restrictions	Moderate	No effect on VOC concentrations in soil vapor or indoor air. Placing deed restrictions and maintaining the Site Management Plan will reduce potential exposure.	High	Easily implemented.	Low	Negligible costs.	Yes	Considered in in conjunction with other process options.
Building Sealing	Caulking/Sealing	Low/ Moderate	Limits the migration of VOCs in subslab soil vapor into the building.	Moderate/ High	Relatively easy to seal cracks; more difficult to seal entire slab. May require relocation of some building activities during implementation.	Low	Uses standard caulking or sealing methods.	Yes	Considered in in conjunction with other process options.
	Concrete	Moderate	Limits the migration of VOCs in subslab soil vapor into the building.	Low	Requires building modification to thicken the concrete pad and limited access during construction. May require relocation of some building activities during implementation.	High	High installation cost.	No	High capital cost and difficulty to implement in comparison to other process options.
SSDS	Individual Fans	High	Limits the migration of VOCs in subslab soil vapor into the building. Removes VOC mass and prevents future accumulation of mass below the slab.	Moderate	Systems can be easily installed.	Moderate	Moderate installation cost. Low operating cost. Requires long-term O&M.	Yes	Considered in in conjunction with other process options.
	Centralized Systems	High	Limits the migration of VOCs in subslab soil vapor into the building. Removes VOC mass present and prevents future accumulation of mass below the slab.	Moderate	System can be easily installed and existing systems can be easily modified.	Moderate	Moderate installation cost. Using multiple low horse power blowers would keep operating costs comparable to SSDS with individual fans. Requires long-term O&M.	Yes	Considered in in conjunction with other process options.

Note:
Shaded cells indicate technologies not retained.

Abbreviations:
O&M - operation and maintenance
SSDS - subslab depressurization system
VOC - volatile organic compound

Table 3-6
Process Options Screening for Groundwater

Feasibility Study
Former George A. Robinson Company, Inc. Site
477 Whitney Road, Penfield, New York

Remedial Technologies	Process Options	Effectiveness Evaluation		Implementability Evaluation		Relative Cost Evaluation		Retained for Consideration	
Not Applicable	No Action	Low	Effectiveness, if any, is attributed to naturally occurring processes.	High	Easily implemented.	Low	No additional costs.	Yes	Use as a baseline for comparison to other alternatives.
Not Applicable	Deed Restrictions	Moderate	No effect on groundwater concentrations. Maintaining the Site Management Plan will reduce potential exposure to residual concentrations.	High	Easily implemented.	Low	Negligible costs.	Yes	Considered in conjunction with other process options.
Groundwater Monitoring	Long-Term Monitoring	Low	Effectiveness, if any, is attributed to naturally occurring processes.	High	Easily implemented.	Low/ Moderate	Likely to require expansion of existing monitoring well network. Long term O&M required.	Yes	Considered in conjunction with other process options. No protectiveness in areas not targeted for active remediation.
	Monitored Natural Attenuation	Moderate	Natural attenuation processes would require an extended timeframe to reduce COC concentrations to cleanup goals. Effectiveness would improve following source removal/treatment.	High	Degradation of CVOCs and some attenuation evident in groundwater results.	Low/ Moderate	Likely to require expansion of existing monitoring well network. Long term O&M required.	Yes	Considered in conjunction with other process options. Limited protectiveness in areas not targeted for active remediation.
Containment	Impermeable Cover	Low	Use/maintain cover to prevent direct contact and rainwater infiltration.	Moderate	Requires extension of impermeable cover (i.e., asphalt, concrete).	Moderate	Moderate capital and O&M costs. May require import of materials to stabilize grassed areas prior to capping.	Yes	Considered in conjunction with other process options. Limited protectiveness in areas not targeted for active remediation.
	Grout Injection	Moderate/ High	Effective for arresting further horizontal migration of dissolved Site COCs downgradient of the grout injection area.	Moderate/ High	Requires key-in to low permeability deposits to prevent underflow. Requires groundwater extraction and treatment upgradient of the flow barrier to prevent groundwater mounding. Requires long-term set aside of onsite area for treatment facility.	High	High capital cost for flow barrier and treatment system installation. Long-term O&M costs.	Yes	Effectively treats all Site groundwater COCs in conjunction with ex situ treatment options.
	Trenched Cut-off Wal	Moderate/ High	Effective for arresting further horizontal migration of dissolved Site COCs downgradient of the cut-off wall.	Moderate/ High	Requires key-in to low permeability deposits to prevent underflow. Requires groundwater extraction and treatment upgradient of the flow barrier to prevent groundwater mounding. Requires long-term set aside of onsite area for treatment facility.	High	High capital cost for flow barrier and treatment system installation. Long-term O&M costs.	Yes	Effectively treats all Site groundwater COCs in conjunction with ex situ treatment options.
	Sheet Piling	Moderate/ High	Effective for arresting further horizontal migration of dissolved Site COCs downgradient of the sheet piling.	Low/ Moderate	Requires key-in to low permeability deposits to prevent underflow. Requires groundwater extraction and treatment upgradient of the flow barrier to prevent groundwater mounding. Requires long-term set aside of onsite area for treatment facility.	High	High capital cost for flow barrier and treatment system installation. Long-term O&M costs.	No	Higher cost and greater implementation challenges in comparison to other process options.
In Situ Physical Treatment	Thermal Treatment	High	Effective for treating dissolved chlorinated solvents and VOCs in groundwater through volatilization. Effective for PFAS. Can effectively reach treatment goals in a short time frame.	Low/ Moderate	Predesign sampling needed to confirm treatment area. Requires installation and maintenance of electrodes or heater wells and recovery and treatment of vapors. The density of the soil would need to be analyzed to determine spacing. Likely to require demolition of Buildings 52, 64, and 101 for access. Would require a large footprint of treatment to target dissolved concentrations.	High	High capital cost for installation of infrastructure and off-gas capture and treatment in large treatment area. High O&M costs.	No	Ineffective for metals. Ineffective for complete destruction of the vapor phase and waste product generation (hydrogen fluoride) being released during treatment of PFAS. Considered in conjunction with other process options.
	Permeable Reactive Barrier or Funnel and Gate	Moderate/ High	Effective for CVOCs, PFAS, and metals with different reactive media. Effectiveness is limited by the ability to achieve full contact with impacted groundwater.	Moderate/ High	Requires key-in to low permeability deposits to prevent underflow.	High	High capital cost for installation. Long-term O&M costs are dependent on the reactive media used.	Yes	Effective for all Site groundwater COCs. Considered in conjunction with other process options.

See Notes on Page 3.

Table 3-6
Process Options Screening for Groundwater

Feasibility Study
Former George A. Robinson Company, Inc. Site
477 Whitney Road, Penfield, New York

Remedial Technologies	Process Options	Effectiveness Evaluation		Implementability Evaluation		Relative Cost Evaluation		Retained for Consideration	
In Situ Chemical Treatment	Oxidation	Moderate/ High	Effective for CVOCs. Ineffective for PFAS. Ineffective for metals. Effectiveness is limited by the ability to achieve full contact with impacted groundwater.	Moderate	Predesign sampling needed to confirm treatment area. May experience reduced distribution and contact with impacted groundwater in till.	High	Moderate capital cost and O&M costs for multiple injections using injection wells installed in close proximity in smaller treatment areas. High O&M costs for multiple injections using direct push injections in larger treatment areas.	Yes	Considered in conjunction with other process options.
	Precipitation	Moderate/ High	Effective for CVOCs and metals. Ineffective for PFAS. Amendment can be targeted to precipitate metals and enhance reductive dechlorination of CVOCs. Metals removed from groundwater are precipitated onto and remail in site soil. Effectiveness is limited by the ability to achieve full contact with impacted groundwater.	Moderate	Predesign sampling needed to confirm treatment area. May experience reduced distribution and contact with impacted groundwater in till.	High	Moderate capital cost and O&M costs for multiple injections using injection wells installed in close proximity in smaller treatment areas. High O&M costs for multiple injections using direct push injections in larger treatment areas.	Yes	Considered in conjunction with other process options.
	Chemical Reduction	Moderate/ High	Effective for CVOCs. Ineffective for PFAS. Ineffective for metals. Effectiveness is limited by the ability to achieve full contact with impacted groundwater.	Moderate	Predesign sampling needed to confirm treatment area. May experience reduced distribution and contact with impacted groundwater in till.	High	Moderate capital cost and O&M costs for multiple injections using injection wells installed in close proximity in smaller treatment areas. High O&M costs for multiple injections using direct push injections in larger treatment areas.	Yes	Considered in conjunction with other process options.
In Situ Biological Treatment	Enhanced Reductive Dechlorination	Moderate/ High	Effective for CVOCs. Ineffective for PFAS. Ineffective for metals. Effectiveness is limited by the ability to achieve full contact with impacted groundwater.	Moderate	Predesign sampling needed to confirm treatment area. May experience reduced distribution and contact with impacted groundwater in till.	High	Moderate capital cost and O&M costs for multiple injections using injection wells installed in close proximity in smaller treatment areas. High O&M costs for multiple injections using direct push injections in larger treatment areas.	Yes	Lower effectiveness in comparison to other in situ process options.
Removal	Excavation/Dewatering	Moderate	Effective for mass removal in areas where DNAPL, soil impacts, and groundwater concentrations are coincident. Groundwater treatment would be limited to the amount of impacted water entering the excavated area and the transport of impacted groundwater to the excavated area.	Moderate	Likely to require demolition of Buildings 64 and 52 (western side of Site) and Building 101 (eastern side of Site) for access. Would require dewatering of the excavation and treatment of recovered water or offsite disposal.	High	High capital cost for building demolition. Offsite disposal of treated groundwater and excavated material and import of backfill would be required.	No	Higher cost and greater implementation challenges in comparison to other process options.
	Groundwater Extraction	High	Effective for all Site COCs. Effectiveness is limited by the ability to fully intercept impacted groundwater. Requires ex-situ treatment and reuse/discharge of treated groundwater (see below).	Moderate	Requires long-term set aside of onsite area for treatment facility.	High	Moderate capital cost to install extraction wells. High capital costs for treatment system installation. Long-term O&M costs.	Yes	Effectively treats all Site groundwater COCs. Limited effectiveness in low permeability soils and till.
	Groundwater Recovery Trenches	High	Effective for all Site COCs. Effectiveness is limited by the ability to fully intercept impacted groundwater. Requires ex situ treatment and reuse/discharge of treated groundwater (see below).	Moderate	May require building demolition for implementation. Requires long-term set aside of onsite area for treatment facility.	High	High capital cost for trench and treatment system installation. Long-term O&M costs.	Yes	Effectively treats all Site groundwater COCs.
Ex Situ Physical Treatment	Air Stripping	Moderate	Effective for ex-situ treatment of VOCs in groundwater. Ineffective for PFAS. Ineffective for metals.	High	Implemented using an air stripping unit.	Low	Low capital cost.	Yes	Considered in conjunction with other ex situ removal technologies.
	Carbon Adsorption	Moderate	Effective for ex-situ treatment of CVOCs in groundwater. Effective for PFAS. Likely ineffective for metals.	High	Carbon absorption capacity for CVOC degradation products such as vinyl chloride is reduced.	Moderate/ High	High infrastructure costs; moderate long-term O&M cost because of carbon regeneration.	No	Higher cost in comparison to other ex situ removal technologies.
	IX Adsorption	Moderate	Effective for ex-situ treatment of metals in groundwater. Ineffective for CVOCs. Ineffective for PFAS.	High	May require different resins in series for removal of all Site groundwater COCs.	Low	Low capital cost; moderate long-term O&M cost because of IX regeneration.	Yes	Considered in conjunction with other ex situ removal technologies.

See Notes on Page 3.

Table 3-6
Process Options Screening for Groundwater

Feasibility Study
Former George A. Robinson Company, Inc. Site
477 Whitney Road, Penfield, New York

Remedial Technologies	Process Options	Effectiveness Evaluation		Implementability Evaluation		Relative Cost Evaluation		Retained for Consideration	
Ex Situ Chemical Treatment	Precipitation	Moderate/ High	Effective for ex-situ treatment of metals in groundwater. Ineffective for CVOCs. Ineffective for PFAS.	High	Implementability depends on maintaining appropriate redox conditions. Different metals may require different amendments.	High	Low capital cost.	Yes	Considered in conjunction with other ex situ removal technologies.
	Ozone Oxidation	Moderate /High	Effective for ex-situ treatment of CVOCs in groundwater. Ineffective for PFAS. Ineffective for metals.	Moderate	Implementability contingent upon addressing health and safety concerns from strong oxidant. Requires production or delivery of ozone in a gaseous state.	High	High capital cost; low to moderate O&M cost.	No	Higher cost and greater implementation challenges in comparison to other ex situ removal technologies.
Disposal	POTW	High	Requires the lowest level of treatment prior to discharge.	Moderate	Requires permitting and construction of discharge line to discharge to POTW.	Moderate	Moderate capital cost and moderate O&M cost.	Yes	Considered in conjunction with removal technologies.
	Treatment Facility	High	Removes the contaminated media from the site.	Moderate	Requires acceptance from disposal facility.	High	High transport cost; disposal cost dependent on the COCs and concentrations.	Yes	Considered in conjunction with removal technologies.
Reuse	Reinjection	High	Requires high level of treatment to meet discharge standards.	Low/ Moderate	Requires permitting and construction of recharge infrastructure on site. Implementability is dictated by the transmissivity of the site materials and the availability of onsite space for recharge infrastructure.	High	High capital cost and moderate O&M cost.	No	Greater implementation challenges in comparison to other process options.
Discharge	Surface Water Discharge	High	Requires high level of treatment to meet discharge standards.	High	Implementability is dictated by SPDES permit requirements.	Low	Negligible capital cost; minimal O&M cost.	Yes	Considered in conjunction with ex situ physical treatment technologies.
	Air Discharge	High	Requires high level of treatment to meet discharge standards.	High	Implementability is dictated by permit requirements.	Low	Low capital cost; low O&M cost.	Yes	Considered in conjunction with ex situ physical treatment technologies.

Note:
Shaded cells indicate technologies not retained.

Abbreviations:
COC - constituent of concern
CVOC - chlorinated volatile organic compound
DNAPL - dense nonaqueous phase liquid
IX - ion exchange
MNA - Monitored Natural Attenuation
O&M - operation and maintenance
PFAS - per- and polyfluoroalkyl substances
POTW - Public Owned Treatment Works
SPDES - State Pollutant Discharge Elimination System
VOC - volatile organic compound

Table 4-1
Summary of Costs for Remedial Alternatives

Feasibility Study Report
Former George A. Robinson Company, Inc. Site
477 Whitney Road, Penfield, New York

Remedial Alternative	Capital Cost	One-Time Future Cost	One-Time Future Cost	Annual O&M and LTM Cost	Total Estimated Cost (Undiscounted)	Total Estimated Cost (Present Value)
1 - No Action	$110,000			$0	$110,000	$110,000
2 - Return to Predisposal Condition	$7,180,000			$528,000	$18,796,000	$16,708,000
3 - Source Excavation, Soil Cover, and Groundwater Treatment	$5,960,000	$220,000 Year 2	$270,000 Year 4	$88,000	$7,770,000	$7,655,000
4 - Source Excavation and Groundwater Treatment	$6,320,000	$220,000 Year 2	$270,000 Year 4	$88,000	$8,130,000	$8,103,000
5 - Partial Source Excavation and Prevention of Offsite Migration	$7,720,000	$190,000 Year 2	$190,000 Year 4	$88,000	$9,860,000	$9,397,000
6 - Partial Source Excavation, Soil cover, and Prevention of Offsite Migration	$9,270,000			$88,000	$11,030,000	$10,858,000

Notes:
LTM = Long-term monitoring
O&M = Operation and maintenance
Present value cost based on 1% annual discount rate (difference between 10-year treasury and US inflation rates).

Table 4-2
Remedial Alternatives Screening Summary

Feasibility Study
Former George A. Robinson Company, Inc. Site
477 Whitney Road, Penfield, New York

Threshold and Balancing Criteria	Alternative 1: No Action	Rating	Alternative 2: Return to Pre-Disposal Conditions	Rating	Alternative 3: Source Soil Excavation, Soil Treatment, and Groundwater Treatment	Rating
Overall protection of public health and the environment	Would not be protective of human health and the environment because soil and groundwater containing COCs at concentrations greater than applicable soil and groundwater standards would remain at the site. Potential exposure to contaminated soil and groundwater by site workers and/or visitors would remain.	**No**	Metals and VOCs at concentrations above criteria in source soils would be eliminated via excavation and off-site disposal. PFAS and VOCs at concentrations above criteria in both on- and off-site groundwater would be reduced through groundwater extraction and treatment. LTM combined with a limited monitored natural attenuation (MNA) assessment would be used to monitor and/or further reduce contaminant concentrations over time to ensure protection of human health and the environment during implementation. Following groundwater extraction and treatment implementation, LTM/MNA would be used to evaluate decreasing COC concentrations over time.	**Yes**	Metals and VOCs at concentrations above criteria in source soils would be eliminated via excavation or, for metals, controlled via in-situ stabilization. VOCs at concentrations above criteria in site groundwater would be reduced through ISCO injections and reductions would be confirmed/tracked through post injection monitoring. PFAS concentrations in site groundwater would be reduced and controlled through injection of colloidal carbon. Offsite groundwater impacts would attenuate and/or be reduced over time due to treatment of on-site sources. LTM/MNA would be used to further reduce and/or track COC concentrations over time to ensure protection of human health and the environment during remedial implementation and achieve/confirm PFAS, VOCs, and metals concentrations below criteria in groundwater.	**Yes**
Compliance with standards, criteria, and guidance (SCGs)	Would not meet the SCGs because contamination would persist at concentrations greater than standards/guidelines in soil and groundwater.	**No**	Would meet soil SCGs over the short term by removing impacted soil and is expected to meet groundwater SCGs over the long term by treating impacted groundwater	**Yes**	Excavation, in-situ treatment, performance monitoring, and reporting would be conducted in compliance with federal and state requirements	**Yes**
Long-term effectiveness and permanence	Would not meet the SCGs over the long term because contamination would persist at concentrations greater than standards/guidelines in soil and groundwater	**--**	High. VOCs and metals in source soils would be removed from the site via excavation. VOCs and PFAS concentrations in groundwater would be significantly reduced over time through groundwater extraction and treatment and natural attenuation for VOCs. Following remedy implementation, concentrations of VOCs, PFAS, and metals in soil and groundwater would be reduced to low levels and show established downward trends to ensure continued compliance with NYSDEC Class GA Standard or Guidance Values.	**5**	High/Moderate VOCs and metals in source soils would be removed from the site via excavation resulting in long-term effectiveness and permanence. Metals in source soils that remain on site would be in a stabilized form preventing/limiting further leaching to groundwater. VOCs in source area groundwater would be directly targeted and their concentrations reduced via ISCO injection. Desorption of PFAS could occur over time, reducing long-term permanence. Concentrations of VOCs and PFAS that remain in groundwater post remediation are expected to attenuate over time and/or be reduced through reduction of mass flux from treated source soils. Follow up injections of either ISCO and/or colloidal carbon may be necessary for long-term effectiveness and permanence.	**4**
Reduction of toxicity, mobility, and volume	Would not reduce the toxicity or mobility of the contaminants; however, the volume of contamination may be reduced over the long term through natural attenuation and/or off-site migration.	**--**	High. Would result in the permanent and significant reduction of toxicity, mobility, and volume of VOCs, PFAS, and metals through removal of source soils and removal and treatment of VOCs and PFAS in groundwater.	**5**	High/Moderate. Would reduce the toxicity, mobility, and volume of VOCs, metals, and PFAS in on-site soil and groundwater. Off-site downgradient groundwater impacts would be reduced over time as a result of reduced mass flux from the site but not be targeted directly.	**4**
Short-term effectiveness	No to minimal risk to workers during limited scope associated with well abandonment.	**--**	Moderate. Manageable risk to workers who excavate soil and operate the treatment system due to the use of heavy equipment during excavation, system install and trenching, and handling of contaminated media.	**3**	Moderate. Manageable risk to workers who excavate soil due to the use of heavy equipment, chemicals, and handling of contaminated media. DPT injections will add risk to workers due to chemical handling and physical hazards.	**4**

See Notes on Page 5.

Table 4-2
Remedial Alternatives Screening Summary

Feasibility Study
Former George A. Robinson Company, Inc. Site
477 Whitney Road, Penfield, New York

Threshold and Balancing Criteria	Alternative 1: No Action	Rating	Alternative 2: Return to Pre-Disposal Conditions	Rating	Alternative 3: Source Soil Excavation, Soil Treatment, and Groundwater Treatment	Rating
Implementability	Can be easily implemented but would not be compliant with NYSDEC regulations/policy	--	Low. Would be implemented using readily available technologies; however, implementation would require extensive site controls, significant clearing both onsite and offsite, significant trenching both on- and off-site in challenging terrain to connect extraction wells to the system, and ability to secure and maintain access agreements with off-site properties. Complex geology poses challenges for effectively targetting impacted groundwater. Periodic redevelopment and/or replacement of extraction wells would likely be required.	**2**	Moderate. Would be implemented using readily available technologies; however, implementation would require extensive site control, pilot testing, and predesign investigation to design an effective treatment approach. Treatment of VOCs in groundwater via ISCO and PFAS via colloidal carbon would be difficult to effectively implement due to complex geology.	**3**
Cost	Approximately $110K for monitoring well abandonment	--	High. $16.7 million (Present Value)	**1**	Moderate. $7.7 million (Present Value)	**3**
Land use	Would not achieve criteria for the current or anticipated future (i.e., commercial or restricted residential) land use	--	Unrestricted Use (Soil and Groundwater). Would return the site to pre-disposal conditions resulting in unrestricted land use.	**5**	Unrestricted Use (Soil) and Restricted Use (Groundwater). COCs in site soil would be reduced to below Protection of Groundwater SCOs. COCs in groundwater would be addressed through in-situ treatment but their concentrations would still exceed NYSDEC Class GA Standard or Guidance Values.	**4**
Green and sustainable remediation	Physical footprint would be negligible, but the alternative would not be resilient and would pose risks to community.	--	Low. Waste management and heavy equipment operation would have significant footprints and be disruptive to the community. Pump and treat system operation would incur long-term waste generation and infrastructure.	**1**	Moderate. Source area excavation would have lower waste footprint compared to Alternative 2. Injections and stabilization would have relatively low footprints for long-term benefits.	**3**
Screening Score Summary						
		--		**22**		**25**

See Notes on Page 5.

Table 4-2
Remedial Alternatives Screening Summary

Feasibility Study
Former George A. Robinson Company, Inc. Site
477 Whitney Road, Penfield, New York

Threshold and Balancing Criteria	Alternative 4: Source Soil Excavation and Groundwater Treatment	Rating	Alternative 5: Partial Source Soil Excavation and Prevention of Offsite Migration	Rating	Alternative 6: Partial Source Soil Removal, Cover, and Prevention of Offsite Migration	Rating
Overall protection of public health and the environment	Metals and VOCs at concentrations above criteria in source soils would be eliminated via excavation. VOCs at concentrations above criteria in site groundwater would be reduced through ISCO injections and reductions would be confirmed/tracked through post injection monitoring. PFAS concentrations in site groundwater would be reduced and controlled through injection of colloidal carbon. Offsite groundwater impacts would attenuate and/or be reduced over time due to treatment of on-site sources. LTM/MNA would be used to further reduce and/or track COC concentrations over time to ensure protection of human health and the environment during remedial implementation and achieve/confirm PFAS, VOCs, and metals concentrations below criteria in groundwater.	**Yes**	Metals and VOCs at concentrations above criteria in source area soils would be partially eliminated via excavation. PFAS concentrations in site groundwater would be reduced and controlled through injection of colloidal carbon. VOCs at concentrations above criteria in on-site groundwater near and downgradient of Building 64 would be reduced through ISCO injections and reductions would be confirmed/tracked through post injection monitoring. Off-site migration of VOC-impacted groundwater near Building 101 would be controlled through PRBs installed at targeted areas along the property boundary. Off-site groundwater impacts would attenuate and/or be reduced over time due to removal of on-site sources. LTM/MNA would be used to further reduce and/or track COC concentrations over time to ensure protection of human health and the environment during remedial implementation and achieve/confirm PFAS, VOCs, and metals concentrations below criteria in groundwater over time.	**Yes**	Metals and VOCs at concentrations above criteria in source area soils would be partially eliminated via excavation. A cover would be installed over remining soils with metals at concentrations exceeding criteria to minimize contact and further leaching to groundwater. PFAS concentrations in site groundwater would be reduced and controlled through injection of colloidal carbon. Off-site migration of VOC-impacted groundwater would be controlled through PRBs installed at targeted areas along the property boundary. Off-site groundwater impacts would attenuate and/or be reduced over time due to source area remediation. LTM/MNA would be used to further reduce and/or track COC concentrations over time to ensure protection of human health and the environment during remedial implementation and achieve/confirm PFAS, VOCs, and metals concentrations below criteria in groundwater over time.	**Yes**
Compliance with standards, criteria, and guidance (SCGs)	Excavation, in-situ treatment, performance monitoring, and reporting would be conducted in compliance with federal and state requirements	**Yes**	Excavation, performance monitoring, and reporting would be conducted in compliance with federal and state requirements.	**Yes**	Expected to meet soil and groundwater SCGs over the long term. Excavation, cover installation, performance monitoring, and reporting would be conducted in compliance with federal and state requirements.	**Yes**
Long-term effectiveness and permanence	High/Moderate VOCs and metals in source soils would be removed from the site via excavation resulting in long-term effectiveness and permanence. VOCs in source area groundwater would be directly targeted and their concentrations reduced via ISCO injection. Desorption of PFAS and/or other bound compounds could occur over time, reducing long-term permanence. Concentrations of VOCs and PFAS that remain in groundwater post remediation are expected to attenuate over time and/or be reduced through reduction of mass flux from removal of source soils. Follow up injections of either ISCO and/or colloidal carbon may be necessary for long-term effectiveness and permanence.	**4**	High/Moderate VOCs and metals in source soils would be removed from the site via excavation resulting in long-term effectiveness and permanence. VOCs in source area groundwater surrounding Building 64 would be directly targeted and their concentrations reduced via ISCO injection. Desorption of PFAS could occur over time, reducing long-term permanence. Concentrations of VOCs and PFAS that remain in groundwater post remediation are expected to attenuate over time and/or be reduced through reduction of mass flux from removal of source soils. Follow up injections of either ISCO and/or colloidal carbon may be necessary for long-term effectiveness and permanence.The effectiveness of the PRB in treating VOCs will require on-going monitoring and potential maintenance.	**4**	Moderate VOCs and metals in source soils would be removed from the site via excavation resulting in long-term effectiveness and permanence. Would not implement source treatment of groundwater for VOCs lowering the effectiveness rating. Desorption of PFAS could occur over time, reducing long-term permanence. Concentrations of VOCs and PFAS that remain in groundwater post remediation are expected to attenuate over time and/or be reduced through reduction of mass flux from removal of source soils. Follow up injections of either ISCO and/or colloidal carbon may be necessary for long-term effectiveness and permanence.The effectiveness of the PRB in treating VOCs will require on-going monitoring and potential maintenance.	**3**
Reduction of toxicity, mobility, and volume	High/Moderate. Would reduce the toxicity, mobility, and volume of VOCs, metals, and PFAS in on-site soil and groundwater. Off-site downgradient groundwater impacts would be reduced over time as a result of reduced mass flux from the site but not be targeted directly.	**4**	High/Moderate. Would reduce the toxicity, mobility, and volume of onsite CVOCs, metals, and PFAS contaminants in both soil and groundwater. Off site downgradient groundwater impacts to the south of Building 101 would rely on the PRB to treat VOCs in groundwater at the fence and decrease mass flux from the site over time.	**4**	Moderate. Would reduce the toxicity, mobility, and volume of onsite CVOCs, metals, and PFAS contaminants in soil. Would not directly treat source VOC contaminants in groundwater but rather rely on containment and treatment as it migrates off-site to reduce mobility.	**3**
Short-term effectiveness	Moderate. Manageable risk to workers who excavate soil due to the use of heavy equipment and handling of contaminated media. DPT injections will add risk to workers due to chemical handling and physical hazards.	**4**	Moderate. Manageable risk to workers excavating soil, handling of contaminated media, conducting the colloidal carbon injection, and installing the PRB.	**4**	Moderate. Manageable risk to workers excavating soil, handling of contaminated media, conducting the colloidal carbon injection, and installing the PRB.	**4**

See Notes on Page 5.

Table 4-2
Remedial Alternatives Screening Summary

Feasibility Study
Former George A. Robinson Company, Inc. Site
477 Whitney Road, Penfield, New York

ARCADIS

Threshold and Balancing Criteria	Alternative 4: Source Soil Excavation and Groundwater Treatment	Rating	Alternative 5: Partial Source Soil Excavation and Prevention of Offsite Migration	Rating	Alternative 6: Partial Source Soil Removal, Cover, and Prevention of Offsite Migration	Rating
Implementability	Moderate. Would be implemented using readily available technologies; however, implementation would require extensive site controls, pilot testing, and predesign investigation to design an effective treatment approach. Treatment of VOCs in groundwater via ISCO and PFAS via colloidal carbon would be difficult to effectively implement due to complex geology.	**3**	Moderate. Would be implemented using readily available technologies; however, implementation would require extensive site controls, pilot testing and predesign investigation to design an effective treatment approach. Treatment of VOCs in groundwater via ISCO and PFAS via colloidal carbon would be difficult to effectively implement due to complex geology. Installation of the PRB is challenging due to site constraints, site access, depth of groundwater, and heterogeneous and complicated geology.	**3**	Moderate. Would be implemented using readily available technologies; however, implementation would require extensive site controls, pilot testing, and predesign investigation to design an effective treatment approach. Treatment of PFAS via colloidal carbon would be difficult to effectively implement due to complex geologyy. Installation of the PRBs is challenging due to site constraints, site access, depth of groundwater, and heterogeneous and complicated geology.	**3**
Cost	Moderate. $8.1 million (Present Value)	**3**	High $9.4 million (Present Value)	**2**	High. $10.9 million (Present Value)	**1**
Land use	Unrestricted Use (Soil) and Restricted Use (Groundwater). Site contaminants in soil would be addressed through excavation and treatment and reduced to below Protection of Groundwater SCOs. Contaminants in groundwater would be addressed through treatment but would still exceed NYSDEC Class GA Standard or Guidance Values.	**4**	Restricted Use (Soil and Groundwater). Unrestricted use would not be attained for soil or groundwater. Site contaminants would continue to exceed NYSDEC Class GA Standard or Guidance Values and SCOs.	**2**	Restricted Use (Soil and Groundwater). Unrestricted use would not be attained for soil or groundwater. Site contaminants would continue to exceed NYSDEC Class GA Standard or Guidance Values and SCOs.	**2**
Green and sustainable remediation	Moderate. Source area excavation would have lower waste footprint compared to Alternative 2. Injections would have relatively low footprints for long-term benefits.	**3**	Moderate. Partial source area excavation and PRB would reduce waste generation. Source area excavation would have lower waste footprint compared to Alternative 2. Without demolition of Building 101, or removal of the soils beneath, these areas could be vulnerable to future extreme weather conditions and could result in potential for migration of impacts. Materials would be needed for the PRB construction. Injections would have relatively low footprints for long-term benefits.	**3**	Moderate. Partial source area excavation, cap, and PRB would reduce waste generation. Source area excavation would have lower waste footprint compared to Alternative 2. Without demolition of Building 101, or removal of the soils beneath, these areas could be vulnerable to future extreme weather conditions and could result in potential for migration of impacts. Materials would be needed for the cap and PRB construction. Injections would have relatively low footprints for long-term benefits.	**3**
Screening Score Summary						
		25		**22**		**19**

See Notes on Page 5.

Table 4-2
Remedial Alternatives Screening Summary

Feasibility Study
Former George A. Robinson Company, Inc. Site
477 Whitney Road, Penfield, New York

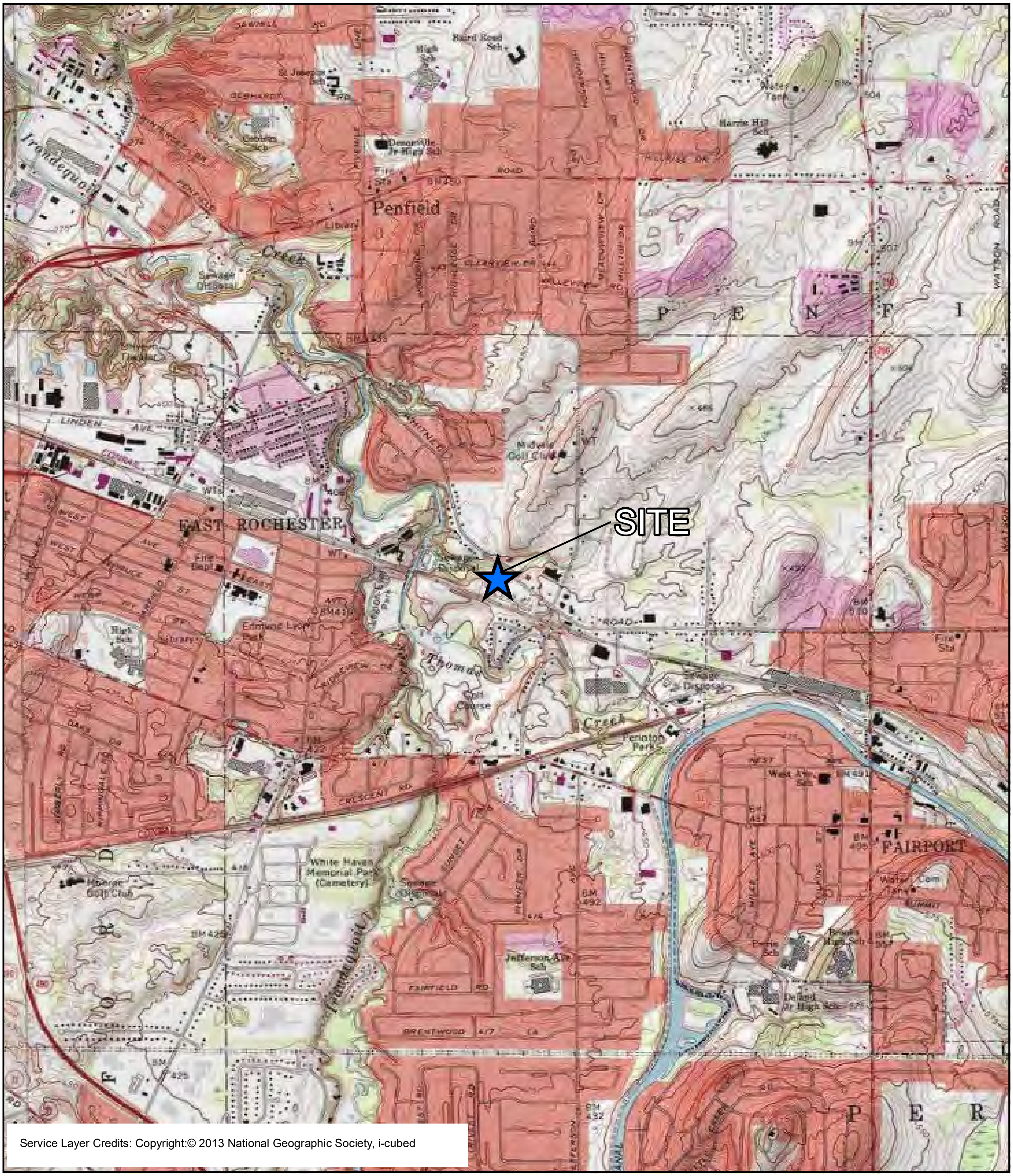
Notes:
All costs are estimated to an accuracy of +50% to -30% (USEPA 2000).
State acceptance and community acceptance modifying criteria will not be given a rating; these will be reflected during the Proposed Plan process.

Acronyms and Abbreviations:
ARAR = applicable or relevant and appropriate requirement
CFR = Code of Federal Regulations
CMR = Code of Massachusetts Regulations
LUC = land use control
MCL = maximum contaminant level
NIA = North Impact Area
NPDWSA = non-potential drinking water source area
PFAS = per- and polyfluoroalkyl substances
RAOs = Remedial Action Objectives
RCRA = Resource Conservation and Recovery Act
redox = oxidation-reduction

Color Code:
Threshold criteria are Pass / Fail
More desirable
Neutral
Less desirable

Rating categories for Threshold and Balancing and Other Criteria (Excluding Cost):
(0) None
(1) Low
(2) Low to moderate
(3) Moderate
(4) Moderate to high
(5) High

Figures



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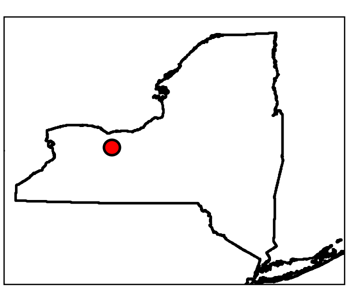

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GEORGE A. ROBINSON & CO., INC. (SITE #8-28-065)
477 WHITNEY ROAD
PENFIELD, NEW YORK
FEASIBILITY STUDY REPORT

SITE LOCATION

ARCADIS

FIGURE
1-1

Document Path: T:_ENV\NYSDEC\George Robinson\mxd\Feasibility Study\Figure 1-1 Site Location.mxd

Legend

- Site Boundary
- Site Fence
- Historical Settling Pond
- Historical Wastewater Lagoon

Note: Historical boundaries are approximate.

Aerial Basemap: Google Satellite

GEORGE A. ROBINSON & CO., INC. (SITE #8-28-065)
477 WHITNEY ROAD
PENFIELD, NEW YORK
FEASIBILITY STUDY REPORT

SITE MAP

ARCADIS

FIGURE
1-2

Document Path: T:_ENV\NYSDEC\George Robinson\mxd\Feasibility Study\Figure 1-2 Site Map.mxd

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GEORGE A. ROBINSON & CO., INC. (SITE #8-28-065)
477 WHITNEY ROAD
PENFIELD, NEW YORK
FEASIBILITY STUDY REPORT

SURROUNDING PROPERTY MAP

ARCADIS

FIGURE
1-3

Legend

Site Boundary

Note: Historical boundaries are approximate.

Aerial Basemap: Google Satellite

N

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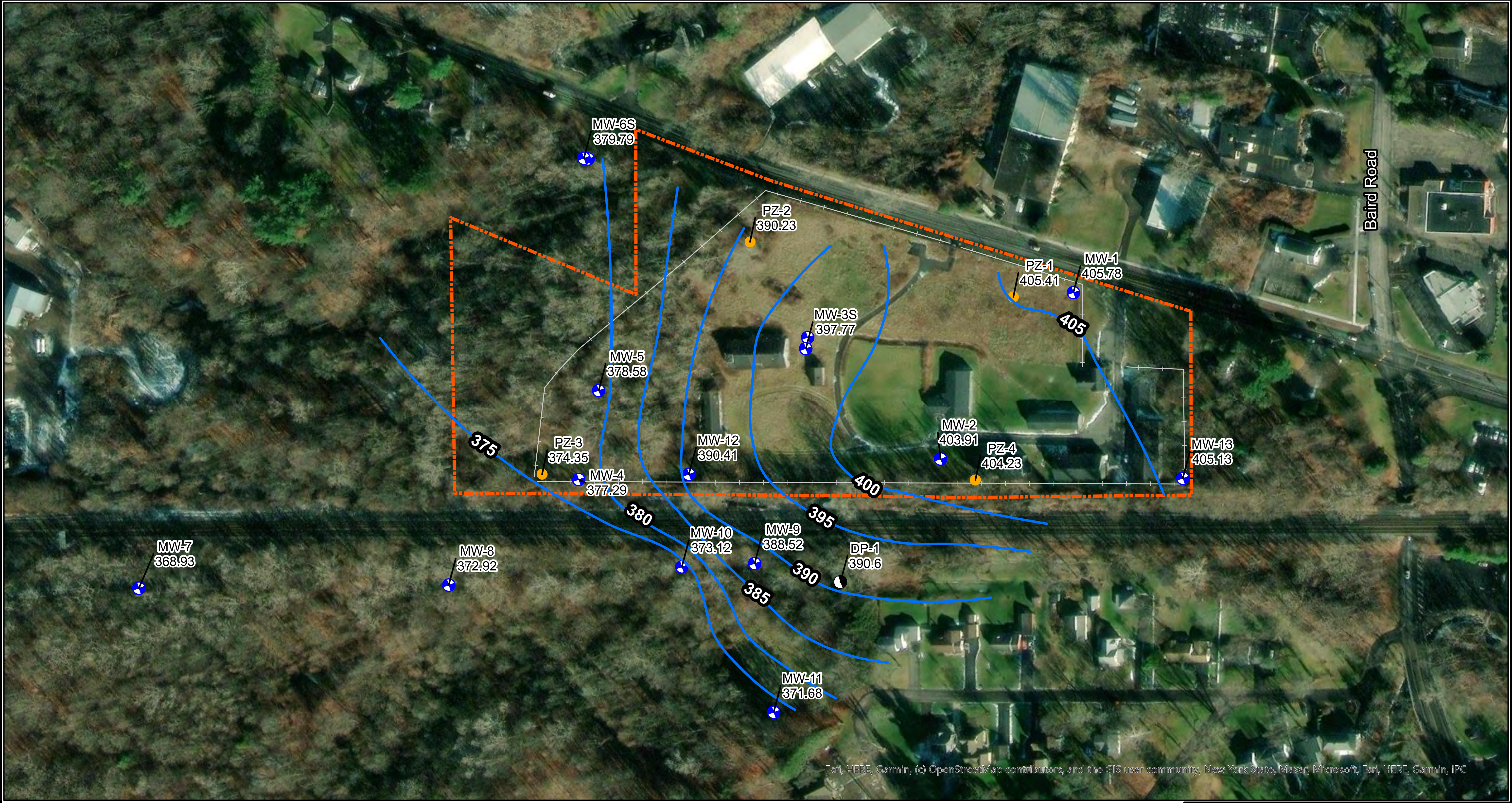

Legend

- Drive Point
- Monitoring Well
- Piezometer
- Site Boundary
- Site Fence (Approximate)

0 120 240 480 720 960 Feet

372.92 Groundwater Elevation (in feet above mean sea level)

375 Groundwater Contour (in feet above mean sea level)

N

GEORGE A. ROBINSON & CO., INC. (SITE #8-28-065)
477 WHITNEY ROAD
PENFIELD, NEW YORK
REMEDIAL INVESTIGATION

GROUNDWATER ELEVATIONS OCTOBER 2019

ARCADIS

FIGURE 1-4

G:\GIS\MOD\00266422.0000\SiteMap.mxd

0 125 250 500 750 1,000 Feet

Legend

- Drive Point
- Monitoring Well
- Piezometer
- Site Boundary
- Equal Elevation Potentiometric Contour
- 368.34 Groundwater Elevation (in feet above mean sea level)
- 375 Groundwater Contour (in feet above mean sea level)

DP-1 was a temporary monitoring point and was not measured in 2022.

Aerial Basemap: Google Satellite

N

GEORGE A. ROBINSON & CO., INC. (SITE #8-28-065)
477 WHITNEY ROAD
PENFIELD, NEW YORK
FEASIBILITY STUDY

POTENTIOMETRIC CONTOURS AUGUST 2022

ARCADIS

FIGURE **1-5**

City: Clifton Park Div/Group: ENV Created By: Last Saved By: LJohns
Project NG Rotterdam
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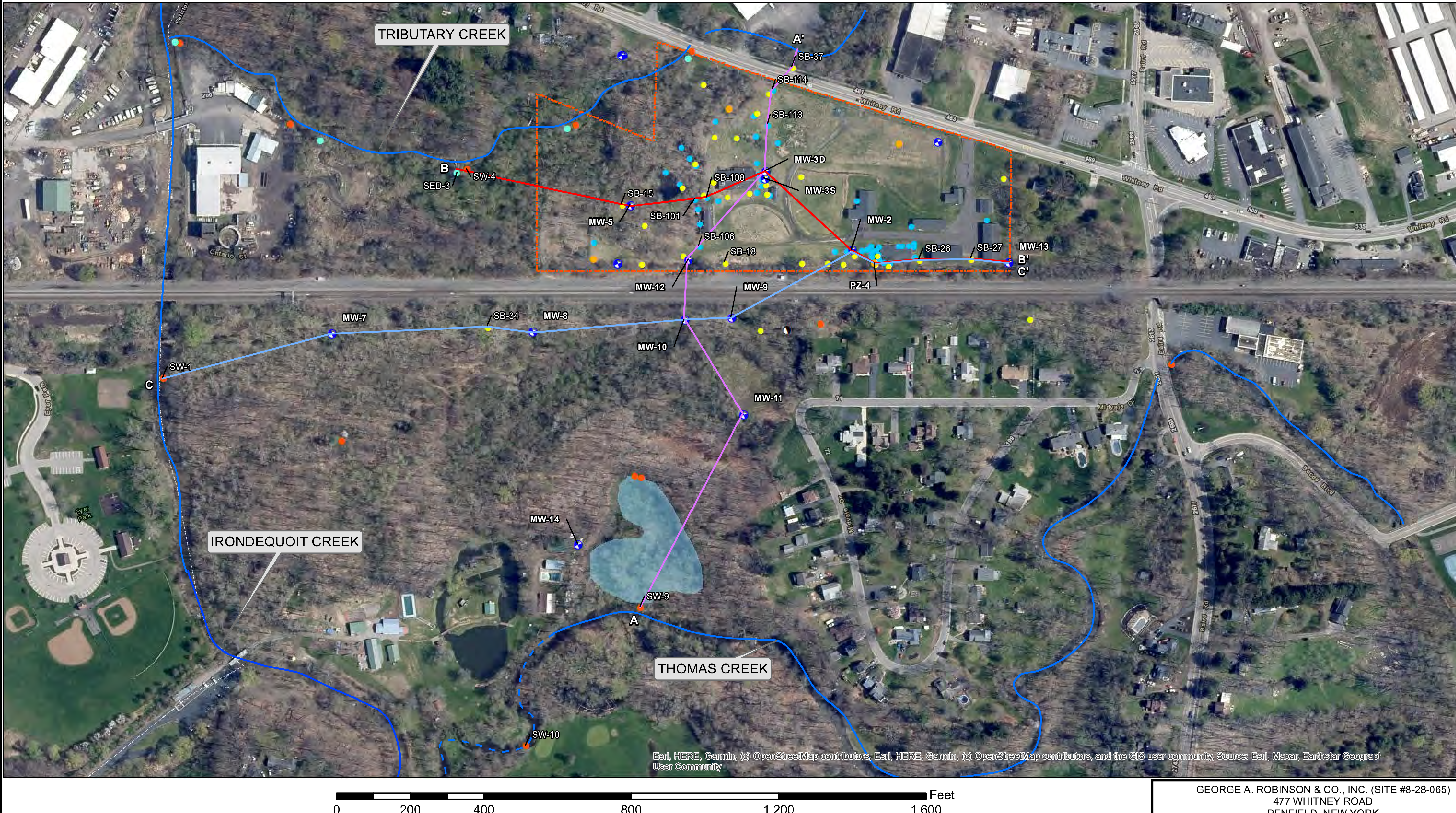


Legend

- Drive Point
- Monitoring Well
- 1-inch Monitoring Well
- Site Characterization Soil Boring
- Remedial Investigation Soil Boring
- Sediment Sample Location
- Surface Water Sample
- Site Boundary (Approximate)
- Wet Area
- World Transportation

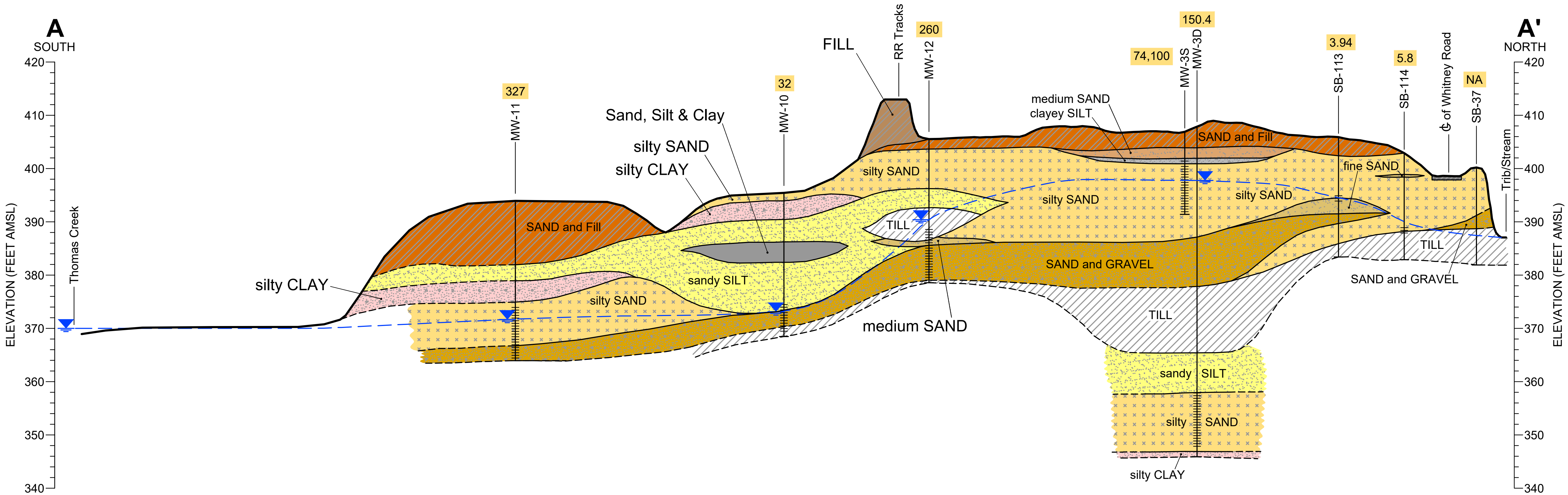
GEORGE A. ROBINSON & CO., INC. (SITE #8-28-065)
477 WHITNEY ROAD
PENFIELD, NEW YORK
FEASIBILITY STUDY

GEOLOGIC CROSS SECTION TRANSECT MAP

ARCADIS

FIGURE
1-6

Document Path: Clifton Park New York Office T:_ENV\NYSDEC\George Robinson\mxd\Cross Section Transects.mxd



LEGEND:

35.75 — Total VOCs IN GROUNDWATER (µg/L)

MW-9S — WELL/BORING ID

APPROXIMATE GROUND SURFACE

LITHOLOGIC CONTACT (DASHED WHERE INFERRED)

INFERRED GROUNDWATER ELEVATION WITH WATER LEVEL MARKER

WELL SCREEN

WELL/BORING BOTTOM

LITHOGRAPHIC KEY:

- SAND and Fill
- FILL
- fine SAND
- silty CLAY
- sandy SILT
- silty SAND
- clayey SILT
- medium SAND
- SAND and GRAVEL
- Interbedded Sand, Silt & Gravel
- TILL

NOTES:

1. CROSS SECTION BASED ON AVAILABLE LITHOLOGY DATA FROM REMEDIAL INVESTIGATION AND SITE CHARACTERIZATION.
2. GROUNDWATER ELEVATIONS FROM THE OCTOBER 2019 EVENT WERE USED TO DEPICT WATER LEVELS.

0 120' 240'
HORIZONTAL SCALE

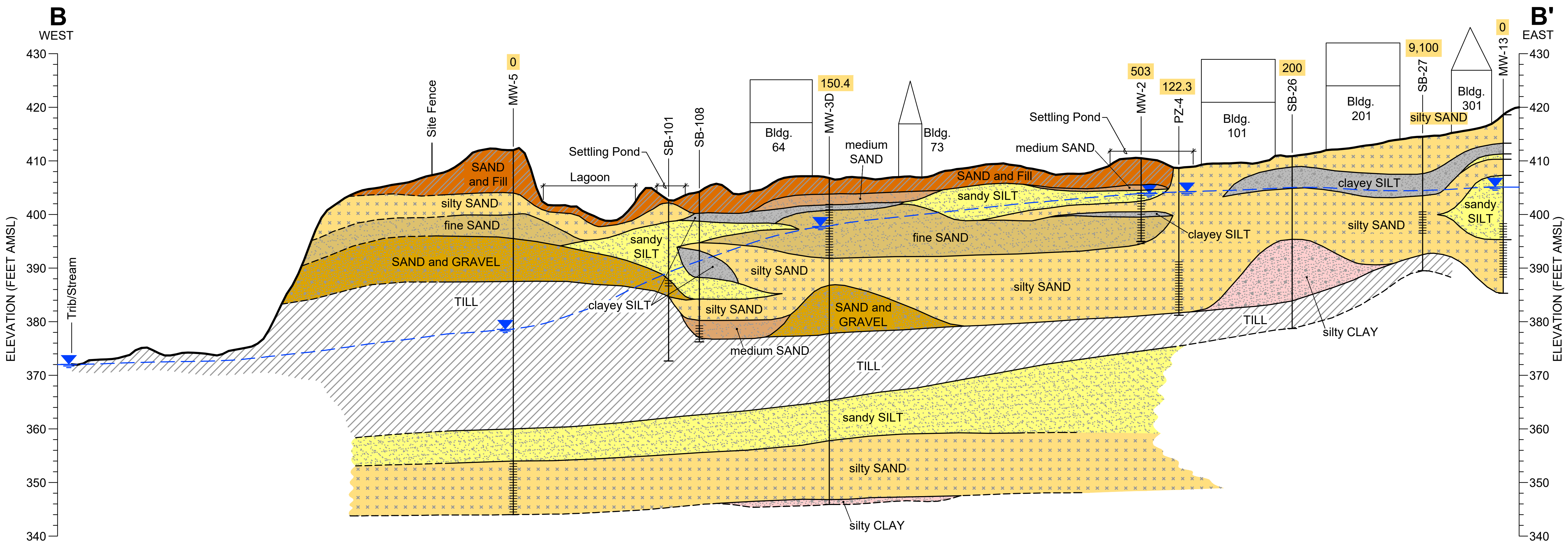
0 20' 40'
VERTICAL SCALE

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
GEORGE A. ROBINSON, PENFIELD, NEW YORK
FEASIBILITY STUDY

CROSS-SECTION A-A'

ARCADIS

FIGURE
1-7



LEGEND:

76.48 — Total VOCs IN GROUNDWATER (µg/L)

SB-108 — WELL/BORING ID

APPROXIMATE GROUND SURFACE

LITHOLOGIC CONTACT (DASHED WHERE INFERRED)

INFERRED GROUNDWATER ELEVATION WITH WATER LEVEL MARKER

WELL SCREEN

WELL/BORING BOTTOM

LITHOGRAPHIC KEY:

- SAND and Fill
- fine SAND
- silty CLAY
- sandy SILT
- silty SAND
- clayey SILT
- medium SAND
- SAND and GRAVEL
- TILL

NOTES:

1. CROSS SECTION BASED ON AVAILABLE LITHOLOGY DATA FROM REMEDIAL INVESTIGATION AND SITE CHARACTERIZATION.
2. GROUNDWATER ELEVATIONS FROM THE OCTOBER 2019 EVENT WERE USED TO DEPICT WATER LEVELS.
3. SETTLING PONDS AND LAGOON NO LONGER IN USE.
4. MW-3D SCREEN DEPICTED IN CROSS SECTION REPRESENTS MW-3S SCREENED INTERVAL.

0 120' 240'
HORIZONTAL SCALE

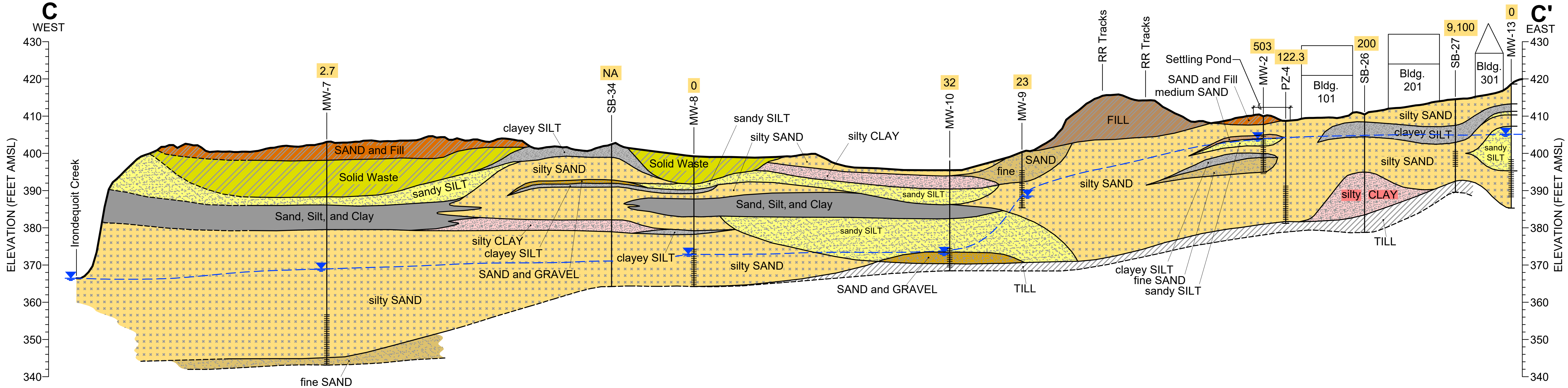
0 20' 40'
VERTICAL SCALE

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
GEORGE A. ROBINSON, PENFIELD, NEW YORK
FEASIBILITY STUDY

CROSS-SECTION B-B'

ARCADIS

FIGURE
1-8



LEGEND:

- Total VOCs IN GROUNDWATER (µg/L)
- WELL/BORING ID
- APPROXIMATE GROUND SURFACE
- LITHOLOGIC CONTACT (DASHED WHERE INFERRED)
- INFERRED GROUNDWATER ELEVATION WITH WATER LEVEL MARKER
- WELL SCREEN
- WELL/BORING BOTTOM

LITHOGRAPHIC KEY:

- FILL
- SAND and Fill
- Solid Waste
- fine SAND
- silty CLAY
- sandy SILT
- silty SAND
- clayey SILT
- medium SAND
- SAND and GRAVEL
- INTERBEDDED SAND, SILT and CLAY
- TILL

NOTES:

1. CROSS SECTION BASED ON AVAILABLE LITHOLOGY DATA FROM REMEDIAL INVESTIGATION AND SITE CHARACTERIZATION.
2. GROUNDWATER ELEVATIONS FROM THE OCTOBER 2019 EVENT WERE USED TO DEPICT WATER LEVELS.
3. SETTLING POND NO LONGER IN USE.
4. NA = NOT AVAILABLE.

0 160' 280'
HORIZONTAL SCALE

0 26.6' 53.3'
VERTICAL SCALE

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
GEORGE A. ROBINSON, PENFIELD, NEW YORK
FEASIBILITY STUDY

CROSS-SECTION C-C'

ARCADIS

FIGURE
1-9

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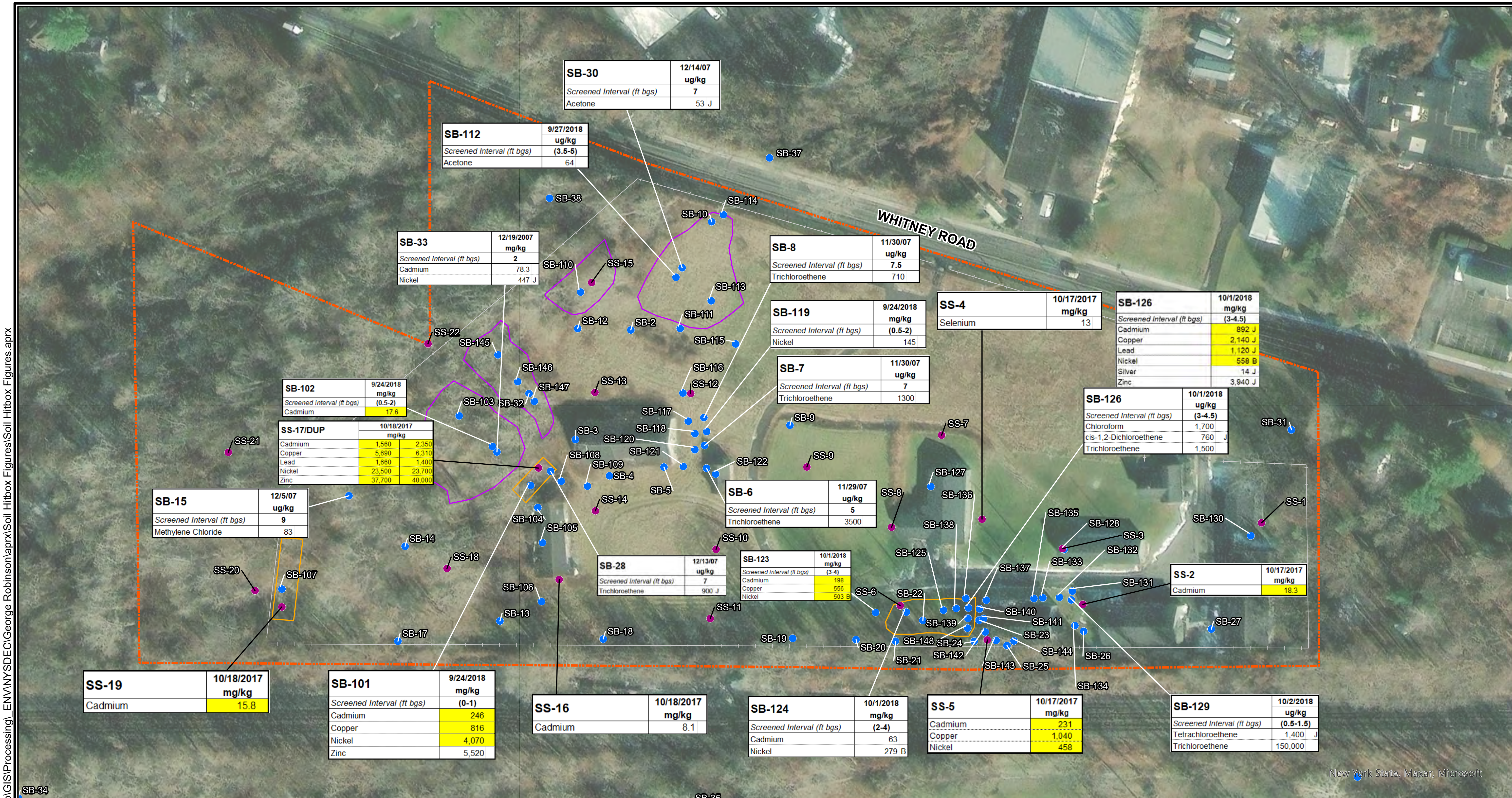

0	80	160	320	480	640 Feet

Legend

- Surface Soil Sample
- Soil Boring
- Site Boundary
- Site Fence (Approximate)
- Settling Pond (Approximate)
- Historic Wastewater Lagoon (Approximate)

Definitions

J - Estimated value
ug/kg - micrograms per kilogram
mg/kg - milligrams per kilogram

NOTE: The yellow highlighted data exceed the Commercial Use Soil Cleanup Objective and the unhighlighted data exceed the Protection of Groundwater Soil Cleanup Objective.

	6 NYCRR Part 375 Protection of Groundwater Soil Cleanup Objective mg/kg	6 NYCRR Part 375 Commercial Use Soil Cleanup Objective mg/kg
Cadmium	7.5	9.3
Copper	1720	270
Lead	450	1,000
Nickel	130	310
Selenium	4	1,500
Zinc	2480	10,000

	6 NYCRR Part 375 Protection of Groundwater Soil Cleanup Objective ug/kg	6 NYCRR Part 375 Commercial Use Soil Cleanup Objective ug/kg
Acetone	50	500,000
Chloroform	370	350,000
cis-1,2-Dichloroethene	250	500,000
Methylene Chloride	50	500,000
Trichloroethene	470	200,000

N

GEORGE A. ROBINSON & CO., INC. (SITE #8-28-065)
477 WHITNEY ROAD
PENFIELD, NEW YORK
FEASIBILITY STUDY

VOCs and Metals in Unsaturated Soil with Concentrations Exceeding Protection of Groundwater SCOs

ARCADIS

FIGURE
2-1

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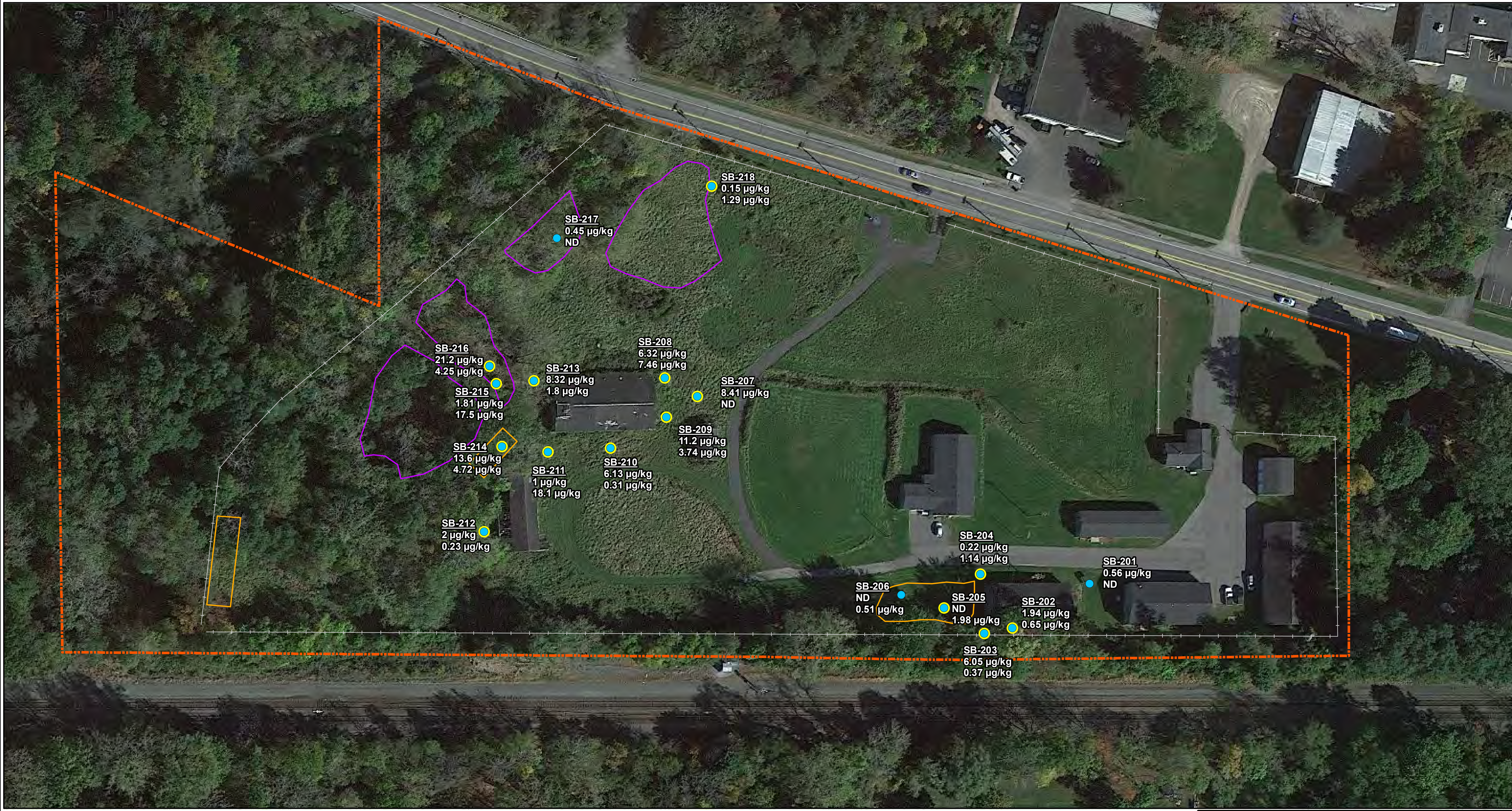

Legend

2023 Soil Boring

- No PFOS Exceedances
- Protection of Groundwater PFOS Exceedance

Protection of Groundwater Guideline Value = 1.0 µg/kg
µg/kg = micrograms per kilogram
PFOS = Perfluorooctanesulfonic acid
ND = Not Detected

- Site Boundary
- Site Fence (Approximate)
- Settling Pond (Approximate)
- Historic Wastewater Lagoon (Approximate)

0 75 150 300 450 600 Feet

N

SB-112 Location ID
2.0 ng/L Surface Soil PFOS Concentration
0.22 ng/L Shallow Soil PFOS Concentration

Background Aerial: Google Satellite

GEORGE A. ROBINSON & CO., INC. (SITE #8-28-065)
477 WHITNEY ROAD
PENFIELD, NEW YORK
FEASIBILITY STUDY

PFOS EXCEEDANCES IN SOIL

ARCADIS

FIGURE
2-2

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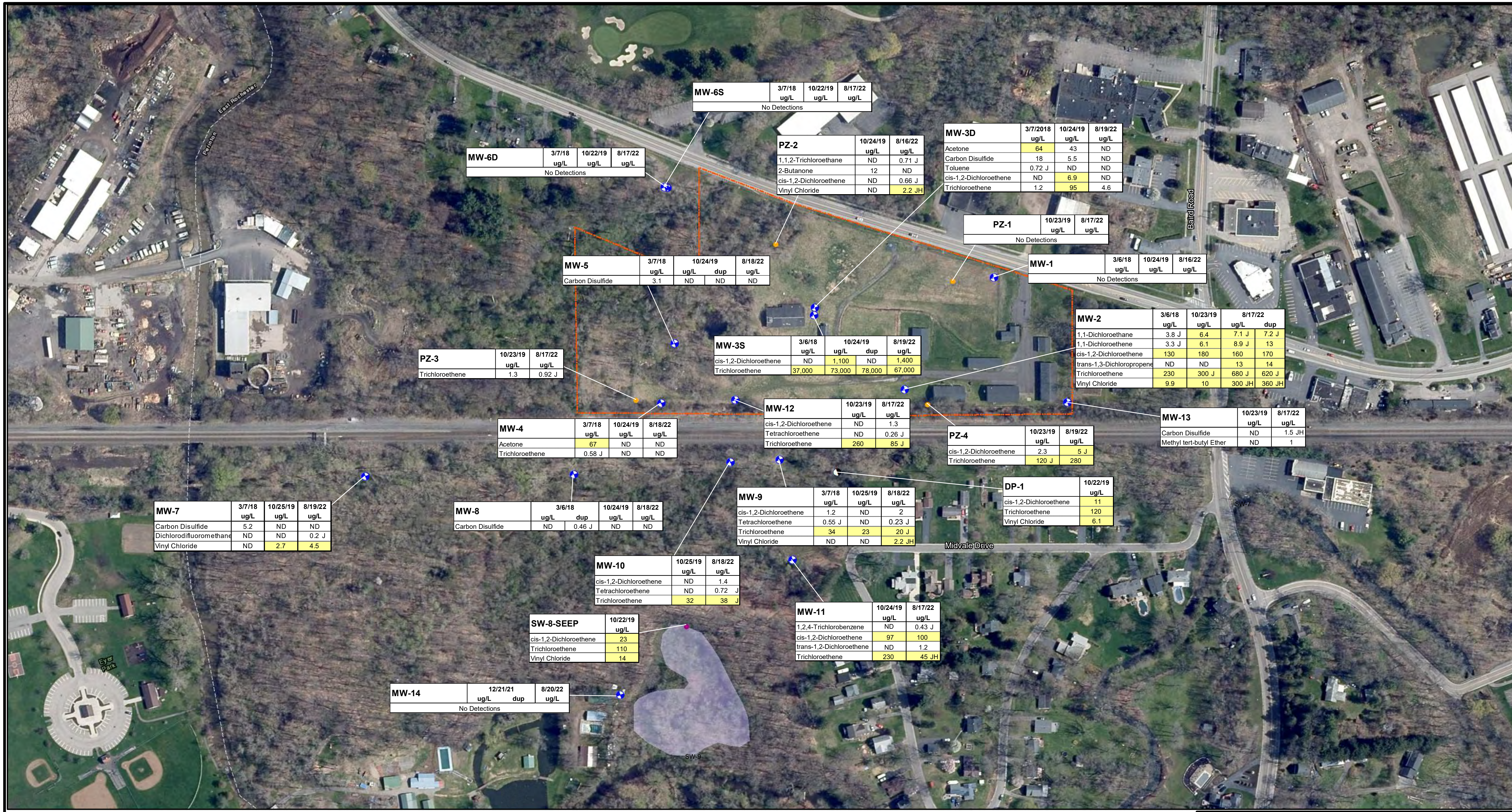

MW-6S	3/7/18 ug/L	10/22/19 ug/L	8/17/22 ug/L
No Detections			

MW-6D	3/7/18 ug/L	10/22/19 ug/L	8/17/22 ug/L
No Detections			

PZ-2	10/24/19 ug/L	8/16/22 ug/L
1,1,2-Trichloroethane	ND	0.71 J
2-Butanone	12	ND
cis-1,2-Dichloroethene	ND	0.66 J
Vinyl Chloride	ND	2.2 JH

MW-3D	3/7/2018 ug/L	10/24/19 ug/L	8/19/22 ug/L
Acetone	64	43	ND
Carbon Disulfide	18	5.5	ND
Toluene	0.72 J	ND	ND
cis-1,2-Dichloroethene	ND	6.9	ND
Trichloroethene	1.2	95	4.6

PZ-1	10/23/19 ug/L	8/17/22 ug/L
No Detections		

MW-5	3/7/18 ug/L	10/24/19 ug/L	10/24/19 dup	8/18/22 ug/L
Carbon Disulfide	3.1	ND	ND	ND

MW-1	3/6/18 ug/L	10/24/19 ug/L	8/16/22 ug/L
No Detections			

MW-2	3/6/18 ug/L	10/23/19 ug/L	8/17/22 ug/L	8/17/22 dup
1,1-Dichloroethane	3.8 J	6.4	7.1 J	7.2 J
1,1-Dichloroethene	3.3 J	6.1	8.9 J	13
cis-1,2-Dichloroethene	130	180	160	170
trans-1,3-Dichloropropene	ND	ND	13	14
Trichloroethene	230	300 J	680 J	620 J
Vinyl Chloride	9.9	10	300 JH	360 JH

MW-3S	3/6/18 ug/L	10/24/19 ug/L	10/24/19 dup	8/19/22 ug/L
cis-1,2-Dichloroethene	ND	1,100	ND	1,400
Trichloroethene	37,000	73,000	78,000	67,000

PZ-3	10/23/19 ug/L	8/17/22 ug/L
Trichloroethene	1.3	0.92 J

MW-12	10/23/19 ug/L	8/17/22 ug/L
cis-1,2-Dichloroethene	ND	1.3
Tetrachloroethene	ND	0.26 J
Trichloroethene	260	85 J

MW-13	10/23/19 ug/L	8/17/22 ug/L
Carbon Disulfide	ND	1.5 JH
Methyl tert-butyl Ether	ND	1

MW-4	3/7/18 ug/L	10/24/19 ug/L	8/18/22 ug/L
Acetone	67	ND	ND
Trichloroethene	0.58 J	ND	ND

PZ-4	10/23/19 ug/L	8/19/22 ug/L
cis-1,2-Dichloroethene	2.3	5 J
Trichloroethene	120 J	280

DP-1	10/22/19 ug/L
cis-1,2-Dichloroethene	11
Trichloroethene	120
Vinyl Chloride	6.1

MW-7	3/7/18 ug/L	10/25/19 ug/L	8/19/22 ug/L
Carbon Disulfide	5.2	ND	ND
Dichlorodifluoromethane	ND	ND	0.2 J
Vinyl Chloride	ND	2.7	4.5

MW-8	3/6/18 ug/L	3/6/18 dup	10/24/19 ug/L	8/18/22 ug/L
Carbon Disulfide	ND	0.46 J	ND	ND

MW-9	3/7/18 ug/L	10/25/19 ug/L	8/18/22 ug/L
cis-1,2-Dichloroethene	1.2	ND	2
Tetrachloroethene	0.55 J	ND	0.23 J
Trichloroethene	34	23	20 J
Vinyl Chloride	ND	ND	2.2 JH

MW-10	10/25/19 ug/L	8/18/22 ug/L
cis-1,2-Dichloroethene	ND	1.4
Tetrachloroethene	ND	0.72 J
Trichloroethene	32	38 J

MW-11	10/24/19 ug/L	8/17/22 ug/L
1,2,4-Trichlorobenzene	ND	0.43 J
cis-1,2-Dichloroethene	97	100
trans-1,2-Dichloroethene	ND	1.2
Trichloroethene	230	45 JH

SW-8-SEEP	10/22/19 ug/L
cis-1,2-Dichloroethene	23
Trichloroethene	110
Vinyl Chloride	14

MW-14	12/21/21 ug/L	12/21/21 dup	8/20/22 ug/L
No Detections			

0 200 400 800 1,200 1,600 Feet

Legend

- Seep Sample
- Drive Point
- Monitoring Well
- 1-inch Monitoring Well
- Approximate Wet Area
- Site Boundary

Notes:
ND = Not Detected.
J = Estimated value.
JH= Estimated, with a bias high.
Units are in micrograms per liter (ug/l)

Concentration exceeds corresponding NYSDEC GA Standard or Guidance Value

N

GEORGE A. ROBINSON & CO., INC. (SITE #8-28-065)
477 WHITNEY ROAD
PENFIELD, NEW YORK
FEASIBILITY STUDY

VOLATILE ORGANIC COMPOUND CONCENTRATIONS IN GROUNDWATER

ARCADIS

FIGURE
2-3

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MW-6S	3/7/2018 ug/L	10/22/2019 ug/L	8/17/2022 ug/L
Antimony	ND	ND	15 J
Arsenic	29	42	35 J
Iron	58,100	64,100	67000 J
Magnesium	38,000	39,100	43000 J
Manganese	3,500	3,900	3700 J

MW-6D	3/7/2018 ug/L	10/22/2019 ug/L	8/17/2022 ug/L
Iron	870	420	1100 J
Magnesium	31,800	33,700	39000 J

PZ-2	10/24/2019 ug/L	8/17/2022 ug/L
Arsenic	41	47 JL
Chromium	77	4.9 JL
Iron	46,700	47000 JL
Manganese	4,700	5000 JL

MW-3D	3/7/2018 ug/L	10/24/2019 ug/L	8/17/2022 ug/L
Iron	40 J	ND	600 J
Magnesium	20,400	1,900	39000 JH

PZ-1	10/24/2019 ug/L	8/17/2022 ug/L
Iron	28,500	54,000
Magnesium	19,000	190000 J
Manganese	490	7,400
Thallium	ND	46 J

MW-5	3/7/2018	10/25/2019		8/17/2022
	ug/L	ug/L	Dup	ug/L
Iron	320	210	230	750
Magnesium	21,000	27,800	27,600	40000 J

MW-1	3/6/2018 ug/L	10/24/2019 ug/L	8/17/2022 ug/L
Magnesium	44,300	17,300	16000 JL

PZ-3	10/25/2019 ug/L	8/17/2022 ug/L
Arsenic	35	11 JH
Berylium	3.3	ND
Chromium	150	120
Hexavalent Chr	NR	73
Iron	134,000	73,000
Lead	54	ND
Magnesium	132,000	190000 J
Manganese	3,900	5,200
Nickel	130	71

MW-3S	3/6/2018	10/24/2019		8/17/2022
	ug/L	ug/L	Dup	ug/L
Chromium	93	15	14	8.4 J
Hexavalent Chr	88	5.8 J	ND	ND
Manganese	490	250	230	450 JH
Nickel	140	73	69	110 J

MW-2	3/6/2018	10/23/2019	8/17/2022	
	ug/L	ug/L	ug/L	DUP
Arsenic	31	37	27 J	100 J
Cadmium	180	140	370 J	220 J
Copper	1,100	550	1300 J	890 J
Iron	13,500	3,400	1800 J	2000 J
Manganese	2,400	4,400	3100 J	3200 J
Nickel	9,400	2,200	2900 J	4300 J

MW-12	10/23/2019 ug/L	8/17/2022 ug/L
Manganese	69	640 J

MW-13	10/23/2019 ug/L	8/17/2022 ug/L
No Exceedances		

MW-4	3/7/2018 ug/L	10/24/2019 ug/L	8/17/2022 ug/L
Iron	450	ND	830 JH
Magnesium	15,800	7,500	36000 JH

PZ-4	10/24/2019 ug/L	8/17/2022 ug/L
Cadmium	28	21 JH
Chromium	53	36 J
Iron	6,300	8500 J
Magnesium	29,500	44000 JH
Manganese	320	470 JH

MW-7	3/8/2018 ug/L	10/25/2019 ug/L	8/17/2022 ug/L
Iron	1,100	3,100	3500 J
Magnesium	38,000	56,700	61000 JH

MW-8	3/6/2018		10/24/2019	8/17/2022
	ug/L	Dup	ug/L	ug/L
Iron	2,500	2,400	1,300	41000 JH
Magnesium	49,000	46,900	40,300	42000 JH

MW-9	3/6/2018 ug/L	10/25/2019 ug/L	8/17/2022 ug/L
Iron	110	ND	880
Magnesium	36,500	39,300	38,000
Manganese	190	55	370

DP-1	10/24/2019 ug/L
Antimony	10 J
Arsenic	90
Beryllium	5.3
Chromium	200
Copper	260
Iron	231,000
Lead	110
Magnesium	247,000
Manganese	7,600
Mercury	1.1
Nickel	290

MW-10	10/25/2019 ug/L	8/17/2022 ug/L
Magnesium	34,700	35000 J

MARSH AREA / SW-8-SEEP	4/10/2019 ug/L	10/22/2019 ug/L
No Exceedances		

MW-11	10/24/2019 ug/L	8/17/2022 ug/L
Magnesium	47,800	66,000
Manganese	2,400	3,000

MW-14	12/21/2021 ug/L	8/17/2022 ug/L
Manganese	68	310 JH

0 200 400 800 1,200 1,600 Feet

N

Legend

- Seep Sample
- Drive Point
- Monitoring Well
- 1-inch Monitoring Well
- Approximate Wet Area
- Site Boundary

Notes:
ND = Not Detected.
J = Estimated value.
JH = Estimated, with a bias high.
Units are micrograms per liter (ug/l).
MARSH AREA and SW-8-SEEP samples were collected from the same location
MARSH AREA and SW-8-SEEP sample results were for Dissolved Metals
MARSH AREA and SW-8-SEEP sample results are compared against TOGS 1.1.1 H(WS) Classes A-C Standards

Concentration exceeds corresponding NYSDEC GA Standard or Guidance Value

GEORGE A. ROBINSON & CO., INC. (SITE #8-28-065)
477 WHITNEY ROAD
PENFIELD, NEW YORK
FEASIBILITY STUDY

METALS CONCENTRATIONS IN GROUNDWATER

ARCADIS

FIGURE 2-4

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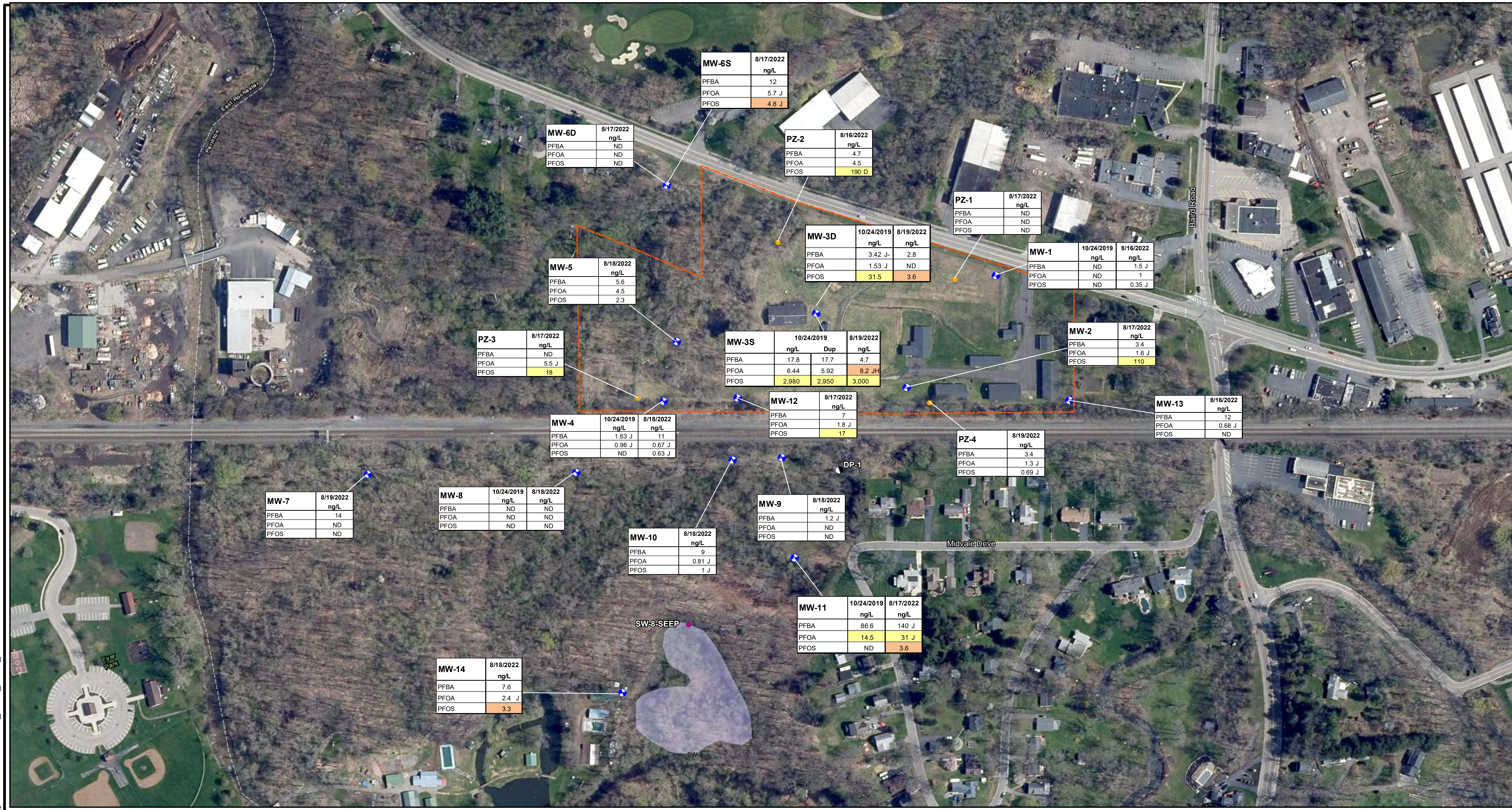

0 200 400 800 1,200 1,600 Feet

N

Legend
- Seep Sample
- Drive Point
- Monitoring Well
- 1-inch Monitoring Well
- Approximate Wet Area
- Site Boundary

Notes:
J = Estimated value.
J- = Estimated value; may have a low bias.
D = A dilution was performed by the laboratory.
Units are nanograms per liter (ng/l)
PFBA - Perfluorobutanoic acid
PFOA - Perfluorooctanoic acid
PFOS - Perfluorooctanesulfonic acid

Exceeds NYSDEC Ambient Water Quality Guidance Value for Protection of Human Health (PFOA = 6.7 ng/L, PFOS = 2.7 ng/L), April 2023.
Exceeds NYSDEC Ambient Water Quality Guidance Value and New York State MCLs for PFOA and PFOS in drinking water.

GEORGE A. ROBINSON & CO., INC. (SITE #8-28-065)
477 WHITNEY ROAD
PENFIELD, NEW YORK
REMEDIAL INVESTIGATION

PFAS CONCENTRATIONS IN GROUNDWATER

ARCADIS

FIGURE
22

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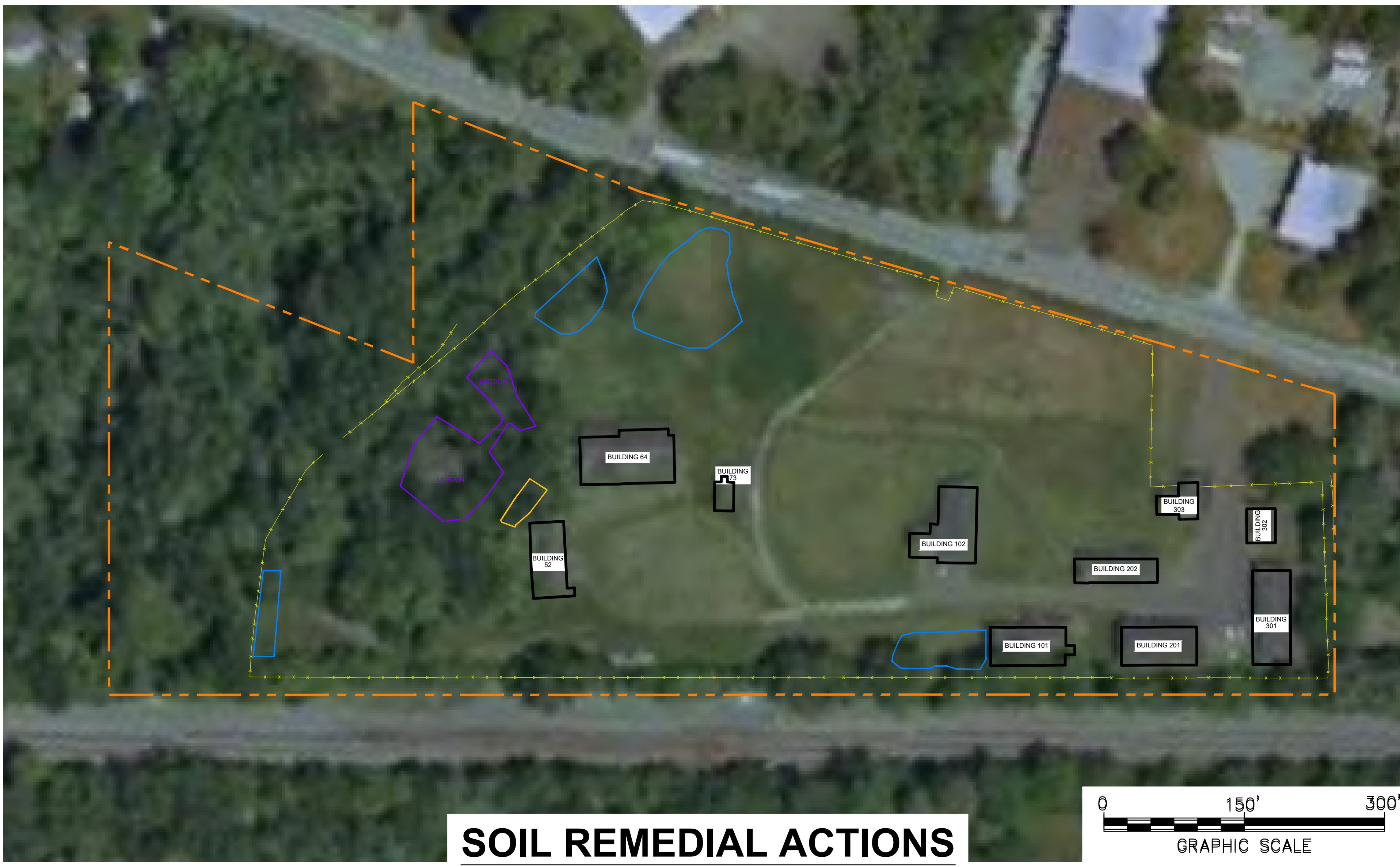
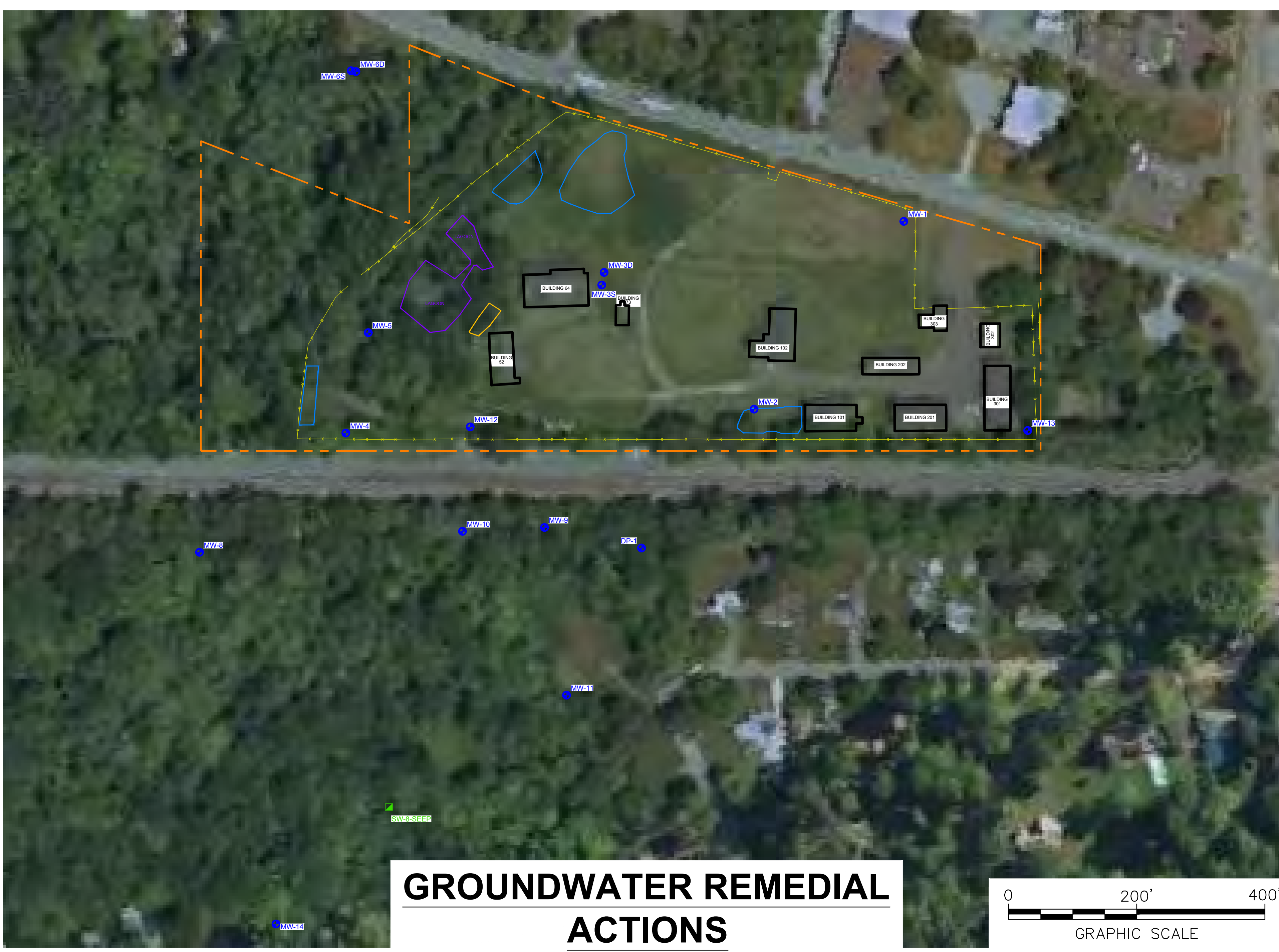


SOIL REMEDIAL ACTIONS



GROUNDWATER REMEDIAL ACTIONS

LEGEND:

- SITE BOUNDARY
- SITE FENCE
- HISTORICAL SETTLING POND
- HISTORICAL WASTEWATER LAGOON
- MONITORING WELL TO BE ABANDONED
- SEEP LOCATION

NOTE:

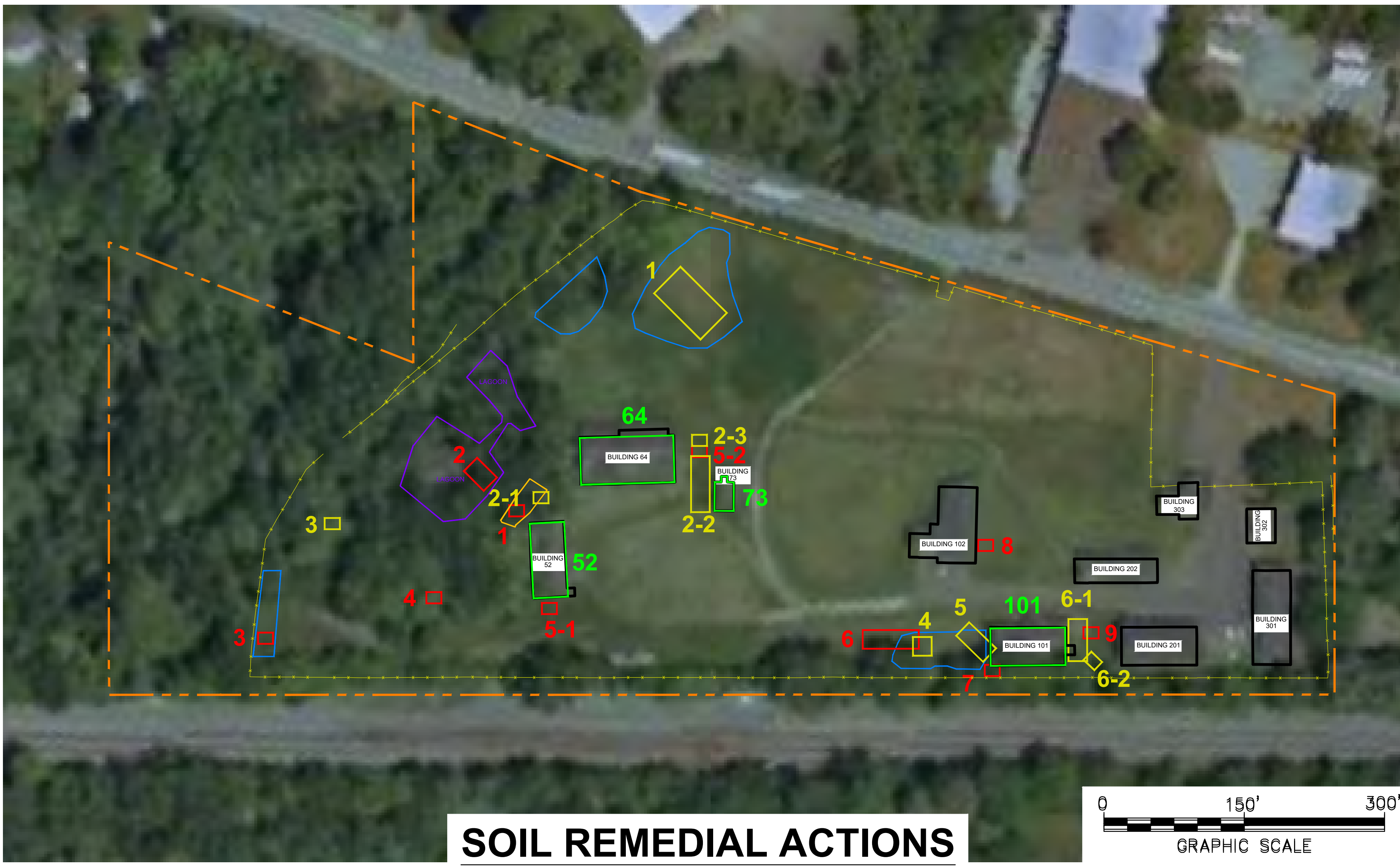
HISTORICAL BOUNDARIES ARE APPROXIMATE.

GEORGE A. ROBINSON & CO. INC. (SITE #8-28-065)
477 WHITNEY ROAD
PENFIELD, NEW YORK
FEASIBILITY STUDY REPORT

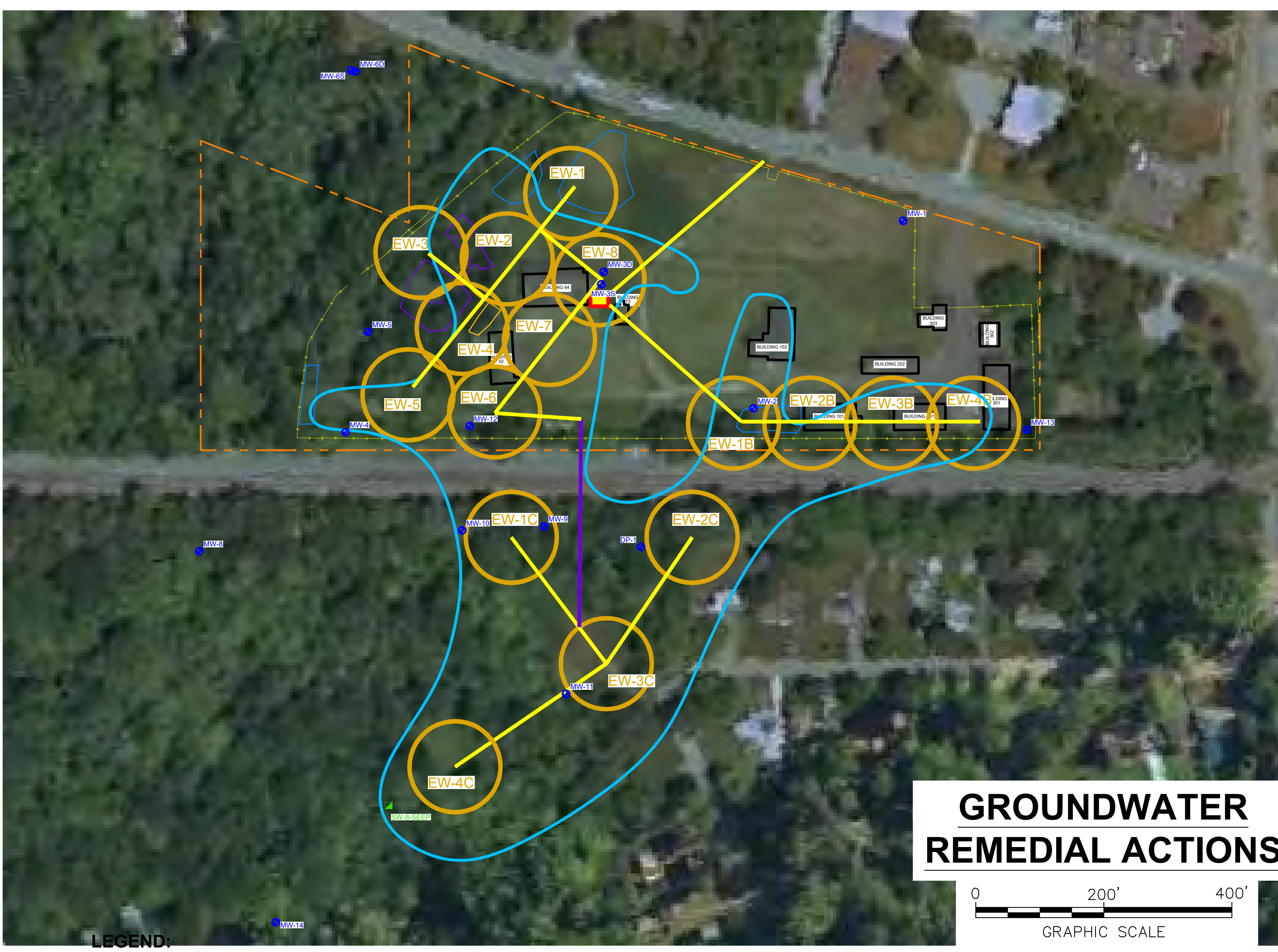
ALTERNATIVE 1: NO ACTION

ARCADIS

FIGURE
4-1



SOIL REMEDIAL ACTIONS



GROUNDWATER REMEDIAL ACTIONS

LEGEND:

- SITE BOUNDARY
- SITE FENCE
- HISTORICAL SETTLING POND
- HISTORICAL WASTEWATER LAGOON
- 3 4 52 EXCAVATION AREA IDENTIFICATION NUMBER
- EXCAVATION TO ADDRESS METALS IN SOIL
- EXCAVATION TO ADDRESS VOCs IN SOIL
- POST-BUILDING DEMOLITION EXCAVATION
- AREA WITH GROUNDWATER CONCENTRATION GREATER THAN CLASS GA STANDARDS
- ASSUMED EXTRACTION WELL RADIUS OF INFLUENCE
- TREATMENT SYSTEM
- TRENCH
- HORIZONTAL DRILLING TO CONNECT OFF-SITE EXTRACTION WELLS
- MONITORING WELL LOCATION
- SEEP LOCATION

NOTE:

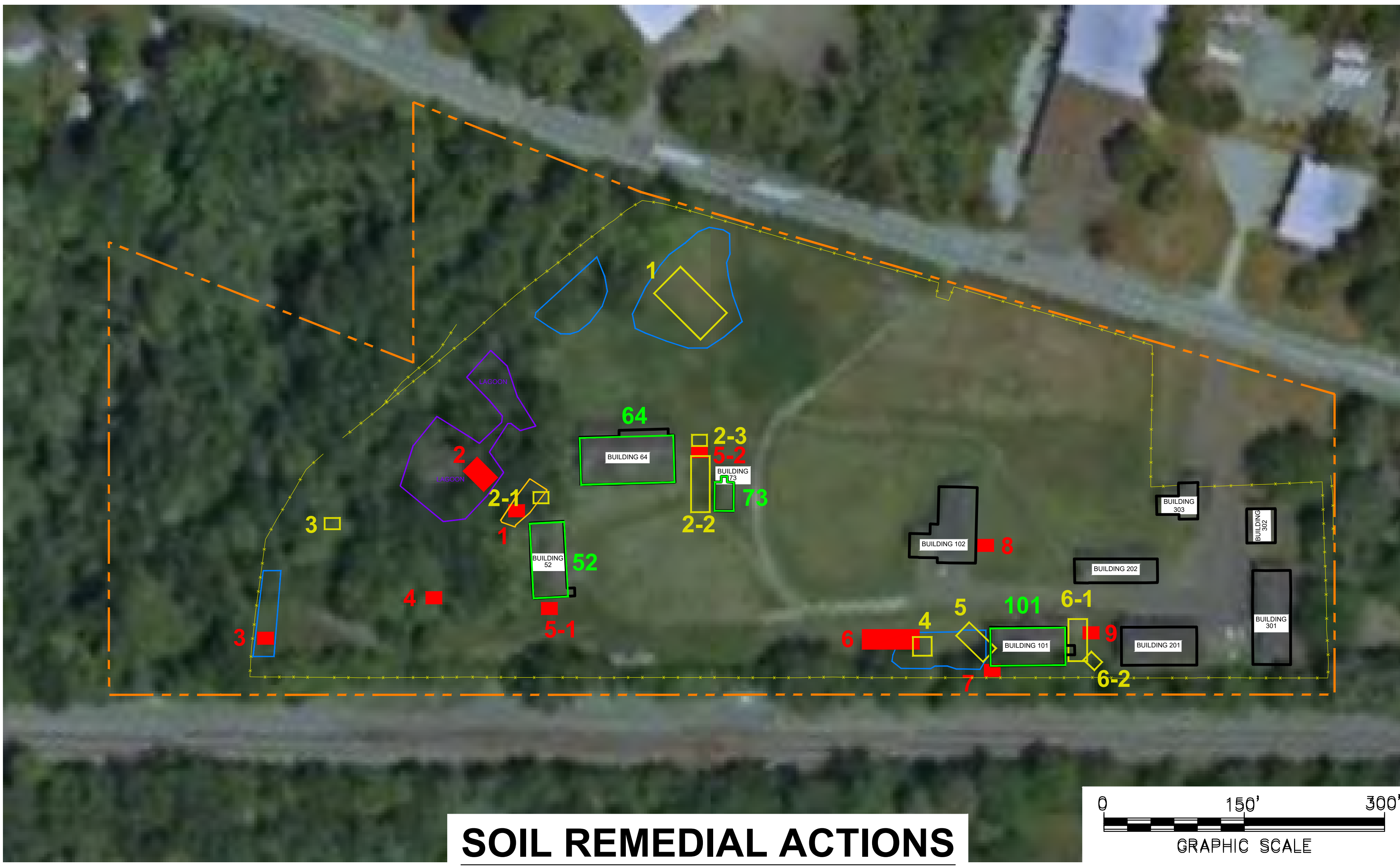
HISTORICAL BOUNDARIES ARE APPROXIMATE.

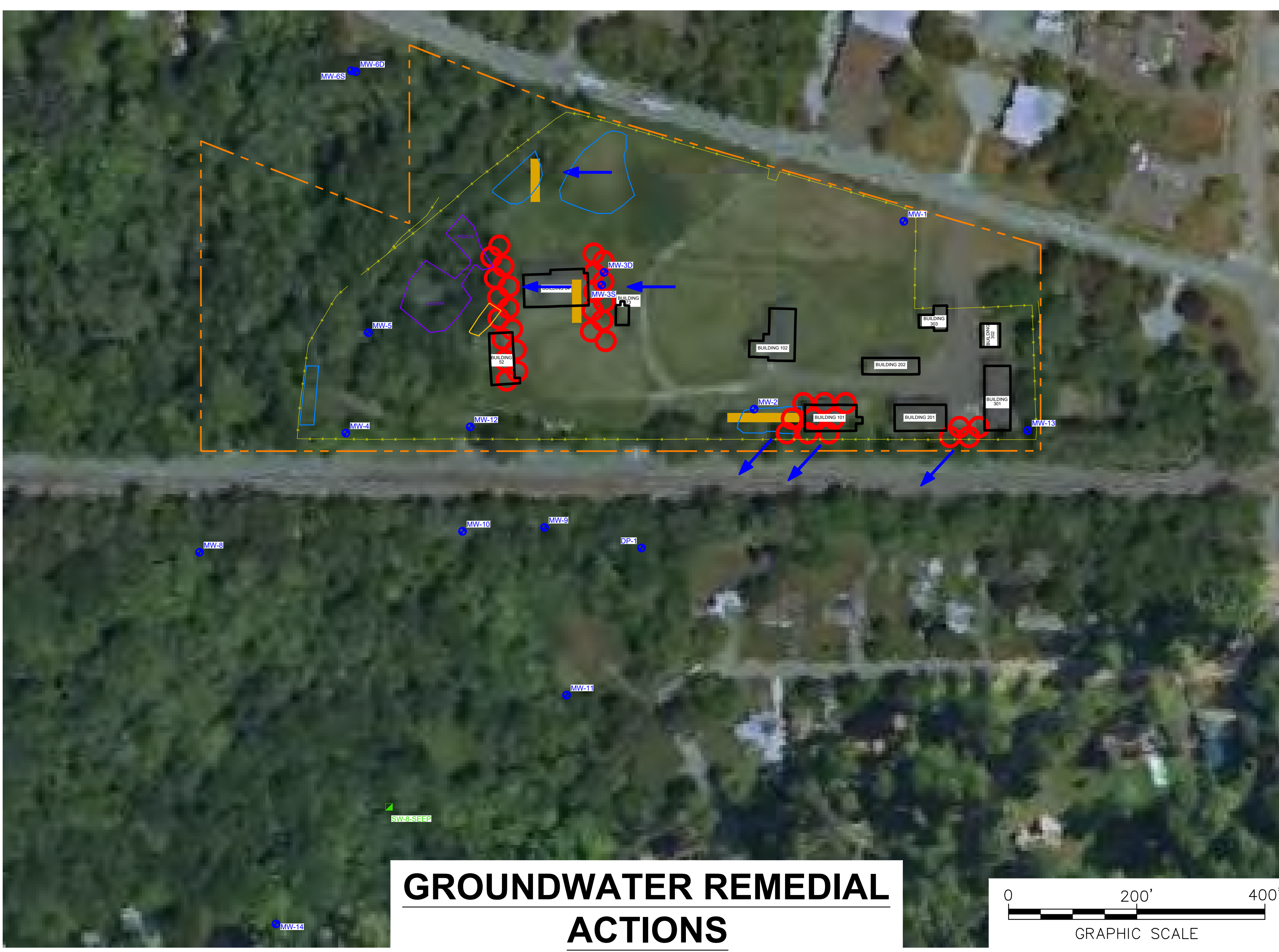
GEORGE A. ROBINSON & CO. INC. (SITE #8-28-065)
477 WHITNEY ROAD
PENFIELD, NEW YORK
FEASIBILITY STUDY REPORT

ALTERNATIVE 2: RESTORATION TO PRE-DISPOSAL CONDITIONS

ARCADIS

FIGURE
4-2





LEGEND:

- SITE BOUNDARY
- SITE FENCE
- HISTORICAL SETTLING POND
- HISTORICAL WASTEWATER LAGOON
- 3 4 52 — EXCAVATION AREA IDENTIFICATION NUMBER
- IN-SITU STABILIZATION TO ADDRESS METALS IN SOIL
- EXCAVATION TO ADDRESS VOCs IN SOIL
- POST-BUILDING DEMOLITION EXCAVATION
- ISCO DPT INJECTION POINT (15' ROI)
- COLLOIDAL CARBON INJECTION AREA
- GROUNDWATER FLOW DIRECTION
- MONITORING WELL LOCATION
- SEEP LOCATION

NOTE: HISTORICAL BOUNDARIES ARE APPROXIMATE.

GEORGE A. ROBINSON & CO. INC. (SITE #8-28-065)
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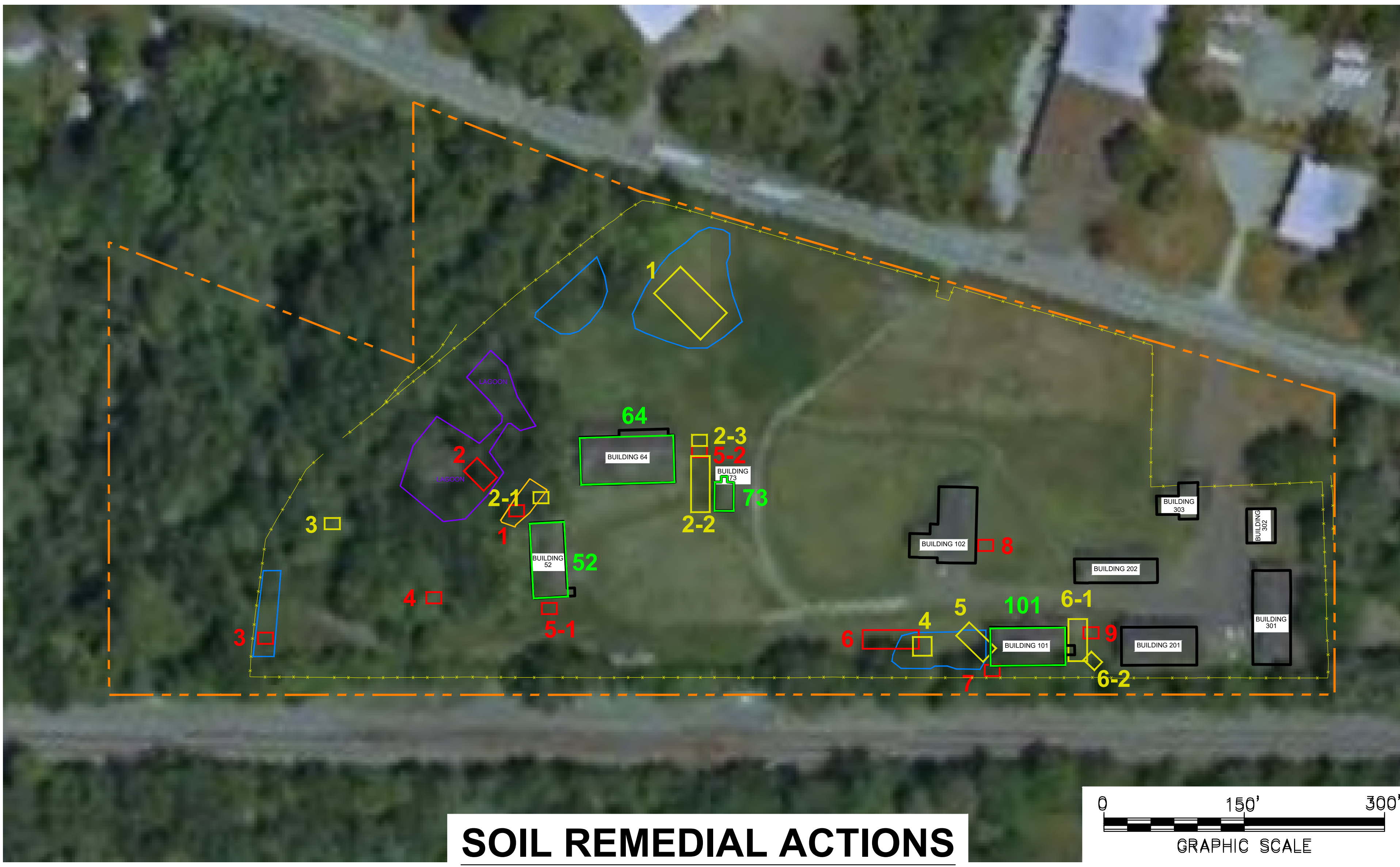
PENFIELD, NEW YORK
FEASIBILITY STUDY REPORT

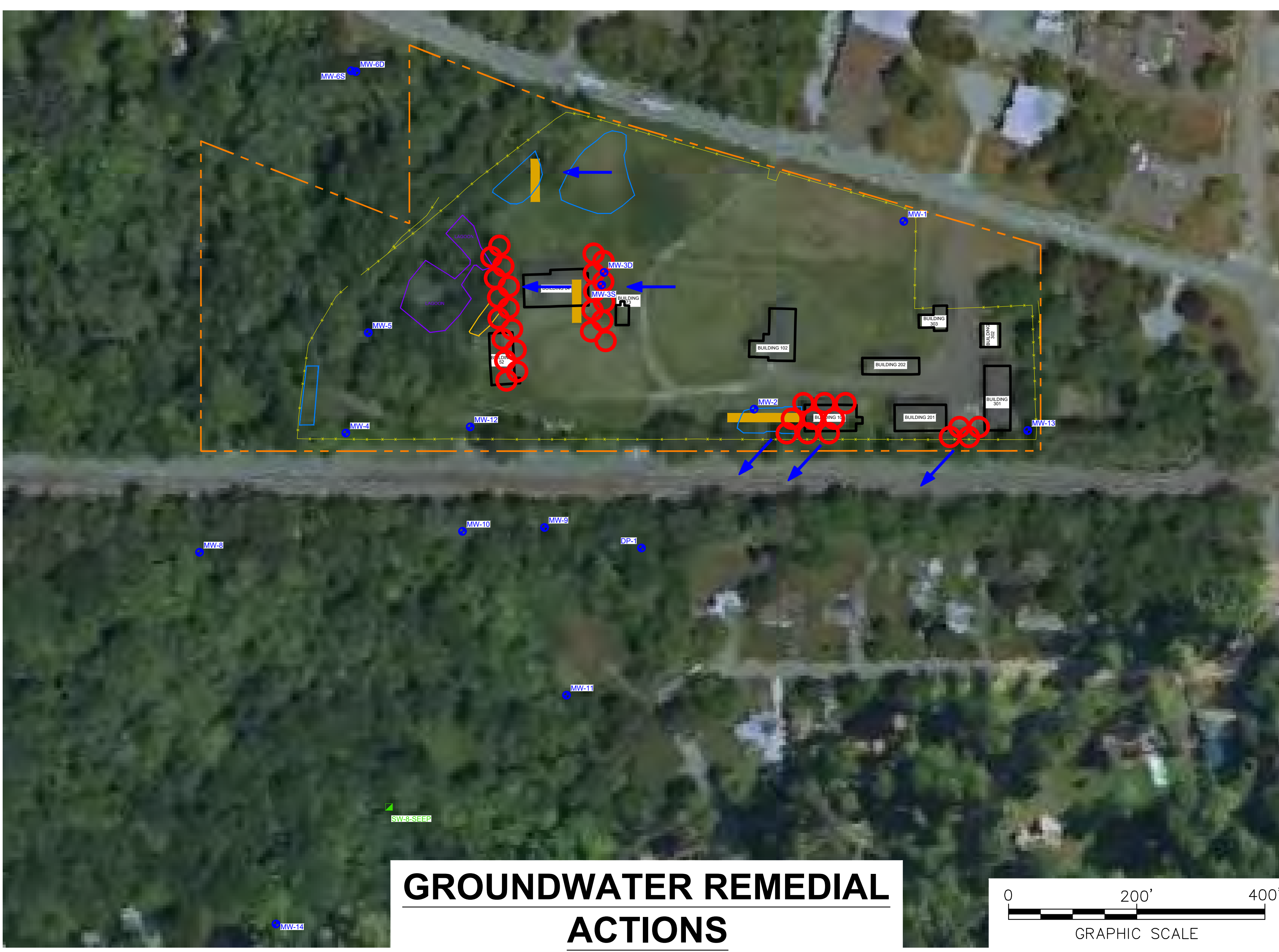
ALTERNATIVE 3: SOURCE SOIL EXCAVATION, SOIL TREATMENT, AND GROUNDWATER TREATMENT

ARCADIS

FIGURE
4-3



SOIL REMEDIAL ACTIONS



GROUNDWATER REMEDIAL ACTIONS

LEGEND:

- SITE BOUNDARY
- SITE FENCE
- HISTORICAL SETTLING POND
- HISTORICAL WASTEWATER LAGOON
- 3 4 52 EXCAVATION AREA IDENTIFICATION NUMBER
- EXCAVATION TO ADDRESS METALS IN SOIL
- EXCAVATION TO ADDRESS VOCs IN SOIL
- POST-BUILDING DEMOLITION EXCAVATION
- ISCO DPT INJECTION POINT (15' ROI)
- PERFORMANCE MONITORING WELL
- COLLOIDAL CARBON INJECTION AREA
- GROUNDWATER FLOW DIRECTION
- MONITORING WELL LOCATION
- SEEP LOCATION

NOTE: HISTORICAL BOUNDARIES ARE APPROXIMATE.

GEORGE A. ROBINSON & CO. INC. (SITE #8-28-065)
477 WHITNEY ROAD
PENFIELD, NEW YORK
FEASIBILITY STUDY REPORT

ALTERNATIVE 4: SOURCE SOIL EXCAVATION AND GROUNDWATER TREATMENT

ARCADIS

FIGURE
4-4

C:\Users\lposenauer\ACCDocs\Arcadis\AUS-NYSDEC-ROBINSON & CO. INC.-PENFIELD New York\Project Files\2023\01-In Progress\01-DWG\FSR-F0X-ALTERNATIVES 1 TO 7.dwg LAYOUT: 4-5 SAVED: 11/17/2023 1:02 PM ACADVER: 24.2S (LMS TECH) PAGESETUP: C-PB-PDF PLOTSTYLETABLE: PLTFULL.CTB PLOTTED: 11/17/2023 1:47 PM BY: POSENAUER, LISA

SOIL REMEDIAL ACTIONS

GROUNDWATER REMEDIAL ACTIONS

LEGEND:

- SITE BOUNDARY
- SITE FENCE
- HISTORICAL SETTLING POND
- HISTORICAL WASTEWATER LAGOON
- 3 4 52 EXCAVATION AREA IDENTIFICATION NUMBER
- EXCAVATION TO ADDRESS METALS IN SOIL
- EXCAVATION TO ADDRESS VOCs IN SOIL
- POST-BUILDING DEMOLITION EXCAVATION
- PERMEABLE REACTIVE BARRIER
- ISCO DPT INJECTION POINT (15' ROI)
- COLLOIDAL CARBON INJECTION AREA
- MONITORING WELL LOCATION
- SEEP LOCATION

NOTE:

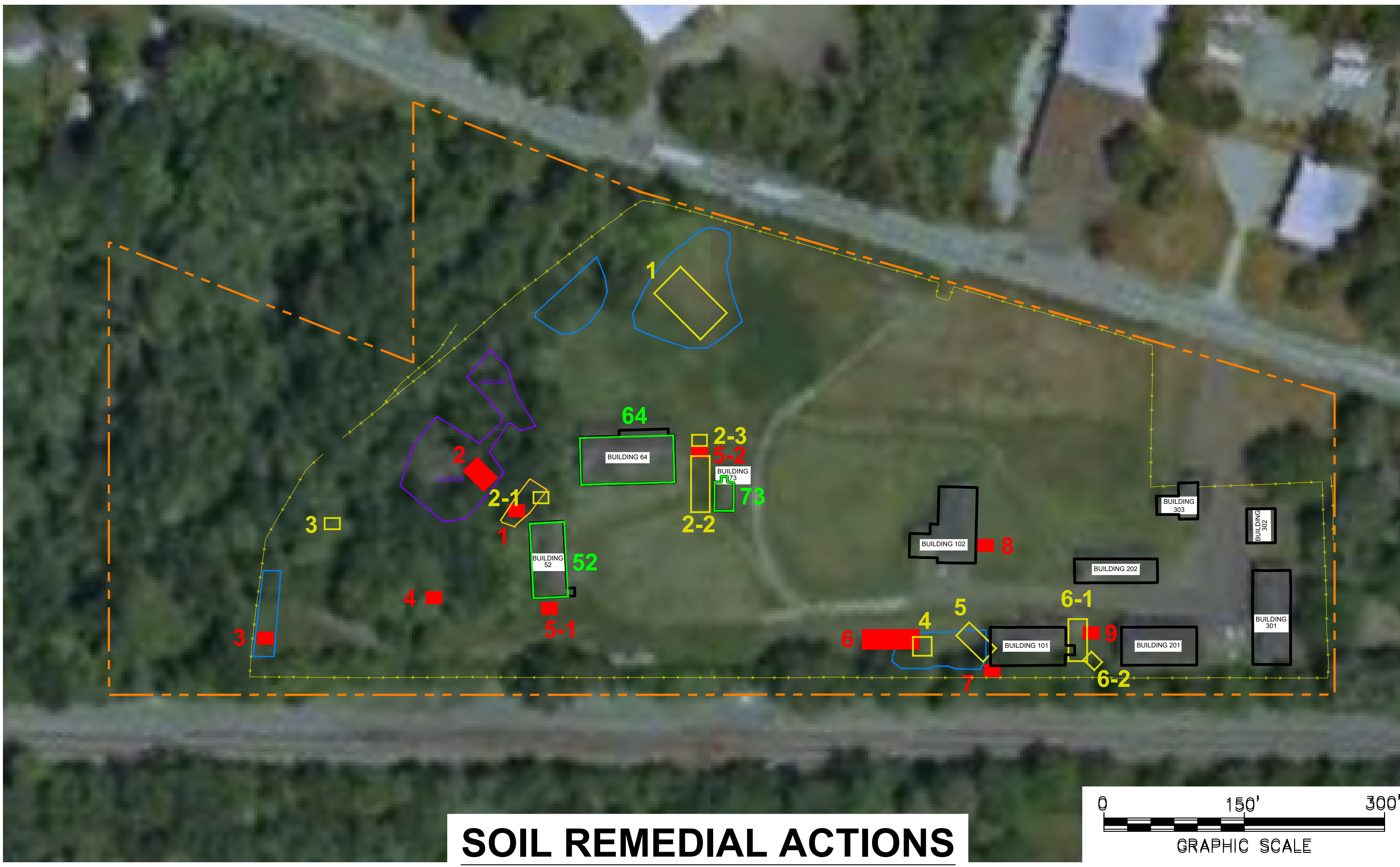
HISTORICAL BOUNDARIES ARE APPROXIMATE.

GEORGE A. ROBINSON & CO. INC. (SITE #8-28-065)
477 WHITNEY ROAD
PENFIELD, NEW YORK
FEASIBILITY STUDY REPORT

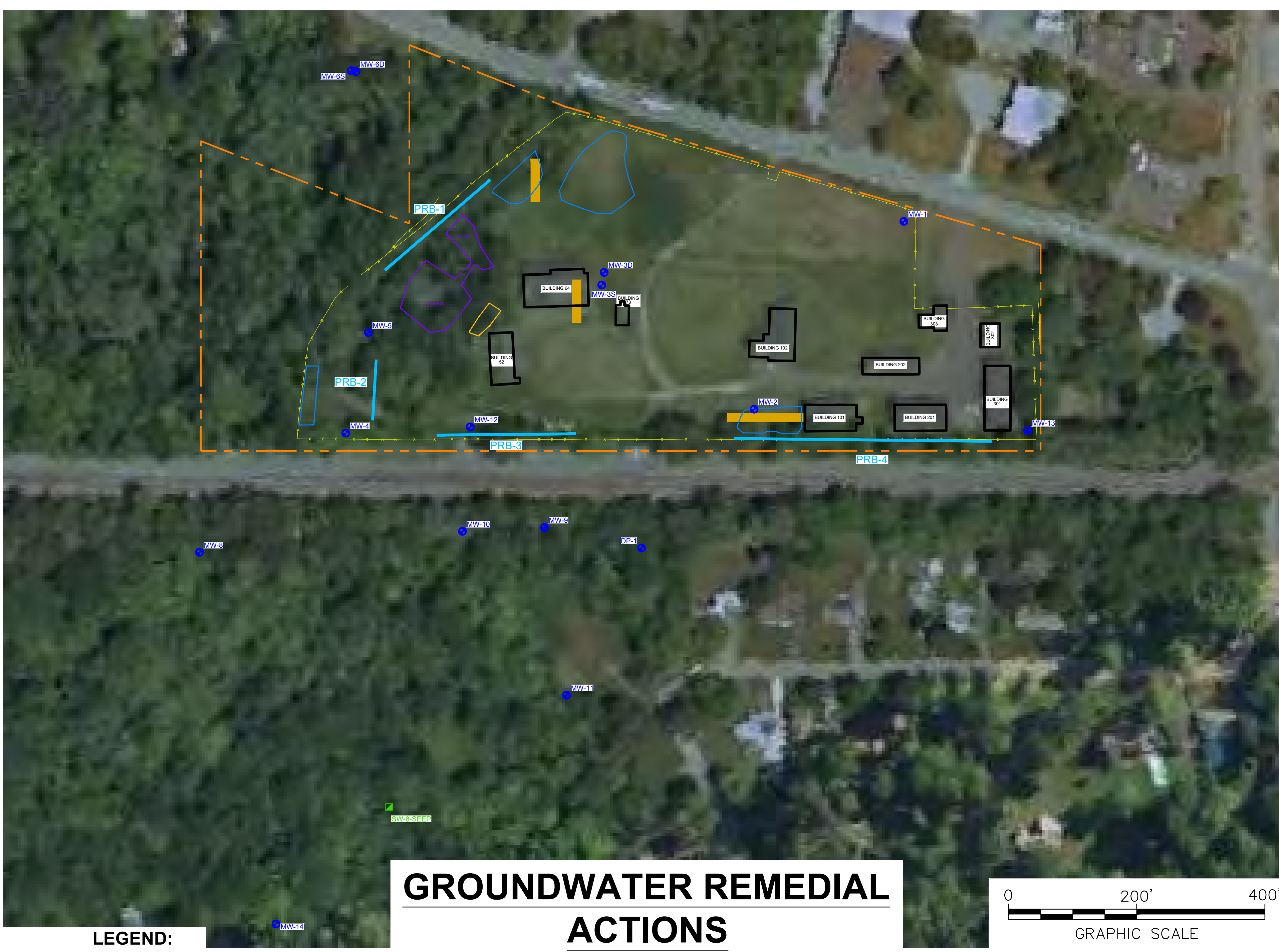
ALTERNATIVE 5: PARTIAL SOURCE SOIL EXCAVATION AND PREVENTION OF OFFSITE MIGRATION

ARCADIS

FIGURE
4-5



SOIL REMEDIAL ACTIONS



GROUNDWATER REMEDIAL ACTIONS

LEGEND:

- SITE BOUNDARY
- SITE FENCE
- HISTORICAL SETTLING POND
- HISTORICAL WASTEWATER LAGOON
- 3 4 52 EXCAVATION AREA IDENTIFICATION NUMBER
- SOIL COVER TO ADDRESS METALS IN SOIL
- EXCAVATION TO ADDRESS VOCs IN SOIL
- POST-BUILDING DEMOLITION EXCAVATION
- PERMEABLE REACTIVE BARRIER
- COLLOIDAL CARBON INJECTION AREA
- MONITORING WELL LOCATION
- SEEP LOCATION

NOTE:

HISTORICAL BOUNDARIES ARE APPROXIMATE.

GEORGE A. ROBINSON & CO. INC. (SITE #8-28-065)
477 WHITNEY ROAD
PENFIELD, NEW YORK
FEASIBILITY STUDY REPORT

ALTERNATIVE 6: PARTIAL SOURCE SOIL EXCAVATION, COVER, AND PREVENTION OF OFFSITE MIGRATION

ARCADIS

FIGURE
4-6

Appendix A

Environmental Justice Screening Tool (EJScreen) Community Report

EJScreen Community Report

This report provides environmental and socioeconomic information for user-defined areas, and combines that data into environmental justice and supplemental indexes.

Monroe County, NY

Blockgroup: 360550119015
Population: 607
Area in square miles: 1.04

COMMUNITY INFORMATION

Low income: 49 percent

People of color: 4 percent

Less than high school education: 3 percent

Limited English households: 3 percent

Unemployment: 6 percent

Persons with disabilities: 16 percent

Male: 44 percent

Female: 56 percent

80 years — Average life expectancy

$32,606 — Per capita income

Number of households: 290

Owner occupied: 88 percent

BREAKDOWN BY RACE

White: 96%

Black: 0%

American Indian: 0%

Asian: 4%

Hawaiian/Pacific Islander: 0%

Other race: 0%

Two or more races: 0%

Hispanic: 0%

BREAKDOWN BY AGE

From Ages 1 to 4	0%
From Ages 1 to 18	23%
From Ages 18 and up	77%
From Ages 65 and up	15%

LIMITED ENGLISH SPEAKING BREAKDOWN

Speak Spanish	0%
Speak Other Indo-European Languages	100%
Speak Asian-Pacific Island Languages	0%
Speak Other Languages	0%

Notes: Numbers may not sum to totals due to rounding. Hispanic population can be of any race.
Source: U.S. Census Bureau, American Community Survey (ACS) 2017 -2021. Life expectancy data comes from the Centers for Disease Control.

LANGUAGES SPOKEN AT HOME

LANGUAGE	PERCENT
English	86%
Spanish	2%
Russian, Polish, or Other Slavic	2%
Other Indo-European	1%
Chinese (including Mandarin, Cantonese)	1%
Other Asian and Pacific Island	3%
Arabic	5%
Other and Unspecified	1%
Total Non-English	14%

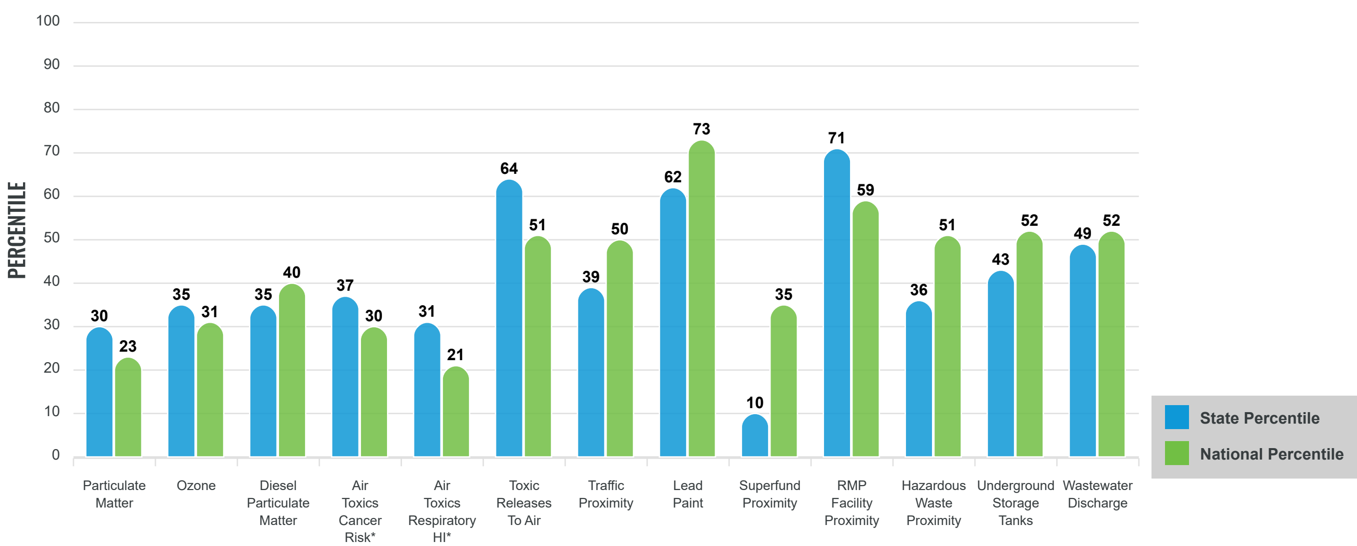
Environmental Justice & Supplemental Indexes

The environmental justice and supplemental indexes are a combination of environmental and socioeconomic information. There are thirteen EJ indexes and supplemental indexes in EJScreen reflecting the 13 environmental indicators. The indexes for a selected area are compared to those for all other locations in the state or nation. For more information and calculation details on the EJ and supplemental indexes, please visit the EJScreen website.

EJ INDEXES

The EJ indexes help users screen for potential EJ concerns. To do this, the EJ index combines data on low income and people of color populations with a single environmental indicator.

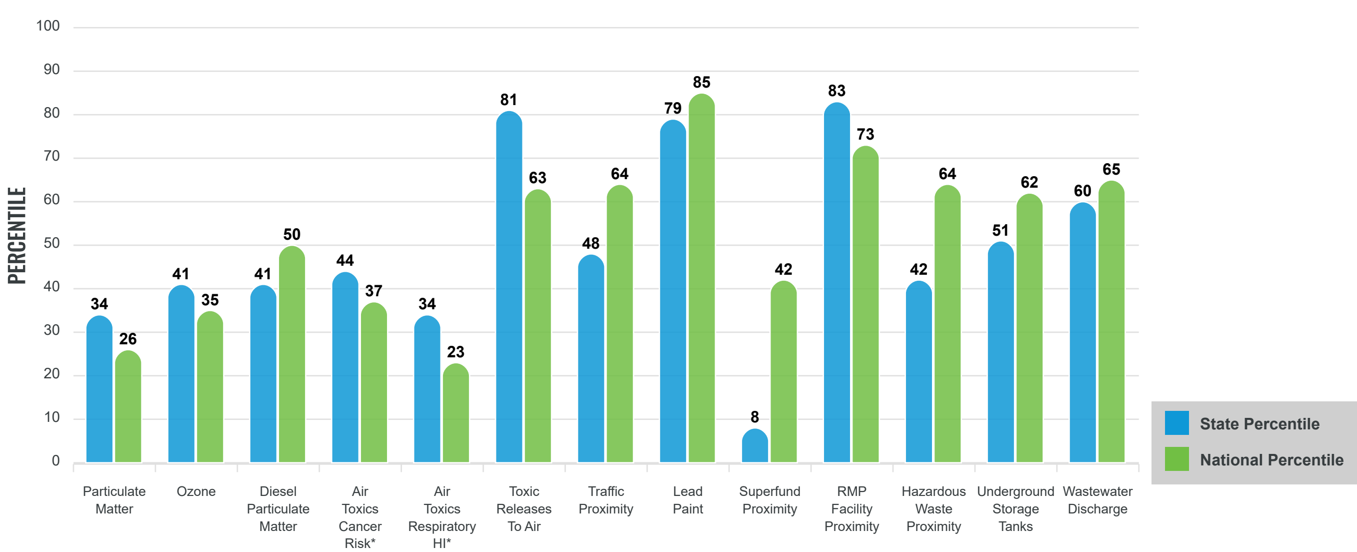
EJ INDEXES FOR THE SELECTED LOCATION



SUPPLEMENTAL INDEXES

The supplemental indexes offer a different perspective on community-level vulnerability. They combine data on percent low-income, percent linguistically isolated, percent less than high school education, percent unemployed, and low life expectancy with a single environmental indicator.

SUPPLEMENTAL INDEXES FOR THE SELECTED LOCATION



These percentiles provide perspective on how the selected block group or buffer area compares to the entire state or nation.

Report for Blockgroup: 360550119015

EJScreen Environmental and Socioeconomic Indicators Data

SELECTED VARIABLES	VALUE	STATE AVERAGE	PERCENTILE IN STATE	USA AVERAGE	PERCENTILE IN USA
POLLUTION AND SOURCES					
Particulate Matter ($\mu g/m^3$)	6.76	7.71	18	8.08	16
Ozone (ppb)	57.9	62.6	25	61.6	23
Diesel Particulate Matter ($\mu g/m^3$)	0.153	0.525	23	0.261	32
Air Toxics Cancer Risk* (lifetime risk per million)	20	25	5	25	5
Air Toxics Respiratory HI*	0.2	0.33	5	0.31	4
Toxic Releases to Air	530	450	85	4,600	47
Traffic Proximity (daily traffic count/distance to road)	77	430	33	210	50
Lead Paint (% Pre-1960 Housing)	0.81	0.55	76	0.3	92
Superfund Proximity (site count/km distance)	0.029	0.24	5	0.13	27
RMP Facility Proximity (facility count/km distance)	0.26	0.21	84	0.43	64
Hazardous Waste Proximity (facility count/km distance)	0.47	4.3	26	1.9	49
Underground Storage Tanks (count/km^2)	0.99	7.7	34	3.9	47
Wastewater Discharge (toxicity-weighted concentration/m distance)	0.0012	5	43	22	50
SOCIOECONOMIC INDICATORS					
Demographic Index	26%	35%	47	35%	44
Supplemental Demographic Index	16%	14%	67	14%	64
People of Color	4%	42%	11	39%	10
Low Income	49%	28%	83	31%	79
Unemployment Rate	6%	6%	64	6%	66
Limited English Speaking Households	3%	7%	59	5%	70
Less Than High School Education	3%	12%	23	12%	24
Under Age 5	0%	5%	0	6%	0
Over Age 64	15%	17%	48	17%	49
Low Life Expectancy	18%	17%	57	20%	34

*Diesel particulate matter, air toxics cancer risk, and air toxics respiratory hazard index are from the EPA's Air Toxics Data Update, which is the Agency's ongoing, comprehensive evaluation of air toxics in the United States. This effort aims to prioritize air toxics, emission sources, and locations of interest for further study. It is important to remember that the air toxics data presented here provide broad estimates of health risks over geographic areas of the country, not definitive risks to specific individuals or locations. Cancer risks and hazard indices from the Air Toxics Data Update are reported to one significant figure and any additional significant figures here are due to rounding. More information on the Air Toxics Data Update can be found at: https://www.epa.gov/haps/air-toxics-data-update.

Sites reporting to EPA within defined area:

Superfund	0
Hazardous Waste, Treatment, Storage, and Disposal Facilities	0
Water Dischargers	4
Air Pollution	1
Brownfields	0
Toxic Release Inventory	2

Other community features within defined area:

Schools	1
Hospitals	0
Places of Worship	0

Other environmental data:

Air Non-attainment	Yes
Impaired Waters	Yes

Selected location contains American Indian Reservation Lands*	No
Selected location contains a "Justice40 (CEJST)" disadvantaged community	No
Selected location contains an EPA IRA disadvantaged community	No

Report for Blockgroup: 360550119015

EJScreen Environmental and Socioeconomic Indicators Data

HEALTH INDICATORS					
INDICATOR	HEALTH VALUE	STATE AVERAGE	STATE PERCENTILE	US AVERAGE	US PERCENTILE
Low Life Expectancy	18%	17%	56	20%	34
Heart Disease	7.5	5.6	91	6.1	77
Asthma	9.9	10	52	10	52
Cancer	9.1	6	97	6.1	96
Persons with Disabilities	14.1%	11.8%	70	13.4%	60

CLIMATE INDICATORS					
INDICATOR	HEALTH VALUE	STATE AVERAGE	STATE PERCENTILE	US AVERAGE	US PERCENTILE
Flood Risk	10%	11%	67	12%	67
Wildfire Risk	0%	1%	0	14%	0

CRITICAL SERVICE GAPS					
INDICATOR	HEALTH VALUE	STATE AVERAGE	STATE PERCENTILE	US AVERAGE	US PERCENTILE
Broadband Internet	5%	13%	28	14%	27
Lack of Health Insurance	3%	5%	39	9%	20
Housing Burden	No	N/A	N/A	N/A	N/A
Transportation Access	Yes	N/A	N/A	N/A	N/A
Food Desert	No	N/A	N/A	N/A	N/A

Footnotes

Report for Blockgroup: 360550119015

Appendix B

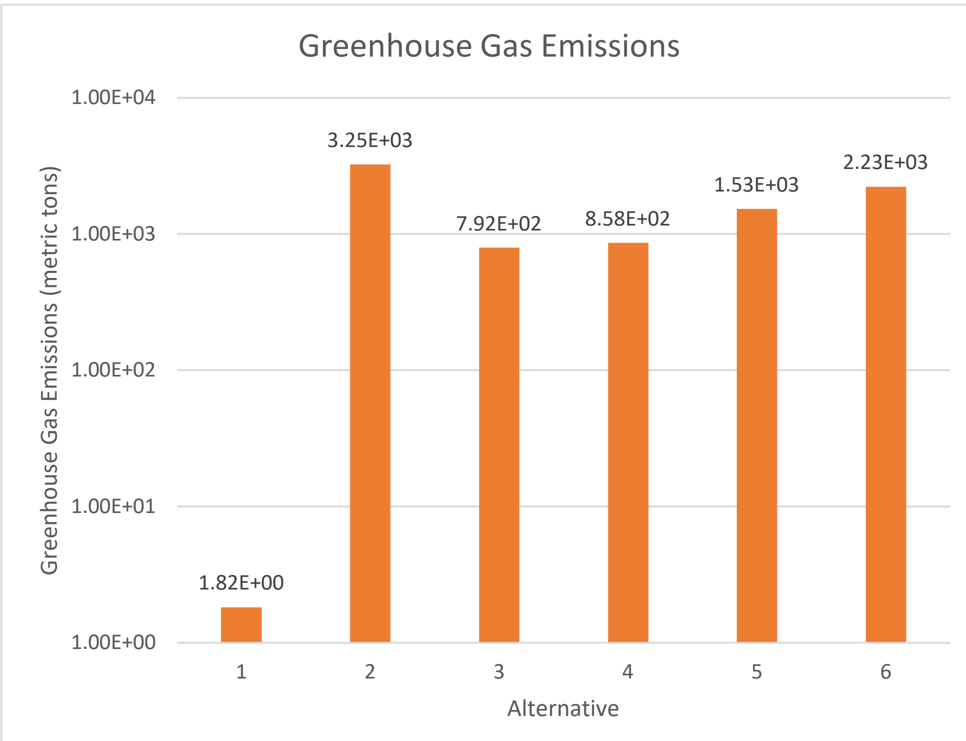
Green and Sustainable Remediation Evaluation

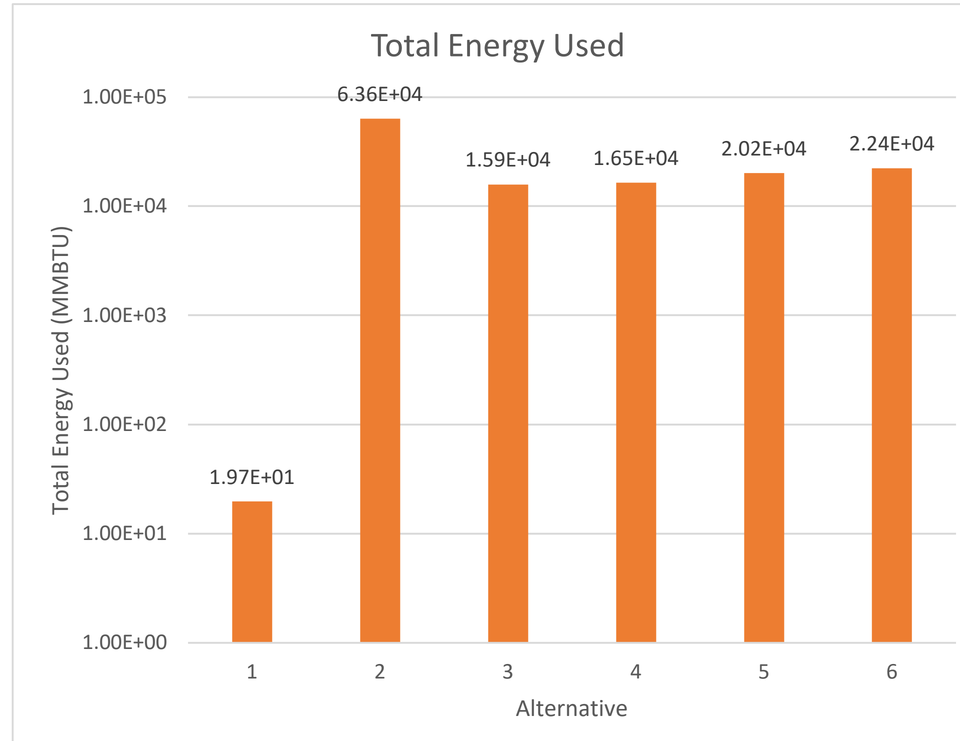
Appendix B
Green and Sustianable Remediation Evaluation

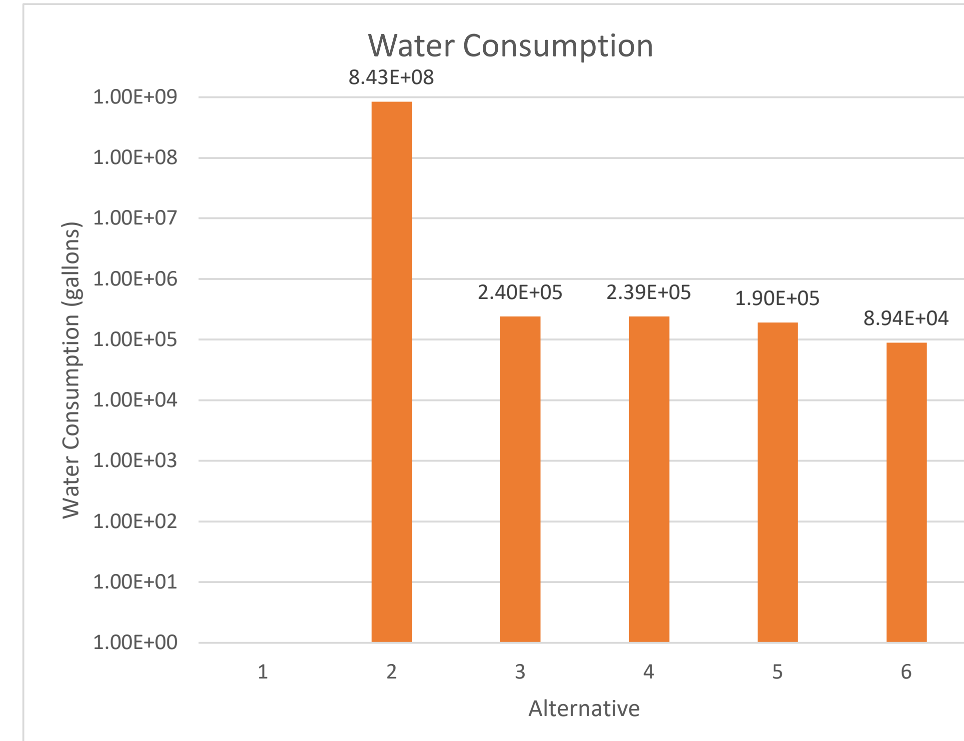
Feasibility Study
Former George A. Robinson Company, Inc. Site
477 Whitney Road, Penfield, New York

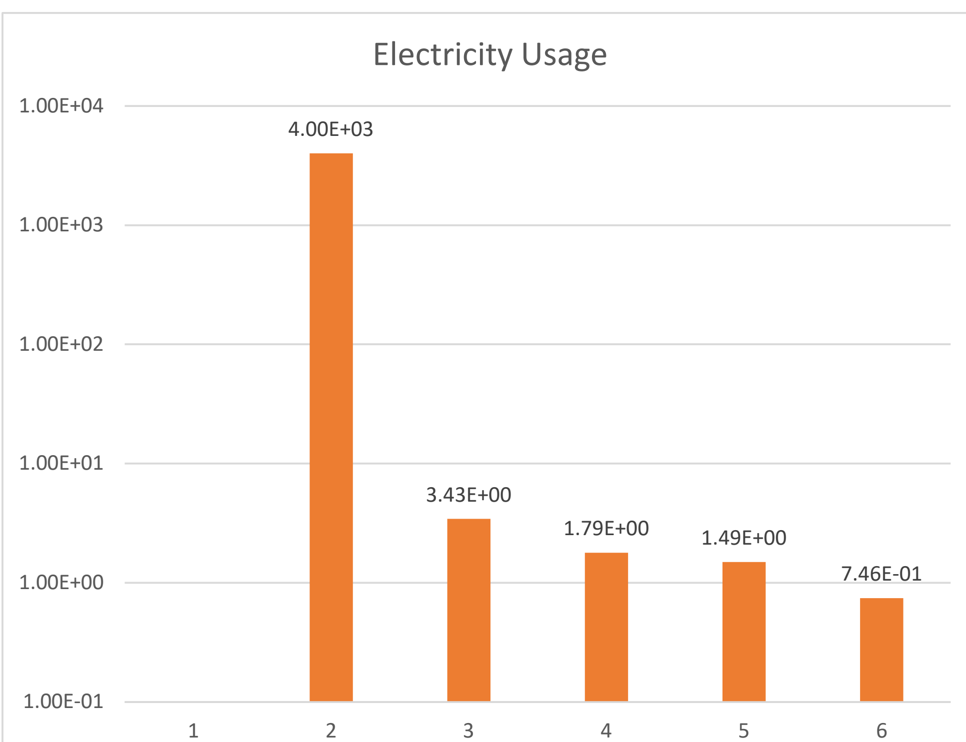
Remedial Alternative	Remediation	Greenhouse Gas Emissions	Total Energy Used	Water Consumption	Electricity Usage	Onsite NOx Emissions	Onsite SOx Emissions	Onsite PM10 Emissions	Total NOx Emissions	Total SOx Emissions	Total PM10 Emissions	Non-Hazardous Waste Landfill Space	Topsoil Consumption	Lost Hours - Injury
		metric ton	MMBTU	gallons	MWH	metric ton	metric ton	metric ton	metric ton	metric ton	metric ton	tons	cubic yards	hours
Alternative 1	Well Destruction	1.82E+00	1.97E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.31E-03	1.79E-03	4.40E-04	0.00E+00	0.00E+00	0.00E+00
	TOTAL	**1.82E+00**	**1.97E+01**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**0.00E+00**	**1.31E-03**	**1.79E-03**	**4.40E-04**	**0.00E+00**	**0.00E+00**	**1.51E-02**
Alternative 2	Soil Remediation	8.55E+02	1.22E+04	0.00E+00	0.00E+00	4.00E-03	8.39E-04	7.74E-04	1.36E+00	1.20E+00	1.70E+00	7.50E+03	5.00E+02	2.10E+00
	Groundwater Remediation	1.34E+02	1.10E+04	1.76E+03	0.00E+00	1.17E-01	1.27E-02	1.14E-02	1.84E-01	9.88E-02	3.04E-02	1.39E+01	0.00E+00	6.50E-01
	Long-Term Monitoring and O&M	2.25E+03	4.03E+04	8.43E+08	4.00E+03	0.00E+00	0.00E+00	0.00E+00	2.76E+00	3.59E+00	1.17E+00	0.00E+00	0.00E+00	5.52E+00
	Building 101 Demolition	1.49E+01	2.09E+02	0.00E+00	0.00E+00	5.20E-03	9.56E-04	6.27E-04	2.21E-02	8.03E-03	3.73E-02	2.00E+02	0.00E+00	7.37E-02
	TOTAL	**3.25E+03**	**6.36E+04**	**8.43E+08**	**4.00E+03**	**1.26E-01**	**1.45E-02**	**1.28E-02**	**4.32E+00**	**4.89E+00**	**2.94E+00**	**7.71E+03**	**5.00E+02**	**8.33E+00**
Alternative 3	Soil Remediation	6.25E+02	9.25E+03	8.37E+02	1.64E+00	3.89E-03	8.09E-04	7.52E-04	1.04E+00	9.94E-01	1.20E+00	5.10E+03	5.00E+02	1.46E+00
	Groundwater Remediation	8.65E+01	5.60E+03	2.36E+05	1.79E+00	7.38E-02	7.54E-03	6.64E-03	2.23E-01	2.39E-01	5.59E-02	4.17E+00	0.00E+00	5.25E-01
	Long-Term Monitoring and O&M	6.57E+01	8.50E+02	3.48E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.05E-02	5.20E-04	2.44E-03	0.00E+00	0.00E+00	3.63E-01
	Building 101 Demolition	1.49E+01	2.09E+02	0.00E+00	0.00E+00	5.20E-03	9.56E-04	6.27E-04	2.21E-02	8.03E-03	3.73E-02	2.00E+02	0.00E+00	7.37E-02
	TOTAL	**7.92E+02**	**1.59E+04**	**2.40E+05**	**3.43E+00**	**8.29E-02**	**9.30E-03**	**8.02E-03**	**1.31E+00**	**1.24E+00**	**1.29E+00**	**5.30E+03**	**5.00E+02**	**2.42E+00**
Alternative 4	Soil Remediation	6.91E+02	9.85E+03	0.00E+00	0.00E+00	3.18E-03	6.67E-04	6.16E-04	1.10E+00	9.76E-01	1.36E+00	6.00E+03	5.00E+02	1.67E+00
	Groundwater Remediation	8.65E+01	5.60E+03	2.36E+05	1.79E+00	7.38E-02	7.54E-03	6.64E-03	2.23E-01	2.39E-01	5.59E-02	4.17E+00	0.00E+00	5.25E-01
	Long-Term Monitoring and O&M	6.57E+01	8.50E+02	3.48E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.05E-02	5.20E-04	2.44E-03	0.00E+00	0.00E+00	3.63E-01
	Building 101 Demolition	1.49E+01	2.09E+02	0.00E+00	0.00E+00	5.20E-03	9.56E-04	6.27E-04	2.21E-02	8.03E-03	3.73E-02	2.00E+02	0.00E+00	7.37E-02
	TOTAL	**8.58E+02**	**1.65E+04**	**2.39E+05**	**1.79E+00**	**8.22E-02**	**9.16E-03**	**7.88E-03**	**1.37E+00**	**1.22E+00**	**1.46E+00**	**6.20E+03**	**5.00E+02**	**2.63E+00**
Alternative 5	Soil Remediation	6.60E+02	9.42E+03	0.00E+00	0.00E+00	3.00E-03	6.29E-04	5.81E-04	1.06E+00	9.42E-01	1.30E+00	5.70E+03	5.00E+02	1.59E+00
	Groundwater Remediation	7.83E+02	9.72E+03	1.86E+05	1.49E+00	7.63E-02	8.92E-03	7.41E-03	1.50E+00	2.49E+00	8.29E-01	1.70E+03	5.00E+02	1.03E+00
	Long-Term Monitoring and O&M	8.23E+01	1.06E+03	4.32E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.57E-02	6.47E-04	3.03E-03	0.00E+00	0.00E+00	4.50E-01
	TOTAL	**1.53E+03**	**2.02E+04**	**1.90E+05**	**1.49E+00**	**7.93E-02**	**9.55E-03**	**7.99E-03**	**2.58E+00**	**3.43E+00**	**2.13E+00**	**7.40E+03**	**1.00E+03**	**3.07E+00**
Alternative 6	Soil Remediation	5.82E+02	8.33E+03	0.00E+00	0.00E+00	3.27E-03	6.84E-04	6.33E-04	9.52E-01	8.75E-01	1.12E+00	4.80E+03	6.85E+02	1.40E+00
	Groundwater Remediation	1.58E+03	1.31E+04	8.54E+04	7.46E-01	3.46E-02	5.63E-03	4.17E-03	2.74E+00	5.10E+00	1.11E+00	2.61E+02	5.00E+02	1.39E+00
	Long-Term Monitoring and O&M	6.92E+01	8.95E+02	4.00E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.16E-02	5.50E-04	2.57E-03	0.00E+00	0.00E+00	3.82E-01
	TOTAL	**2.23E+03**	**2.24E+04**	**8.94E+04**	**7.46E-01**	**3.79E-02**	**6.32E-03**	**4.80E-03**	**3.71E+00**	**5.98E+00**	**2.23E+00**	**5.06E+03**	**1.19E+03**	**3.17E+00**

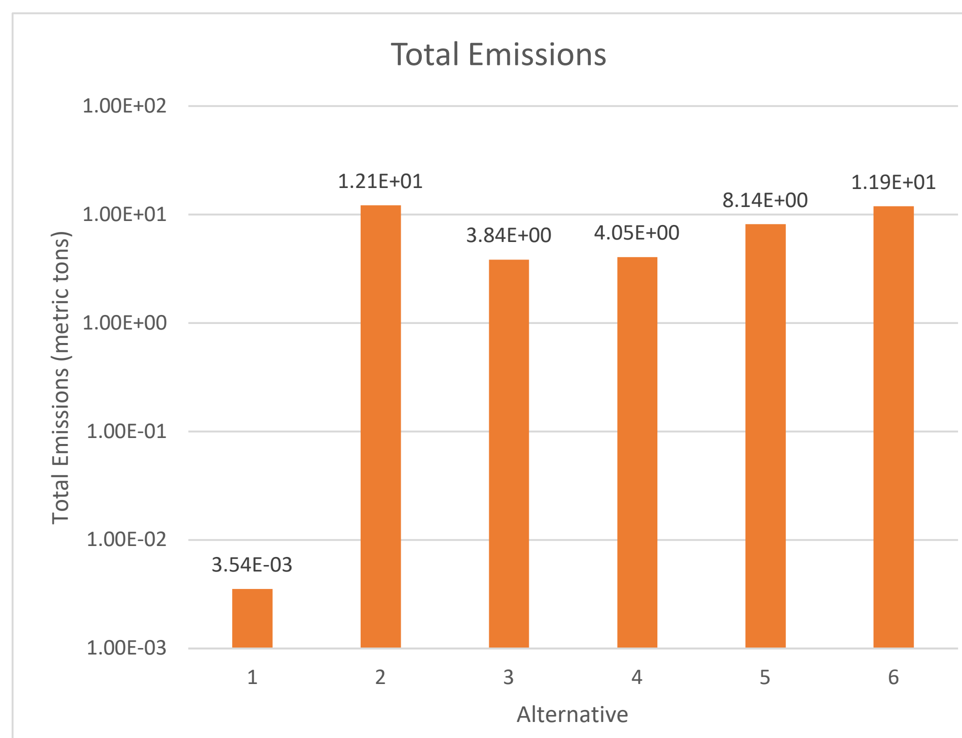
Abbreviations:
MMBTU = one million British thermal units
MWH = megawatt hours
NOx = nitrogen oxides
PM10 = particulate matter with a diameter of 10 micometers or less
SOx = sulfur oxides

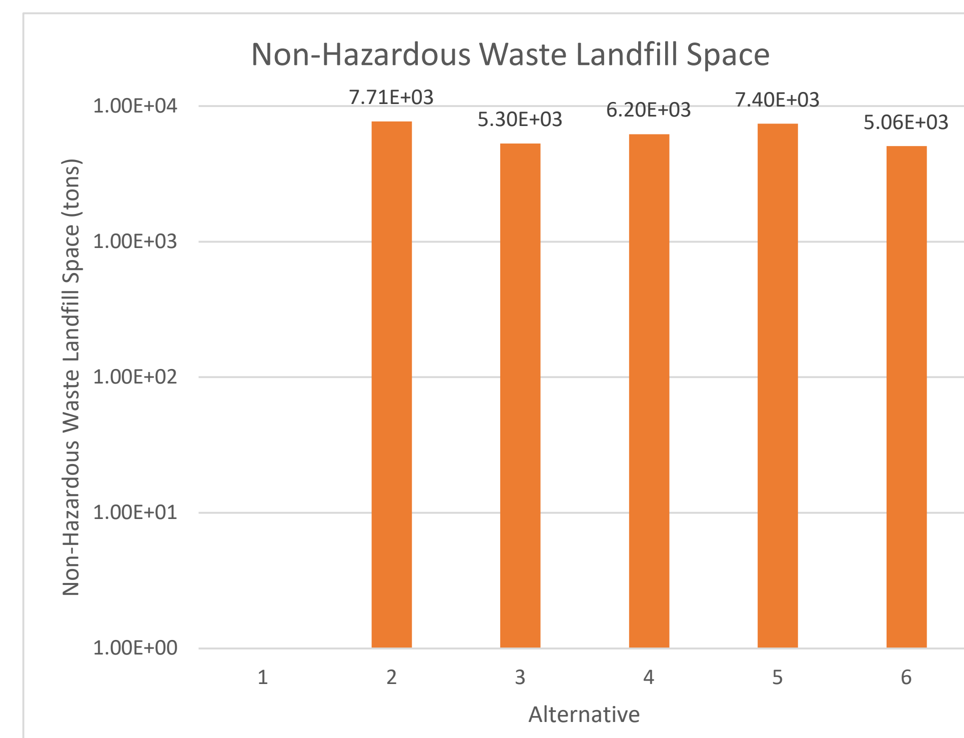

Greenhouse Gas Emissions
Greenhouse Gas Emissions (metric tons)
1.00E+04
1.00E+03
1.00E+02
1.00E+01
1.00E+00
1.82E+00
3.25E+03
7.92E+02
8.58E+02
1.53E+03
2.23E+03
1 2 3 4 5 6
Alternative


Total Energy Used
Total Energy Used (MMBTU)
1.00E+05
1.00E+04
1.00E+03
1.00E+02
1.00E+01
1.00E+00
1.97E+01
6.36E+04
1.59E+04
1.65E+04
2.02E+04
2.24E+04
1 2 3 4 5 6
Alternative


Water Consumption
Water Consumption (gallons)
1.00E+09
1.00E+08
1.00E+07
1.00E+06
1.00E+05
1.00E+04
1.00E+03
1.00E+02
1.00E+01
1.00E+00
8.43E+08
2.40E+05
2.39E+05
1.90E+05
8.94E+04
1 2 3 4 5 6
Alternative


Electricity Usage
1.00E+04
1.00E+03
1.00E+02
1.00E+01
1.00E+00
1.00E-01
4.00E+03
3.43E+00
1.79E+00
1.49E+00
7.46E-01
1 2 3 4 5 6


Total Emissions
Total Emissions (metric tons)
1.00E+02
1.00E+01
1.00E+00
1.00E-01
1.00E-02
1.00E-03
3.54E-03
1.21E+01
3.84E+00
4.05E+00
8.14E+00
1.19E+01
1 2 3 4 5 6
Alternative


Non-Hazardous Waste Landfill Space
Non-Hazardous Waste Landfill Space (tons)
1.00E+04
1.00E+03
1.00E+02
1.00E+01
1.00E+00
7.71E+03
5.30E+03
6.20E+03
7.40E+03
5.06E+03
1 2 3 4 5 6
Alternative

Appendix C

Remedial Alternatives Cost Detail

Table C-1
Summary of Costs for Alternative 1

Feasibility Study Report
Former George A. Robinson Company, Inc. Site
477 Whitney Road, Penfield, New York

Item Description	Estimated Quantity	Unit	Unit Price	Cost
Capital Costs				
Alternative Implementation				
Well Abandonment	20	Well	$3,600	$72,000
			Subtotal	**$72,000**
Management				
Close-Out Reporting	1	Lump Sum	$17,000	$17,000
			Subtotal	**$17,000**
			Total Capital Costs	**$89,000**
		Construction Contingency (20%)		**$14,400**

CAPITAL COST (ROUNDED)	**$110,000**
ONE TIME FUTURE COSTS	**$0**
O&M COST	**$0**
LTM COST	**$0**
TOTAL UNDISCOUNTED COST (30 YEARS)	**$110,000**
PRESENT VALUE	**$110,000**

Note: Present value cost based on 1% annual discount rate (difference between 10-year treasury and US inflation rates).

Table C-2
Summary of Costs for Alternative 2

Feasibility Study Report
Former George A. Robinson Company, Inc. Site
477 Whitney Road, Penfield, New York

ARCADIS

Item Description	Estimated Quantity	Unit	Unit Price	Cost
Capital Costs				
Site Preparation / Final Remedial Design				
Demolition of Buildings 52, 64, 73, and 101	1	Lump Sum	$870,000	$870,000
Pre-Design Investigation	1	Lump Sum	$80,000	$80,000
Site Preparation and Submittals	1	Lump Sum	$170,000	$170,000
			Subtotal	**$1,120,000**
Alternative Implementation				
Installation of Sheet Piling	2,500	Vertical Square Feet	$50	$125,000
Excavation and Loadout of Soil Source Areas	4,400	Cubic Yard	$70	$308,000
Transportation and Disposal of Excavated Soils	7,500	Ton	$300	$2,250,000
Backfill of Excavated Areas	7,500	Ton	$45	$337,500
Site Restoration Post Excavation	1	Lump Sum	$40,000	$40,000
System Installation Preparation	1	Lump Sum	$30,000	$30,000
Extraction Well Installation, Trenching, and Infrastructure	1	Lump Sum	$790,000	$790,000
Treatment System and Building	1	Lump Sum	$330,000	$330,000
			Subtotal	**$4,210,500**
Management				
Engineering Design and Coordination	1	Lump Sum	$140,000	$140,000
Construction Oversight	1	Lump Sum	$640,000	$640,000
			Subtotal	**$780,000**
			Total Capital Cost	**$6,110,500**
		Construction Contingency (20%)		**$1,066,100**
Operation and Maintenance (O&M) Costs				
Annual Operation and Maintenance				
Inspection (twice a week) and Oversight	1	Per Year	$165,000	$165,000
System Expenses	1	Per Year	$250,000	$250,000
Data Compilation, Oversight, and Reporting	1	Per Year	$25,000	$25,000
			Subtotal	**$440,000**
Annual Long-Term Monitoring (LTM)				
Semi-Annual Sampling and Analysis for 20 Wells	1	Per Year	$50,000	$50,000
Semi-Annual Sampling Waste Drum Disposal	4	Per Year	$2,000	$8,000
Semi-Annual Data Analysis and Reporting	1	Per Year	$30,000	$30,000
			Subtotal	**$88,000**

CAPITAL COST (ROUNDED)	**$7,180,000**
ONE TIME FUTURE COSTS	**$0**
ANNUAL O&M	$440,000
ANNUAL LTM	$88,000
ANNUAL O&M and LTM	**$528,000**
TOTAL O&M COST (20 YEARS)	$8,800,000
TOTAL LTM COST (20 YEARS)	$1,760,000
TOTAL UNDISCOUNTED COST (20 YEARS)	**$18,796,000**
PRESENT VALUE (20 Years)	**$16,708,000**

Note: Present value cost based on 1% annual discount rate (difference between 10-year treasury and US inflation rates).

Table C-3
Summary of Costs for Alternative 3

ARCADIS

Feasibility Study Report
Former George A. Robinson Company, Inc. Site
477 Whitney Road, Penfield, New York

Item Description	Estimated Quantity	Unit	Unit Price	Cost
Capital Costs				
Site Preparation / Final Remedial Design				
Demolition of Buildings 52, 64, 73, and 101	1	Lump Sum	$870,000	$870,000
Pre-Design Investigation	1	Lump Sum	$70,000	$70,000
Site Preparation and Submittals	1	Lump Sum	$150,000	$150,000
			Subtotal	**$1,090,000**
Alternative Implementation				
Installation of Sheet Piling	2,030	Vertical Square Feet	$50	$101,500
Excavation and Loadout of Soil Source Areas	3,000	Cubic Yard	$70	$210,000
Excavation and Staging for Mixing Area	500	Cubic Yard	$35	$17,500
Transportation and Disposal of Excavated Soils	5,100	Ton	$300	$1,530,000
Backfill of Excavated Areas	5,100	Ton	$45	$229,500
Site Restoration Post Excavation	1	Lump Sum	$40,000	$40,000
Terrabond ® 3% By Weight	26	Ton	$400	$10,200
Amendment Mixing and Backfill of Treated Soils	500	Cubic Yard	$50	$25,000
In-Situ Chemical Oxidation (ISCO) Injection Subcontractors	1	Lump Sum	$94,000	$94,000
Oxidant (sodium permanganate)	58,000	Pounds	$3	$192,000
Other ISCO Injection Supplies / Analytical	1	Lump Sum	$30,000	$30,000
ISCO Performance Monitoring Well Installation and Initial Sampling Round	9	Well	$3,640	$32,800
Colloidal Carbon Injection Subcontractors	1	Lump Sum	$120,000	$120,000
Colloidal Carbon	168	Injection Point	$5,000	$840,000
Other Colloidal Carbon Injection Supplies / Analytical	1	Lump Sum	$30,000	$30,000
			Subtotal	**$3,502,500**
Management				
Engineering Design and Coordination	1	Lump Sum	$90,000	$90,000
Construction Oversight	1	Lump Sum	$350,000	$350,000
			Subtotal	**$440,000**
			Total Capital Cost	**$5,032,500**
		Construction Contingency (20%)		**$918,500**
Operation and Maintenance (O&M) Costs				
ISCO Performance Monitoring (Year 2)				
Baseline and 7 post-monitoring sampling events	12	Well	$15,500	$190,000
Reporting	1	Lump Sum	$30,000	$30,000
			Subtotal	**$220,000**
Follow-up ISCO Injection (Year 4)				
ISCO Injection Subcontractors	1	Lump Sum	$70,000	$70,000
Oxidant (sodium permanganate)	38,280	Pound	$3	$127,000
Other Injection Supplies/Analytical	1	Lump Sum	$30,000	$30,000
Oversight	1	Lump Sum	$40,000	$40,000
			Subtotal	**$267,000**
Annual Long-Term Monitoring				
Semi-Annual Sampling and Analysis for 20 Wells	1	Per Year	$50,000	$50,000
Semi-Annual Sampling Waste Drum Disposal	4	Per Year	$2,000	$8,000
Semi-Annual Data Analysis and Reporting	1	Per Year	$30,000	$30,000
			Subtotal	**$88,000**

CAPITAL COST (ROUNDED)	**$5,960,000**
ONE-TIME FUTURE COSTS (YEAR 2)	**$220,000**
ONE-TIME FUTURE COSTS (YEAR 4)	**$270,000**
ANNUAL LTM COST	**$88,000**
UNDISCOUNTED LTM COST (15 YEARS)	$1,320,000
TOTAL UNDISCOUNTED COST (15 YEARS)	**$7,770,000**
PRESENT VALUE ONE-TIME FUTURE COSTS (YEAR 2) (ROUNDED)	$216,000
PRESENT VALUE ONE-TIME FUTURE COSTS (YEAR 4) (ROUNDED)	$259,000
PRESENT VALUE OF LTM	$1,220,000
Present Value (15 Years)	**$7,655,000**

Note: Present value cost based on 1% annual discount rate (difference between 10-year treasury and US inflation rates).

Table C-4
Summary of Costs for Alternative 4

Feasibility Study Report
Former George A. Robinson Company, Inc. Site
477 Whitney Road, Penfield, New York

Item Description	Estimated Quantity	Unit	Unit Price	Cost
Capital Costs				
Site Preparation / Final Remedial Design				
Demolition of Buildings 52, 64, 73, and 101	1	Lump Sum	$870,000	$870,000
Pre-Design Investigation	1	Lump Sum	$70,000	$70,000
Site Preparation and Submittals	1	Lump Sum	$160,000	$160,000
			Subtotal	**$1,100,000**
Alternative Implementation				
Installation of Sheet Piling	2,030	Vertical Square Feet	$50	$101,500
Excavation and Loadout of Soil Source Areas	3,500	Cubic Yard	$70	$245,000
Transportation and Disposal of Excavated Soils	6,000	Ton	$300	$1,800,000
Backfill of Excavated Areas	6,000	Ton	$45	$270,000
Site Restoration Post Excavation	1	Lump Sum	$40,000	$40,000
In-Situ Chemical Oxidation (ISCO) Injection Subcontractors	1	Lump Sum	$94,000	$94,000
Oxidant (sodium permanganate)	58,000	Pounds	$3	$192,000
Other ISCO Injection Supplies / Analytical	1	Lump Sum	$30,000	$30,000
ISCO Performance Monitoring Well Installation and Initial Sampling Round	9	Well	$3,460	$31,100
Colloidal Carbon Injection Subcontractors	1	Lump Sum	$120,000	$120,000
Colloidal Carbon	168	Injection Point	$5,000	$840,000
Other Colloidal Carbon Injection Supplies / Analytical	1	Lump Sum	$30,000	$30,000
			Subtotal	**$3,793,600**
Management				
Engineering Design and Coordination	1	Lump Sum	$90,000	$90,000
Construction Oversight	1	Lump Sum	$350,000	$350,000
			Subtotal	**$440,000**
			Total Capital Cost	**$5,333,600**
		Construction Contingency (20%)		**$978,720**
Operation and Maintenance (O&M) Costs				
ISCO Performance Monitoring (Year 2)				
Baseline and 7 post-monitoring sampling events	12	Well	$15,500	$190,000
Reporting	1	Lump Sum	$30,000	$30,000
			Subtotal	**$220,000**
Follow-up ISCO Injection (Year 4)				
ISCO Injection Subcontractors	1	Lump Sum	$70,000	$70,000
Oxidant (sodium permanganate)	38,280	Pound	$3	$127,000
Other Injection Supplies/Analytical	1	Lump Sum	$30,000	$30,000
Oversight	1	Lump Sum	$40,000	$40,000
			Subtotal	**$267,000**
Annual Long-Term Monitoring				
Semi-Annual Sampling and Analysis for 20 Wells	1	Per Year	$50,000	$50,000
Semi-Annual Sampling Waste Drum Disposal	4	Per Year	$2,000	$8,000
Semi-Annual Data Analysis and Reporting	1	Per Year	$30,000	$30,000
			Subtotal	**$88,000**

CAPITAL COST (ROUNDED)	**$6,320,000**
ONE-TIME FUTURE COSTS (YEAR 2)	**$220,000**
ONE TIME FUTURE COSTS (YEAR 4)	**$270,000**
ANNUAL LTM COST	**$88,000**
UNDISCOUNTED LTM COST (15 YEARS)	$1,320,000
TOTAL UNDISCOUNTED COST (15 YEARS)	**$8,130,000**
PRESENT VALUE ONE-TIME FUTURE COSTS (YEAR 2) (ROUNDED)	$216,000
PRESENT VALUE ONE-TIME FUTURE COSTS (YEAR 4) (ROUNDED)	$259,000
PRESENT VALUE OF LTM	$1,220,000
Present Value (15 Years)	**$8,103,000**

Table C-5
Summary of Costs for Alternative 5

Feasibility Study Report
Former George A. Robinson Company, Inc. Site
477 Whitney Road, Penfield, New York

Item Description	Estimated Quantity	Unit	Unit Price	Cost
Capital Costs				
Site Preparation / Final Remedial Design				
Demolition of Buildings 52, 64, and 73	1	Lump Sum	$790,000	$790,000
Pre-Design Investigation	1	Lump Sum	$110,000	$110,000
Site Preparation and Submittals	1	Lump Sum	$390,000	$390,000
			Subtotal	**$1,290,000**
Alternative Implementation				
Installation of Sheet Piling	2,030	Vertical Square Feet	$50	$101,500
Excavation and Loadout of Soil Source Areas	3,300	Cubic Yard	$70	$231,000
Transportation and Disposal of Excavated Soils	5,700	Ton	$300	$1,710,000
Backfill of Excavated Areas	5,700	Ton	$45	$256,500
Site Restoration Post Excavation	1	Lump Sum	$40,000	$40,000
In-Situ Chemical Oxidation (ISCO) Injection Subcontractors	1	Lump Sum	$72,000	$72,000
Oxidant (sodium permanganate)	40,000	Pounds	$3	$132,000
Other ISCO Injection Supplies / Analytical	1	Lump Sum	$20,000	$20,000
ISCO Performance Monitoring Well Installation and Initial Sampling Round	9	Well	$2,440	$22,000
Permeable Reactive Barrier (PRB) Installation Subcontractor	1	Lump Sum	$350,000	$350,000
Loadout, Transportation, and Disposal of Soil from PRB Areas	1,000	Cubic Yard	$125	$125,000
PRB Zero Valent Iron	473	Ton	$1,200	$567,000
PRB Sand for construction	1,400	Ton	$55	$77,000
PRB Restoration (surface completion and restoration of the installation area, removing the working platforms, reseeding)	1	Lump Sum	$40,000	$40,000
Colloidal Carbon Injection Subcontractors	1	Lump Sum	$120,000	$120,000
Colloidal Carbon	168	Injection Point	$5,000	$840,000
Other Colloidal Carbon Injection Supplies / Analytical	1	Lump Sum	$30,000	$30,000
			Subtotal	**$4,734,000**
Management				
Engineering Design and Coordination	1	Lump Sum	$90,000	$90,000
Construction Oversight	1	Lump Sum	$400,000	$400,000
			Subtotal	**$490,000**
			Total Capital Cost	**$6,514,000**
			Construction Contingency (20%)	**$1,204,800**
Operation and Maintenance (O&M) Costs				
ISCO Performance Monitoring (Year 2)				
Baseline and 7 post-monitoring sampling events	8	Well	$19,400	$160,000
Reporting	1	Lump Sum	$30,000	$30,000
			Subtotal	**$190,000**
Follow-up ISCO Injection (Year 4)				
ISCO Injection Subcontractors	1	Lump Sum	$48,000	$48,000
Oxidant (sodium permanganate)	26,400	Pound	$3	$88,000
Other Injection Supplies/Analytical	1	Lump Sum	$24,000	$24,000
Oversight	1	Lump Sum	$30,000	$30,000
			Subtotal	**$190,000**
Annual Long-Term Monitoring				
Semi-Annual Sampling and Analysis for 20 Wells	1	Per Year	$50,000	$50,000
Semi-Annual Sampling Waste Drum Disposal	4	Per Year	$2,000	$8,000
Semi-Annual Data Analysis and Reporting	1	Per Year	$30,000	$30,000
			Subtotal	**$88,000**

CAPITAL COST (ROUNDED)	**$7,720,000**
ONE-TIME FUTURE COSTS (YEAR 2)	**$190,000**
ONE TIME FUTURE COSTS (YEAR 4)	**$190,000**
ANNUAL LTM COST	**$88,000**
UNDISCOUNTED LTM COST (20 YEARS)	$1,760,000
TOTAL UNDISCOUNTED COST (20 YEARS)	**$9,860,000**
PRESENT VALUE ONE-TIME FUTURE COSTS (YEAR 2) (ROUNDED)	$186,000
PRESENT VALUE ONE-TIME FUTURE COSTS (YEAR 4) (ROUNDED)	$183,000
PRESENT VALUE OF LTM	$1,220,000
Present Value (20 Years)	**$9,397,000**

Note: Present value cost based on 1% annual discount rate (difference between 10-year treasury and US inflation rates).

Table C-6
Summary of Costs for Alternative 6

Feasibility Study Report
Former George A. Robinson Company, Inc. Site
477 Whitney Road, Penfield, New York

ARCADIS

Item Description	Estimated Quantity	Unit	Unit Price	Cost
Capital Costs				
Site Preparation / Final Remedial Design				
Demolition of Buildings 52, 64, and 73	1	Lump Sum	$790,000	$790,000
Pre-Design Investigation	1	Lump Sum	$110,000	$110,000
Site Preparation and Submittals	1	Lump Sum	$740,000	$740,000
			Subtotal	**$1,640,000**
Alternative Implementation				
Installation of Sheet Piling	2,030	Vertical Square Feet	$50	$101,500
Excavation and Loadout of Soil Source Areas	2,800	Cubic Yard	$70	$196,000
Transportation and Disposal of Excavated Soils	4,800	Ton	$300	$1,440,000
Backfill of Excavated Areas	4,800	Ton	$45	$216,000
1-Foot Cover	315	Ton	$45	$14,000
Site Restoration Post Excavation	1	Lump Sum	$40,000	$40,000
Permeable Reactive Barrier (PRB) Installation Subcontractor	1	Lump Sum	$860,000	$860,000
Loadout, Transportation, and Disposal of Soil from PRB Areas	2,300	Cubic Yard	$125	$287,500
PRB Zero Valent Iron	1,087	Ton	$1,200	$1,304,100
PRB Sand for construction	3,200	Ton	$55	$176,000
PRB Restoration (surface completion and restoration of the installation area, removing the working platforms, reseeding)	1	Lump Sum	$40,000	$40,000
Colloidal Carbon Injection Subcontractors	1	Lump Sum	$120,000	$120,000
Colloidal Carbon	168	Injection Point	$5,000	$840,000
Other Colloidal Carbon Injection Supplies / Analytical	1	Lump Sum	$30,000	$30,000
			Subtotal	**$5,665,100**
Management				
Engineering Design and Coordination	1	Lump Sum	$90,000	$90,000
Construction Oversight	1	Lump Sum	$410,000	$410,000
			Subtotal	**$500,000**
			Total Capital Cost	**$7,805,100**
		Construction Contingency (20%)		**$1,461,020**
Long-Term Monitoring (LTM) Costs				
Annual Long-Term Monitoring				
Semi-Annual Sampling and Analysis for 20 Wells	1	Per Year	$50,000	$50,000
Semi-Annual Sampling Waste Drum Disposal	4	Per Year	$2,000	$8,000
Semi-Annual Data Analysis and Reporting	1	Per Year	$30,000	$30,000
			Subtotal	**$88,000**

CAPITAL COST (ROUNDED)	**$9,270,000**
ONE TIME FUTURE COSTS	**$0**
TOTAL O&M COST	**$0**
ANNUAL LTM COST	**$88,000**
UNDISCOUNTED LTM COSTS (YEARS 1-20)	$1,760,000
TOTAL UNDISCOUNTED COST (20 YEARS)	**$11,030,000**
PRESENT VALUE OF LTM	$1,588,000
Present Value (20 Years)	**$10,858,000**

Note: Present value cost based on 1% annual discount rate (difference between 10-year treasury and US inflation rates).

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