Final
Feasibility Study Report

New York State Department of Environmental Conservation Investigation and Design Engineering Services
Standby Contract No. D004437
Work Assignment No. D004437-30

Pride Solvent & Chemical Company
(Site No: 1-52-025)
West Babylon, New York

December 2011

CDM

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Project: NYSDEC Standby Contract No. D004437
Work Assignment No. D004437-30

Subject: Final Feasibility Study Report
Remedial Investigation/Feasibility Study
Pride Solvent and Chemical Company
West Babylon, Suffolk County, New York
Site ID No. 1-52-025

Dear Ms. Diaz:

Camp Dresser & McKee (CDM) is pleased to present this Final Feasibility Study Report for the above referenced site. This report was prepared in accordance with Task 6 of this work assignment and Final DER-10 (May 2010). If you have any questions regarding this submittal, please contact me at (732) 590-4674.

Very truly yours,

Seth Kellogg

Seth Kellogg, PG
Senior Project Manager
Camp Dresser & McKee Inc.

cc: R. Ockerby, NYSDOH
Project File

Pride Solvents & Chemical Company
(Site No: 1-52-025)
West Babylon, New York

Final Feasibility Study Report
Professional Engineer Certification

"I John P. Blaum, P.E. certify that I am currently a New York State registered professional engineer and *that this Feasibility Study Report was prepared in accordance with all applicable statutes and regulations and in substantial conformance with the DER Technical Guidance for Site investigation and Remediation (DER-10) and that all activities were performed in full accordance with the DER-approved work plan and any DER-approved modifications."*

SEAL

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12-23-2011
Date

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Section 1
Introduction

This Feasibility Study (FS) Report for Pride Solvent and Chemical Company Site (herein referred to as the "Site") located at 78 and 88 Lamar Street in West Babylon, Suffolk County, New York was prepared by Camp Dresser and McKee (CDM) for the New York State Department of Environmental Conservation (NYSDEC) under the Engineering Services for Investigation and Design, Standby Contract No. D004437. All background and site information used in the development of this FS report was furnished by NYSDEC. This information has been supplemented with data and information collected during a site remedial investigation (RI) conducted by CDM in 2008. The Site was formerly used as a solvent recycling facility at which soil, groundwater, and soil vapor contamination have been identified. This FS report was developed in accordance with the recent New York State guidance entitled *"Division of Environmental Remediation (DER)-10 Technical Guidance for Site Investigation and Remediation", dated June 2010.*

1.1 Purpose

The objective of this FS is to develop and present remedial alternatives that are appropriate for addressing site contamination as delineated in the RI report (CDM 2009). This FS serves as the mechanism to develop, screen and evaluate remedial alternatives for shallow and deep groundwater, and provides a recommendation for future evaluation of sub-slab soil vapor and indoor air.

The objectives of the FS are to:

- Develop remedial action objectives (RAOs) for site-related contamination
- Develop site-specific remedial action criteria
- Identify, screen, and select remedial technologies and process options that will appropriately address contamination associated with the Site
- Assemble and rank the retained technologies and process options into remedial alternatives for evaluation and comparative analysis

1.2 Operable Units

Upon evaluation of the unique and separate nature of the contamination in the shallow and deep groundwater zones, NYSDEC has decided to create two operable units at the Site. Operable Unit (OU) 1 will consist of the vadose zone contamination and shallow groundwater contamination. OU2 includes the deep groundwater contamination and the contaminated clay unit. In this FS, technologies and alternatives will be discussed and evaluated separately for each operable unit.

1.3 Organization of Feasibility Study Report

This FS Report is comprised of nine sections. The following identifies the organization of the report and the contents of each section.

Section 1: Introduction. This section provides the background information regarding the purpose and the organization of this FS report.

Section 2: Site Description and History. This section provides the Site background including the Site location and description, description of physical characteristics of the site, site history, and summary of previous investigations.

Section 3: Summary of Remedial Investigation. This section provides the summary of field activities associated with each of the four phases comprising the field investigation for the RI/FS, ,nature and extent of contamination, contaminant fate and transport, and exposure/risk assessment.

Section 4: Remedial Goals and Remedial Action Objectives. This section presents a list of remedial goals and RAOs by considering the characterization of contaminants, the risk assessments, and compliance with standard, criteria, and guidance (SCGs).

Section 5: General Response Actions. This section identifies general response actions.

Section 6: Identification and Screening of Remedial Technologies. This section identifies and screens remedial technologies and process options for each medium.

Section 7: Development and Analysis of Remedial Alternatives. This section presents the remedial alternatives developed by combining the feasible technologies and process options. This section also provides detailed descriptions and preliminary design assumptions regarding the alternatives that were retained. This information is used to develop the cost estimates for each alternative. This section also provides a detailed analysis of each alternative with respect to the following eight criteria: overall protection of public health and the environment; compliance with SCGs; long-term effectiveness and permanence; reduction of toxicity, mobility, or volume with treatment; short-term effectiveness; implementability; cost; and community acceptance. An overall comparison between the various remedial alternatives is also examined in this section.

Section 8: Recommended Remedy. This section provides the recommended remedy for each medium.

Section 9: References. A complete list of the references cited in the FS Report is presented in this section.

Section 2
Site Description and History

The following sections describe the Site location and description, site history, and a summary of previous investigations.

2.1 Site Location and Description

The Site, comprised of two adjacent buildings occupying 78 and 88 Lamar Street, is located in West Babylon, Suffolk County, New York. A Site location map is provided as **Figure 2-1.** The Site is located within the West Babylon Industrial Area (also referred to as the Pinelawn Industrial Area). To the north, south, east, and west of the Site are various other commercial and manufacturing facilities. Approximately 500 feet west of the Site is the Babylon Town Landfill.

The Site is approximately 1.38 acres in size and is currently occupied by two buildings. Paved parking, loading and unloading, and storage areas are present to the north of the 88 Lamar Street building, south of the 78 Lamar Street building, and between both buildings. The Site and surrounding properties are depicted in **Figure 2-2**. With the exception of a small landscaped area in front of each building, the Site is developed with buildings, asphalt, or concrete. Additionally, the northern portion of the property at 88 Lamar Street is unpaved. Cracked pavement extends to approximately half way between the site buildings and the north property line; beyond the pavement, the lot is sand and gravel. Each building has its own septic system: the septic system for 78 Lamar Street is located beneath the parking lot to the south, and the septic system for 88 Lamar Street is located under the front lawn. Located in the paved areas on the Site are 14 drywells for stormwater collection, two of which are connected to ancillary leaching pools. These features are shown in **Figure 2-2**.

2.2 Physical Characteristics of the Study Area

2.2.1 Topography

The Site is approximately 60 feet above mean sea level (amsl). Local topography slopes gently from the northeast to the southwest in the vicinity of the Site (USGS Amityville, New York 7.5-Minute topographic map, 1994). The site is located on the Pleistocene-aged glacial outwash deposits south of the Ronkonkoma Moraine (Doriski and Wilde-Katz, 1983).

2.2.2 Site Geology

Long Island is comprised of Cretaceous- and Pleistocene-aged unconsolidated deposits overlying a southward sloping surface of Early Paleozoic- to Precambrian-aged bedrock, with some Holocene-aged deposits along present-day streams, marshes and shorelines. The resulting wedge of sediments thickens southeasterly from its thinnest point in northern Queens, to a maximum thickness of 2,000 feet in southeastern Long Island.

Three major geologic formations are present on Long Island. In order of increasing depth these are the Upper Pleistocene deposits (known as the upper glacial aquifer), the Upper Cretaceous-aged Magothy Formation and the Upper Cretaceous-aged Raritan Formation. The Raritan Formation is subdivided in to the basal Lloyd Sand Member and the overlying Raritan Clay.

2.2.2.1 Upper Pleistocene Sediments

The shallowest Pleistocene-aged deposits are those that comprise the upper glacial aquifer. These deposits are primarily comprised of glacial till of the terminal moraines along the central axis of Long Island, and outwash deposits of sand and gravel between and south of the Moraines. The Site is near the south shore of Long Island, where outwash deposits are dominated by fine to coarse sand and gravel. The upper glacial deposits are approximately 85 feet thick in the study area, with the base of the unit lying at approximately 25 feet below msl.

Pleistocene-aged deposits unconformably overlie the Cretaceous-aged deposits. The Site lies along the edge of the Gardiners Clay, a marine deposit composed of grayish-green and brown silt and clay with marine shells, glauconite and a few layers of sand. (Smolensky, et al., 1989). The Gardiners Clay reportedly pinches out in the vicinity of the Site. A clay layer that may be associated with the Gardiners Clay was identified in the study area at the contact between the upper glacial and Magothy aquifers. The clay layer is found reasonably close to the elevation where the Gardiners Clay would be expected based upon regional maps. While previous investigations call into question whether this unit is indeed the Gardiners Clay, based upon lithologic and stratigraphic inconsistencies (Environmental Resource Management (ERM), 2004), it is believed that the clay layer likely does represent the edge or a lobe of the Gardiners Clay. The upper surface of the clay layer has been found continuously at depths ranging from 81 to 93.5 feet bgs (25 to 29 feet below msl) across the study area. The thickness of the clay layer ranges from ten to almost 20 feet across the study area; however, the clay tends to occur in lenses towards the north portion of the study area. The clay surface generally slopes westerly at the Site and southerly to the south of the Site. These variations in the depth of the clay, as well as the patterns of contamination observed atop the clay layer indicate that the clay layer is “wrinkled” or scoured – features which are considered to be consistent with glacial sequences.

2.2.2.2 Cretaceous Sediments

The dominant Magothy lithology is generally is fine to medium quartz sand interbedded with coarse sand, sandy clay, and solid clay. Lignite, pyrite, and iron oxide concretions are also found in the Magothy. The top of the Mathothy is approximately 35 feet below msl (approximately 95 feet below ground surface (bgs)). The thickness of the Magothy is approximately 800 feet at the Site.

2.2.3 Site Hydrogeology

The Site is immediately underlain by moderately to highly permeable sand, gravel and cobble outwash deposits of the upper glacial aquifer (Smolensky, et al. 1989). The estimated average horizontal hydraulic conductivity is 270 ft/day, with the outwash deposits being about twice as conductive as the till deposits. The vertical anisotropy is approximately 10:1. ERM (2004) reported a horizontal hydraulic gradient of 0.0015 across the Site, and estimated the groundwater flow rate at 1.5 ft/day based upon the hydraulic conductivity of 250 ft/day and a porosity of 25%. Over the years of past investigations, various estimates of groundwater velocities have been made at the Site, ranging from 0.9 to 3.2 ft/day as summarized by ERM (2004).

The clay layer underlying the upper glacial aquifer across the study area serves as a confining unit between the upper glacial and underlying Magothy aquifers. The estimated vertical hydraulic conductivity of the clay is 0.001 ft/day. The Magothy aquifer is the principal water supply aquifer in Nassau and Suffolk Counties, attributing to its appreciable thickness. Its average horizontal hydraulic conductivity is reported to be approximately 50 ft/day with a vertical anisotropy of 100:1.

Depth to water at the Site ranged from 7.84 to 10.37 feet bgs in February 2009. It should be noted that this is approximately 7.35 feet higher than the groundwater elevations measured by ERM in August 2002. Since there is no reported groundwater pumping in the vicinity of the site, it is assumed that seasonal variations in precipitation, recharge, and evapotranspiration are responsible for this discrepancy. Based upon these data the saturated thickness above the clay ranges from approximately 63 to 70 feet but varies seasonally and somewhat from location to location across the study area. Groundwater contour maps constructed using groundwater elevations from monitoring wells screened across the water table indicate that shallow groundwater flows to the south-southeast across the study area (**Figure 2-3**). A similar groundwater flow direction was found for the deeper strata, just above the clay.

Vertical gradients are variable across the study area. During the 2002 ERM investigation, the vertical gradient within the upper glacial aquifer were upward in the northern portion of the site and downward at the southern portion of the site. This trend was reversed in the 2008 data, where the vertical gradient in the northern portion of the site was downward and the vertical gradient in the southern portion of the site was slightly upward.

The vertical gradient across the clay unit was evaluated during the remedial investigation and revealed a downward gradient across the clay at well cluster MW-12D/SM (upgradient of the Site) and well cluster MW-14D/SM (cross-gradient from the site). At onsite well cluster ERM-MW-07D/MW-07SM, a slight upward gradient was observed across the clay.

2.3 Site History

The Site was occupied by Pride from 1960 to the late 1990's/early 2000's and was operated as a chemical and solvent distribution and reclamation facility. Presently, the property is owned by Pride and leased to a roll-off container distributing company and an autobody shop. During the time period that Pride operated the site, the facility was regulated as a hazardous waste treatment, storage, and disposal (TSD) facility under the Resource Conservation and Recovery Act (RCRA). Modifications were made to the facility over the years, reportedly in accordance with construction plans approved by the Suffolk County Department of Health Services in compliance with Article XII of the Suffolk County Sanitary Code (ERM, 2004).

The facility received and stored waste solvents and then reclaimed the material via a filtration and distillation process. The operations at 78 Lamar Street included storage and reclamation of chlorinated and fluorinated solvents by distillation. The building was used primarily for drum storage. A small portion of the building housed the distillation process operations. The remainder of the building was occupied by office space. Reportedly, Pride Solvents received waste chlorinated solvents and Freon(s) in 55-gallon drums. Portions of the wastes received were stored indoors within an epoxy-coated, bermed spill containment area constructed in the storage area. Full 55-gallon drums were also stored in an uncovered storage area outside.

Operations at the 88 Lamar Street facility were limited, reportedly, to bulk storage, drum packaging, and distribution of non-flammable and combustible organic solvents. Behind 88 Lamar Street (west) is a bermed, covered drum storage area with an epoxy-coated concrete floor. The north yard of this portion of the property formerly contained sixteen (16) underground storage tanks (USTs). Twelve of the USTs were removed by Tyree Brothers Environmental Services, Inc (Tyree) in 2001. None of the 12 USTs that were removed were observed to be leaking. The remaining four USTs were abandoned in-place with concrete. Despite the reported good condition of the USTs, about 50 yards of impacted soil were removed and disposed of off-site during tank removal. It is suspected that releases occurred from the piping; however, it is possible that releases occurred from overfilling, as well.

2.4 Summary of Previous Investigations

Chlorinated volatile organic compound (CVOC) contamination associated with the Site was first identified in 1982 to 1983 by the Suffolk County Department of Health during an industrial complex-wide groundwater screening (GWS) program. At that time tetrachloroethene (PCE), trichloroethene (TCE), 1,1,1-trichloroethane (1,1,1-TCA), 1,2-dichloroethene (cis- and 1,2-DCE), and 1,1-dichloroethane (1,1,-DCA), were detected in groundwater and were believed to be the result of multiple releases and sources at the Site. Results from the study indicated that a CVOC plume, originating from the industrial complex, extended approximately two miles downgradient (south toward Edison Avenue) and approximately 1,000 feet laterally. (ERM, 2004)

In 1984, Woodward-Clyde conducted a Phase I Preliminary Site Assessment at the Site. TCE, PCE, toluene, and methylene chloride were indentified at concentrations ranging from part-per-billion (ppb) to part-per-million (ppm) in soils from the on-site drywells. Additionally, TCE and PCE were detected in the storm drains at 88 Lamar Street. (ERM, 2004)

In 1991, H2M Group conducted a hydrogeologic and groundwater quality investigation at the Site, which included installation of five monitoring wells (MW-01 through MW-05). **Figure 2-4** depicts the monitoring well locations in the study area. The five monitoring wells were screened from 10 to 20 ft bgs, which is slightly below the water table, as measured during the February 2009 groundwater sampling event. The greatest concentration of total VOCs was observed at the shallow well MW-01 (2,549.9 µg/L), which is located on the southwest portion of the 78 Lamar Street property. During well installation, VOCs were detected in unsaturated soils at four of the five monitoring well locations (all except MW-03). Concentrations ranged from 0.022 to 0.977 ppm. (ERM, 2004)

In 1993, Tyree conducted an investigation at the Site, which entailed the collection of groundwater, surface and subsurface soil samples in the vicinity of the locations investigated by the H2M Group in 1991. Only the presence of methylene chloride was confirmed in the surface soils. The chlorinated solvents 1,1,1-TCA, TCE, and PCE were detected in MW-01 groundwater at concentrations exceeding the applicable NYDSEC groundwater standards (individual constituent concentrations were not provided, but total VOCs ranged from 1 to 2,400 µg/L). TCE and PCE were detected in MW-04 at respective concentrations of 4 µg/L and 22 µg/L. (ERM, 2004)

In 1996, Tyree conducted an additional investigation at the Site. Activities included the installation of six monitoring wells (MW-06 through MW-11) to 20 feet bgs, installation of ten direct-push borings to 5 and 10 feet bgs (B-1 through B-10) in the vadose zone, septic system and drywell sampling, and groundwater sampling at the six new wells. Investigation locations are depicted on **Figure 2-4**.

Most of the borings were installed in the vicinity of the drum storage area. Boring B-9 was advanced between two USTs that were reportedly abandoned in place in the parking area of the 88 Lamar Street building. Soil samples at this location (depth not specified) contained 0.79 ppm PCE. Groundwater at all of the new monitoring wells contained PCE. The three most downgradient (MW-06, MW-07, and MW-08) exhibited the greatest concentrations (180 µg/L, 82 µg/L, and 60 µg/L, respectively). TCE was detected in four of the new wells (MW-06, MW-07, MW-08, and MW-09) at concentrations ranging from 7 to 32 µg/L. (ERM, 2004)

In 2000, ERM conducted an additional investigation to evaluate groundwater quality and assess the potential presence of dense non-aqueous phase liquid (DNAPL) in the upper glacial aquifer at the Site. Geophysical investigations conducted in 2001 identified the presence of 12 of the 16 USTs at the Site. The geophysical survey reports are provided in Appendix A. These reports were gathered from Appendix C of the ERM 2004 RI. The Site features and locations of the USTs are depicted in Figures 1 and 2 of the geophysical reports. The ERM subsurface investigation locations are provided in **Figure 2-4**.

Intrusive activities included the following:

- Installation of 17 off-site groundwater screening points (P-01 through P-17) in the vicinity of the Site to evaluate the geomorphology of the top of clay and groundwater quality
- Eight monitoring wells were installed (cluster ERM-01S/D through cluster ERM-04S/D). The shallow wells of each cluster straddled the water table, and the deep wells were installed to the top of clay.
- Six on-site (B-1 through B-6) and four off-site (L-1 through L-4) soil borings were evaluated with an electrical conductivity probe to locate the top of the clay layer.
- A membrane interface probe (MIP-01 through MIP-05) was used to qualitatively evaluate VOC contamination with depth to the top of clay.
- Forty-one soil borings (P-18 through P-58) were installed to evaluate VOC contamination in unsaturated Site soils.
- Groundwater screening was conducted to the anticipated top of clay at on-site borings P-19, P-21, P-24, and P-57.
- Ten groundwater screening locations were installed downgradient and off-site (P-68 through P-77) to the top of clay.
- When it was determined that data gaps still existed, ERM conducted an additional side-gradient investigation that involved the installation of ten additional groundwater screening points (MLP-78 through MLP-87).
- Additionally, three monitoring wells (ERM-MW-05D, ERM-MW-06D, and ERM-MW-07D) were installed to the top of the clay layer that underlies the upper glacial aquifer.
- Subsequent to monitoring well installation, a comprehensive round of groundwater sampling was conducted. (ERM, 2004)

Results of the ERM investigations identified estimated concentrations of VOCs (2 ppm at 19 ft bgs) in the yard between 78 and 88 Lamar Street at ERM soil boring P-45, where former USTs were located. PCE was detected at a concentration of 0.028 ppm at soil boring P-34 in the north yard of 88 Lamar Street in the vicinity of additional former USTs. Samples of the clay from ERM-MW-05D and ERM-MW-06D contained estimated concentrations of PCE (12 and 1.1 ppm, respectively), TCE (estimated 1.2

ppm at ERM-MW-05D and 5.9 ppm at ERM-MW-06D), and 1,1,1-TCA (estimated 0.6 and 0.27 ppm, respectively). It is believed that much of the source area for the VOC contamination was removed from the Site during UST removal and subsequent excavation, as discussed in Section 1.3.1 above. (ERM, 2004)

Groundwater quality at the Site was evaluated by ERM in its 2004 report, which broke down the upper glacial aquifer into three zones for simplicity purposes: upper groundwater zone (the approximate upper third of the saturated thickness of the aquifer), intermediate groundwater zone (approximate middle third of the saturated thickness of the aquifer), and lower groundwater zone (approximate bottom third of the saturated thickness of the aquifer). In general, based on Table 12 of the ERM 2004 RI report, the highest concentrations of VOCs in the upper groundwater zone were identified at MLP-78, P-09, P-55, and P-07. P-09 primarily contained PCE and TCE (67 µg/L and 26 µg/L, respectively, from 17 to 20 ft bgs), while MLP-78 also contained 1,1,1-TCA (140 µg/L), 1,1,-DCA (6.2 µg/L), and 1,1-DCE (6.3 µg/L). It was believed that the location of MLP-78 was a former source area for these contaminants. (ERM, 2004)

Based on Table 13 of the ERM 2004 RI report, the intermediate groundwater zone contained the highest concentrations of VOCs onsite and immediately downgradient of the site. The highest concentrations were observed in the vicinity of MLP-78 on-site (31 µg/L PCE, 34 µg/L TCE, and 70 µg/L 1,1,1-TCA) and at P-69 offsite (82 µg/L PCE). (ERM, 2004) While ERM stated that concentrations above applicable standards were encountered on the east side of Lamar Street at P-80, no such boring is known to have existed, based on review of available literature. It is assumed that this was a typographic error.

Based on Table 14 of the ERM 2004 RI report, the lower groundwater zone contained elevated concentrations of PCE, with concentrations being the highest on-Site just south of the main building at 78 Lamar Street (P-07, P-50, ERM-MW-06D, ERM-MW-05D, MLP-78, and ERM-MW-01D, with concentrations ranging from 130 to 5,000 µg/L) and between the main buildings at the 78 and 88 Lamar Street properties (P-40 and ERM-MW-07D with respective PCE concentrations of 14,000 and 590 µg/L). Off-site and downgradient, the following locations contained PCE, TCE, and associated breakdown products at concentrations well above the applicable standards: P-68, P-69, MLP-80, ERM-MW-02D, P-13, and P-14. PCE concentrations ranged from 1,500 to 5,100 µg/L. TCE concentrations ranged from an estimated value of 45 to 1,500 µg/L. 1,1,1-TCA concentrations ranged from an estimated concentration of 20 to 2,000 µg/L. Based on the results of the ERM investigation, it was concluded that the possibility existed that DNAPL is present below the source area(s) at the Site. Due to the lack of available lithologic data, it was unknown as to whether the clay functioned as an adequate barrier to prevent the migration of site-related contaminants into the Magothy aquifer from the upper glacial aquifer (ERM 2004).

Section 3
Summary of Remedial Investigation

3.1 Introduction

This section provides a summary of the Remedial Investigation Report (RIR) dated October 2009. The report detailed the results of the field investigation conducted in accordance with the Pride Solvents and Chemical Site Remedial Investigation/Feasibility Study Work Plan dated August 2008 (Work Plan). The RIR was developed in accordance with the "Standby Contract Work Assignment, Remedial Investigation/Feasibility Study, Site No. 1-52-025" issued May 27, 2008. The RIR also followed the guidelines set forth in the *"Division of Environmental Remediation (DER)-10 Technical Guidance for Site Investigation and Remediation", dated June 2010.*

3.2 Summary of Field Investigation

The objective of the Remedial Investigation (RI) for the Site was to characterize the horizontal and vertical extent of groundwater contamination in the upper glacial aquifer, assess potential for subsurface soil contamination, and characterize the groundwater flow. The field investigation was conducted from October 2008 through January 2009.

Field tasks for the RI included:

- Lithologic sampling and groundwater screening (GWS) at 23 locations along 5 transects oriented perpendicular to groundwater flow (and Lamar Street);
- Subsurface soil sampling;
- Installation and development of 9 new monitoring wells: 6 in the upper glacial aquifer, screened immediately above the clay layer and the other 3 screened in the shallow Magothy Formation beneath the clay layer;
- Two rounds of groundwater sampling: one round included existing monitoring wells and was conducted during the GWS phase of work; the second sampling round was conducted following the installation of the new monitoring wells and included both existing and new wells;
- Community Air Monitoring.

3.3 Nature and Extent of Contamination

3.3.1 Approach to the Evaluation of Contamination

The characterization and evaluation of the nature and extent of contamination is focused on those constituents identified as Site-related contaminants, which were generally determined by evaluating historical information on contaminant sources, exceedances of screening criteria, the frequency and magnitude of the exceedance, and background concentrations. Although all other detected contaminants were also subject to the media-specific screening process, they are not all discussed in detail in the text.

3.3.1.1 Selection of Screening Criteria

The soil analytical results were compared to the Unrestricted Use Soil Cleanup Objectives as listed in the 6 NYCRR Part 375 (Environmental Remediation Programs) Subpart 375-6. The groundwater analytical results were compared to the New York State Standards and Guidance Values for Class GA Groundwater (NYSDEC TOGS 1.1.1). Soil vapor and indoor air samples collected in October 2006 by ERM were compared to the NYSDOH Soil Vapor/Indoor Air Decision Matrices 1 and 2 in Section 3 of the *Final Guidance for Evaluating Soil Vapor Intrusion in the State of New York* (October 2006).

3.3.1.2 Selection of Representative Contaminants

A wide variety of contaminants were identified during the RI, including PCE, TCE, and 1,1,1-TCA, *cis*-1,2-DCE, 1,1-DCA, 1,1-DCE, acetone, chloroform, chloromethane, 1,2-dichlorobenzene, methyl acetate, methylene chloride, 1,2,4-trichlorobenzene, 1,1,2-trichloro-1,2,2-trifluoroethane, toluene, and xylenes. However, a more limited group of representative Site-related contaminants were used to focus the evaluation of the nature and extent of contamination in groundwater and soil. To select these representative contaminants, CDM reviewed the analytical data collected during the RI, analyzed the spatial distribution of contamination and detection frequencies/levels, and reviewed the historical data for the Site (e.g., elevated levels of PCE, TCE, 1,1,1-TCA, *cis*-1,2-DCE, and 1,1-DCA in groundwater in the vicinity of the Site as revealed by the investigation conducted by the Suffolk County Department of Health during 1982-1983).

Based on this analysis, it was determined that PCE, TCE and 1,1,1-TCA generally exhibited the greatest spatial distribution and highest detected levels, and thus are most representative of Site-related contamination. To facilitate the discussion of fate and transport of these three contaminants, the PCE/TCE degradation products *cis*-1,2-DCE and vinyl chloride (VC), and 1,1,1-TCA degradation products 1,1-DCA, 1,1-DCE and chloroethane (CA), are also selected as representative contaminants.

3.3.2 Nature and Extent of Contamination

3.3.2.1 Groundwater

The groundwater screening investigation successfully characterized the boundaries of the plume area. The highest concentrations of CVOC groundwater contamination were detected at the base of the upper glacial aquifer, along the axis of the plume. CVOCs were also consistently detected in the shallow interval (approximately 20 feet) at concentrations approximately two times the screening criteria. The shallow monitoring wells show results similar to the detection in the groundwater screening investigation, with CVOC concentrations within 4 times of screening criteria. The highest concentrations of CVOCs were detected in the deep monitoring wells screened in the thin layer of silty sand or silt that lies just above the clay. Historically, CVOC concentrations detected in the vicinities of MW-5D, MW-7D, MW-13D, and MW-15D/former ERM-MW02 cluster have exceeded 1% the solubility for PCE, which indicates the potential for the presence of DNAPL in these locations. No site related contaminants were detected in the shallow Magothy Formation during the 2009 RI. The results of the groundwater screening are illustrated on **Figure 3-1** and detailed on **Table 3-1.** The analytical results from the two monitoring well sampling events are summarized in **Tables 3-2 and 3-3** and illustrated on **Figures 3-2 and 3-3.**

3.3.2.2 Soil Investigation

PCE was detected at concentrations exceeding screening criteria at the interface above the clay layer in GWS-15 and GWS-11. The concentration detected at GWS-15, which was advanced to the south of the 78 Lamar Street building in the vicinity of the on-site leaching structures and drywells, may be an indication of DNAPL in that area. Soil sampling results are detailed on **Table 3-4** and detections are presented on **Figure 3-4**.

3.3.2.3 October 2006 ERM Air Sampling

In October 2006, ERM collected 20 indoor air samples and 11 sub-slab soil vapor samples. Additional details regarding the 2006 ERM soil vapor investigation are discussed in the RIR. For ease of discussion, the properties have been assigned a random number (1 through 7):

- Property 1: Indoor air sample IA-01 co-located with sub-slab soil vapor sample SS-01; IA-02 and IA-03 in same room as sub-slab soil vapor samples SS-02 and SS-03
- Property 2: Indoor air sample IA-04; indoor air sample IA-05 co-located with sub-slab soil vapor sample SS-04; and indoor air sample IA-06 and sub-slab soil samples SS-05 and SS-06 (in same room but separated by walls)
- Property 3: Indoor air samples IA-07, IA-08, IA-09 and sub-slab sample SS-07
- Property 4: Indoor air samples IA-10, IA-11, IA-12 and sub-slab sample SS-08
- Property 5: Indoor air samples IA-13, IA-14, IA-15 and sub-slab sample SS-09
- Property 6: Indoor air samples IA-16, IA-17, IA-18 and sub-slab sample SS-10
- Property 7: Indoor air samples IA-19, IA-20 and sub-slab sample SS-11 (no schematic available)

In the data set, the laboratory detection limits above current action levels, so that in most cases the detection limits themselves exceed the action levels listed in the NYSDOH Soil Vapor/Indoor Air decision matrices. The following discussion is based on evaluation of the results that exceed their respective method detection limits only.

Based on the NYSDOH Soil Vapor/Indoor Air Matrices 1 and 2, concentrations of TCE and PCE, respectively, in indoor air and sub-slab soil vapor at Property 1(IA-01 - 1,100 and 140 µg/m^3, IA-02 – 3,200 and 110 µg/ m^3, IA-03 – 3,000 and 88 µg/ m^3, SS-01 – 18,000 and 260,000 µg/ m^3, SS-02 – 54,000 and 450,000 µg/ m^{3}and SS-03 – 28,000 and 540,000 µg/ m^3), warrant Mitigation.

At Property 2, (IA-04 – 5.4 and 8.1 µg/ m^3, IA-05 – 2.2 and 5.4 µg/ m^3, IA-06 – 2.5 and 6.6 µg/ m^3, SS-04 – 2,500 and 750 µg/ m^3, SS-05 – 3,600 and 21,000 µg/ m^3, and SS-06 – 640 and 5,700 µg/ m^3) concentrations of TCE and PCE in sub-slab soil vapor and indoor air warrant Mitigation, particularly in the Back Room.

At Property 3 (IA-07 – 14 µg/m3, IA-08 – 14µg/ m^3, IA-09 -24 µg/ m^3, and SS-07 – 1,200 µg/ m^3) and Property 4 (IA-10 – 2.9 µg/ m^3, IA-11 – 2.7 µg/ m^3, IA-12 – 3.0 µg/ m^3, and SS-08 – 2,100 µg/ m^3), concentrations of PCE in sub-slab soil vapor and indoor air warrant Mitigation.

At Property 5, (IA-13 – 3.3 µg/ m^3, IA-14 – 3.4 µg/ m^3, IA-15 – 2.7 U µg/ m^3, and SS-09 – 270 µg/ m^3) concentrations of PCE in sub-slab soil vapor and indoor air warrant Monitoring/Mitigation.

At Property 6, concentrations of PCE in sub-slab soil vapor and indoor air (IA-16 – 1,600 µg/ m^3, IA-17 – 3,500 µg/ m^3, IA-18 – 810 µg/ m^{3}and SS-10 – 9,500 µg/ m^3), warrant Mitigation, and concentrations of TCE (IA-16 – 11 U µg/ m^3, IA-17 – 21 U µg/ m^3, IA-18 – 5.4 U µg/ m^{3}and SS-10 – 190 µg/ m^3), warrant Monitoring.

At Property 7, concentrations of PCE in sub-slab soil vapor and indoor air (IA-19 – 2.4 µg/ m^3, IA-20 – 2.0 µg/ m^{3}and SS-11 – 210 µg/ m^3) warrant Monitoring.

3.4 Contaminant Fate and Transport

3.4.1 Summary of the Evaluation of Natural Attenuation

The lack or rare detection of 1,1,1-TCA, TCE, and PCE biodegradation intermediate products such as cis-1,2-DCE, VC, 1,1-DCA, and CA, along with the generally unfavorable geochemical characteristics of the groundwater (i.e., relatively aerobic condition, relatively high Eh and lack of reducing zone, insufficient carbon source, etc.) indicate that the subsurface conditions at the Site may not be conductive to natural attenuation. The subsurface conditions may need to be altered, utilizing appropriate engineering measures such as addition of electron donors, nutrients, and even appropriate microorganisms, in order to establish more favorable conditions (e.g., depletion of dissolved oxygen (DO) and other competing electron acceptors such as nitrate and sulfate, sufficient source of energy etc.) before the natural attenuation via reductive dechlorination can be applied as a feasible remedy at the Site.

3.4.2 Conceptual Site Model

The conceptual site model (CSM) is developed to integrate all the different types of information collected during an RI, including geology, hydrogeology, site background and setting, and the fate and transport of contamination associated with the Site. **Figure 3-5** shows the conceptual site model for the Pride Solvent and Chemical site.

3.4.2.1 Physical Setting with Respect to Groundwater Movement

All of the groundwater on Long Island is derived from precipitation. The volume of water that percolates down to the water table and recharges the reservoir is the residual of the total precipitation not returned to the atmosphere by evapotranspiration or lost to the sea by runoff. The sandy nature of the surface and subsurface soils results in a high rate of infiltration. At the Site, which is mostly covered by impervious surfaces such as buildings, paved parking lots, and roads, surface runoff is directed to storm sewers. The site is immediately underlain by the sand, gravel and cobbles of the upper glacial aquifer.

A clay layer is present beneath most of the site, at the base of the upper glacial aquifer. The upper surface of the clay layer has been found at depths ranging from 81 to 93.5 feet bgs (25 to 29 feet below msl). The thickness of the clay layer ranges from ten to almost 20 feet across the study area. However, the clay tends to occur in lenses towards the north portion of the study area. The clay surface generally slopes westerly at the site and southerly in offsite areas to the south of the site. The clay layer, where present, functions as a confining unit for the Magothy aquifer.

From 2000 to 2002, depth to water at the site ranged from 17 to 19 feet bgs based upon water levels collected from on-site monitoring wells (ERM, 2004). In 2008, depth to water at the site ranged from 8 to 14 feet bgs. Based upon these data, the saturated thickness above the clay is approximately 70-80 feet. Groundwater contour maps constructed using groundwater elevations from monitoring wells screened across the water table indicate that shallow groundwater flows to the south-southeast across the study area. A similar groundwater flow direction was found for the deeper strata, just above the clay. ERM (2004) reported a horizontal hydraulic gradient of 0.0015 across the site, and estimated the groundwater flow rate at 1.5 ft/day based upon a hydraulic conductivity of 250 ft/day and an effective porosity of 25%. Over the years of past investigations, various estimates of groundwater velocities have been made at the site, ranging from 0.9 to 3.2 ft/day as summarized by ERM (2004).

Vertical gradients above the clay were measured during 2002 and 2004 at four monitoring well clusters downgradient of the site. During 2002, the vertical gradient was upward at the northern two (of the four well clusters) and downward at the southern two well clusters. During 2004, all four monitoring well clusters exhibited downward gradients within the upper glacial aquifer.

3.4.2.2 Potential Contaminant Sources

Operations at the 88 Lamar Street facility were limited, reportedly, to bulk storage, drum packaging, and distribution of non-flammable and combustible organic solvents. Behind 88 Lamar Street (west) is a bermed, covered drum storage area with an epoxy-coated concrete floor. The north yard of this portion of the property formerly contained sixteen (16) underground storage tanks (USTs). Contamination is reportedly due to former poor handling practices, disposal or releases from the Pride Solvent and Chemical Site. Over the past 25 years, investigations have detected CVOCs in concentrations exceeding screening criteria in the on-site surface and sub-surface soils, on-site drywells, septic systems, the 88 Lamar Street storm drain, and on-site and off-site groundwater. It is believed that much of the source area for the VOC contamination was removed from the site during UST removal and subsequent excavation.

3.4.2.3 Expected Transport and Fate of Site Contaminants

Site contaminants released to the soil surface would be expected to infiltrate into the soil and move primarily downward, through the unsaturated zone. Chlorinated solvents such as PCE and TCE can move downward in the undissolved phase or dissolved in precipitation-derived water. When the undissolved solvents reach the groundwater they dissolve in the groundwater and move in the direction of groundwater flow. If the quantity of solvent reaching the water table is sufficient, some of it may remain in an undissolved state and continue to move downward under the influence of gravity. The undissolved solvent can act as a continual source of dissolved groundwater contamination.

The DNAPL released at the Site migrated through the upper glacial aquifer and settled into “wrinkles” in the clay at the base of the aquifer. The flow of the DNAPL was directed by gravity through the “wrinkles” rather than in a linear pattern with the flow of groundwater. Therefore, the highest concentrations of groundwater contamination are not detected in a linear pattern with distance from the site, but are associated with the “wrinkles” in the clay layer. The DNAPL has diffused into the clay layer and deeper areas of the aquifer which are characterized by finer silty-sands and silts. In these areas, the groundwater velocity is likely to be much lower than the average reported velocity for the upper glacial aquifer and the DNAPL is attenuating at a slower rate.

Natural attenuation of chlorinated solvents is a documented process, with TCE breaking down through a known decay chain of compounds, with daughter products including cis-1,2-DCE and VC. These latter two chemicals have been detected intermittently in water samples from the Site and cis-1,2-DCE has been infrequently detected in air samples. The lack of 1,1,1-TCA, TCE, and PCE biodegradation intermediate products such as cis-1,2-DCE, VC, 1,1-DCA, and CA, along with the generally unfavorable geochemical characteristics of the groundwater (i.e., relatively aerobic condition, relatively high Eh and lack of reducing zone, insufficient carbon source etc.) indicate that the subsurface conditions at the Site may not be conductive to natural attenuation.

3.4.2.4 Air

PCE and TCE are volatile organic chemicals. As such, they volatilize to the atmosphere and, in the unsaturated soil zone, to the pore spaces between soil particles. Volatile chemicals dissolved in groundwater also volatilize into the overlying unsaturated zone. Vapors move through the unsaturated zone pore spaces, often seeking preferential flow pathways such as sandier zones with more porosity and permeability, gravel commonly placed beneath concrete basements or pipelines that may be backfilled with sandy material. As vapors move through the unsaturated zone, they can enter structures, such as homes, affecting air quality. Vapor movement may also be affected by differential pressure gradients, either natural (e.g., caused by weather changes) or man-made (e.g., pressure differences inside and outside structures). Based on historical sampling results (2006), the groundwater contamination from the Site is impacting the sub-slab and indoor air quality at the properties adjacent to and downgradient from the Site.

3.4.2.5 Potential Receptors

The area is served by public water, so there is no potential impact to human health from drinking or bathing with water from the Site. However, based on the indoor air and sub-slab soil vapor data collected in 2006 (ERM 2007), there is potential for exposure to workers within the Site buildings and in buildings located downgradient of the Site.

3.5 Conclusions and Recommendations

This section provides a summary of the major findings of the RI. Conclusions are drawn from the various investigations that were conducted to determine the nature and extent of contamination in soil, air and groundwater. Recommendations are also provided.

3.5.1 Conclusions

The significant findings of the RI are as follows:

- The data collected during the RI, in conjunction with historical data, has helped to characterize the nature and extent of contamination.

- The characterization of the Site will support this Feasibility Study.

- A groundwater plume containing CVOCs extends south/southeast from the Site. The RI delineated (to below applicable standards) the nature and extent of the plume horizontally, with the exception of the area west of MW-13D. The vertical distribution of the CVOC groundwater contamination is well defined, with moderate (2 to 4 times screening criteria) concentrations detected at the water table, and high (100 to 1,000 times screening criteria) concentrations detected above the clay layer.

- The concentrations of CVOCs in the deep groundwater samples indicate the potential for DNAPL to be present in the aquifer above the clay layer.

- CVOCs were detected in an on-site soil sample collected from the top of the clay layer at concentrations that exceed screening criteria and indicate the potential for the presence of DNAPL.

- Chemical and geochemical data suggest that aquifer conditions are not conducive to natural attenuation of chlorinated ethenes via reductive dechlorination. However, the data gathered during the ERM and 2008 remedial investigations indicate that natural attenuation does occur via reductive dechlorination, albeit to a limited extent.

- On comparison of past and current groundwater concentrations, as well as Site-defined fate and transport variables, it is apparent that some groundwater contamination has dissolved and dispersed. There was no Site-related contamination detected in the shallow Magothy Formation.

- Based on the 2006 ERM soil vapor and indoor air sampling, the potential for soil vapor intrusion to impact indoor air quality at the Site and neighboring buildings does exist.

3.5.2 Recommendations

Based on the findings of the RI, no additional data or activities will be required prior to FS development. However, the following additional data may be needed to complete a remedial design for the site:

- It is recommended that a second phase of vapor intrusion investigation be conducted at properties downgradient of the original seven investigated in 2006, unless a source assessment (inventory and/or sub-slab soil vapor sample) shows that any potential or actual indoor air issues are directly related to normal business practices.

- To complete the remedial design, the horizontal and vertical extent of VOC contamination in the Gardner's Clay will need to be delineated.

Section 4
Remedial Goals and Remedial Action Objectives

Remedial action objectives (RAOs) are media-specific goals for protecting human health and the environment that serve as guidance for the development of remedial alternatives. The process of identifying the RAOs follows the identification of affected media and contaminant characteristics; evaluation of exposure pathways, contaminant migration pathways and exposure limits; and the evaluation of chemical concentrations that will result in acceptable exposure. The RAOs are based on regulatory requirements for unrestricted use that may apply to the various remedial activities being considered for the Site. This section of the FS reviews the affected media and contaminant exposure pathways and identifies Federal, State, and local regulations that may affect remedial actions.

Preliminary remediation goals (PRGs) were selected based on federal or state standards, criteria, and guidance (SCGs), background concentrations, and with consideration also given to other requirements such as analytical detection limits. These PRGs were then used as a benchmark in the technology screening, alternative development, and detailed evaluation of alternatives presented in the subsequent sections of the FS report.

4.1 Standards, Criteria, and Guidance

To determine whether the Site groundwater contains contamination at levels of concern, State and Federal SCGs were assessed. The regulatory SCGs and the applicability of these SCGs to the Site are summarized in the following sections.

Potential SCGs are divided into three groups:

- Chemical-specific SCGs
- Location-specific SCGs
- Action-specific SCGs

4.1.1 Chemical-specific Standards, Criteria, and Guidance

Chemical-specific SCGs are health- or technology-based numerical values that establish concentration or discharge limits for specific chemicals or classes of chemicals. There are no chemical-specific Federal SCGs for cleanup of contaminated soil, but there is a State SCG for soil. Therefore, NYSDEC Unrestricted Use Soil Cleanup Objectives are applicable requirements according to NYSDEC Inactive Hazardous Waste Disposal Site Remedial Program under 6 NYRR Part 375 Subpart 375-2.

Groundwater at the Site currently is not being used as a source of drinking water, but NYSDEC classifies all fresh groundwater in the state as "Class GA fresh groundwater", for which the assigned best usage is as a source of potable water supply. Therefore, although there are no known current users of groundwater at or near the Site, the groundwater is assumed to be a source of drinking water in the future. Therefore, New York State Groundwater Quality Standards are applicable requirements and the Federal and New York State primary drinking water standards are applicable if an action involves future use of groundwater as a public supply source.

4.1.1.1 Federal Standards, Criteria, and Guidance

Federal Drinking Water Standards

- National Primary Drinking Water Standards (40 CFR 141). Potentially applicable if an action involves future use of groundwater as a public supply source.

4.1.1.2 New York Standards, Criteria, and Guidance

Soil Standards and Criteria

- NYSDEC Inactive Hazardous Waste Disposal Site Remedial Program 6 NYCRR Part 375 Subpart 375-2, Environmental Remediation Programs, Unrestricted Use Soil Cleanup Objectives, December 14, 2006. Used as the primary basis for setting numerical criteria for soil cleanups.

Groundwater Standards and Guidance

- New York State Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations (Technical and Operational Guidance Series (TOGS) 1.1.1). Used for setting numerical criteria for groundwater cleanups.

- New York State Surface Water and Groundwater Quality Standards and Groundwater Effluent Limitations (6 New York Environmental Conservation Rules and Regulations (NYCRR) Part 703). Applicable for assessing water quality at the Site during remedial activities.

Drinking Water Standards

- NYSDOH Drinking Water Standards (10 NYCRR Part 5). Potentially applicable if an action involves future use of groundwater as a public supply source.

Soil Vapor and Indoor Air Guidance

- Final Guidance for Evaluating Soil Vapor Intrusion in the State of New York (NYSDOH 2006) is considered relevant and appropriate to soil vapor and indoor air at and in the vicinity of the Site. The 2006 NYSDOH Vapor Intrusion guidance indicates that the State of New York does not have any standards, criteria, or guidance values for subsurface vapors. The guidance is appropriate for evaluation of indoor air and sub-slab soil vapor contamination due to soil vapor intrusion and determination of appropriate course(s) of action to follow to reduce exposure to the chemical(s) in the air.

4.1.2 Location-specific Standards, Criteria, and Guidance

Location-specific SCGs are those which are applicable or relevant and appropriate due to the location of the Site or area to be remediated. Based on the historic site information there is no location specific criteria that could be applicable.

4.1.3 Action-specific Standards, Criteria, and Guidance

Action-specific SCGs are requirements which set controls and restrictions to particular remedial actions, technologies, or process options. These regulations do not define Site cleanup levels but do affect the implementation of specific remedial technologies. These action-specific SCGs are considered in the screening and evaluation of various technologies and process options in subsequent sections of this report.

4.1.3.1 Federal Standards, Criteria, and Guidance

General - Site Remediation

- Occupational Safety and Health Administration (OSHA) Worker Protection (29 CFR 1904, 1910, 1926)

Discharge of Groundwater

- Federal Clean Water Act - National Pollutant Discharge Elimination System (40 CFR 100 et seq.); Effluent Guidelines and Standards for the Point Source Category (40 CFR 414); Ambient Water Quality Criteria (40 CFR 131.36)
- Federal Safe Drinking Water Act - Underground Injection Control Program (40 CFR 144, 146)

4.1.3.2 New York Standards, Criteria, and Guidance

New York Solid and Hazardous Waste Management Regulations (6 NYCRR)

- Hazardous Waste Management System - General (Part 370)
- Solid Waste Management Regulations (Part 360)
- Identification and Listing of Hazardous Waste (Part 371)

Disposal of Hazardous Waste (6 NYCRR)

- Standards for Universal Waste (Part 374-3)
- Land Disposal Restrictions (Part 376)

Discharge of Groundwater (6 NYCRR)

- State Pollutant Discharge Elimination System (SPDES) (Part 750-757)
- Surface Water and Groundwater Quality Standards and Groundwater Effluent Limitations (6 NYCRR Part 703)
- Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations (TOGS 1.1.1)

Air Quality Management

- New York General Provisions (6 NYCRR Part 211)
- New York Air Quality Standards (6 NYCRR Part 257)
- New York State Department of Environmental Conservation (DAR-1) Air Guide 1, Guidelines for the Control of Toxic Ambient Contaminants
- New York State Department of Health Generic Community Air Monitoring Plan

4.2 Remedial Action Objectives

Based on the evaluation of the nature and extent of contamination in soil, groundwater and vapor, the following preliminary RAOs were developed:

4.2.1 Remedial Action Objectives for Groundwater

The recommended RAOs for groundwater at the Site are as follows:

- Minimize the off-site migration of volatile organic compounds in groundwater at concentrations that pose a potential risk to off-site receptors
- Protect human health and the environment by mitigating the on-site contaminated groundwater CGs

4.2.2 Remedial Action Objectives for Indoor Air

For buildings at and in the vicinity of the Site for which indoor air contamination cannot be ruled out as being caused by normal business practices, the recommended RAOs are as follows:

- Protect human health by restoring indoor air concentrations of site-related contaminants to within typical background ranges and/or within New York State Department of Health Indoor Air Guideline Values.

4.3 Remediation Goals

The remediation goals (RGs) were selected based on state promulgated SCGs, background concentrations, and with consideration given to other requirements such as analytical detection limits and guidance values. The RGs for Operable Unit 1 and Operable Unit 2 will be determined separately based on the recommended alternative. The primary site-related constituents of concern are CVOCs.

4.3.1 OU1 Remediation Goals

Shallow groundwater (OU1) RGs are determined by the New York State Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations (TOGS 1.1.1) and applicable regional specific background values.

4.3.2 OU2 Remediation Goals

Deep Groundwater (OU2) RGs are based on New York State Soil Cleanup Objectives for the Protection of Groundwater (Part 375-3.8(b)), the New York State Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations (TOGS 1.1.1), and applicable regional specific background values. The RG for OU2 will be source removal.

Section 5
General Response Actions

General response actions (GRAs) were identified based on the established RAOs and site conditions. GRAs are those actions that, individually or in combination, satisfy the RAOs for the identified media by reducing the concentrations of hazardous substances or reducing the likelihood of contaminant exposure by receptors. Potentially applicable GRAs at the Site include no action, institutional/engineering controls, monitored natural attenuation, containment, removal/extraction, treatment, and disposal/discharge.

5.1 No Action

The National Contingency Plan (NCP) and CERCLA require the evaluation of a No Action alternative as a basis for comparison with other remedial alternatives. A No Action alternative will be evaluated at this New York site. Under the No Action alternative, remedial actions are not implemented, the current status of the Site remains unchanged, and no action would be taken to reduce the potential for exposure to contamination.

5.2 Environmental Easement / Site Management Plan

Institutional/Engineering Controls typically are measures that minimize access (e.g., fencing) or restrict future use of the Site (e.g., restrictions on the use of groundwater). These limited measures are implemented to provide some protection of human health and the environment from exposure to site contaminants. An environmental easement is required for projects where the remedy requires institutional and/or engineering controls. Institutional/Engineering Controls are generally used in conjunction with other remedial technologies; alone they are not effective in preventing contaminant migration or reducing contamination. They are also used to continue monitoring contaminant migration (e.g., long-term monitoring).

5.3 Monitored Natural Attenuation

Monitored Natural Attenuation (MNA) is a response action by which the mass and toxicity of contaminants are reduced by naturally occurring processes in the groundwater. Processes which reduce contamination levels in groundwater include dilution, dispersion, volatilization, adsorption, biodegradation, and abiotic chemical reactions with other subsurface constituents. As this GRA relies on naturally occurring processes, the effectiveness of MNA must be demonstrated by data collected from a regular monitoring schedule. Data would need to show that naturally occurring attenuation processes would be expected to reduce contaminant levels to the PRGs within a reasonable timeframe and/or within a reasonable physical boundary.

5.4 Containment

Containment actions use physical or hydraulic control methods, such as low permeability barriers and/or groundwater extraction wells, to minimize or eliminate contaminant migration and potential exposure to receptors. Containment technologies do not involve treatment to reduce the toxicity or mass of contaminants. The response actions require long-term monitoring to determine whether containment actions are performing successfully. The NCP does not prefer containment response actions since they do not provide permanent remedies.

5.5 Removal/Extraction

Removal response actions refer to methods typically used to excavate and handle soil, sediment, waste, and/or other solid materials. An extraction-based response action provides reduction in mobility and volume of contaminants by removing the contaminated groundwater from the subsurface using such means as groundwater extraction wells or interceptor trenches. Groundwater extraction is typically used in conjunction with other technologies to achieve the RAOs for the removed media, such as treatment or disposal options. Groundwater extraction can also provide hydraulic containment to prevent migration of dissolved contaminants. The extraction response action does not reduce the concentrations of contaminants in groundwater. It merely transfers the contaminants to be managed under another response action.

5.6 Treatment

Treatment involves the destruction of contaminants in the affected media, transfer of contaminants from one media to another, or molecular transformation of the contaminants. The result is a reduction in toxicity, mobility, or volume of the contaminants. Treatment technologies vary among environmental media and can consist of chemical, physical, thermal, and biological processes. Treatment can occur in place or above ground. The treatment GRA is usually preferred unless site- or contaminant-specific characteristics inhibit feasibility from an engineering, implementation, or cost perspective.

5.7 Disposal/Discharge

Following extraction, groundwater must be managed appropriately. Extracted groundwater that meets regulatory standards (by treatment, if necessary) can be disposed of or discharged via on-site injection into the subsurface, on-site surface recharge of the underlying aquifer, discharge to a publically owned treatment works, or discharge to surface water bodies.

Section 6
Identification and Screening of Remedial Technologies

Upon evaluation of the unique and separate nature of the contamination in the shallow and deep groundwater zones, NYSDEC has decided to create two operable units at the site. Operable unit (OU) 1 will consist of the shallow groundwater and vadose zone contamination. OU2 includes the deep groundwater contamination and the contaminated clay unit. In Sections 6 through 8, technologies and alternatives will be discussed and evaluated separately for each operable unit.

Potential remedial technologies and process options associated with each GRA are identified and screened in this section. Representative remedial technologies and process options that are retained will be used to develop remedial action alternatives in the following section.

The technology screening approach is based upon the procedures outlined in *DER-10 Technical Guidance for Site Investigation and Remediation* (NYSDEC 2010) and *Final Guidance for Evaluating Soil Vapor Intrusion in the State of New York* (NYSDOH 2006). The evaluation process uses three criteria: Effectiveness, Implementability, and Relative Cost. Among these three, the effectiveness criterion outweighs the implementability and relative cost criteria. These criteria are described below:

Effectiveness

This evaluation criterion focuses on the effectiveness of process options to reduce the toxicity, mobility, or volume of contamination for long term protection and for meeting the RAOs and PRGs. It also evaluates the potential impacts to human health and the environment during construction and implementation, and how proven and reliable the process is with respect to site-specific conditions.

Implementability

This evaluation criterion encompasses both the technical and administrative feasibility of the technology or process option. It includes an evaluation of pretreatment requirements, residuals management, and the relative ease or difficulty in performing the operation and maintenance (O&M) requirements. Process options that are clearly ineffective or unworkable at the site are eliminated by this criterion.

Relative Cost

Cost plays a limited role in the screening process. Both capital costs as well as O&M costs are considered. The cost analysis is based on engineering judgment and each process is evaluated as to whether costs are low, moderate, or high relative to the other options within the same technology type.

Retained remedial technologies and process options are used to develop remedial action alternatives, either alone or in combination with other technologies.

6.1 Remedial Technologies for Operable Unit 1

6.1.1 No Action

The No Action alternative is not a technology. The No Action alternative is considered as a basis for comparison.

Effectiveness - The No Action alternative is used as a baseline against which other technologies may be compared. It generally does not provide measures that would comply with SCGs, or otherwise meet RAOs. The No Action alternative does not reduce the impacts to human health and the environment.

Implementability - The No Action alternative is implementable given there is no action required.

Relative Cost - The No Action alternative involves no capital or O&M costs.

Conclusion – The No Action alternative is retained for further consideration.

6.1.2 Institutional Controls

Institutional Controls do not reduce the toxicity, mobility, or volume of contamination, but can be implemented to reduce the probability of exposure to contaminants. Institutional controls consist of administrative actions which control use of the site (e.g., restrictions on the use of groundwater) to reduce direct human contact of contaminated water. Institutional controls generally require long term monitoring of contaminant concentrations. Typical institutional controls are discussed below.

6.1.2.1 Environmental Easements

Environmental easements are regulatory actions that are used to restrict certain types of uses for properties where exposure pathways to contaminants may be created as a result of those uses. Environmental easements may be used to restrict or minimize intrusive activities within the contamination plume without certain controls in place.

Effectiveness - Environmental easements could effectively restrict or eliminate use of contaminated groundwater, thereby reducing risks to human health. Environmental easements would not reduce the migration and the associated environmental impact of the contaminated groundwater.

Implementability - Environmental easements are easily implementable through the existing administrative system.

Relative Cost - The cost to implement environmental easements is low. Some administrative, long-term monitoring and periodic assessment cost would be required.

Conclusion – Environmental easements will be retained for further consideration.

6.1.2.2 Restrictions on the Use of Groundwater

Groundwater use restrictions are regulatory actions that are used to regulate installation of groundwater wells and other uses of groundwater.

Effectiveness - Groundwater use restrictions would reduce the potential for human exposure pathways to contaminated groundwater. Groundwater use restrictions will not reduce the migration and the associated environmental impact of the contaminated groundwater.

Implementability - Implementation would be easy via the existing permitting process. Groundwater use restrictions may also be implemented, in addition to remediation activities, as a protective measure to prevent future exposure to contaminants during remediation.

Relative Cost - The cost to implement groundwater use restrictions is low.

Conclusion - Groundwater use restrictions will be retained for further consideration.

6.1.2.3 Long-term Monitoring

Long-term monitoring includes periodic sampling and analysis of groundwater samples. This program would provide an indication of the movement of the contaminants and/or of the progress of remedial activities, including monitored natural attenuation.

Effectiveness - Long-term monitoring alone would not be effective in meeting the RAOs. It would not alter the effects of the contamination on human health and the environment. Monitoring is a proven and reliable process for tracking the migration of contaminants during and following treatment.

Implementability - Long-term monitoring could be easily implemented. All monitoring wells are easily accessible for sample collection. Equipment, material, and sampling procedures are readily available.

Relative Cost - Long-term monitoring involves low capital and moderate O&M cost.

Conclusion - Long-term monitoring will be retained for further consideration.

6.1.3 Monitored Natural Attenuation

Monitored natural attenuation (MNA) refers to the remedial action that relies on naturally occurring attenuation processes to achieve site-specific RAOs within a reasonable time frame. Monitoring groundwater quality over time is necessary to demonstrate that the expected attenuation processes are actually occurring. Natural attenuation processes that reduce contaminant concentrations in groundwater include destructive (biodegradation and chemical reactions with other subsurface constituents) and non-destructive mechanisms (dilution, dispersion, volatilization, and adsorption).

Biodegradation is typically the most significant destructive attenuation mechanism. The chlorinated solvents PCE, TCE and 1,1,1-TCA attenuate predominantly by reductive dechlorination under anaerobic conditions. Breakdown products cis-1,2-DCE, VC, and ethane attenuate under both anaerobic and aerobic conditions. The primary anaerobic reductive dechlorination pathway for PCE to ethene is given below:

PCE → TCE → cis-1,2-DCE → VC → Ethene

The primary anaerobic reductive dechlorination pathway for 1,1,1-TCA to ethane is given below:

1,1,1-TCA → 1,1-DCA → Chloroethane → Ethane

Reductive dechlorination is a process requiring an adequate supply of electron donors (the chlorinated solvent molecule is the electron acceptor). The existence of other electron acceptors—oxygen, nitrate/nitrite, ferric iron, or sulfate—can compete with the chlorinated solvent molecule as the preferred electron acceptor and inhibit or limit the dechlorination process. The highest reductive dechlorination rates for PCE, TCE, and 1,1,1-TCA have been observed under anaerobic, highly reducing conditions associated with methanogenic reactions. By analyzing biogeochemistry data, including distribution of electron acceptors (e.g. nitrate/nitrite, ferric iron, and sulfate concentrations), metabolic by-products, and the contaminant distribution and time trends, it is possible to determine whether active biotransformation of the chlorinated solvents is occurring.

Effectiveness - MNA is an effective remediation approach for sites where natural mechanisms can be demonstrated to minimize or prevent the further migration of elevated contaminant concentrations. Based on the review of the RI monitoring well data, it appears that anaerobic reductive dechlorination of VOCs is not occurring at sufficient levels in the groundwater. The concentration of PCE remains high whereas concentrations of degradation products TCE, cis-1,2 DCE and VC are very low or non-detect. Site groundwater is under aerobic conditions. There is also no evidence of depletion of electron acceptors.

Implementability - Natural attenuation is considered to be easily implementable. Materials and services necessary to model and monitor the contaminant dynamics are readily available. Site restrictions and/or institutional controls may be required as long-term control measures as part of the MNA alternative.

Relative Cost - Modeling and monitoring for MNA involves low capital cost and moderate O&M cost.

Conclusion – Due to lack of evidence of destructive natural attenuation processes at the Site, MNA will not be included for further consideration to reduce PCE, TCE, and 1,1,1-TCA. However, it will be retained for the natural attenuation of further breakdown products.

6.1.4 Containment

Low-permeability vertical barrier walls could be installed downgradient of source areas or plumes to control contaminant migration. The walls would be constructed using slurry or sheet piling to the top of a low permeability layer. Barrier walls would only be effective in areas of the Site where a high water table and shallow depth of the aquifer and confining clay unit are found. Within these areas, both types of barrier walls (i.e., slurry or sheet pile) would be effective for redirecting contaminated groundwater flow. Barrier walls can be used in combination with a groundwater extraction system; the walls would minimize the amount of pumping required to maintain hydraulic control by acting as a physical barrier, restricting clean groundwater inflow from side-gradient areas into the capture zone.

6.1.4.1 Slurry Walls

Slurry walls are constructed by pumping a low-permeability slurry, typically consisting of either a soil-bentonite or cement-bentonite mixture, into an excavated trench. Excavation can be completed using a long-arm excavator and a clam shovel to meet the required depth. The slurry would be pumped into the trench during the course of excavation to keep the sidewalls from collapsing. For the most effective slurry wall design, the base of the wall is embedded into a low permeability layer, such as clay or bedrock, so that groundwater does not bypass the wall by flowing underneath it.

Effectiveness - Slurry walls would effectively achieve hydraulic control and containment if properly constructed. Upon the completion of remedial activities, the walls would remain in place and continue to influence groundwater flow patterns on a localized scale.

Implementability - Slurry walls are implementable in general, and the construction materials and services are readily available. However, the depth to the confining layer where an effective wall would be based exceeds the potential depths of trench excavation. Implementation would be difficult.

Relative Cost - Slurry walls involve high capital cost.

Conclusion - Slurry walls will not be retained for further consideration due to difficulties with implementability.

6.1.4.2 Sheet Pile Barriers

Sheet pile barriers are constructed by driving or vibrating sections of steel sheet piling into the ground. Each sheet pile section is interlocked at its edges, and the seams are often grouted to prevent leakage.

Effectiveness - Sheet pile walls can be effective at providing hydraulic control. Upon the completion of remedial activities, the sheet piles can be vibrated out of the ground, disassembled, and removed from the site, provided that the structural integrity of the sheeting and joints are still good at the time of removal. Otherwise, the sheets would be cut off below ground surface, and the walls would continue to influence groundwater flow patterns on a localized scale. Sheet pile material may deteriorate overtime due to reaction with constituents in groundwater.

Implementability - Sheet pile walls are implementable, and construction materials and services are readily available. However, the depth to the confining layer exceeds the potential depths of trench excavation. Implementation would be difficult.

Relative Cost - Sheet pile walls involve high capital cost.

Conclusion - Sheet pile walls will not be retained for further consideration due to implementability difficulty.

6.1.5 Groundwater Extraction / Hydraulic Containment

Groundwater extraction involves placing extraction wells to intercept the flow of contaminated groundwater and hydraulically prevent contamination from migrating downgradient. This technology is also used for dewatering when it is necessary to lower the water table to facilitate installation/operation of other remedial technologies. The extracted groundwater is typically treated ex-situ and disposed of on site or off site.

6.1.5.1 Extraction Wells

This technology involves the installation of groundwater extraction wells within areas of contamination to provide hydraulic control and capture contaminants. The specific extraction well locations would be determined through groundwater modeling and/or pilot testing.

Effectiveness - Extraction wells are effective in providing hydraulic control and contaminant removal for sites where the hydrogeology is well understood and the pumping rate necessary to maintain hydraulic control is sustainable. The soils at the Site consist primarily of sand, gravel, and cobbles with an estimated groundwater flow rate of 1.5 ft/day and hydraulic conductivity of 250 ft/day. These conditions make extraction implementable. Furthermore, the shallow thickness of the contaminated aquifer in OU1 and the relative lack of lateral dispersion in the plume imply that a focused pumping regime could contain and extract the dissolved contamination.

Implementability - Extraction wells are implementable and the equipment and materials are readily available. However, the extracted groundwater may require treatment prior to discharge or re-injection to remove the site contaminants, as well as reduce concentrations of naturally occurring metals that could foul the system or exceed discharge requirements. Due to space constraints and discharge limitations, implementability would be reduced if large treatment vessels are required (i.e., high groundwater extraction flow rate).

Relative Cost - Installation of extraction wells involves moderate capital costs and O&M costs could be high if the extraction system needs to be operated for several decades.

Conclusion – Given the favorable hydrogeology, shallow thickness of the contaminated interval and relatively narrow plume, a groundwater extraction system would likely be effective at the Site. Groundwater extraction wells will be retained for further consideration.

6.1.6 In-Situ Treatment

In-situ treatment technologies either intercept and immobilize or degrade contaminants in the subsurface passively (for example: phytoremediation and permeable reactive barriers), or mobilize and/or destroy contaminants in the subsurface aggressively and significantly shorten the required remediation time (such as in situ chemical oxidation and in situ bioremediation). Many of the passive technologies require little maintenance but do not remove contamination rapidly. The active technologies significantly speed up the removal rate—including the residual free phase or adsorbed contaminants where pump-and-treat technology and other extraction technologies are less effective. In-situ treatment also reduces the possibility of contaminant exposure to the site worker. Several in-situ treatment technologies were identified as potentially applicable at the Site, and are discussed below.

6.1.6.1 Permeable Reactive Barriers

Permeable reactive barriers (PRBs) provide in situ treatment of groundwater and are designed to intercept contaminated groundwater flow. These reactive barriers differ from highly impermeable barriers, such as slurry walls, or sheet pilings, which restrict the movement of a groundwater plume. PRBs can be installed as permanent, semi-permanent, or replaceable units that transect the contaminant flux path and act as a treatment wall. They can be vertically oriented, such that the contaminant flux mobilized in the groundwater passes through the PRB, or horizontal, in cases where a geological layer such as clay is contaminated, and flux diffusing upward off the layer must be controlled. When the contaminated groundwater passes through the reactive zone of the barrier, the contaminants are either immobilized or chemically degraded to less harmful product(s).

Effectiveness -PRBs have been effective in degrading chlorinated solvents. Periodic reactivation of the PRB may be necessary to retain its effectiveness.

Implementability – Vertically oriented PRBs are installed downgradient, perpendicularly intersecting the contaminated groundwater flow. Installation via trenching is implementable at the OU1 due to the shallow depth of the contaminated zone.

Relative Cost - PRBs involves high capital and low O&M costs. However, the replacement cost could be as high as the capital cost.

Conclusion - PRBs will be retained for further consideration.

6.1.6.2 In-Situ Chemical Oxidation

In-situ chemical oxidation (ISCO) is an active approach that involves the injection into the subsurface of chemical oxidants that destroy organic contaminants in groundwater. Complete oxidation of contaminants results in their breakdown into innocuous compounds such as carbon dioxide, water, and chloride. A number of factors affect the performance of this technology, including effectiveness of oxidant delivery to the contaminated zone, oxidant type, dose of oxidant, contaminant type and concentration, and non-contaminant oxidant demand.

Commonly used oxidants include ozone, Fenton's Reagent, potassium permanganate, activated sodium persulfate, catalyzed percarbonate, etc. Permanganate can oxidize PCE, TCE, DCE and VC effectively, generating manganese dioxide precipitation in the subsurface, but will not be effective for 1,1,1-TCA. Fenton's Reagent, activated persulfate, and catalyzed percarbonate generate radicals to oxidize contaminants. Radicals can oxidize a wide variety of contaminants, but they are non-selective and have extremely short lifetimes. Therefore, effectively delivering the oxidants into the contaminant zones and ensuring that the radicals come into contact with contaminants is a challenge, especially considering the low concentrations found in OU1 groundwater.

Effectiveness - ISCO has been effectively used at multiple sites to destroy contaminant mass in the subsurface. Success depends on the ability to deliver oxidants to the contaminated zones, allowing direct contact of oxidants and contaminant for the reduction/oxidation chemical reaction to occur. Reactivity with dissolved contamination in the Upper Glacial Aquifer would be rapid. Other oxidizable substrates such as natural organics and reduced metals would also consume oxidants. To treat contamination effectively sufficient oxidants would need to be applied to meet these competing demands.

Implementability – ISCO would be implementable at the site.

Relative Cost - ISCO involves high capital and low O&M costs.

Conclusion - ISCO will not be retained for further consideration in OU1 because of the low concentrations of contaminants and high expected oxidant demand of the native soil.

6.1.6.3 In-Situ Air Sparging/Soil Vapor Extraction

In-situ air sparging (AS) is a technology in which air is injected into the groundwater for the purpose of removing organic contaminants by volatilization and stripping. As air moves up through the groundwater, VOCs partition into the gas phase and are transported to the vadose zone. Soil vapor extraction (SVE) is typically used in conjunction with air sparging to eliminate off-site migration of vapors. SVE uses vacuum (or vacuum and forced air together) to mobilize soil gas and remove volatilized organic contaminants in the vadose zone. The AS/SVE combined system would employ a number of AS wells, with SVE trenches, wells, or blankets placed among the AS wells to extract the sparge vapors. An off-gas treatment system using vapor phase carbon adsorption and permanganate may be necessary to limit the release of captured vapors to the atmosphere.

Effectiveness - AS/SVE has been shown to be effective in removing VOCs from groundwater. This process is dependent upon how well the injected air permeates into the groundwater from the injection point, and how well the SVE captures the vapors. The ability of the SVE to capture the contaminants forced into the unsaturated zone is an important component due to the potential risk of VOC migration into buildings located within the area of contaminated groundwater. The contaminated vadose zone and shallow groundwater in OU1 are more permeable zones where AS/SVE would be effective.

Implementability - Most components of AS/SVE are implementable.

Relative Cost - AS/SVE involves high capital and moderate O&M costs.

Conclusion - AS/SVE will be retained for further consideration in OU1

6.1.6.4 Enhanced Anaerobic Bioremediation

Enhanced Anaerobic Biodegradation (EAB) is a remedial technology designed to facilitate the in-situ biological destruction of chlorinated VOCs over a wide range of concentrations in groundwater. EAB involves the injection of an electron donor and potentially nutrients or dechlorinating microorganisms (i.e., bioaugmentation) into the contaminated groundwater zones. This combined delivery stimulates the natural growth and metabolism of microorganisms that detoxify chlorinated solvent contamination in an environment otherwise low in organic content.

Effectiveness - For most sites, biological dechlorination reactions are limited by (1) the availability of biodegradable organic carbon (i.e., electron donor) that serves as an energy and carbon source for indigenous microorganisms and/or (2) elevated concentrations of competing electron acceptors that inhibit the activity of the dechlorinating microbes. The addition of an electron donor as an energy and carbon source for indigenous microorganisms would stimulate the development of reduced groundwater environments that are conducive to dechlorination reactions (i.e., methanogenic conditions), and fuel the dechlorination process itself. For some sites, the extent of VOC dechlorination may be stalled at a biological intermediate such as DCE, VC, DCA, or chloroethane due to the absence of the indigenous microorganisms capable of reductively biodegrading all source and intermediate VOCs to non-toxic compounds. Under this scenario, active dechlorinating microorganisms may be amended to the subsurface through a process termed bioaugmentation. EAB can be effective in a heterogeneous subsurface environment because once produced, the dechlorination conditions and bacteria would persist for some time, and contaminants diffusing out of low permeable zones can be treated.

Implementability - Anaerobic conditions would need to be created in-situ using electron donor injections. The groundwater at the Site is aerobic and flows relatively quick, therefore a viscous amendment would be needed to withstand the high groundwater flow velocities.

Relative Cost - EAB involves moderate capital and O&M cost.

Conclusion - EAB will be retained for further consideration.

6.1.6.5 In-Situ Thermal Remediation

In-Situ Thermal Remediation (ISTR) applies heat to the subsurface in order to partition contaminants from the dissolved phase into the vapor phase. Subsurface temperatures above the boiling point of water are commonly achieved. The heated, vaporized contaminant mass will then rise upward in the aquifer and must be captured.

Effectiveness – Mass removal of 99% or more from the targeted saturated zone is common. ISTR is frequently applied under active structures and not affected by geologic variations. During the operation, it takes up to 4-5 weeks to heat the targeted zone. Once temperature is reached the process is easily maintained with little supervision. Based on previous case studies, mass partitioning from dissolved or sorbed phases to the vapor phase has been effective in as little as 60 days.

Implementability - Installation and operation are feasible. A soil vapor extraction system would be required to capture the vaporized contaminants rising from the heated groundwater into the vadose zone. An aboveground treatment system for the extracted vapor would be needed.

Relative Cost - ISTR involves very high capital and O&M cost.

Conclusion –ISTR will be retained for further consideration due to its effectiveness at removing contamination.

6.1.7 Discharge

Any groundwater extracted from the subsurface will need to be discharged on-site or off-site. Potential on-site and off-site discharge options for groundwater are evaluated below.

6.1.7.1 On-site Handling

There are multiple options for handling treated groundwater on-site: recharge basin, injection wells, leaching basin, or infiltration gallery.

Effectiveness - The effectiveness of this option would rely on suitable percolation rates into the aquifer. Proper design and construction is important, including adequate pipe sizing, proper placement of the wells, and reliable construction materials. Furthermore, the precipitation of metal oxides formed from naturally occurring metals in the groundwater could foul a system.

Implementability - To discharge treated effluent to a series of injection wells would be implementable, given that standard construction methods and materials would be utilized. Discharging treated water into the aquifer may cause spreading of contamination.

Relative Cost - This technology involves moderate capital and high O&M costs.

Conclusion - This technology will be retained for further consideration

6.1.7.2 Off-site Handling

Assuming the pumped groundwater could be piped to an appropriate off-site location, the same on-site technology described above could be installed on an off-site property as well. Additionally, it may be possible to discharge water to the publically owned treatment works (POTW) that handles municipal wastewater.

Effectiveness - The effectiveness of this option would rely on suitable percolation rates into the aquifer. Proper design and construction is important, including adequate pipe sizing, proper placement of the wells, and reliable construction materials. Furthermore, the precipitation of metal oxides formed from naturally occurring metals in the groundwater could foul a system.

Implementability - To discharge treated effluent to a series of injection wells would be implementable, given that standard construction methods and materials would be utilized. Discharging treated water into the aquifer may cause spreading of contamination. Discharge to a POTW would require the agreement of the POTW management, as well as a conveyance system that could handle the expected flow rates from the pumping.

Relative Cost - This technology involves moderate capital and high O&M costs.

Conclusion - This technology will be retained for further consideration.

6.2 Remedial Technologies for Operable Unit 2

6.2.1 No Action

The No Action alternative is not a technology. The No Action alternative is considered as a basis for comparison.

Effectiveness - The No Action alternative is used as a baseline against which other technologies may be compared. It generally does not provide measures that would comply with SCGs, or otherwise meet RAOs. In addition, it would not be protective of human health and the environment.

Implementability - The No Action alternative is implementable given there is no action required.

Relative Cost - The No Action alternative involves no capital or O&M costs.

Conclusion – The No Action alternative is retained for further consideration.

6.2.2 Institutional Controls

Institutional Controls do not reduce the toxicity, mobility, or volume of contamination, but can be implemented to reduce the probability of exposure to contaminants. Institutional controls consist of administrative actions which control use of the site (e.g., restrictions on the use of groundwater) to reduce direct human contact of contaminated water. Institutional controls generally require long term monitoring of contaminant concentrations. Typical institutional controls are discussed below.

6.2.2.1 Environmental Easements

Environmental easements are regulatory actions that are used to prevent certain types of uses for properties where exposure pathways to contaminants may be created as a result of those uses. Environmental easements may be used to prevent intrusive activities within the contamination plume.

Effectiveness - Environmental easements could effectively restrict or eliminate use of contaminated groundwater, thereby reducing risks to human health. Environmental easements would not reduce the migration and the associated environmental impact of the contaminated groundwater.

Implementability - Environmental easements are easily implementable through the existing administrative system.

Relative Cost - The cost to implement environmental easements is low. Some administrative, long-term monitoring and periodic assessment cost would be required.

Conclusion – Environmental easements will be retained for further consideration.

6.2.2.2 Restrictions on the Use of Groundwater

Groundwater use restrictions are regulatory actions that are used to regulate installation of groundwater drinking water wells and other uses of groundwater.

Effectiveness - Groundwater use restrictions would reduce the potential for human exposure pathways to contaminated groundwater. Groundwater use restrictions will not reduce the migration and the associated environmental impact of the contaminated groundwater.

Implementability - Implementation would be easy via the existing permitting process. Groundwater use restrictions may also be implemented, in addition to remediation activities, as a protective measure to prevent future exposure to contaminants during remediation.

Relative Cost - The cost to implement groundwater use restrictions is low.

Conclusion - Groundwater use restrictions will be retained for further consideration.

6.2.2.3 Long-term Monitoring

Long-term monitoring includes periodic sampling and analysis of groundwater samples. This program would provide an indication of the movement of the contaminants and/or of the progress of remedial activities, including monitored natural attenuation.

Effectiveness - Long-term monitoring alone would not be effective in meeting the RAOs. It would not alter the effects of the contamination on human health and the environment. Monitoring is a proven and reliable process for tracking the migration of contaminants during and following treatment.

Implementability - Long-term monitoring could be easily implemented. All monitoring wells are easily accessible for sample collection. Equipment, material, and sampling procedures are readily available.

Relative Cost - Long-term monitoring involves low capital and moderate O&M cost.

Conclusion - Long-term monitoring will be retained for further consideration.

6.2.3 Monitored Natural Attenuation

Monitored natural attenuation (MNA) refers to the remedial action that relies on naturally occurring attenuation processes to achieve site-specific RAOs within a reasonable time frame. Monitoring groundwater quality over time is necessary to demonstrate that the expected attenuation processes are actually occurring. Natural attenuation processes that reduce contaminant concentrations in groundwater include destructive (biodegradation and chemical reactions with other subsurface constituents) and non-destructive mechanisms (dilution, dispersion, volatilization, and adsorption).

Biodegradation is typically the most significant destructive attenuation mechanism. The chlorinated solvents PCE, TCE and 1,1,1-TCA attenuate predominantly by reductive dechlorination under anaerobic conditions. Breakdown products cis-1,2-DCE, VC, and ethane attenuate under both anaerobic and aerobic conditions. The primary anaerobic reductive dechlorination pathway for PCE to ethene is given below:

$$\text{PCE} \rightarrow \text{TCE} \rightarrow \text{cis-1,2-DCE} \rightarrow \text{VC} \rightarrow \text{Ethene}$$

The primary anaerobic reductive dechlorination pathway for 1,1,1-TCA to ethane is given below:

$$\text{1,1,1-TCA} \rightarrow \text{1,1-DCA} \rightarrow \text{Chloroethane} \rightarrow \text{Ethane}$$

Reductive dechlorination is a process requiring an adequate supply of electron donors (the chlorinated solvent molecule is the electron acceptor). The existence of other electron acceptors—oxygen, nitrate/nitrite, ferric iron, or sulfate—can compete with the chlorinated solvent molecule as the preferred electron acceptor and inhibit or limit the dechlorination process. The highest reductive dechlorination rates for PCE, TCE, and 1,1,1-TCA have been observed under anaerobic, highly reducing conditions associated with methanogenic reactions. By analyzing biogeochemistry data, including distribution of electron acceptors (e.g. nitrate/nitrite, ferric iron, and sulfate concentrations), metabolic by-products, and the contaminant distribution and time trends, it is possible to determine whether active biotransformation of the chlorinated solvents is occurring.

Effectiveness - MNA is an effective remediation approach for sites where natural mechanisms can be demonstrated to minimize or prevent the further migration of elevated contaminant concentrations. Based on the review of the RI monitoring well data, it appears that anaerobic reductive dechlorination of VOCs is not occurring at sufficient levels in the groundwater. The concentration of PCE remains high whereas concentrations of degradation products TCE, cis-1,2 DCE and VC are very low or non-detect. Site groundwater is under aerobic conditions. There is also no evidence of depletion of electron acceptors.

Implementability - Natural attenuation is considered to be easily implementable. Materials and services necessary to model and monitor the contaminant dynamics are readily available. Site restrictions and/or institutional controls may be required as long-term control measures as part of the MNA alternative.

Relative Cost - Modeling and monitoring for MNA involves low capital cost and moderate O&M cost.

Conclusion – Due to lack of evidence of destructive natural attenuation processes at the Site, MNA will not be included for further consideration to reduce PCE, TCE, and 1,1,1-TCA. However, it will be retained for the natural attenuation of further breakdown products.

6.2.4 Containment

Low-permeability vertical barrier walls could be installed downgradient of source areas or plumes to control contaminant migration. The walls would be constructed using slurry or sheet piling to the top of a low permeability layer. Barrier walls would only be effective in areas of the Site where a high water table and shallow depth of the aquifer and confining clay unit are found. Within these areas, both types of barrier walls (i.e., slurry or sheet pile) would be effective for redirecting contaminated groundwater flow. Barrier walls can be used in combination with a groundwater extraction system; the walls would minimize the amount of pumping required to maintain hydraulic control by acting as a physical barrier, restricting clean groundwater inflow from side-gradient areas into the capture zone.

6.2.4.1 Slurry Walls

Slurry walls are constructed by pumping a low-permeability slurry, typically consisting of either a soil-bentonite or cement-bentonite mixture, into an excavated trench. Excavation can be completed using a long-arm excavator and a clam shovel to meet the required depth. The slurry would be pumped into the hole during the course of excavation to keep the sidewalls from collapsing.

Effectiveness - Slurry walls would effectively achieve hydraulic control if properly built. Upon the completion of remedial activities, the walls would remain in place and continue to influence groundwater flow patterns on a localized scale.

Implementability - Slurry walls are implementable in general, and the construction materials and services are readily available. However, the 90′ depth to the contaminated zone and thickness of the contaminated aquifer in OU2 exceed the potential depths of trench excavation. Implementation would be difficult.

Relative Cost - Slurry walls involve high capital cost.

Conclusion - Slurry walls will not be retained for further consideration due to difficulties with implementability.

6.2.4.2 Sheet Pile Barriers

Sheet pile barriers are constructed by driving or vibrating sections of steel sheet piling into the ground. Each sheet pile section is interlocked at its edges, and the seams are often grouted to prevent leakage.

Effectiveness - Sheet pile walls can be effective at providing hydraulic control. Upon the completion of remedial activities, the sheet piles can be vibrated out of the ground, disassembled, and removed from the site, provided that the sheeting and joints are still of good structural integrity at the time of removal. Otherwise, the sheets would be cut off below ground surface, and the walls would continue to influence groundwater flow patterns on a localized scale. Sheet pile material may deteriorate overtime due to reaction with constituents in groundwater.

Implementability - Sheet pile walls are implementable, and construction materials and services are readily available. However, the 90′ depth to the contaminated zone and thickness of the contaminated aquifer in OU2 exceed the potential installation depths of sheet piling. Implementation would be difficult.

Relative Cost - Sheet pile walls involve high capital cost.

Conclusion - Sheet pile walls will not be retained for further consideration due to implementability difficulty.

6.2.5 Groundwater Extraction / Hydraulic Containment

Groundwater extraction involves placing extraction wells to intercept the flow of contaminated groundwater and hydraulically prevent contamination from migrating downgradient. This technology is also used for dewatering when it is necessary to lower the water table to facilitate installation/operation of other remedial technologies. The extracted groundwater is typically treated ex-situ and disposed of on site or off site.

6.2.5.1 Extraction Wells

This technology involves the installation of groundwater extraction wells within areas of contamination to provide hydraulic control and capture contaminants. The specific extraction well locations would be determined through groundwater modeling and/or pilot testing.

Effectiveness - Extraction wells are effective in providing hydraulic control and contaminant removal for sites where the hydrogeology is well understood and the pumping rate necessary to maintain hydraulic control is sustainable. The soils at the Site consist primarily of sand, gravel, and cobbles with an estimated groundwater flow rate of 1.5 ft/day and hydraulic conductivity of 250 ft/day. These conditions make extraction implementable. Furthermore, the clay aquitard and relative lack of lateral dispersion in the plume imply that a focused pumping regime could contain and extract the dissolved contamination.

Implementability - Extraction wells are implementable, and the equipment and materials are readily available. However, the extracted groundwater may require treatment prior to discharge or re-injection to remove the site contaminants, as well as reduce concentrations of naturally occurring metals that could foul the system or exceed discharge requirements. Due to space constraints, implementability would be reduced if large treatment vessels are required (i.e., high groundwater extraction flow rate).

Relative Cost - Installation of extraction wells involves moderate capital costs and O&M costs could be high if the extraction system needs to be operated for several decades.

Conclusion – Given the favorable hydrogeology, presence of the clay aquitard, and relatively narrow plume, a groundwater extraction system would likely be effective in OU2. Groundwater extraction wells will be retained for further consideration.

6.2.6 In-Situ Treatment

In-situ treatment technologies either intercept and immobilize or degrade contaminants in the subsurface passively (for example: phytoremediation and permeable reactive barriers), or mobilize and/or destroy contaminants in the subsurface aggressively and significantly shorten the required remediation time (such as in situ chemical oxidation and in situ bioremediation). Many of the passive technologies require little maintenance but do not remove contamination rapidly. The active technologies significantly speed up the removal rate—including the residual free phase or adsorbed contaminants where pump-and-treat technology and other extraction technologies are less effective. In situ treatment also reduces the possibility of exposure of contaminants to the site worker. Several in situ treatment technologies were identified as potentially applicable at the Site, and are discussed below.

6.2.6.1 Permeable Reactive Barriers

Permeable reactive barriers (PRBs) provide in-situ treatment of groundwater and are designed to intercept contaminated groundwater flow. These reactive barriers differ from highly impermeable barriers, such as slurry walls, or sheet pilings, which restrict the movement of a groundwater plume. PRBs can be installed as permanent, semi-permanent, or replaceable units which transect the contaminant flux path and act as a treatment wall. They can be vertically oriented, such that the contaminant flux mobilized in the groundwater passes through the PRB, or horizontal, in cases where a geological layer such as clay is contaminated, and flux diffusing upward off the layer must be controlled. When the contaminated groundwater passes through the reactive zone of the barrier, the contaminants are either immobilized or chemically degraded to less harmful product(s).

Effectiveness -PRBs have been effective in degrading chlorinated solvents. Periodic reactivation of the PRB may be necessary to retain its effectiveness.

Implementability – Vertically oriented PRBs are installed downgradient, perpendicularly intersecting the contaminated groundwater flow. Installation via trenching is not implementable at the Site due to the depth of the contaminated zone in OU2. Installation of a horizontally oriented PRB on top of the clay via well injection would be implementable.

Relative Cost - PRBs involves high capital and low O&M costs. The replacement cost could be as high as the capital cost.

Conclusion - PRBs will be retained for further consideration.

6.2.6.2 In-Situ Chemical Oxidation

In-situ chemical oxidation (ISCO) is an active approach that involves the injection into the subsurface of chemical oxidants that destroy organic contaminants in groundwater. Complete oxidation of contaminants results in their breakdown into innocuous compounds such as carbon dioxide, water, and chloride. A number of factors affect the performance of this technology, including effectiveness of oxidant delivery to the contaminated zone, oxidant type, dose of oxidant, contaminant type and concentration, and non-contaminant oxidant demand.

Commonly used oxidants include ozone, Fenton's Reagent, potassium permanganate, activated sodium persulfate, catalyzed percarbonate, etc. Permanganate can oxidize PCE, TCE, DCE and VC effectively, generating manganese dioxide precipitation in the subsurface, but will not be effective for 1,1,1-TCA. Fenton's Reagent, activated persulfate, and catalyzed percarbonate generate radicals to oxidize contaminants. Radicals can oxidize a wide variety of contaminants, but they are non-selective and have extremely short lifetimes. Therefore, effectively delivering the oxidants into the contaminant zones and ensuring that the radicals come into contact with contaminants is a challenge.

<u>*Effectiveness*</u> - ISCO has been effectively used at multiple sites to destroy contaminant mass in the subsurface. Success depends on the ability to deliver oxidants to the contaminated zones, allowing direct contact of oxidants and contaminant for the reduction/oxidation chemical reaction to occur. Reactivity with dissolved contamination in the Upper Glacial Aquifer would be rapid. It would likely be difficult, however, to deliver oxidants to the contamination in the low permeable zones, such as the clay and any overlying silt. The clay would need to be fractured first in order to inject oxidant into it. Poor application can result in large pockets of untreated contaminants, and other oxidizable substrates such as natural organics and reduced metals would also consume oxidants. To treat contamination effectively sufficient oxidants would need to be applied to meet these competing demands, but there is still the potential that ISCO would not reduce groundwater concentrations to less than the PRGs.

<u>*Implementability*</u> – ISCO would be implementable in OU2. Fracturing technology would be needed to introduce oxidants directly into the contaminated clay layer.

<u>*Relative Cost*</u> - ISCO involves high capital and low O&M costs.

<u>*Conclusion*</u> - ISCO will be retained for further consideration for treatment of the high concentrations in the clay.

6.2.6.3 In-Situ Air Sparging/Soil Vapor Extraction

In-situ air sparging (AS) is a technology in which air is injected into the groundwater for the purpose of removing organic contaminants by volatilization and stripping. As air moves up through the groundwater, VOCs partition into the gas phase and are transported to the vadose zone. Soil vapor extraction (SVE) is typically used in conjunction with air sparging to eliminate off-site migration of vapors. SVE uses vacuum (or vacuum and forced air together) to mobilize soil gas and remove volatilized organic contaminants in the vadose zone. The AS/SVE combined system would employ a number of AS wells, with SVE trenches, wells, or blankets placed among the AS wells to extract the sparge vapors. An off-gas treatment system using vapor phase carbon adsorption and permanganate may be necessary to limit the release of captured vapors to the atmosphere.

Effectiveness - AS/SVE has been shown to be effective in removing VOCs from groundwater. This process is dependent upon how well the injected air permeates into the groundwater from the injection point, and how well the SVE captures the vapors. The ability of the SVE to capture the contaminants forced into the unsaturated zone is an important component due to the potential risk of VOC migration into buildings located within the area of contaminated groundwater. An air sparge system would not be effective at treating the contamination sorbed to the clay layer in OU2 since the low permeability of this matrix would inhibit the distribution of air.

Implementability - Most components of AS/SVE are implementable. Due to the depth of contamination, an extensive SVE system would likely be required due to horizontal migration of vapors rising to the surface.

Relative Cost - AS/SVE involves high capital and moderate O&M costs.

Conclusion - AS/SVE will not be retained for further consideration in OU2 given the low permeability of the impacted clay layer and the vertical distance between the contaminated clay layer and the vadose zone, where the soil vapor extraction system would be installed.

6.2.6.4 Enhanced Anaerobic Bioremediation

Enhanced Anaerobic Biodegradation (EAB) is a remedial technology designed to facilitate the in situ biological destruction of chlorinated VOCs over a wide range of concentrations in groundwater. EAB involves the injection of an electron donor and potentially nutrients or dechlorinating microorganisms (i.e., bioaugmentation) into the contaminated groundwater zones. This combined delivery stimulates the natural growth and metabolism of microorganisms that detoxify chlorinated solvent contamination in an environment otherwise low in organic content.

Effectiveness - For most sites, biological dechlorination reactions are limited by (1) the availability of biodegradable organic carbon (i.e., electron donor) that serves as an energy and carbon source for indigenous microorganisms and/or (2) elevated concentrations of competing electron acceptors that inhibit the activity of the dechlorinating microbes. The addition of an electron donor as an energy and carbon source for indigenous microorganisms would stimulate the development of reduced groundwater environments that are conducive to dechlorination reactions (i.e., methanogenic conditions), and fuel the dechlorination process itself. For some sites, the extent of VOC dechlorination may be stalled at a biological intermediate such as

DCE, VC, DCA, or chloroethane due to the absence of the indigenous microorganisms capable of reductively biodegrading all source and intermediate VOCs to non-toxic compounds. Under this scenario, active dechlorinating microorganisms may be amended to the subsurface through a process termed bioaugmentation. EAB can be effective in a heterogeneous subsurface environment because once produced, the dechlorination conditions and bacteria would persist for some time, and contaminants diffusing out of low permeable zones can be treated.

Implementability - Anaerobic conditions would need to be created in-situ using electron donor injections. The groundwater in OU2 is aerobic and flows relatively rapidly, therefore a viscous amendment would be needed to withstand the high groundwater flow velocities.

Relative Cost - EAB involves moderate capital and O&M cost.

Conclusion - EAB will be retained for further consideration in OU2.

6.2.6.5 In-Situ Thermal Remediation

In-Situ Thermal Remediation (ISTR) applies heat to the subsurface in order to partition contaminants from the dissolved phase into the vapor phase. Subsurface temperatures above the boiling point of water are commonly achieved. The heated, vaporized contaminant mass will then rise upward in the aquifer and must be captured.

Effectiveness – Mass removal of 99% or more from the targeted saturated zone is common. ISTR is frequently applied under active structures and not affected by geologic variations. During the operation, it takes up to 4-5 weeks to heat the targeted zone. Once temperature is reached the process is easily maintained with little supervision. Based on previous case studies, mass partitioning from dissolved or sorbed phases to the vapor phase has been effective in as little as 60 days.

Implementability - Installation and operation are feasible. However, the depth and dispersed nature of the contamination would require an extensive system. Given the depth of the targeted treatment zone (>70ft bgs) and the groundwater flow rate in OU2, the fate of the vapor rising from the heated clay would need to be carefully evaluated, and a system to capture the contaminant mass would need to be implemented. This system could comprise groundwater extraction wells directly adjacent to the heated contaminant source zone. An aboveground treatment system for the extracted groundwater would be needed, in addition to a feasible discharge or disposal option.

Relative Cost - ISTR involves very high capital and O&M cost.

Conclusion –ISTR will be retained for further consideration due to its effectiveness at removing sorbed contamination from clay.

6.2.7 Discharge

Any groundwater extracted from the subsurface will need to be discharged on-site or off-site. Potential on-site and off-site discharge options for groundwater are evaluated below.

6.2.7.1 On-site Handling

There are multiple options for handling treated groundwater on-site: recharge basin, injection wells, leaching basin, or infiltration gallery.

Effectiveness - The effectiveness of this option would rely on suitable percolation rates into the aquifer. Proper design and construction is important, including adequate pipe sizing, proper placement of the wells, and reliable construction materials. Furthermore, the precipitation of metal oxides formed from naturally occurring metals in the groundwater could foul a system.

Implementability - To discharge treated effluent to a series of injection wells would be easily and readily implementable, given that standard construction methods and materials would be utilized. Discharging treated water into the aquifer may cause spreading of contamination.

Relative Cost - This technology involves moderate capital and high O&M costs.

Conclusion - This technology will be retained for further consideration

6.2.7.2 Off-site Handling

Assuming the pumped groundwater could be piped to an appropriate off-site location, the same on-site technology described above could be installed on an off-site property as well. Additionally, it may be possible to discharge water to the publically owned treatment works (POTW) that handles municipal wastewater.

Effectiveness - The effectiveness of this option is based on the volume of water extracted and would rely on suitable percolation rates into the aquifer for reinjection. Proper design and construction is important, including adequate pipe sizing, proper placement of the wells, and reliable construction materials. Furthermore, the precipitation of metal oxides formed from naturally occurring metals in the groundwater could foul a system.

Implementability - To discharge treated effluent to a series of injection wells would be easily and readily implementable, given that standard construction methods and materials would be utilized. Discharging treated water into the aquifer may cause spreading of contamination. Discharge to a POTW would require the agreement of the POTW management, as well as a conveyance system that could handle the expected flow rates from the pumping.

Relative Cost - This technology involves moderate capital and high O&M costs.

Conclusion - This technology will be retained for further consideration.

6.3 Summary of Remedial Technology Screening

6.3.1 Operable Unit 1

Remedial alternatives for OU1 are described briefly in Table 6-1. The retained technologies and process options include the following:

- No Action;
- Institutional/Engineering Control: environmental easements, groundwater use restrictions, long term monitoring;
- Monitored Natural Attenuation;
- Groundwater extraction and treatment;
- Permeable reactive barriers;
- Enhanced anaerobic bioremediation;
- Air sparge/soil vapor extraction;
- In-situ Thermal Remediation.

6.3.2 Operable Unit 2

Remedial technologies for OU2 are described briefly in Table 6-2. The retained technologies and process options include the following:

- No Action;
- Institutional/Engineering Control: environmental easements, groundwater use restrictions, long term monitoring;
- Monitored Natural Attenuation;
- Groundwater extraction and treatment;
- Permeable reactive barriers;
- In-situ chemical oxidation;
- Enhanced anaerobic bioremediation;

- Air sparge/soil vapor extraction;
- In-situ Thermal Remediation.

Section 7

Development and Analysis of Remedial Alternatives

Representative remedial technologies and process options that have been retained during the screening in Section 6 were used to develop the remedial action alternatives described in this section.

7.1 Evaluation Criteria for Detailed Screening of Technologies

The technology screening approach is based upon the procedures outlined in "*DER-10 Technical Guidance for Site Investigation and Remediation*" (NYSDEC 2010). These criteria are classified into the following three groups and are described below:

Threshold Criteria: Threshold criteria are requirements that each alternative must meet in order to be considered for selection.

- **Overall Protection of Human Health and the Environment**. This criterion is an evaluation of the remedy's ability to protect public health and the environment, assessing how risks posed through each existing or potential pathway of exposure are eliminated, reduced or controlled through removal, treatment, engineering controls or institutional controls. The remedy's ability to achieve each of the RAOs is evaluated.

- **Compliance with New York State Standards, Criteria, and Guidance (SCGs)**. Compliance with SCGs addresses whether a remedy will meet environmental laws, regulations, and other standards and criteria. In addition, this criterion includes the consideration of guidance which the Department has determined to be applicable on a case-specific basis.

Primary Balancing Criteria: These criteria are used to distinguish the relative effectiveness of each alternative so that decision makers compare the positive and negative aspects of each of the remedial strategies.

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

- **Reduction of Toxicity, Mobility or Volume**. Preference is given to alternatives that permanently and significantly reduce the toxicity, mobility or volume of the wastes at the Site.

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

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

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

Modifying Criterion: This criterion is taken into account after evaluating those above. It is evaluated after public comments on the FS and Proposed Remedial Action Plan (PRAP) have been received. This criterion is not evaluated in this FS.

- **Community Acceptance**. Concerns of the community regarding the RI/FS reports and the PRAP are evaluated. A responsiveness summary will be prepared that describes public comments received and the manner in which the Department will address the concerns raised. If the selected remedy differs significantly from the proposed remedy, notices to the public will be issued describing the differences and reasons for the changes.

Note that “Land Use” is not an applicable criterion since the remedial goal is unrestricted use.

7.2 Development and Detailed Analysis of Remedial Action Alternatives

Remedial action alternatives have been developed based on the potential for these alternatives to meet the SCGs, RAOs, and PRGs described in Section 4. In Section 6, a preliminary screening of available remedial action technologies was performed for each Operable Unit. The technologies and processes retained are used to develop remedial action alternatives in this Section.

In order to meet site-wide PRGs, alternatives were developed and are presented below for two Operable Units (Figure 7-1):

1. Operable Unit 1 contains the vadose zone containing total VOC's greater than 1,000 ppb near 78 Lamar St., and the shallow groundwater contamination underlying the vadose zone contamination.

2. Operable Unit 2 contains the impacted section of the clay layer and groundwater directly above the clay layer.

The following three alternatives were developed for OU1, the vadose zone and shallow groundwater:

- Alternative OU1-1 – No Action
- Alternative OU1-2 - Institutional Controls
- Alternative OU1-3 – Air Sparge / Soil Vapor Extraction

For OU2, Site data indicate that VOCs have sorbed to low-permeability stiff clay underlying the Upper Glacial Aquifer. The clay is acting as a reservoir of contamination that diffusing into the deeper sections of the Upper Glacial Aquifer, creating groundwater concentrations greater than PRGs. Given sufficient time, it is not unreasonable to suspect that the VOCs will eventually migrate through the clay and impact the Magothy Aquifer.

Five alternatives were developed for OU2, the deep groundwater and impacted section of the clay layer. These alternatives were developed and costed to meet the OU2 remediation goal of source removal. As such, they are intended to remediate the majority of the remaining contaminant mass in the deep groundwater and clay layer at the Site. The alternatives are:

- Alternative OU2-1 – No Action
- Alternative OU2-2 - Institutional Controls
- Alternative OU2-3 – In-situ thermal remediation of the impacted clay layer
- Alternative OU2-4 – In-situ treatment of the impacted clay layer by fracturing and application of amendments
- Alternative OU2-5 – Enhanced anaerobic bioremediation applied as a permeable reactive barrier over the impacted clay layer

For each of these OU2 alternatives, a pre-design investigation of the clay layer will be necessary. The investigation will seek to determine both the horizontal and vertical extent of contamination in the clay layer.

7.2.1 Operable Unit 1

The technologies and process options retained after the screening step were combined into three alternatives designed to satisfy the RAOs presented in Section 4 for the OU1 vadose zone and shallow groundwater. The No Action alternative was retained in accordance with the NCP to serve as a baseline for comparison with the other alternatives for the Site.

7.2.1.1 Alternative OU1-1 – No Action

This alternative applies to the three impacted zones of the Site. The No Action alternative was retained for comparison purposes as required by the NCP. No remedial actions would be implemented as part of the No Action alternative. Groundwater would continue to migrate and the contamination would continue to attenuate through dilution, dispersion, limited biodegradation (although on-site data do not indicate biodegradation, this may not be true off-site), etc. This alternative does not include institutional controls or long-term groundwater monitoring.

Overall Protection of Human Health and the Environment
The No Action alternative does not provide overall protection of human health and the environment and does not meet the RAOs. Currently, contaminated groundwater is not used as drinking water. However, this alternative does not prevent future use of contaminated groundwater, which poses potential human risks above EPA threshold values through direct contact, ingestion, and inhalation. Because no remedial action would be implemented under this alternative, no means would be available to prevent current and future exposure.

Compliance with SCGs
Due to the presence of chlorinated VOCs above the groundwater quality standards and drinking water standards, this alternative would not comply with the chemical-specific SCGs for groundwater for a sustained period. As this alternative involves no action, location- and action-specific SCGs are not applicable.

Long-term Effectiveness and Permanence
The No Action alternative is not considered a permanent remedy. The contaminants would not be destroyed, yet concentrations would be reduced only gradually through natural dispersion and dilution. This alternative, however, would not provide adequate control of risks to human health or the environment because there are no mechanisms to prevent current and future exposure. Under this alternative there would be no mechanism in place to prevent future risk to human health; therefore, this alternative would not be considered effective in the long term.

Reduction of Toxicity, Mobility or Volume through Treatment
The implementation of this alternative would not affect the toxicity, mobility, or volume of the contamination.

Short-term Effectiveness
This alternative would not include a remedial action. Therefore, it would have no short-term impact to workers or the community. There would be no adverse environmental impacts to habitats or vegetation.

Implementability
This alternative is easily implemented, since no services or permits would be required.

Cost
There would be no cost under this alternative.

7.2.1.2 Alternative OU1-2 – Institutional Controls

Institutional controls such as environmental easements, site management plans, groundwater use restrictions, and long-term monitoring were retained in Section 6 as screened alternatives. These alternatives together would be instituted to impose restrictions in the subsurface zones.

An initial comparison of historical and current data (see Sections 1 through 3 of this report) indicate that the total VOCs plume may not be growing, and that the high groundwater flow velocity at the Site is controlling plume size by dilution and dispersion. If these mechanisms are in fact controlling plume size, Institutional Controls could potentially meet the RAOs at the Site. The length of time to achieve remedial objectives will depend on the groundwater flow velocity, as well as the amount of contaminant mass in the vadose zone and the rate of mass transfer from the vadose zone into the shallow groundwater. It is important to acknowledge that the data collected thus far do not allow for a statistically significant determination of plume shrinkage (a minimum of eight sampling rounds would be recommended for plume stability analysis).

For cost comparison purposes, it is assumed that long-term monitoring would be performed for the 20-year FS evaluation period, quarterly for the first five years and annually after that. A review of site conditions would be conducted every five years using data obtained from a long-term monitoring program. The periodic review report (PRR) would include an evaluation of the extent of contamination and an assessment of contaminant migration and attenuation over time. The five-year review would determine if monitoring should be discontinued. The monitoring program would be modified as needed based on the monitoring results.

Overall Protection of Human Health and the Environment
Alternative OU1-2 would only meet the RAOs if it could be proved that the plume is shrinking due to dilution and dispersion. This alternative would not minimize the migration of contaminants and would not protect the environment since there are no active removal mechanisms to restore the groundwater quality. This alternative may provide partial protection from exposure due to intrusive or drilling activities into

groundwater but would not protect human health from contaminant migration into buildings due to vertical vapor migration. The estimated duration of a monitoring program would be 20 years, revised as deemed appropriate from the periodic review of the monitoring program data and results.

Compliance with SCGs
This alternative would only meet the chemical-specific SCGs if it could be proved that the plume is shrinking due to dilution and dispersion. This is unlikely within the next 20 years. This alternative does not involve any subsurface intrusion, operation, or treatment. Location-specific SCGs do not apply. Groundwater monitoring would comply with action-specific SCGs.

Long-term Effectiveness and Permanence
This alternative would not provide long-term effectiveness since contamination is migrating off-site. This alternative would not provide permanence since no active remedy would be implemented. While the concentration of contaminants may reduce over time, the overall mass would not be reduced in the near future since degradation has not been observed.

Reduction of Toxicity, Mobility or Volume through Treatment
This alternative would not reduce the toxicity, mobility, or volume of the Site contamination since natural processes such as biodegradation are unlikely to be neither active nor sufficient to reduce contaminant toxicity, mobility, or volume.

Short-term Effectiveness
This alternative would include some site work and would cause minimal and short-term impacts to the workers and surrounding communities. Use of personal protective equipment (PPE) by workers during groundwater sampling would minimize contaminant exposure.

Implementability
Institutional controls could be easily implemented.

Cost
The total present worth cost for alternative OU1-2 is approximately $480,000. Capital costs associated with this alternative are $42,800; the monitoring cost is $16,000 per event for 20 years. Detailed cost estimates are presented in Appendix B.

7.2.1.3 Alternative OU1-3 – Air Sparge and Soil Vapor Extraction

This alternative is designed to simultaneously treat contaminants in the vadose zone and the shallow groundwater zone.

An AS/SVE system would be installed on the southern portion of the Site. Air would be injected (sparged) into the contaminated groundwater in order to remove contaminants through volatilization and stripping. The resulting contaminant vapors would be collected through a system of soil vapor extraction wells screened in the subsurface. These vapor extraction wells would capture not only the vapor rising from the sparged groundwater, but also serve to draw air through the contaminated vadose zone, stripping the contaminants from the soil. The extracted vapor would then be treated with activated carbon to remove the contaminants in the vapor stream prior to release of the vapor to the atmosphere.

The AS/SVE system would consist of the following components:

- Air sparge wells – Sparge wells would be placed in the treatment area, with screens at or below the desired treatment depth. Based on a typical result for air sparging in sandy soil, a 10-foot radius of influence was estimated. 40 sparge points would be required to treat the shallow groundwater contamination.

- Air compressor – The compressor would provide pressurized air to the sparge wells.

- Vapor Extraction Wells – 12 vapor extraction wells would be spaced in the treatment zone to capture vapor. The wells would be screened in the vadose zone, and the filter pack would be covered with a seal (e.g., clay, bentonite, plastic) to prevent short-circuiting to the atmosphere. A 20 foot radius of influence has been used for costing purposes.

- SVE system – The system would include a blower for inducing a vacuum on the extraction trenches, a knockout tank for collection of soil vapor condensate, and activated carbon treatment units required to treat extracted vapor and condensed water.

- Trenching - Trenches would be required to connect the system infrastructure.

A pre-design investigation would be performed to obtain the site-specific design parameters. The above estimates are for cost estimating purposes. The design will change based on the results of the ROI test.

Operation and maintenance would be performed weekly to monitor the system performance. Subsequent monitoring frequency would be determined based on system performance. Institutional controls and long-term groundwater monitoring program would be implemented as described under Alternative OU1-2. The Site reviews would include an evaluation of the extent of contamination and effectiveness of treatment. If contamination remains, the Site PRR would also include an assessment of contaminant migration and attenuation over time. The total duration of this alternative is estimated to be 5 years based on the travel time of contaminants at the Site.

Overall Protection of Human Health and the Environment

This alternative would provide protection of human health and the environment. AS/SVE would remove and/or destroy the contaminants within the treatment zone permanently; the remaining very low contaminant concentrations are expected to be reduced through natural processes such as dilution and dispersion. This alternative would meet the RAOs. Institutional controls would eliminate the exposure pathway for contaminated groundwater to local receptors before the RAOs and the PRGs are achieved. In addition, the SVE portion of the remedy would prevent migration of contaminated vapor to the sub-slab area, where pathways to human receptors exist.

Compliance with SCGs

This alternative would achieve chemical-specific SCGs. The contaminant concentrations would be reduced actively through the AS system within the groundwater treatment area and the SVE system would reduce soil contaminant concentrations actively in the vadose zone.

Long-term Effectiveness and Permanence

The alternative provides an effective, permanent remedy for the targeted OU. AS/SVE would provide treatment of contaminated shallow groundwater within the area exceeding the PRG and the overlying vadose zone, and would significantly reduce and eventually eliminate the long-term health risks at the Site. The environment would be protected by effectively removing the contaminants from the shallow groundwater and soil. The remaining contaminants at low concentrations would be reduced over time through natural processes. Treatment residuals would meet the SCGs at the Site following completion of the remedy.

Reduction of Toxicity, Mobility or Volume through Treatment

This alternative would significantly reduce the toxicity, mobility, and volume of contamination. The volume and toxicity of contaminated groundwater would be reduced by the stripping of contamination from groundwater and soil. Mobility of soil vapor would be controlled by the vacuum applied to the treatment area, which would prevent vapor migration.

Short-term Effectiveness

This alternative would have some short-term impacts to the community and the environment. AS/SVE would need to be installed and operated on the Site for approximately 5 years. Installation of the system would be performed without significant risk to the community. Site workers would wear appropriate PPE to minimize exposure to contamination and as protection from physical hazards. In addition, risks posed by the extracted vapor would be effectively managed by treatment of the vapor prior to discharge.

Implementability

The key implementability concern involves the installation of sparge points and extraction wells through concrete and pavement and inside a warehouse. Existing site operations and infrastructure may inhibit the optimal layout of the remediation system. Successful implementation at this Site depends on an adequate understanding of site geology and its effects on system design.

AS/SVE technology has been demonstrated successfully in full scale applications. Pilot testing would be necessary to demonstrate effectiveness and to establish the site-specific design parameters. Performance can be easily monitored using saturated-zone and vadose-zone monitoring points.

Cost

The total present worth for Alternative OU1-3 is $1,520,000. The estimated capital cost is $602,560. The annual O&M (five years) and monitoring costs (10 years) is $195,000. Detailed cost estimates are presented in Appendix B.

7.2.2 Comparative Analysis of Operable Unit 1 Alternatives

The three alternatives for Operable Unit 1, the vadose zone and shallow groundwater, include:

- Alternative OU1-1 – No Action
- Alternative OU1-2 - Institutional Controls
- Alternative OU1-3 – Air sparge and soil vapor extraction

7.2.2.1 Overall Protection of Human Health and the Environment

Alternative OU1-1 would not provide protection of human health and the environment, since contamination would remain in groundwater for a long time in the future and no mechanism would be implemented to prevent exposure to contaminated groundwater. Alternative OU1-2 would only be protective if a statistically sound evaluation showed the plume to be shrinking. Alternative OU1-3 is an active treatment method that would remove contamination from the subsurface, thereby meeting the RAOs and providing protection to human health and the environment.

7.2.2.2 Compliance with SCGs

The Site groundwater is currently contaminated with chlorinated VOCs above the SCG. Alternative OU1-1 would not address the contamination so would not comply with the chemical-specific SCGs. Alternative OU1-2 would only meet the chemical-specific SCGs if it could be proved that the plume is shrinking due to dilution and dispersion. Alternatives OU1-3 would achieve chemical-specific SCGs by actively removing the contamination from the subsurface.

7.2.2.3 Long-term Effectiveness and Permanence

Alternative OU1-1 is not considered to be an effective or permanent remedy in that the magnitude of the remaining risks would be unknown. Alternative OU1-2 would provide long-term effectiveness since the exposure pathway of contaminated groundwater to local receptors would be eliminated through institutional controls;

however, the permanence of this alternative is unclear. At least eight quarters of monitoring is necessary to determine if the plume is shrinking due to dilution and dispersion, and if cleanup levels could be achieved within 30 years. The AS/SVE alternative would provide greater effectiveness and permanence.

7.2.2.4 Reduction of Toxicity, Mobility, or Volume through Treatment

The implementation of Alternatives OU1-1 and OU1-2 would not affect the toxicity, mobility, or volume of the contaminants through treatment. Alternative OU1-3 would not affect the mobility of contaminants in groundwater. However, contaminant volume would be reduced permanently. Toxicity will be reduced by the above ground treatment system.

7.2.2.5 Short-term Effectiveness

Alternative OU1-1 would have no short-term impact to workers or the community since remedial actions would not be performed. Alternative OU1-2 would have minimal short-term impact to the community, since workers would only be on site for periodic sampling. Alternative OU1-3 would have some impacts to the community and the environment due to site work and the continued operation of the AS/SVE system. Given the primarily sandy geology at the Site, retardation of contaminant movement will not be as great as in other more organic soils. Extraction of the contaminants should therefore not be prolonged.

7.2.2.6 Implementability

Alternative OU1-1 is easily implemented since no services or permits would be required. Alternative OU1-2 is easily implemented since site work would consist of sampling existing monitoring wells. Administrative requirements for obtaining institutional controls are potentially minimal, and groundwater monitoring services are readily available. For Alternative OU1-3, existing site operations and infrastructure may inhibit the optimal placement of the remediation system.

7.2.2.7 Cost

A comparative summary table of the cost estimates for each alternative is shown below.

Alternative	Present Value Cost	Capital Costs	Annual Costs
OU1-1 – No Action	$0	$0	$0
OU1-2 – Institutional Controls	$480,000	$42,800	$16,000
OU1-3 – Air Sparge / Soil Vapor Extraction	$1,520,000	$602,560	$195,000

7.3.1 Operable Unit 2

The technologies and process options retained after the screening step were combined into five alternatives designed to satisfy the RAOs presented in Section 4 for Operable Unit 2, the deep groundwater and impacted clay layer. The alternatives were developed and costed to address the majority of the contamination in the deep groundwater and clay layer. The No Action alternative was retained in accordance with the NCP to serve as a baseline for comparison with the other alternatives for the Site.

7.3.1.1 Alternative OU2-1 – No Action

The No Action alternative was retained for comparison purposes as required by the NCP. No remedial actions would be implemented as part of the No Action alternative. Groundwater would continue to migrate and the contamination would continue to attenuate through dilution, dispersion, limited biodegradation (although on-site data do not indicate biodegradation, this may not be true off-site), etc. This alternative does not include institutional controls or long-term groundwater monitoring.

Overall Protection of Human Health and the Environment
The No Action alternative does not provide overall protection of human health and the environment and does not meet the RAOs. Currently, contaminated groundwater is not used as drinking water. However, this alternative does not prevent future use of contaminated groundwater, which poses potential human risks above EPA threshold values through direct contact, ingestion, and inhalation. Because no remedial action would be implemented under this alternative, no means would be available to prevent current and future exposure.

Compliance with SCGs
Due to the presence of chlorinated VOCs above the groundwater quality standards and drinking water standards, this alternative would not comply with the chemical-specific SCGs for groundwater for a sustained period. As this alternative involves no action, location- and action-specific SCGs are not applicable.

Long-term Effectiveness and Permanence
The No Action alternative is not considered a permanent remedy. The contaminants would not be destroyed, yet concentrations would be reduced only gradually through natural dispersion and dilution. This alternative, however, would not provide adequate control of risks to human health or the environment because there are no mechanisms to prevent current and future exposure. Under this alternative there would be no mechanism in place to prevent future risk to human health; therefore, this alternative would not be considered effective in the long term.

Reduction of Toxicity, Mobility or Volume through Treatment
The implementation of this alternative would not affect the toxicity, mobility, or volume of the contamination.

Short-term Effectiveness
This alternative would not include a remedial action. Therefore, it would have no short-term impact to workers or the community. There would be no adverse environmental impacts to habitats or vegetation.

Implementability
This alternative is easily implemented, since no services or permits would be required.

Cost
There would be no cost under this alternative.

7.3.1.2 Alternative OU2-2 – Institutional Controls

Institutional controls such as environmental easements, site management plans, groundwater use restrictions, and long term monitoring were retained in section 6 as screened alternatives. These alternatives together would be instituted to impose restrictions in the subsurface zones.

An initial comparison of historical and current data (see Sections 1 through 3 of this report) indicate that the total VOCs plume may not be growing, and that the high groundwater flow velocity at the Site is controlling plume size by dilution and dispersion. If these mechanisms are in fact controlling plume size, Institutional Controls could potentially meet the RAOs at the Site. The length of time to achieve remedial objectives will depend on the groundwater flow velocity, as well as the amount of contaminant mass sorbed into the clay layer and its rate of desorption. The presence of DNAPL in trapped fissures or pockets could also provide a continuing source of dissolved phase contamination. It is important to acknowledge that the data collected thus far do not allow for a statistically significant determination of plume shrinkage (a minimum of eight sampling rounds would be recommended for plume stability analysis).

For cost comparison purposes, it is assumed that long-term monitoring would be performed for the 20-year FS evaluation period, quarterly for the first five years and annually after that. A review of site conditions would be conducted every five years using data obtained from a long-term monitoring program. The Site PRR would include an evaluation of the extent of contamination and an assessment of contaminant migration and attenuation over time. The five-year PRR would determine if monitoring should be discontinued. The monitoring program would be modified as needed based on the monitoring results.

Overall Protection of Human Health and the Environment
Alternative OU2-2 would only meet the RAOs if it could be proved that the plume is shrinking due to dilution and dispersion. This alternative would not minimize the migration of contaminants and would not protect the environment since there are no active removal mechanisms to restore the groundwater quality. This alternative may provide partial protection from exposure due to intrusive or drilling activities into groundwater but would not protect human health from contaminant migration into buildings due to vertical vapor migration. The estimated duration of a monitoring program would be 20 years, revised as deemed appropriate from the periodic review of the monitoring program data and results.

Compliance with SCGs
This alternative would only meet the chemical-specific SCGs if it could be proved that the plume is shrinking due to dilution and dispersion. This is unlikely within the next 20 years. This alternative does not involve any subsurface intrusion, operation, or treatment. Location-specific SCGs do not apply. Groundwater monitoring would comply with action-specific SCGs.

Long-term Effectiveness and Permanence
This alternative would not provide long-term effectiveness since contamination is migrating off-site. This alternative would not provide permanence since no active remedy would be implemented. While the concentration of contaminants may reduce over time, the overall mass would not be reduced in the near future since degradation has not been observed.

Reduction of Toxicity, Mobility or Volume through Treatment
This alternative would not reduce the toxicity, mobility, or volume of the Site contamination since natural processes such as biodegradation are unlikely to be neither active nor sufficient to reduce contaminant toxicity, mobility, or volume.

Short-term Effectiveness
This alternative would include some site work and would cause minimal and short-term impacts to the workers and surrounding communities. Use of personal protective equipment (PPE) by workers during groundwater sampling would minimize contaminant exposure.

Implementability
Institutional controls could be easily implemented.

Cost
The total present worth cost for alternative OU2-2 is approximately $1,260,000. Capital costs associated with this alternative are $42,800; the monitoring cost is $50,010 per event for 20 years. Detailed cost estimates are presented in Appendix B.

7.3.1.3 Alternative OU2-3 – In-Situ Thermal Remediation of the Impacted Clay Layer

In-Situ Thermal Remediation (ISTR) applies heat to the impacted zone in order to partition the contaminants into the vapor phase. The targeted geological zone must be heated to greater than the boiling point of the contaminants of concern. Once this temperature is reached, it will not matter whether the contaminant is present as NAPL, dissolved phase, or sorbed to soil: the contaminant mass will undergo a phase-shift to become heated vapor that will rise vertically through pore space.

In the most common application of ISTR, the entire water column of the aquifer is heated above the contaminant boiling point, and the contaminant vapor is then captured in the vadose zone with a soil vapor extraction system. Given the depth to the contaminated zone at the Site and the fact that clean water overlies the contamination, this common system setup is not feasible at the Site. Instead, it will be necessary to first allow the contaminant mass to contact groundwater that is below the boiling point--such that the mass is then transferred into the groundwater. This groundwater would then be extracted and treated.

The ISTR alternative is designed to treat the most highly impacted clay in-situ. The full nature and extent of clay contamination will be delineated during a pre-design investigation. A series of electrodes would be inserted into the impacted clay approximately 19 feet apart. Wattage from the local electricity grid would be applied to the electrodes. In the subsurface, the electrical current would travel through the clay (from one electrode to another), and the resistance in the clay between electrodes would create the heat needed. Given the low porosity of the clay, this Electrical Resistance Heating will be an effective thermal technique to heat the clay. As stated earlier, vaporized solvents would rise out of the clay through the pore spaces and into the overlying Upper Glacial Aquifer. Groundwater extraction wells would be drilled and screened right adjacent to the heated clay, and used to extract the contaminant mass (now dissolved in cooler groundwater) and bring the water to the surface for treatment with an air stripper and activated carbon. For cost estimating purposes, vertically-screened wells are proposed. However, extraction wells drilled and screened horizontally above the clay would likely reduce the total number of well heads at ground surface.

Modeling would be needed to design the system. Once the contaminants are vaporized in the heated clay, it would be necessary to understand how the contaminants would be expected to rise into the Upper Glacial Aquifer, and where specifically they would be expected to re-dissolve. Incorporating this information into a groundwater flow model would allow designers to appropriately place the groundwater extraction system to ensure that the contamination released from the clay is completely captured.

Overall Protection of Human Health and the Environment

This alternative would provide protection of human health and the environment. The vaporized contaminant mass in the clay would rise out of the clay layer into the Upper Glacial Aquifer, where it would be collected and removed from the environment using a groundwater extraction and treatment system. The remaining very low contaminant concentrations are expected to be reduced through natural processes such as dilution and dispersion in the subsurface. This alternative would meet RAOs. Institutional controls would eliminate the exposure pathway for contaminated groundwater to local receptors before the RAOs and the PRGs are achieved.

Compliance with SCGs

This alternative would achieve chemical-specific SCGs. The groundwater contaminant concentrations in the upper glacial aquifer will be reduced because the source of the contamination—VOCs sorbed to the clay layer—will have been remediated.

Long-term Effectiveness and Permanence
The alternative would provide long-term effectiveness and permanence. A pilot scale study would be required to obtain site specific design parameters, such as the appropriate spacing of electrodes. A groundwater flow model would be needed to design the groundwater extraction system, since only the effective capture of the mass vaporizing from the clay provide long-term effectiveness and permanence. Remaining contamination at low concentrations would be reduced over time through natural processes.

Reduction of Toxicity, Mobility or Volume through Treatment
This alternative would significantly reduce the toxicity and volume of groundwater contamination by removing the contaminant source, VOCs in the clay layer. ISTR would not reduce the mobility of the contaminants.

Short-term Effectiveness
This alternative would include substantial site work and would cause impacts to the workers and surrounding communities. Use of personal protective equipment (PPE) by workers during groundwater sampling would minimize contaminant exposure. If the contaminated clay is successfully heated above the boiling points of the contaminants, the vaporized contaminants will rise into the Upper Glacial Aquifer on the order of months.

Implementability
In-situ thermal remediation is a well known process based on the simple principle of heating the contaminants above their boiling points to free them from the aqueous or sorbed phases. Modeling will be needed to understand the contaminants' behaviors once they are released from the clay, as well as the groundwater flow patterns adjacent to the clay. There is a risk that ISTR may not be implementable at the Site if groundwater conditions make capturing contaminants dissolved in groundwater difficult. Furthermore, given the large areal extent of the impacted clay and the need for multiple electrodes and extraction points over the entire area, securing access to neighboring properties for personnel and equipment may be difficult. Existing site operations and infrastructure may inhibit the optimal layout of the remediation system. Identifying acceptable discharge/disposal options for the treated groundwater may also be problematic, as will the need to secure the large amounts of electricity from the grid to run the thermal system.

Cost
The total present worth for Alternative OU2-3 is $6,790,000. The estimated capital cost is $5,450,000. The estimated O&M costs are $740,000 and the monitoring cost is $50,000 per event for 20 years. Detailed cost estimates are presented in Appendix B.

7.3.1.4 Alternative OU2-4 – In-situ Treatment of the Impacted Clay Layer by Fracturing and Application of Amendments

The technology for fracturing low-permeability geological units was developed for the oil and gas industry, and has only recently started to be applied in the environmental remediation industry. In this application, boreholes are drilled into the clay layer, and then force is applied to the clay using either pneumatic or hydraulic pressure to overcome the confining stress and material strength of the clay and open a network of thin fractures in the clay matrix. These fractures will be targeted in the contaminated intervals of the clay. Amendments are then directly injected into the fractures to remediate the VOCs. Once in the fractures, the amendments will permeate into the microporous structure of the clay to contact and destroy the VOC contaminants. The contractor can fracture and inject at different depths in one borehole.

The fractures can be allowed to close after injecting the amendment. Alternatively, the fractures can be "propped open" by injecting clean sand into the fractures, allowing the borehole to be completed as a permanent well and receive multiple injections over time. This approach has benefits if contaminant concentrations are high and multiple injections are expected. However, the risk is that fractures may have propagated vertically through the clay, opening pathways for flow of contaminated groundwater into the Magothy Aquifer underneath the clay. In either scenario, it is possible that a pathway—either temporary or "propped open"—may be created into the Magothy resulting in the addition of a limited volume of the injected amendment into the Magothy.

A treatability study will be needed to determine a suitable amendment for injection into the fractures (such as a chemical oxidant, bioremediation amendment, and/or zero-valent iron). A pre-design investigation will be necessary to delineate the impacted clay. A pilot study will also be necessary to determine the likely radius and pattern of fractures in the impacted clay at the Site. For this feasibility study, costs were developed assuming one round of fracturing and injection of activated persulfate every 20 feet. Fractures will be allowed to close in order to protect the Magothy Aquifer. It is assumed that fluid will be injected into two fracture networks in each borehole: one created near the top of the clay, and a second network created at a greater depth.

Overall Protection of Human Health and the Environment

This alternative would provide protection of human health and the environment. The in-situ treatment would destroy the contaminants within the treatment zone permanently; the remaining very low contaminant concentrations are expected to be reduced through natural processes such as dilution and dispersion in the subsurface. This alternative would meet RAOs. Institutional controls would eliminate the exposure pathway for contaminated groundwater to local receptors before the RAOs and the PRGs are achieved.

Compliance with SCGs

This alternative would achieve chemical-specific SCGs. The groundwater contaminant concentrations in the upper glacial aquifer will be reduced because the source of the contamination—VOCs sorbed to the clay layer—will have been remediated.

Long-term Effectiveness and Permanence
The alternative would provide long-term effectiveness and permanence. In-situ treatment of VOCs in the clay would significantly reduce and eventually eliminate the long-term health risks at the Site and protect the environment by destroying contaminant mass in-situ. The remaining contaminants at low concentrations would be reduced over time through natural processes. A bench-scale study and a pilot scale study would be required to obtain site specific design parameters, such as appropriate amendment and dosing and the radius of influence of each injection. Amendments could potentially not reach VOC contamination in trapped fissures or pockets. These untreated pockets could provide a continuing source of contamination, or require additional rounds of amendment injection.

Reduction of Toxicity, Mobility or Volume through Treatment
This alternative would significantly reduce the toxicity and volume of groundwater contamination by destroying the contaminants in situ. Treatment in the clay would not reduce the mobility of the contaminants. Depending on the fracturing method used, the possibility will exist of either creating temporary or "propped open" pathways from the Upper Glacial Aquifer into the Magothy Aquifer.

Short-term Effectiveness
This alternative would include substantial site work and would cause impacts to the workers and surrounding communities during the injection phase. Use of personal protective equipment (PPE) by workers during groundwater sampling would minimize contaminant exposure. Injected amendments should destroy contamination on contact.

Implementability
Fracturing and injection of amendments has been demonstrated successfully in full scale applications in clay. Bench scale testing would be necessary to identify the appropriate amendment. Experienced companies would be procured through competitive bid to implement this alternative. Existing site operations and infrastructure may inhibit the optimal layout of the remediation system. Successful implementation at this Site depends on an adequate understanding of site geology and its effects on system design.

Cost
The total present worth for Alternative OU2-4 is $2,690,000. The estimated capital cost is $1,800,000. There are no O&M costs associated with this alternative. The monitoring cost is $50,000 per event for 20 years. Detailed cost estimates are presented in Appendix B.

7.3.1.5 Alternative OU2-5 – Enhanced Anaerobic Bioremediation Applied as a Permeable Reactive Barrier over the Impacted Clay Layer plus Long Term Monitoring

Enhanced Anaerobic Bioremediation (EAB) of chlorinated VOCs at the Site could be implemented via the injection of electron donors, carbon, and nutrients into the subsurface. Specifically, the amendments would be injected such that a layer of amendment would cover the most highly impacted section of the clay layer, reducing contaminant flux into the aquifer. The full nature and extent of the impacted clay contamination would be determined during a pre-design investigation. The amendments would act as a horizontally-oriented permeable reactive barrier (PRB). As VOCs diffuse out of the clay layer, the biological reductive dechlorination reactions would occur inside the horizontal PRB. The degradation byproducts passing out of the PRB and into the upper glacial aquifer would be expected to attenuate under the native aerobic conditions at the Site. The destruction of contaminants in the PRB will be kinetically limited by the rate of VOC desorption from the clay and into the PRB. Once reductive conditions were established in the PRB, dechlorination would be relatively rapid. The induced concentration gradient between the PRB and the clay could increase the rates of mass transfer for contaminants out of the clay.

Identifying the correct type of bioremediation amendment and an effective way to create the horizontal PRB are key tasks. Given the high groundwater flow velocity in the upper glacial aquifer, a slow release, high-viscosity amendment would be required to withstand shear stress from groundwater. For cost estimating purposes, emulsified soybean oil is selected for injection every 20 feet at the Site, yet other technologies should also be evaluated during the design stage. Emulsified oil is reported to last up to 24 months; for costing purposes, it is assumed that five injection rounds will be needed. Institutional controls and MNA in the upper glacial aquifer would be implemented following the four year treatment period. Quarterly monitoring would be conducted for the first five years and annually after that for a total of 20 years. A review of site conditions would be conducted every five years. The site PRR would include an evaluation of the extent of contamination and effectiveness of treatment. If contamination remains, the site PRR would also include an assessment of contaminant migration and attenuation over time.

Overall Protection of Human Health and the Environment

This alternative would provide protection of human health and the environment. It would meet the RAOs. Contaminant flux from the clay layer into the upper glacial aquifer would be reduced through EAB. It is possible that at this Site, reductive dechlorination may stall at *cis*-DCE and 1,1-DCA formation. However, *cis*-DCE and 1,1-DCA can likely be degraded through various pathways in aerobic conditions. Given the *de facto* aerobic conditions at the Site, aerobic biodegradation would be expected to occur once injection of EAB nutrients etc. was terminated. The groundwater monitoring program would be used to determine if these concentrations are higher than the PRG.

Institutional controls would eliminate the exposure pathway for local receptors to contaminated groundwater before it is restored. The implementation of EAB includes the delivery to the subsurface of a considerable amount of food-grade amendment.

Compliance with SCGs

ERB in combination with PRB would reduce contaminants to meet the chemical-specific SCGs. Implementation of EAB would reduce contaminant concentrations in both the clay and the upper glacial aquifer. The remaining contaminants in groundwater would be reduced to PRGs through natural attenuation processes. The PRGs are anticipated to be achieved within 10 years based on five injection rounds of bioremediation amendments followed by aerobic biodegradation of the remaining breakdown products.

This action would meet action- and location-specific SCGs. Health and safety requirements would be met.

Long-term Effectiveness and Permanence

This action would have long-term effectiveness and permanence. EAB, once established, would destroy the PCE, TCE, and 1,1,1-TCA mass, thereby reducing the risk posed by the contaminants in the upper glacial aquifer. There is a chance that the dechlorination process may stall at *cis*-DCE, VC and/or 1,1-DCA; however, it is likely that a return to aerobic conditions at the Site would be adequate to stimulate aerobic biodegradation of these products.

Institutional controls would prevent the exposure of contaminated groundwater during the time before the groundwater quality is restored.

Reduction of Toxicity, Mobility or Volume through Treatment

In-situ bioremediation would reduce the toxicity and volume of contamination in both the clay and the upper glacial aquifer. Chlorinated VOCs would be biotransformed to ethene, ethane, and carbon dioxide. The intermediate product, VC, is more toxic than TCE, but accumulation of VC is unlikely because of its ability to degrade under aerobic conditions. Intermediates, such as DCEs, DCA, and VC, would be closely monitored. Mobility of the contaminants would be slightly reduced by the horizontal PRB (however, reducing mobility is not the intention of a PRB).

Short-term Effectiveness

This alternative would include substantial site work and would cause impacts to the workers and surrounding communities during the injection phase. Use of personal protective equipment (PPE) by workers during groundwater sampling would minimize contaminant exposure. Once the biological community becomes established in the PRB (on the order of months), the reductive dechlorination reactions inside the PRB will be relatively rapid.

Implementability

This alternative is technically implementable. The processes that govern degradation reactions are well understood, and technical feasibility of enhanced bioremediation has been established at numerous sites. Despite this, bioremediation is still considered an innovative technology. It would require bench and pilot scale testing prior to implementation. In general, no significant technical difficulties are anticipated. No difficulty in obtaining a permit for the injection of bioremediation amendments into groundwater is anticipated.

This alternative would be constructed and implemented using conventional construction methods and equipment. Services and materials for implementation of this alternative are readily available. Existing site operations and infrastructure may inhibit the optimal layout of the remediation system. Additionally, multiple rounds of injections would be expected over a timeframe on the order of years (estimated at five injection rounds over 10 years for costing purposes).

No problems are anticipated for the implementation and enforcement of the institutional controls.

Cost
The total present worth for Alternative OU2-5 is $3,590,000. The estimated capital cost is $2,300,000 and the monitoring cost is $50,000 per event for 20 years. Detailed cost estimates are presented in Appendix B

7.3.2 Comparative Analysis of Operable Unit 2 Alternatives

The five alternatives for OU2, the deep groundwater and impacted clay, include:

- Alternative OU2-1 – No Action
- Alternative OU2-2 - Institutional Controls
- Alternative OU2-3 – In-situ thermal remediation of the impacted clay layer
- Alternative OU2-4 – In-situ treatment of the impacted clay layer by fracturing and application of amendments
- Alternative OU2-5 – Enhanced anaerobic bioremediation applied as a permeable reactive barrier over the impacted clay layer

7.3.2.1 Overall Protection of Human Health and the Environment

Alternative OU2-1 would not provide protection of human health and the environment, since contamination would remain in groundwater for a long time in the future, and no mechanism would be implemented to prevent exposure to contaminated groundwater. Alternative OU2-2 would only be protective if a statistically sound evaluation showed the plume to be shrinking. Alternatives OU2-3 through OU2-5 are active treatment methods that either destroy mass in-situ or remove contamination from the subsurface, thereby meeting the RAOs and providing protection to human health and the environment.

7.3.2.2 Compliance with SCGs

The Site groundwater is currently contaminated with chlorinated VOCs above the groundwater quality standards and drinking water standards. Alternative OU2-1 would not address the contamination so would not comply with the chemical-specific SCGs. Alternative OU2-2 would only meet the chemical-specific SCGs if it could be proved that the plume is shrinking due to dilution and dispersion. However, it would not meet the remedial goal of source removal. Alternatives OU2-3 through OU2-5 are all designed for source removal; the main differentiator is the amount of time required for cleanup.

7.3.2.3 Long-term Effectiveness and Permanence

Alternative OU2-1 is not considered to be an effective or permanent remedy in that the magnitude of the remaining risks would be unknown. Alternative OU2-2 would provide long-term effectiveness since the exposure pathway of contaminated groundwater to local receptors would be eliminated through institutional controls; however, the permanence of this alternative is unclear. At least eight quarters of monitoring is necessary to determine if the plume is shrinking due to dilution and dispersion, and if cleanup levels could be achieved within 30 years.

Alternative OU2-3, in-situ thermal remediation, would provide the greatest opportunity for long-term effectiveness and permanence. The clay would be heated thoroughly across a broad area and thickness, causing the contaminants in the heated zone to vaporize and be removed from the clay. As long as the vaporized contaminants are captured by the groundwater extraction system and treated, the remedy would be considered effective and permanent.

The effectiveness and permanence of Alternative OU2-4, in-situ treatment of the clay via fracturing and injection of amendments, would also provide an opportunity for long term effectiveness and permanence, but at more risk than the ISTR alternative or the EAB alternative. This is because the critical need for Alternative OU2-4 is that the injected amendment (such as a chemical oxidant) must come into contact with the contaminant in order for the contaminant destruction to occur. Given that the fracturing pattern and success of injecting the amendment is unknown until it is actually implemented, there is the potential that areas of contamination in the clay may not be treated.

Alternative OU2-5 will not target contaminant mass in the clay like the other two alternatives; the purpose will be to control the flux of contamination off of the clay into the overlying aquifer. In order to control this flux, the bio-amendment would need to be in place until a great enough mass of contaminant in the clay had fluxed off and the PRG of source removal was met. This timeframe is uncertain.

7.3.2.4 Reduction of Toxicity, Mobility, or Volume through Treatment

The implementation of Alternatives OU2-1 and OU2-2 would not affect the toxicity, mobility, or volume of the contaminants through treatment. As planned, the three active remedial alternatives would all reduce the volume of contamination through treatment. Both OU2-4 and OU2-5, fracturing and enhanced anaerobic bioremediation, would reduce mobility of the contaminants. Alternative OU2-3, however, would be specifically designed to *increase* mobility initially, by spurring mass transfer from the clay and into groundwater. But overall, mobility would be reduced as long as the contamination in the groundwater was effectively captured.

7.3.2.5 Short-term Effectiveness

Alternative OU2-1 would have no short-term impact to workers or the community since remedial actions would not be performed. Alternative OU2-2 would have minimal short-term impact to the community, since workers would only be on site for periodic sampling. Alternatives OU2-3 through OU2-5 would have some impacts to the community and the environment due to site work and the continued operation of a groundwater extraction and treatment system.

As planned, thermal remediation (OU2-3) would take the shortest time to be effective. The clay could be heated to the appropriate temperature on the order of weeks once the electrodes are in place. The short-term effectiveness of Alternative OU2-4, fracturing and injection of amendment, will depend greatly on the fracturing pattern and contact between the contamination and the injected amendment: the better the contact, the more short-term effectiveness. Once installed, Alternative OU2-5 will fairly quickly lead to lower contaminant concentrations in the overlying groundwater as the flux out of the clay is controlled. However, the reduction in volume of contamination in the clay will be much slower than the other two active alternatives since OU2-5 will not involve active remediation of the clay itself.

7.3.2.6 Implementability

Alternative OU2-1 is easily implemented since no services or permits would be required. Alternative OU2-2 is easily implemented since site work would consist of sampling monitoring wells. Administrative requirements for obtaining institutional controls are potentially minimal, and groundwater monitoring services are readily available.

Implementation issues may arise for all three active remediation alternatives due to the need to conduct subsurface operations across the entire areal extent of impacted clay. Overall, the thermal remediation alternative, OU2-3, will be the most difficult to implement because it will require above-ground infrastructure (electrodes, extraction wells, treatment system, treated water disposal/discharge) as well as coordination with utilities. The bioremediation alternative, OU2-5, will likely be the next most difficult remedy to implement, primarily because multiple rounds of injections are expected over the next decade. The fracturing alternative, OU2-4, will be the least difficult alternative to implement. Injection points will still be needed to cover the areal extent of the most impacted clay, but fewer injection rounds than the bioremediation alternative are expected. However, fracturing is a specialized technology relative to injection of bioremediation amendments, and procuring experienced fracturing contractors may be difficult.

7.3.2.7 Cost

A comparative summary table of the cost estimates for each alternative is shown below.

Alternative	Present Value Cost	Capital Costs	Annual Costs
OU2-1 – No Action	$0	$0	$0
OU2-2 – Institutional Controls	$1,260,000	$43,000	$50,000
OU2-3 – ISTR	$6,790,000	$5,450,000	$50,000
OU2-4 – Fracturing and application of amendments	$2,690,000	$1,800,000	$50,000
OU2-5 – EAB as horizontal PRB	$3,590,000	$2,300,000	$50,000

Section 8
Recommended Remedies

8.1 Operable Unit 1 – Shallow Groundwater

For OU1, the contaminated vadose zone and shallow groundwater, Alternative OU1-3 Air Sparge / Soil Vapor Extraction (AS/SVE) is the recommended alternative. The matrix is predominantly sandy, indicating that contaminant retardation will not be significant and air sparging and vapor extraction will be effective in the short and long term. The alternative is implementable with well-understood technologies and will achieve the RG.

8.2 Operable Unit 2 – Deep Groundwater

OU2 comprises the deep groundwater and clay layer impacted by VOCs. Since the RG for OU2 is source removal, the alternatives described in Section 7 were developed and costed out to target the deep groundwater and impacted clay directly underneath OU1. This area is assumes to contain the majority of the contaminants sorbed to clay.

Alternative OU2-5, Enhanced Anaerobic Bioremediation applied as a Permeable Reactive Barrier over the impacted clay layer plus long term monitoring, is the recommended alternative for OU2. This alternative will be effective in the short term in reducing contamination in the deep groundwater by reducing contaminant flux from the clay layer into the Upper Glacial Aquifer. Over the longer term (approximately ten years), the chemical gradients induced between the Permeable Reactive Barrier and the impacted clay will serve to draw contamination out of the clay, thereby achieving the RG of source removal. This alternative is implementable with existing techniques and technologies.

8.3 Soil Vapor Intrusion

Indoor air and sub-slab soil vapor concentrations previously detected at several properties warrant mitigation or monitoring. However, it is likely that the AS/SVE remedial alternative recommended for OU1 will mitigate soil vapor intrusion at the Site. Following the completion of the AS/SVE remedy, surrounding properties should be resampled and the need for mitigation should be further evaluated.

Section 9
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Tables

Table 3-1
2008 Groundwater Screening Analytical Results
Pride Solvents Chemical Company
Babylon, New York

Sample ID	TOGS 1.1.1 Class GA Guidance/ Standards	GWS01-18	GWS01-55	GWS01-85	GWS02-10	GWS02-30	GWS02-65	GWS02-75	GWS02-80	GWS03-15-20	GWS03-35-40	GWS03-82-87
Sample Depth (feet bgs)		**18-23**	**50-55**	**80-85**	**10-15**	**25-30**	**60-65**	**70-75**	**75-80**	**15-20**	**35-40**	**82-87**
Sampling Date		**10/8/08**	**10/8/08**	**10/07/08**	**10/9/08**	**10/9/08**	**10/9/08**	**10/9/08**	**10/9/08**	**10/13/08**	**10/13/08**	**10/13/08**
Volatile Organic Compound (µg/L)												
Acetone	50 G	30 U,LS	30 U,LS	30 U	30 U	30 U	30 U	30 U	30 U	30 U	30 U	30 U
Benzene	1 S	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
2-Butanone (MEK)	NC	30 U	30 U	30 U	30 U	30 U	30 U	30 U	30 U	30 U	30 U	30 U
Carbon disulfide	NC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Carbon tetrachloride	5 S	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Chlorobenzene	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Chloroethane	5 POC	5.0 U,LS	5.0 U,LS	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Chloroform	7 S	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
c-1,2-Dichloroethene	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	1.6	0.50 U	0.50 U
Dibromochloromethane	50 G	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,2-Dichlorobenzene	3 S	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,2-Dichloroethane	0.6 S	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,3-Dichlorobenzene	3 S	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,3-Dichloropropane	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,4-Dichlorobenzene	3 S	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,1-Dichloroethane	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U,LC	0.50 U	0.50 U,LC
1,1-Dichloroethene	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Ethylbenzene	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
m+p-Xylene	NC	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Methyl Isobutyl Ketone (MIBK)	NC	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U
Methyl-t-butyl ether	NC	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Methylene chloride	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
o-Xylene	NC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Tetrachloroethene	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	***8.9***	0.50 U	0.50 U
Toluene	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,1,1-Trichloroethane	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,1,2,2-Tetrachloroethane	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,1,2-Trichlorotrifluoroethane	NC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,2,3-Trichloropropane	0.04 S	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,2,4-Trichlorobenzene	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
t-1,2-Dichloroethene	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Trichloroethene	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	1.3	0.50 U	0.50 U
Vinyl chloride	2 S	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U

Notes:

B = analyte detected in associated method blank
LC = results maybe biased low due to continuing calibration verification not within control limits
LS = results maybe biased low due to surrogate recovery not within control limits
U = compounds not detected at reporting limit
NC = no criteria
µg/L = microgram per liter
bgs = below ground surface
POC = principle organic compound
S = standard value
G = guidance value
Bold = exceeds criteria
🟨 = hit
*GWS11-70-75 is GWS11-90-95 in laboratory data pack.
**GWS14-75-80 is GWS13-76-80 in laboratory data pack.

Table 3-1
2008 Groundwater Screening Analytical Results
Pride Solvents Chemical Company
Babylon, New York

Sample ID	TOGS 1.1.1 Class GA Guidance/ Standards	GWS04-15-20	GWS04-35-40	GWS04-85-90	GWS05-16-20	GWS05-49-53	GWS05-79-83	GWS06-16-20	GWS06-46-50	GWS06-74-78	GWS07-20-25	GWS07-25-30
Sample Depth (feet bgs)		**15-20**	**35-40**	**85-90**	**16-20**	**49-53**	**79-83**	**16-20**	**46-50**	**74-78**	**20-25**	**25-30**
Sampling Date		**10/14/08**	**10/14/08**	**10/14/08**	**10/15/08**	**10/15/08**	**10/15/08**	**10/15/08**	**10/15/08**	**10/15/08**	**10/16/08**	**10/16/08**
Volatile Organic Compound (µg/L)												
Acetone	50 G	30 U	30 U	30 U	30 U	30 U	30 U	30 U	30 U	30 U	30 U	30 U
Benzene	1 S	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
2-Butanone (MEK)	NC	30 U	30 U	30 U	30 U	30 U	30 U	30 U	30 U	30 U	30 U	30 U
Carbon disulfide	NC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Carbon tetrachloride	5 S	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Chlorobenzene	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Chloroethane	5 POC	5.0 U,LC	5.0 U	5.0 U	5.0 U,LC	5.0 U	5.0 U,LC	5.0 U,LC	5.0 U	5.0 U	5.0 U	5.0 U
Chloroform	7 S	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
c-1,2-Dichloroethene	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	1.4	1.8
Dibromochloromethane	50 G	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,2-Dichlorobenzene	3 S	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,2-Dichloroethane	0.6 S	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,3-Dichlorobenzene	3 S	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,3-Dichloropropane	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,4-Dichlorobenzene	3 S	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,1-Dichloroethane	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,1-Dichloroethene	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Ethylbenzene	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
m+p-Xylene	NC	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.2	1.0 U
Methyl Isobutyl Ketone (MIBK)	NC	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U
Methyl-t-butyl ether	NC	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Methylene chloride	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
o-Xylene	NC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Tetrachloroethene	5 POC	0.50 U	0.50 U	0.50 U	4.7	0.50 U	0.50 U	2.7	0.50 U	0.50 U	***5.9***	3.8
Toluene	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	2.3	0.63
1,1,1-Trichloroethane	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,1,2,2-Tetrachloroethane	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,1,2-Trichlorotrifluoroethane	NC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,2,3-Trichloropropane	0.04 S	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,2,4-Trichlorobenzene	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
t-1,2-Dichloroethene	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Trichloroethene	5 POC	0.50 U	0.50 U	0.50 U	0.58	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	2.2	0.81
Vinyl chloride	2 S	0.50 U	0.50 U,LC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U

Notes:
B = analyte detected in associated method blank
LC = results maybe biased low due to continuing
calibration verification not within control limits
LS = results maybe biased low due to surrogate
recovery not within control limits
U = compounds not detected at reporting limit
NC = no criteria
µg/L = microgram per liter
bgs = below ground surface
POC = principle organic compound
S = standard value
G = guidance value
Bold = exceeds criteria
🟨 = hit
*GWS11-70-75 is GWS11-90-95 in laboratory data pack.
**GWS14-75-80 is GWS13-76-80 in laboratory data pack

Table 3-1
2008 Groundwater Screening Analytical Results
Pride Solvents Chemical Company
Babylon, New York

Sample ID	**TOGS 1.1.1 Class GA Guidance/ Standards**	**GWS07-45-50**	**GWS07-65-70**	**GWS07-80-85**	**GWS08-16-20**	**GWS08-26-30**	**GWS08-56-60**	**GWS08-76-80**	**GWS09-16-20**	**GWS09-40-44**	**GWS09-60-64**	**GWS09-80-83**
Sample Depth (feet bgs)		**45-50**	**65-70**	**80-85**	**16-20**	**26-30**	**56-60**	**76-80**	**16-20**	**40-44**	**60-64**	**80-84**
Sampling Date		**10/16/08**	**10/16/08**	**10/15/08**	**10/16/08**	**10/16/08**	**10/16/08**	**10/16/08**	**10/16/08**	**10/16/08**	**10/16/08**	**10/16/08**
Volatile Organic Compound (µg/L)												
Acetone	50 G	30 U	30 U	30 U	30 U	30 U	30 U	30 U	30 U	30 U	30 U	30 U
Benzene	1 S	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
2-Butanone (MEK)	NC	30 U	30 U	30 U	30 U	30 U	30 U	30 U	30 U	30 U	30 U	30 U
Carbon disulfide	NC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Carbon tetrachloride	5 S	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Chlorobenzene	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Chloroethane	5 POC	5.0 U	5.0 U	5.0 U,LC	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U,LC	5.0 U	5.0 U
Chloroform	7 S	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
c-1,2-Dichloroethene	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Dibromochloromethane	50 G	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,2-Dichlorobenzene	3 S	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,2-Dichloroethane	0.6 S	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,3-Dichlorobenzene	3 S	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,3-Dichloropropane	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,4-Dichlorobenzene	3 S	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,1-Dichloroethane	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,1-Dichloroethene	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Ethylbenzene	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
m+p-Xylene	NC	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Methyl Isobutyl Ketone (MIBK)	NC	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U
Methyl-t-butyl ether	NC	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Methylene chloride	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
o-Xylene	NC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Tetrachloroethene	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	***9.3***	0.50 U	0.50 U	0.50 U
Toluene	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,1,1-Trichloroethane	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	***13***	0.50 U	0.50 U	0.50 U
1,1,2,2-Tetrachloroethane	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,1,2-Trichlorotrifluoroethane	NC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,2,3-Trichloropropane	0.04 S	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,2,4-Trichlorobenzene	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
t-1,2-Dichloroethene	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Trichloroethene	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Vinyl chloride	2 S	0.50 U	0.50 U,LC	0.50 U	0.50 U	0.50 U	0.50 U,LC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U,LC

Notes:
B = analyte detected in associated method blank
LC = results maybe biased low due to continuing
calibration verification not within control limits
LS = results maybe biased low due to surrogate
recovery not within control limits
U = compounds not detected at reporting limit
NC = no criteria
µg/L = microgram per liter
bgs = below ground surface
POC = principle organic compound
S = standard value
G = guidance value
Bold = exceeds criteria
🟨 = hit
*GWS11-70-75 is GWS11-90-95 in laboratory data pack.
**GWS14-75-80 is GWS13-76-80 in laboratory data pack

Table 3-1
2008 Groundwater Screening Analytical Results
Pride Solvents Chemical Company
Babylon, New York

Sample ID	**TOGS 1.1.1 Class GA Guidance/ Standards**	**GWS10-15-20**	**GWS10-30-35**	**GWS10-50-55**	**GWS10-67-70**	**GWS10-78-83**	**GWS11-15-20**	**GWS11-20-25**	**GWS11-40-45**	**GWS11-70-75***	**GWS11-85-90**	**GWS12-15-20**
Sample Depth (feet bgs)		**15-20**	**30-35**	**50-55**	**65-70**	**78-83**	**15-20**	**20-25**	**40-45**	**70-75**	**85-90**	**15-20**
Sampling Date		**10/20/08**	**10/20/08**	**10/20/08**	**10/20/08**	**10/20/08**	**10/22/08**	**10/22/08**	**10/22/08**	**10/22/08**	**10/22/08**	**10/24/08**
Volatile Organic Compound (µg/L)												
Acetone	50 G	30 U	30 U	30 U	30 U	30 U	30 U	30 U	30 U	30 U	30 U	30 U
Benzene	1 S	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
2-Butanone (MEK)	NC	30 U	30 U	30 U	30 U	30 U	30 U	30 U	30 U	30 U	30 U	30 U
Carbon disulfide	NC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Carbon tetrachloride	5 S	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Chlorobenzene	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Chloroethane	5 POC	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Chloroform	7 S	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
c-1,2-Dichloroethene	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Dibromochloromethane	50 G	0.50 U	0.50 U	0.50 U	0.50 U	0.88	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,2-Dichlorobenzene	3 S	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,2-Dichloroethane	0.6 S	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,3-Dichlorobenzene	3 S	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,3-Dichloropropane	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,4-Dichlorobenzene	3 S	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,1-Dichloroethane	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,1-Dichloroethene	5 POC	0.50 U	0.50 U,LC	0.50 U,LC	0.50 U	0.50 U,LC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Ethylbenzene	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
m+p-Xylene	NC	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Methyl Isobutyl Ketone (MIBK)	NC	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U
Methyl-t-butyl ether	NC	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Methylene chloride	5 POC	0.53 B	0.66 B	0.66 B	0.52 B	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
o-Xylene	NC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Tetrachloroethene	5 POC	0.59	1.2	0.84	3.3	***44***	0.50 U	0.62	0.50 U	1.6	***19***	1.2
Toluene	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,1,1-Trichloroethane	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.95	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,1,2,2-Tetrachloroethane	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,1,2-Trichlorotrifluoroethane	NC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,2,3-Trichloropropane	0.04 S	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,2,4-Trichlorobenzene	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
t-1,2-Dichloroethene	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Trichloroethene	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	1.6	0.50 U	0.50 U	0.50 U	1.1	2.3	0.50 U
Vinyl chloride	2 S	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U

Notes:
B = analyte detected in associated method blank
LC = results maybe biased low due to continuing
calibration verification not within control limits
LS = results maybe biased low due to surrogate
recovery not within control limits
U = compounds not detected at reporting limit
NC = no criteria
µg/L = microgram per liter
bgs = below ground surface
POC = principle organic compound
S = standard value
G = guidance value
Bold = exceeds criteria
🟨 = hit
*GWS11-70-75 is GWS11-90-95 in laboratory data pack.
**GWS14-75-80 is GWS13-76-80 in laboratory data pack

Table 3-1
2008 Groundwater Screening Analytical Results
Pride Solvents Chemical Company
Babylon, New York

Sample ID	**TOGS 1.1.1 Class GA Guidance/ Standards**	**GWS12-40-45**	**GWS12-85-90**	**GWS13-15-20**	**GWS13-40-45**	**GWS13-65-75**	**GWS13-80-85**	**GWS14-15-20**	**GWS14-25-30**	**GWS14-40-45**	**GWS14-60-65**	**GWS14-GWS-75-80****
Sample Depth (feet bgs)		**40-45**	**85-90**	**15-20**	**40-45**	**65-70**	**80-85**	**15-20**	**25-30**	**40-45**	**60-65**	**75-80**
Sampling Date		**10/24/08**	**10/24/08**	**10/28/8**	**10/28/8**	**10/28/8**	**10/28/8**	**10/30/08**	**10/30/08**	**10/30/08**	**10/30/08**	**10/29/08**
Volatile Organic Compound (µg/L)												
Acetone	50 G	30 U	30 U	30 U	30 U	30 U	30 U	30 U	30 U	30 U	30 U	30 U
Benzene	1 S	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
2-Butanone (MEK)	NC	30 U	30 U	30 U	30 U	30 U	30 U	30 U	30 U	30 U	30 U	30 U
Carbon disulfide	NC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Carbon tetrachloride	5 S	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Chlorobenzene	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Chloroethane	5 POC	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Chloroform	7 S	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
c-1,2-Dichloroethene	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Dibromochloromethane	50 G	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,2-Dichlorobenzene	3 S	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,2-Dichloroethane	0.6 S	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,3-Dichlorobenzene	3 S	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,3-Dichloropropane	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,4-Dichlorobenzene	3 S	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,1-Dichloroethane	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	1.3	1.3	0.50 U	0.50 U	0.50 U	0.50 U
1,1-Dichloroethene	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Ethylbenzene	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
m+p-Xylene	NC	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Methyl Isobutyl Ketone (MIBK)	NC	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U
Methyl-t-butyl ether	NC	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Methylene chloride	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
o-Xylene	NC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Tetrachloroethene	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	3.3	***62***	***8.7***	2.7	0.50 U	0.50 U	1.2
Toluene	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,1,1-Trichloroethane	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	***5.8***	0.50 U	0.50 U	0.50 U	0.50 U	1.3
1,1,2,2-Tetrachloroethane	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,1,2-Trichlorotrifluoroethane	NC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,2,3-Trichloropropane	0.04 S	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,2,4-Trichlorobenzene	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
t-1,2-Dichloroethene	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Trichloroethene	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	***11***	1.6	0.50 U	0.50 U	0.50 U	0.84
Vinyl chloride	2 S	0.5 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U,LC	0.50 U	0.50 U	0.50 U	0.50 U

Notes:

B = analyte detected in associated method blank

LC = results maybe biased low due to continuing calibration verification not within control limits

LS = results maybe biased low due to surrogate recovery not within control limits

U = compounds not detected at reporting limit

NC = no criteria

µg/L = microgram per liter

bgs = below ground surface

POC = principle organic compound

S = standard value

G = guidance value

Bold = exceeds criteria

🟨 = hit

*GWS11-70-75 is GWS11-90-95 in laboratory data pack.

**GWS14-75-80 is GWS13-76-80 in laboratory data pack

Table 3-1
2008 Groundwater Screening Analytical Results
Pride Solvents Chemical Company
Babylon, New York

Sample ID	TOGS 1.1.1 Class GA Guidance/ Standards	GWS15-15-20	GWS15-35-40	GWS15-60-65	GWS15-80-85	GWS16-17-21	GWS16-27-31	GWS16-47-51	GWS16-67-71	GWS17-10-14	GWS17-36-40	GWS17-56-60
Sample Depth (feet bgs)		**15-20**	**35-40**	**60-65**	**80-85**	**17-21**	**27-31**	**47-51**	**67-71**	**10-14**	**36-40**	**56-60**
Sampling Date		**11/03/08**	**11/03/08**	**11/3/2008**	**11/03/08**	**11/03/08**	**11/03/08**	**11/03/08**	**11/03/08**	**11/04/08**	**11/04/08**	**11/04/08**
Volatile Organic Compound (µg/L)												
Acetone	50 G	30 U	30 U	30 U	30 U	30 U	30 U	30 U	30 U	30 U	30 U	30 U
Benzene	1 S	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
2-Butanone (MEK)	NC	30 U	30 U	30 U	30 U	30 U	30 U	30 U	30 U	30 U	30 U	30 U
Carbon disulfide	NC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Carbon tetrachloride	5 S	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Chlorobenzene	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U,LC	0.50 U	0.50 U
Chloroethane	5 POC	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Chloroform	7 S	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	4.2	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
c-1,2-Dichloroethene	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Dibromochloromethane	50 G	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.53	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,2-Dichlorobenzene	3 S	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,2-Dichloroethane	0.6 S	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,3-Dichlorobenzene	3 S	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,3-Dichloropropane	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,4-Dichlorobenzene	3 S	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,1-Dichloroethane	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,1-Dichloroethene	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Ethylbenzene	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
m+p-Xylene	NC	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Methyl Isobutyl Ketone (MIBK)	NC	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U
Methyl-t-butyl ether	NC	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Methylene chloride	5 POC	0.50 U	0.50 U	0.50 U	0.5 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
o-Xylene	NC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Tetrachloroethene	5 POC	***6.3***	1.5	2.2	***8.3***	2.1	0.50 U	0.50 U	0.50 U	0.50 U	0.65	0.50 U
Toluene	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,1,1-Trichloroethane	5 POC	0.50 U	0.50 U	0.50 U	1.4	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,1,2,2-Tetrachloroethane	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U,LC	0.50 U	0.50 U
1,1,2-Trichlorotrifluoroethane	NC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,2,3-Trichloropropane	0.04 S	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,2,4-Trichlorobenzene	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
t-1,2-Dichloroethene	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Trichloroethene	5 POC	1.6	0.50 U	0.50 U	1.1	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Vinyl chloride	2 S	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U

Notes:

B = analyte detected in associated method blank
LC = results maybe biased low due to continuing
calibration verification not within control limits
LS = results maybe biased low due to surrogate
recovery not within control limits
U = compounds not detected at reporting limit
NC = no criteria
µg/L = microgram per liter
bgs = below ground surface
POC = principle organic compound
S = standard value
G = guidance value
Bold = exceeds criteria
🟨 = hit
*GWS11-70-75 is GWS11-90-95 in laboratory data pack.
**GWS14-75-80 is GWS13-76-80 in laboratory data pack

Table 3-1
2008 Groundwater Screening Analytical Results
Pride Solvents Chemical Company
Babylon, New York

Sample ID	**TOGS 1.1.1 Class GA Guidance/ Standards**	**GWS17-81-85**	**GWS18-15-20**	**GWS18-30-35**	**GWS18-40-45**	**GWS18-75-80**	**GWS19-16-20**	**GWS19-33-37**	**GWS19-53-57**	**GWS19-73-77**	**GWS20-23-27**	**GWS20-43-47**
Sample Depth (feet bgs)		**81-85**	**15-20**	**30-35**	**40-45**	**75-80**	**16-20**	**33-37**	**53-57**	**73-77**	**23-27**	**43-47**
Sampling Date		**11/04/08**	**11/05/08**	**11/05/08**	**11/04/08**	**11/04/08**	**11/05/08**	**11/05/08**	**11/05/08**	**11/04/08**	**11/06/08**	**11/06/08**
Volatile Organic Compound (µg/L)												
Acetone	50 G	30 U	30 U	30 U	30 U	30 U	30 U	30 U	30 U	30 U	30 U	30 U
Benzene	1 S	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
2-Butanone (MEK)	NC	30 U	30 U	30 U	30 U	30 U	30 U	30 U	30 U	30 U	30 U	30 U
Carbon disulfide	NC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Carbon tetrachloride	5 S	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Chlorobenzene	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Chloroethane	5 POC	5.0 U,LC	5.0 U,LC	5.0 U,LC	5.0 U	5.0 U,LC	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Chloroform	7 S	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
c-1,2-Dichloroethene	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.53	0.50 U
Dibromochloromethane	50 G	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,2-Dichlorobenzene	3 S	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,2-Dichloroethane	0.6 S	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,3-Dichlorobenzene	3 S	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,3-Dichloropropane	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,4-Dichlorobenzene	3 S	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,1-Dichloroethane	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.88	0.50 U
1,1-Dichloroethene	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Ethylbenzene	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
m+p-Xylene	NC	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Methyl Isobutyl Ketone (MIBK)	NC	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U
Methyl-t-butyl ether	NC	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Methylene chloride	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
o-Xylene	NC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Tetrachloroethene	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.62	0.75	0.58	1.6	1.0
Toluene	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,1,1-Trichloroethane	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	1.8	3.3	2.9	0.50 U	0.50 U
1,1,2,2-Tetrachloroethane	5 POC	0.50 U,LC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,1,2-Trichlorotrifluoroethane	NC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,2,3-Trichloropropane	0.04 S	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
1,2,4-Trichlorobenzene	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
t-1,2-Dichloroethene	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U
Trichloroethene	5 POC	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.61	0.50 U
Vinyl chloride	2 S	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U

Notes:
B = analyte detected in associated method blank
LC = results maybe biased low due to continuing calibration verification not within control limits
LS = results maybe biased low due to surrogate recovery not within control limits
U = compounds not detected at reporting limit
NC = no criteria
µg/L = microgram per liter
bgs = below ground surface
POC = principle organic compound
S = standard value
G = guidance value
Bold = exceeds criteria
🟨 = hit
*GWS11-70-75 is GWS11-90-95 in laboratory data pack.
**GWS14-75-80 is GWS13-76-80 in laboratory data pack

Table 3-2
Groundwater Sampling Analytical Results
October 2008

Pride Solvents Chemical Company
Babylon, New York

Sample ID	**TOGS 1.1.1 Class GA Guidance/ Standards Standards**	65986-ERM-4D		65986-ERM-4S		65986-MW-01		65986-MW-6		65986-MW6-DUP		65986-ERM-MW06D		65986-ERM-MW-01D	
Location		ERM-MW-04D		ERM-MW-04S		MW-01		MW-06		MW-06		ERM-MW-06D		ERM-MW-01D	
Sampling Date		10/21/08		10/21/08		10/21/08		10/21/08		10/21/08		10/21/08		10/22/08	
		µg/L		µg/L		µg/L		µg/L		µg/L		µg/L		µg/L	
Acetone	50 G	30	U	30	U	30	U	30	U	30	U	30	U	30	U
Benzene	1 S	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U
2-Butanone (MEK)	NC	30	U	30	U	30	U	30	U	30	U	30	U	30	U
Carbon disulfide	NC	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U
Carbon tetrachloride	5 S	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U
Chlorobenzene	5 POC	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U
Chloroethane	5 POC	5.0	U,LC	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U
Chloroform	7 S	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U
c-1,2-Dichloroethene	5 POC	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U
Dibromochloromethane	50 G	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U
1,2-Dichlorobenzene	3 S	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U
1,2-Dichloroethane	0.6 S	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U
1,3-Dichlorobenzene	3 S	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U
1,3-Dichloropropane	5 POC	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U
1,4-Dichlorobenzene	3 S	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U
1,1-Dichloroethane	5 POC	0.50	U	0.50	U	***8.6***		0.50	U	0.50	U	0.50	U	0.50	U
1,1-Dichloroethene	5 POC	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U
Ethylbenzene	5 POC	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U
m+p-Xylene	NC	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U	1.0	U
Methyl Isobutyl Ketone (MIBK)	NC	20	U	20	U	20	U	20	U	20	U	20	U	20	U
Methyl-t-butyl ether	NC	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U
Methylene chloride	5 POC	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.5	U	0.50	U
o-Xylene	NC	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.5	U	0.50	U
Tetrachloroethene	5 POC	0.50	U	0.50	U	***18***		1.1		1.5		***92***		***230***	E
Toluene	5 POC	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U
1,1,1-Trichloroethane	5 POC	0.50	U	0.50	U	0.62		0.50	U	0.50	U	0.50	U	***17***	
1,1,2,2-Tetrachloroethane	5 POC	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U
1,1,2-Trichlorotrifluoroethane	NC	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.88	HC
1,2,3-Trichloropropane	0.04 S	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U
1,2,4-Trichlorobenzene	5 POC	0.50	U	0.50	U	0.59		0.50	U	0.50	U	0.99		0.50	U
t-1,2-Dichloroethene	5 POC	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U
Trichloroethene	5 POC	0.50	U	0.50	U	3.3		0.50	U	0.50	U	3.2		***13***	
Vinyl chloride	2 S	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U	0.50	U
Dibromofluoromethane	%	107		97.4		96.2		101		96.5		104		96	
Toluene-D8	%	101		104		104		105		105		105		115	
Bromofluorobenzene	%	91.8		101		103		99.6		105		97.8		102	

Notes:

E = estimated, exceeds calibration range

HC = Results maybe biased high due to continuing calibration verification (CCV) not within control limits.

LC = results maybe biased low due to continuing calibration verification not within control limits

U = compounds not detected at reporting limit

NC = no criteria

µg/L = microgram per liter

POC = principle organic compound

S = standard value

G = guidance value

Bold = exceeds criteria

🟨 = hit

Table 3-2
Groundwater Sampling Analytical Results
October 2008

Pride Solvents Chemical Company
Babylon, New York

Sample ID	**TOGS 1.1.1 Class GA Guidance/ Standards Standards**	65986-ERM-MW-05D		665986-ERM-MW-07		65986-ERM-MW-08		65986-ERM-MW-01S		65986-MW-09		65986-MW-02		65986-MW-07D	
Location		ERM-MW-05D		MW-07		MW-08		ERM-MW-01S		MW-09		MW-02		MW-07	
Sampling Date		10/22/08		10/22/08		10/22/08		10/22/08		10/23/08		10/23/08		10/23/08	
		µg/L		µg/L		µg/L		µg/L		µg/L		µg/L		µg/L	
Acetone	50 G	3000	U	30	U	30	U	30	U	300	U	30	U	3000	U
Benzene	1 S	50	U	0.50	U	0.50	U	0.50	U	5.0	U	0.50	U	50	U
2-Butanone (MEK)	NC	3000	U	30	U	30	U	30	U	300	U	30	U	3000	U
Carbon disulfide	NC	50	U	0.50	U	0.50	U	0.50	U	5.0	U	0.50	U	50	U
Carbon tetrachloride	5 S	50	U	0.50	U	0.50	U	0.50	U	5.0	U	0.50	U	50	U
Chlorobenzene	5 POC	50	U	0.50	U	0.50	U	0.50	U	5.0	U	0.50	U	50	U
Chloroethane	5 POC	500	U	5.0	U	5.0	U	5.0	U	50	U	5.0	U	500	U
Chloroform	7 S	50	U	0.50	U	0.50	U	0.50	U	5.0	U	0.50	U	50	U
c-1,2-Dichloroethene	5 POC	50	U	0.50	U	1.2		7.7		5.0	U	0.50	U	50	U
Dibromochloromethane	50 G	50	U	0.50	U	0.50	U	0.50	U	5.0	U	0.50	U	50	U
1,2-Dichlorobenzene	3 S	50	U	0.50	U	0.50	U	0.50	U	5.0	U	0.50	U	50	U
1,2-Dichloroethane	0.6 S	50	U	0.50	U	0.50	U	0.50	U	5.0	U	0.50	U	50	U
1,3-Dichlorobenzene	3 S	50	U	0.50	U	0.50	U	0.50	U	5.0	U	0.50	U	50	U
1,3-Dichloropropane	5 POC	50	U	0.50	U	0.50	U	0.50	U	5.0	U	0.50	U	50	U
1,4-Dichlorobenzene	3 S	50	U	0.50	U	0.50	U	0.50	U	5.0	U	0.50	U	50	U
1,1-Dichloroethane	5 POC	50	U	0.62		0.50	U	0.50	U	***5.4***		0.50	U	50	U
1,1-Dichloroethene	5 POC	50	U	0.50	U	0.50	U	0.50	U	5.0	U	0.50	U	50	U
Ethylbenzene	5 POC	50	U	0.50	U	0.50	U	0.50	U	5.0	U	0.50	U	50	U
m+p-Xylene	NC	100	U	1.0	U	1.0	U	1.0	U	10	U	1.0	U	100	U
Methyl Isobutyl Ketone (MIBK)	NC	2000	U	20	U	20	U	20	U	200	U	20	U	2000	U
Methyl-t-butyl ether	NC	500	U	5.0	U	5.0	U	5.0	U	50	U	5.0	U	500	U
Methylene chloride	5 POC	50	U	0.50	U	0.50	U	0.50	U	5.0	U	0.50	U	50	U
o-Xylene	NC	50	U	0.50	U	0.50	U	0.54		5.0	U	0.50	U	50	U
Tetrachloroethene	5 POC	***1900***		4.8		***10***		***5.7***		***18***		3.0		***710***	
Toluene	5 POC	50	U	0.50	U	0.50	U	0.50	U	5.0	U	0.50	U	50	U
1,1,1-Trichloroethane	5 POC	***950***		0.67		1.1		0.50	U	5.0	U	0.50	U	***72***	
1,1,2,2-Tetrachloroethane	5 POC	50	U	0.50	U	0.50	U	0.50	U	5.0	U	0.50	U	50	U
1,1,2-Trichlorotrifluoroethane	NC	50	U	0.50	U	0.50	U	0.50	U	5.0	U	0.50	U	50	U
1,2,3-Trichloropropane	0.04 S	50	U	0.50	U	0.50	U	0.50	U	5.0	U	0.50	U	50	U
1,2,4-Trichlorobenzene	5 POC	50	U	0.50	U	0.50	U	0.50	U	5.0	U	0.50	U	50	U
t-1,2-Dichloroethene	5 POC	50	U	0.50	U	0.50	U	0.50	U	5.0	U	0.50	U	50	U
Trichloroethene	5 POC	***610***		1.6		2.8		1.0		5.0	U	0.86		***57***	
Vinyl chloride	2 S	50	U	0.50	U	0.50	U	0.50	U	5.0	U	0.50	U	50	U
Dibromofluoromethane	%	88.9		98.4		98.1		96.6		108		100		109	
Toluene-D8	%	104		103		102		103		117		116		118	
Bromofluorobenzene	%	98.3		102		104		104		95.4		104		101	

Notes:

E = estimated, exceeds calibration range

HC = Results maybe biased high due to continuing calibration verification (CCV) not within control limits.

LC = results maybe biased low due to continuing calibration verification not within control limits

U = compounds not detected at reporting limit

NC = no criteria

µg/L = microgram per liter

POC = principle organic compound

S = standard value

G = guidance value

Bold = exceeds criteria

🟨 = hit

Table 3-2
Groundwater Sampling Analytical Results
October 2008
Pride Solvents Chemical Company
Babylon, New York

Sample ID	TOGS 1.1.1 Class GA Guidance/ Standards Standards	65986-ERM-MW-03D		65986-ERM-MW-03S	
Location		ERM-MW-03D		ERM-MW-03S	
Sampling Date		10/23/08		10/31/08	
		µg/L		µg/L	
Acetone	50 G	30	U	30	U
Benzene	1 S	0.50	U	0.50	U
2-Butanone (MEK)	NC	30	U	30	U
Carbon disulfide	NC	0.50	U	0.50	U
Carbon tetrachloride	5 S	0.50	U	0.50	U
Chlorobenzene	5 POC	0.50	U	0.50	U
Chloroethane	5 POC	5.0	U	5.0	U
Chloroform	7 S	0.50	U	0.50	U,LC
c-1,2-Dichloroethene	5 POC	0.50	U	0.50	U
Dibromochloromethane	50 G	0.50	U	0.50	U
1,2-Dichlorobenzene	3 S	0.50	U	0.50	U
1,2-Dichloroethane	0.6 S	0.50	U	0.50	U
1,3-Dichlorobenzene	3 S	0.50	U	0.50	U
1,3-Dichloropropane	5 POC	0.50	U	0.50	U
1,4-Dichlorobenzene	3 S	0.50	U	0.50	U
1,1-Dichloroethane	5 POC	0.50	U	0.50	U
1,1-Dichloroethene	5 POC	0.50	U	0.50	U
Ethylbenzene	5 POC	0.50	U	0.50	U
m+p-Xylene	NC	1.0	U	1.0	U
Methyl Isobutyl Ketone (MIBK)	NC	20	U	20	U
Methyl-t-butyl ether	NC	5.0	U	5.0	U
Methylene chloride	5 POC	0.50	U	0.50	U
o-Xylene	NC	0.50	U	0.50	U
Tetrachloroethene	5 POC	0.50	U	0.50	U
Toluene	5 POC	0.50	U	0.50	U
1,1,1-Trichloroethane	5 POC	0.50	U	0.50	U
1,1,2,2-Tetrachloroethane	5 POC	0.50	U	0.50	U
1,1,2-Trichlorotrifluoroethane	NC	0.50	U	0.50	U
1,2,3-Trichloropropane	0.04 S	0.50	U	0.50	U
1,2,4-Trichlorobenzene	5 POC	0.50	U	0.50	U
t-1,2-Dichloroethene	5 POC	0.50	U	0.50	U
Trichloroethene	5 POC	0.50	U	0.50	U
Vinyl chloride	2 S	0.50	U	0.50	U,LC
Dibromofluoromethane	%	98.4		95	
Toluene-D8	%	112		101	
Bromofluorobenzene	%	89.9		101	

Notes:

E = estimated, exceeds calibration range

HC = Results maybe biased high due to continuing calibration verification (CCV) not within control limits.

LC = results maybe biased low due to continuing calibration verification not within control limits

U = compounds not detected at reporting limit

NC = no criteria

µg/L = microgram per liter

POC = principle organic compound

S = standard value

G = guidance value

Bold = exceeds criteria

🟨 = hit

Table 3-3
Groundwater Sampling Analytical Results
February 2009
Pride Solvents Chemical Company
Babylon, New York

Sample ID	**TOGS 1.1.1 Class GA Guidance/ Standards**		**ERM-MW-01D**	**ERM-MW-01S**	**ERM-MW-03D**	**ERM-MW-03S**	**ERM-MW-04D**	**ERM-MW-04S**	**MW-04X**	**ERM-MW-05D**	**ERM-MW-06D**	**ERM-MW-07D**	**MW-7SM**	**MW-01**	**MW-02**	**MW-03**	**MW-03X**	**MW-04**	**MW-05**
Lab Sample Number			**H0261-12**	**H0261-11**	**H0245-02**	**H0245-03**	**H0245-08**	**H0245-09**	**H0245-01**	**H0245-07**	**H0245-12**	**H0261-17**	**H0261-16**	**H0245-11**	**H0261-19**	**H0245-17**	**H0245-18**	**H0261-22**	**H0245-16**
Sampling Date			**2/25/2009**	**2/25/2009**	**2/19/2009**	**2/19/2009**	**2/19/2009**	**2/19/2009**	**2/19/2009**	**2/19/2009**	**2/20/2009**	**2/26/2009**	**2/26/2009**	**2/20/2009**	**2/26/2009**	**2/23/2009**	**2/23/2009**	**2/27/2009**	**2/23/2009**
Volatile Organic Compound (µg/L)																			
1,1,1-Trichloroethane	5	POC	2.4	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	***300 D***	0.5 U	***68 D***	0.5 U	0.31 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1,2,2-Tetrachloroethane	5	POC	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1,2-Trichloro-1,2,2-trifluoroethane	5	POC	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1.1	0.5 U	1.7	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1,2-Trichloroethane	1	S	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1-Dichloroethane	5	POC	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	3.4	0.5 U	1.7	0.5 U	4.3	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1-Dichloroethene	5	POC	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	***25***	0.5 U	0.84	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,2,3-Trichlorobenzene	5	POC	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,2,4-Trichlorobenzene	5	POC	0.5 UJ	0.5 UJ	0.5 UJ	0.5 UJ	0.5 UJ	0.5 UJ	0.5 UJ	0.5 UJ	0.5 U	1.7 J	0.5 UJ	0.5 U	0.5 UJ	0.5 U	0.5 U	0.5 UJ	0.5 U
1,2-Dibromo-3-chloropropane	0.04	S	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,2-Dibromoethane	NL		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,2-Dichlorobenzene	3	S	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	3	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,2-Dichloroethane	0.6	S	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,2-Dichloropropane	1	S	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,3-Dichlorobenzene	3	S	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,4-Dichlorobenzene	3	S	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
2-Butanone	NL		5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
2-Hexanone	50	G	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 UJ	5 UJ	5 U	5 UJ	5 U	5 UJ	5 UJ	5 U	5 UJ
4-Methyl-2-pentanone	NL		5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 UJ	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Acetone	50	G	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	***120***	5 U
Benzene	NL		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Bromochloromethane	5	POC	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Bromodichloromethane	50	G	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Bromoform	50	G	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Bromomethane	5	POC	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Carbon disulfide	NL		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Carbon tetrachloride	5	S	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Chlorobenzene	5	POC	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Chloroethane	5	POC	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Chloroform	7	S	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1.4	0.5 U
Chloromethane	NL		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1.9	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
cis-1,2-Dichloroethene	5	POC	0.5 U	***5.8***	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
cis-1,3-Dichloropropene	0.4	S	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	***0.5 U***	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Cyclohexane	NL		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Dibromochloromethane	50	G	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Dichlorodifluoromethane	5	POC	0.5 U	0.5 U	0.5 UJ	0.5 UJ	0.5 UJ	0.5 UJ	0.5 UJ	0.5 UJ	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Ethylbenzene	5	POC	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Isopropylbenzene	5	POC	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Methyl acetate	NL		0.5 U	0.5 U	0.5 UJ	0.5 UJ	0.5 UJ	0.5 UJ	0.5 UJ	0.5 UJ	0.5 UJ	0.5 U	0.5 U	0.5 UJ	0.5 U	0.5 UJ	0.5 UJ	1100 D	0.5 UJ
Methyl tert-butyl ether	NL		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Methylcyclohexane	NL		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Methylene chloride	5	POC	0.5 U	0.5 U	0.5 UJ	0.5 UJ	0.5 UJ	0.5 UJ	0.5 UJ	0.5 UJ	0.5 UJ	0.5 U	0.5 U	0.5 UJ	0.5 U	0.5 UJ	0.5 UJ	0.5 U	0.5 UJ
Styrene	5	POC	0.5 U	0.5 U	0.5 UJ	0.5 UJ	0.5 UJ	0.5 UJ	0.5 UJ	0.5 UJ	0.5 UJ	0.5 U	0.5 U	0.5 UJ	0.5 U	0.5 UJ	0.5 UJ	0.5 U	0.5 UJ
Tetrachloroethene	5	POC	***83 D***	***11***	0.5 U	0.5 U	0.49 J	0.72 U	0.47	***590 D***	***18***	***1100 D***	0.5 U	**17.68**	3.9	0.5 U	0.5 U	3.8	0.5 U
Toluene	5	POC	0.46 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.95	2.2	0.5 U	0.5 U	0.5 U	0.5 U	***110 D***	0.5 U
trans-1,2-Dichloroethene	5	POC	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
trans-1,3-Dichloropropene	0.4	S	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	***0.5 U***	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Trichloroethene	5	POC	2.6	1.3	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	***190 D***	0.37 J	***56 JD***	0.5 U	3.45	0.71	0.5 U	0.5 U	0.47 J	0.5 U
Trichlorofluoromethane	5	POC	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Vinyl chloride	2	S	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Xylenes (Total)	5	POC	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Wet Chemistry																			
Alkalinity, Total (As CaCO3) (mg/L CaCO3)	NL		23	46	20 U	60	20 U	88	89	24	31	22	38	77	32	20 U	20 U	120	43
Chloride (mg/L)	250000	S	12	36	12	10	12	13	13	13	12	14	10	9.7	6	11	11	35	9.6
Ethane (µg/L)	NL		1.2 U	1.3 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.3 U	1.2 U	1.2 U	1.2 U	1.3 U	1.3 U	1.2 U	1.3 U
Ethene (µg/L)	NL		1.5 U	1.6 U	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U	1.6 U	1.5 U	1.5 U	1.5 U	1.6 U	1.6 U	1.5 U	1.6 U
Methane (µg/L)	NL		0.6 U	180	0.6 U	150	0.6 U	19	97	0.58 U	0.6 U	0.61 U	11	0.6 U	0.6 U	0.61 U	0.61 U	0.6 U	0.61 U
Nitrogen, Nitrite (As N) (mg/L)	10000	S	0.13 U	2.4	5	0.7	5.3	4.4	4.1	0.13 U	0.13 U	4.7	0.13 U	1.1	2	5.1	5	0.13 U	2.5
Nitrogen, Nitrite (As N) (mg/L)	10000	S	4.5	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	5.6	4.4	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	9.7	0.13 U
Organic Carbon, Total (mg/L)	NL		10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	12	10 U
Sulfate (mg/L)	250000	S	34	24	34	16	33	27	27	34	34	33	30	56	25	33	32	29	36

Notes:
U = compounds not detected at reporting limit
J = estimated concentration
D = the reported value is from a secondary analysis with a dilution factor. The original analysis exceeded the calibration range.
µg/L = microgram per liter
NL = compounds currently has no standard or guidance value
POC = principle organic compound
S = standard value
G = guidance value
Bold = exceeds criteria
🟨 = hit

Table 3-3
Groundwater Sampling Analytical Results
February 2009
Pride Solvents Chemical Company
Babylon, New York

Sample ID	TOGS 1.1.1 Class GA Guidance/ Standards		MW-06	MW-07	MW-08	MW-09	MW-10	MW-11	MW-12D	MW-12SM	MW-13D	MW-14D	MW-14SM	MW-15D	MW-16D	MW-17D
Lab Sample Number			**H0245-06**	**H0245-13**	**H0261-18**	**H0261-15**	**H0245-19**	**H0245-20**	**H0261-02**	**H0261-03**	**H0261-08**	**H0261-09**	**H0261-10**	**H0261-04**	**H0261-07**	**H0261-01**
Sampling Date			**2/19/2009**	**2/20/2009**	**2/26/2009**	**2/26/2009**	**2/23/2009**	**2/23/2009**	**2/24/2009**	**2/24/2009**	**2/25/2009**	**2/25/2009**	**2/25/2009**	**2/24/2009**	**2/25/2009**	**2/24/2009**
Volatile Organic Compound (µg/L)																
1,1,1-Trichloroethane	5	POC	0.5 U	0.5 U	0.5 U	0.32 J	0.5 U	0.5 U	0.5 U	0.5 U	***410*** ***D***	1.7	0.5 U	***18***	0.5 U	0.5 U
1,1,2,2-Tetrachloroethane	5	POC	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1,2-Trichloro-1,2,2-trifluoroethane	5	POC	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1.1	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1,2-Trichloroethane	1	S	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,1-Dichloroethane	5	POC	0.5 U	0.5 U	0.5 U	4.1	0.5 U	0.5 U	0.5 U	0.5 U	***9***	0.5 U	0.5 U	1.9	0.5 U	0.5 U
1,1-Dichloroethene	5	POC	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	***8.4***	0.5 U	0.5 U	0.82	0.5 U	0.5 U
1,2,3-Trichlorobenzene	5	POC	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,2,4-Trichlorobenzene	5	POC	0.5 UJ	0.5 U	0.5 UJ	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 UJ	0.5 UJ	0.5 U	0.5 UJ	0.5 U	0.5 U
1,2-Dibromo-3-chloropropane	0.04	S	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,2-Dibromoethane	NL		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,2-Dichlorobenzene	3	S	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,2-Dichloroethane	0.6	S	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,2-Dichloropropane	1	S	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,3-Dichlorobenzene	3	S	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,4-Dichlorobenzene	3	S	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
2-Butanone	NL		5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
2-Hexanone	50	G	5 U	5 UJ	5 U	5 U	5 UJ	5 UJ	5 UJ	5 U	5 UJ	5 U	5 U	5 U	5 U	5 U
4-Methyl-2-pentanone	NL		5 U	5 U	5 U	5 U	5 U	5 U	5 UJ	5 U	5 UJ	5 U	5 U	5 U	5 U	5 U
Acetone	50	G	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Benzene	NL		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Bromochloromethane	5	POC	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Bromodichloromethane	50	G	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Bromoform	50	G	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Bromomethane	5	POC	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Carbon disulfide	NL		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Carbon tetrachloride	5	S	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Chlorobenzene	5	POC	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Chloroethane	5	POC	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Chloroform	7	S	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Chloromethane	NL		0.5 U	0.5 U	0.5 U	0.3 J	0.5 U	0.5 U	0.52	0.38 J	0.93 U	0.5 U	0.5 U	0.71	0.5 U	0.5 U
cis-1,2-Dichloroethene	5	POC	0.5 U	0.5 U	1.2	0.5 U	0.5 U	0.5 U	0.5 UJ	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
cis-1,3-Dichloropropene	0.4	S	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Cyclohexane	NL		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Dibromochloromethane	50	G	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Dichlorodifluoromethane	5	POC	0.5 UJ	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Ethylbenzene	5	POC	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Isopropylbenzene	5	POC	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Methyl acetate	NL		0.5 UJ	0.5 UJ	0.5 U	0.5 U	0.5 UJ	0.5 UJ	0.5 U	0.5 U	0.5 U	1.3	0.5 U	0.5 U	0.5 U	0.5 U
Methyl tert-butyl ether	NL		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Methylcyclohexane	NL		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Methylene chloride	5	POC	0.5 UJ	0.5 UJ	0.5 U	0.5 U	0.5 UJ	0.5 UJ	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Styrene	5	POC	0.5 UJ	0.5 UJ	0.5 U	0.5 U	0.5 UJ	0.5 UJ	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Tetrachloroethene	5	POC	1	3.2	***10***	***16***	0.5 U	0.5 U	0.5 U	0.5 U	**1200** **D**	**64** **D**	0.5 U	**290** **D**	0.52	0.71
Toluene	5	POC	0.5 U	0.5 U	0.48 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1.8	1.1	2.1	0.5 U	3.7	0.5 U
trans-1,2-Dichloroethene	5	POC	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 UJ	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
trans-1,3-Dichloropropene	0.4	S	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Trichloroethene	5	POC	0.5 U	0.59	1.1	2.5	0.5 U	0.5 U	0.5 U	0.5 U	**300** **D**	2.3	0.5 U	***25***	0.5 U	0.5 U
Trichlorofluoromethane	5	POC	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Vinyl chloride	2	S	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Xylenes (Total)	5	POC	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Wet Chemistry																
Alkalinity, Total (As CaCO3) (mg/L CaCO3)	NL		40	42	23	71	60	42	26	49	25	26	59	25	22	20 U
Chloride (mg/L)	250000	S	14	5.9	15	11	10	16	12	7	13	11	5.8	13	94	10
Ethane (µg/L)	NL		1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.3 U	1.3 U	1.3 U	1.2 U	1.2 U	1.3 U	1.2 U	1.2 U	1.3 U
Ethene (µg/L)	NL		1.5 U	1.5 U	1.5 U	1.5 U	1.5 U	1.6 U	1.6 U	1.6 U	1.5 U	1.5 U	1.6 U	1.5 U	1.5 U	1.6 U
Methane (µg/L)	NL		0.58 U	0.6 U	0.6 U	0.6 U	0.6 U	0.61 U	2.6	330	0.6 U	0.63	560	0.6 U	0.6 U	0.63 U
Nitrogen, Nitrite (As N) (mg/L)	10000	S	0.13 U	2.4	3.2	1.5	1.9	1.3	4.3	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	3	4.1
Nitrogen, Nitrite (As N) (mg/L)	10000	S	4.2	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	0.13 U	5.3	5	0.13 U	5.5	0.13 U	0.13 U
Organic Carbon, Total (mg/L)	NL		10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Sulfate (mg/L)	250000	S	59	26	19	49	47	21	40	21	36	29	20	30	73	27

Notes:
U = compounds not detected at reporting limit
J = estimated concentration
D = the reported value is from a secondary analysis with a dilution factor. The original analysis exceeded the calibration range.
µg/L = microgram per liter
NL = compounds currently has no standard or guidance value
POC = principle organic compound
S = standard value
G = guidance value
Bold = exceeds criteria
🟨 = hit

Table 3-4
Soil Analytical Results
Pride Solvents Chemical Company
Babylon, New York

Sample ID		SB02-79		SB03-85		SB03-90		SB07-21		GWS09-80-81		SB11-23		SB11-89		SB15-82	
Location		GWS-02		GWS-03		GWS-03		GWS-07		GWS-09		GWS-11		GWS-11		GWS-15	
Sample Depth (feet bgs)	Unrestricted Use Criteria	79		85		90		21		80-81		23		89		82	
Sampling Date		10/09/08		10/13/08		10/13/08		10/15/08		10/16/08		10/21/08		10/21/08		11/03/08	
Volatile Organic Compounds (µg/kg)																	
Acetone	50	1700	U,LC	3500	U	4500	U	1200	U	1700	U	1200	U	5300	U	6800	U
Benzene	60	29	U	58	U	75	U	21	U	28	U	21	U	88	U	110	U
2-Butanone (MEK)	NC	1700	U	3500	U	4500	U	1200	U	1700	U	1200	U	5300	U	6800	U
Carbon disulfide	NC	29	U,LC	58	U	75	U	21	U	28	U	21	U	88	U	110	U
Carbon tetrachloride	760	29	U	58	U	75	U	21	U	28	U	21	U	88	U	110	U
Chlorobenzene	1100	29	U	58	U	75	U	21	U	28	U	21	U	88	U	110	U
Chloroethane	NC	290	U,LC	580	U	750	U	210	U,LC	280	U	210	U	880	U	1100	U,LC
Chloroform	370	29	U	58	U	75	U	21	U	28	U	21	U	88	U	110	U
c-1,2-Dichloroethene	250	29	U	58	U	75	U	21	U	28	U	21	U	88	U	110	U
Dibromochloromethane	NC	29	U	58	U	75	U	21	U	28	U	21	U	88	U	110	U
1,2-Dichlorobenzene	1100	29	U	58	U	75	U	21	U	28	U	21	U	88	U	110	U
1,2-Dichloroethane	20	29	U	58	U	75	U	21	U	28	U	21	U	88	U	110	U
1,3-Dichlorobenzene	2400	29	U	58	U	75	U	21	U	28	U	21	U	88	U	110	U
1,3-Dichloropropane	NC	29	U	58	U	75	U	21	U	28	U	21	U	88	U	110	U
1,4-Dichlorobenzene	1800	29	U	58	U	75	U	21	U	28	U	21	U	88	U	110	U
1,1-Dichloroethane	270	29	U	58	U,LC	75	U	21	U	28	U	21	U	88	U	110	U
1,1-Dichloroethene	330	29	U,LC	58	U	75	U	21	U	28	U	21	U	88	U	110	U
Ethylbenzene	1000	29	U	58	U	75	U	21	U	28	U	21	U	88	U	110	U
m+p-Xylene	260	58	U	120	U	150	U	41	U	56	U	41	U	180	U	230	U
Methyl Isobutyl Ketone (MIBK)	NC	1700	U	3500	U	4500	U	1200	U	1100	U	830	U	3500	U	4500	U
Methyl-t-butyl ether	930	29	U,LC	58	U	75	U	21	U	280	U	210	U	880	U	1100	U
Methylene chloride	50	29	U,LC	58	U	75	U	21	U	28	U	21	U	88	U	110	U,LC
o-Xylene	260	29	U	58	U	75	U	21	U	28	U	21	U	88	U	110	U
Tetrachloroethene	1300	29	U	320		75	U	21	U	28	U	21	U	***2000***		***7800***	
Toluene	700	29	U	58	U	75	U	21	U	28	U	21	U	88	U	110	U
1,1,1-Trichloroethane	680	29	U	58	U	75	U	21	U	28	U	21	U	88	U	110	U,LC
1,1,2,2-Tetrachloroethane	NC	29	U	58	U	75	U	21	U	28	U	21	U	88	U	110	U
1,1,2-Trichlorotrifluoroethane	NC	29	U,LC	58	U	75	U	21	U	28	U	21	U	88	U	110	U
1,2,3-Trichloropropane	NC	29	U	58	U	75	U	21	U	28	U	21	U	88	U	110	U
1,2,4-Trichlorobenzene	NC	29	U	58	U	75	U	21	U	28	U	21	U	88	U	160	
t-1,2-Dichloroethene	190	29	U,LC	58	U	75	U	21	U	28	U	21	U	88	U	110	U
Trichloroethene	470	29	U	100		75	U	21	U	28	U	21	U	88	U	270	
Vinyl chloride	20	29	U,LC	58	U	75	U	21	U	28	U	21	U	88	U	110	U

NOTES:

LC = results maybe biased low due to continuing calibration verification not within control limits
U = compounds not detected at reporting limit
µg/kg = microgram per kilogram
bgs = below ground surface
NC = no criteria
Bold = exceeds criteria
🟨 = hit

Table 3-4
Soil Analytical Results
Pride Solvents Chemical Company
Babylon, New York

Sample ID		GWS17-84.5-88		GWS19-25-25.5		GWS20-86-86.5		SB22-87		GWS23-20-21		GWS23-40-41		GWS23-86.5-87	
Location		GWS-17		GWS-19		GWS-20		GWS-22		GWS-23		GWS-23		GWS-23	
Sample Depth (feet bgs)	Unrestricted Use Criteria	84.5-88		25-25.5		86-86.5		87		20-21		40-41		86.5-87	
Sampling Date		11/03/08		11/04/08		11/06/08		11/06/08		11/06/08		11/06/08		11/07/08	
Volatile Organic Compounds (µg/kg)															
Acetone	50	1700	U	1500	U	1500	U	1200	U	1700	U	1500	U	1800	U
Benzene	60	29	U	25	U	25	U	19	U	28	U	25	U	30	U
2-Butanone (MEK)	NC	1700	U	1500	U	1500	U	1200	U	1700	U	1500	U	1800	U
Carbon disulfide	NC	29	U	25	U	25	U	19	U	28	U	25	U	30	U
Carbon tetrachloride	760	29	U	25	U	25	U	19	U	28	U	25	U	30	U
Chlorobenzene	1100	29	U	25	U	25	U	19	U	28	U	25	U	30	U
Chloroethane	NC	290	U,LC	250	U,LC	250	U	190	U,LC	280	U,LC	250	U	300	U,LC
Chloroform	370	29	U	25	U	25	U	19	U	28	U	25	U	30	U
c-1,2-Dichloroethene	250	29	U	25	U	25	U	19	U	28	U	25	U	30	U
Dibromochloromethane	NC	29	U	25	U	25	U	19	U	28	U	25	U	30	U
1,2-Dichlorobenzene	1100	29	U	25	U	25	U	19	U	28	U	25	U	30	U
1,2-Dichloroethane	20	29	U	25	U	25	U	19	U	28	U	25	U	30	U
1,3-Dichlorobenzene	2400	29	U	25	U	25	U	19	U	28	U	25	U	30	U
1,3-Dichloropropane	NC	29	U	25	U	25	U	19	U	28	U	25	U	30	U
1,4-Dichlorobenzene	1800	29	U	25	U	25	U	19	U	28	U	25	U	30	U
1,1-Dichloroethane	270	29	U	25	U	25	U	19	U	28	U	25	U	30	U
1,1-Dichloroethene	330	29	U	25	U	25	U	19	U	28	U	25	U	30	U
Ethylbenzene	1000	29	U	25	U	25	U	19	U	28	U	25	U	30	U
m+p-Xylene	260	58	U	49	U	49	U	39	U	56	U	50	U	61	U
Methyl Isobutyl Ketone (MIBK)	NC	1200	U	980	U	990	U	780	U	1100	U	1000	U	1200	U
Methyl-t-butyl ether	930	290	U	250	U	250	U	190	U	280	U	250	U	300	U
Methylene chloride	50	29	U	25	U	25	U	19	U	28	U	25	U	30	U
o-Xylene	260	29	U	25	U	25	U	19	U	28	U	25	U	30	U
Tetrachloroethene	1300	140		25	U	25	U	19	U	28	U	25	U	30	U
Toluene	700	29	U	25	U	25	U	19	U	28	U	25	U	30	U
1,1,1-Trichloroethane	680	29	U	25	U	25	U	19	U	28	U	25	U	30	U
1,1,2,2-Tetrachloroethane	NC	29	U	25	U,LC	25	U	19	U	28	U	25	U	30	U
1,1,2-Trichlorotrifluoroethane	NC	29	U	25	U	25	U	19	U	28	U	25	U	30	U
1,2,3-Trichloropropane	NC	29	U	25	U	25	U	19	U	28	U	25	U	30	U
1,2,4-Trichlorobenzene	NC	29	U	25	U	25	U	19	U	28	U	25	U	30	U
t-1,2-Dichloroethene	190	29	U	25	U	25	U	19	U	28	U	25	U	30	U
Trichloroethene	470	69		25	U	25	U	19	U	28	U	25	U	30	U
Vinyl chloride	20	29	U,LC	25	U	25	U	19	U	28	U	25	U	30	U

NOTES:

LC = results maybe biased low due to continuing calibration verification not within control limits

U = compounds not detected at reporting limit

µg/kg = microgram per kilogram

bgs = below ground surface

NC = no criteria

Bold = exceeds criteria

🟨 = hit

Table 6-1
Identification and Screening of Remedial Technologies
Operable Unit 1, Shallow Groundwater and Vadose Zone
Pride Solvents and Chemical Company
Babylon, New York

Remedial Technology	Description	Effectiveness	Implementability	Cost	Retained? (Y/N)
1. No Action	▪ The No Action alternative is not a technology. ▪ The No Action alternative is considered as a basis for comparison.	▪ This alternative is used as a baseline against which other technologies will be compared.	▪ It is implementable given there is no action required.	▪ Does not require any capital cost.	Yes
2. Environmental Easements	▪ Environmental easements are regulatory actions that may be used to prevent intrusive activities within the contaminated plume.	▪ Effectively restrict or eliminate use of contaminated groundwater, thereby reducing risks to human health. ▪ It will not restrict the migration of contaminant and its impact on groundwater.	▪ Easily implementable through existing administrative system.	▪ Low administrative cost and long term monitoring.	Yes
3. Well Drilling Restrictions	▪ Well drilling restrictions are regulatory actions that are used to regulate installation of groundwater drinking water wells.	▪ May effectively meet RAOs through restriction of future site use or activities which could create human exposure pathways to contaminated groundwater. ▪ It will not restrict the migration of contaminant and its impact on groundwater.	▪ Implementable via existing permitting process.	▪ Low administrative cost.	Yes
4. Long Term Monitoring	▪ Long-term monitoring includes periodic sampling and analysis of groundwater samples.	▪ Long-term monitoring alone would not be effective in meeting the RAOs. ▪ It will not alter the effects of contamination on human exposure but it is a proven and reliable process for tracking the migration of contaminants during and following treatment.	▪ Easily implementable.	▪ Low capital and moderate O&M cost.	Yes
5. Monitored Natural Attenuation (MNA)	▪ MNA refers to the remedial action that relies on naturally occurring attenuation processes to achieve site-specific RAOs within a reasonable time frame.	▪ Evidence of significant biodegradation has not been observed at the Site.	▪ Easily implementable.	▪ Low capital cost and moderate O&M.	Yes
6. Slurry Walls	▪ Slurry walls are constructed by pumping a low-permeability slurry, typically consisting of either a soil-bentonite or cement-bentonite mixture, into an excavated trench.	▪ Slurry walls would effectively achieve hydraulic control if properly built.	▪ Slurry walls are not implementable due to the depth to a confining layer.	▪ High capital cost.	No
7. Sheet Pile Barriers	▪ Sheet pile barriers are constructed by driving or vibrating sections of steel sheet piling into the ground. Each sheet pile section is interlocked at its edges, and the seams are often grouted to prevent leakage.	▪ Sheet Piles would effective achieve hydraulic control if properly built.	▪ Sheet pile barriers are not implementable due to the depth to a confining layer.	▪ High capital cost.	No
8. Groundwater Extraction Wells	▪ This technology involves the installation of groundwater extraction wells within areas of contamination to provide hydraulic control and to capture contaminants.	▪ The on-site hydrogeologic conditions favor groundwater extraction technology for this site.	▪ Challenges due to large foot print requirement of groundwater treatment system.	▪ Moderate capital cost and moderate O&M cost.	Yes

Table 6-1
Identification and Screening of Remedial Technologies
Operable Unit 1, Shallow Groundwater and Vadose Zone
Pride Solvents and Chemical Company
Babylon, New York

Remedial Technology	Description	Effectiveness	Implementability	Cost	Retained? (Y/N)
9. Permeable Reactive Barriers (PRB)	▪ Permeable reactive barriers (PRBs) provide in situ treatment of groundwater and are designed to intercept contaminated groundwater flow. ▪ When the contaminated groundwater passes through the reactive zone of the barrier, the contaminants are either immobilized or chemically degraded to less harmful product(s).	▪ PRBs have been effective in degrading chlorinated solvents.	▪ A vertical PRB is not feasible due to the thickness of the saturated zone.	▪ High capital cost and low O&M cost. ▪ High replacement cost.	Yes
10. In Situ Chemical Oxidation (ISCO)	▪ Contaminants are destroyed through chemical oxidation reactions. ▪ Oxidants can be injected into the treatment area using injection wells, direct push technology, and fracturing. ▪ Oxidant type is dictated by the contaminant. ▪ Repeat application of oxidant is generally required due to mass transfer from areas of low permeability into areas of high permeability.	▪ Effectiveness of ISCO depends on adequate contact between oxidants and contaminants. ▪ Oxidants that could effectively oxidize PCE include, but are not limited to Fenton's reagent, activated persulfate, ozone, and potassium permanganate etc.	▪ Oxidants can be delivered through injections. Large amounts of oxidant would be required given the low concentrations of target contaminants and high expected soil oxidant demand,	▪ High capital cost and low O&M cost.	No
11. In Situ Air Sparging/Soil Vapor Extraction	▪ Air sparged into the groundwater removes organic contaminants by volatilization and stripping. A Soil Vapor Extraction (SVE) system collects the volatilized contaminants.	▪ AS/SVE has been shown to be effective in removing VOCs from shallow groundwater zones.	▪ AS/SVE is implementable for the shallow groundwater and vadose zone contamination in OU1	▪ High capital cost and moderate O&M cost.	Yes
12. Enhanced Anaerobic Bioremediation (EAB)	▪ Enhanced Anaerobic Biodegradation (EAB) is a remedial technology designed to facilitate the in situ biological destruction of chlorinated VOCs over a wide range of concentrations. ▪ EAB involves the injection of an electron donor and potentially nutrients or dechlorinating microorganisms (i.e., bioaugmentation) into the subsurface.	▪ EAB can be effective in a heterogeneous subsurface environment because once produced, the dechlorination conditions and bacteria would persist for some time, and contaminants diffusing out of low permeable zones can be treated.	▪ A viscous amendment would be required to sustain the anaerobic conditions required for reductive dechlorination.	▪ Moderate capital and O&M cost.	Yes
13. In Situ Thermal Remediation (ISTR)	▪ Heat is applied to the subsurface soils and groundwater using technologies such as electrical resistivity heating (ERH). ▪ For chlorinated solvents, vaporization is the driving mechanism for mass removal. ▪ Typically applied in conjunction with soil vapor extraction (SVE).	▪ Extremely rapid remediation. Case studies have shown large percentage of mass is removed on a time frame of months. ▪ Process is easily maintained with little supervision once high temperature is reached. ▪ System is only effective if vaporized chlorinated solvents are captured and treated.	▪ The vaporized contaminants would rise from the shallow groundwater into the vadose zone, and be captured by a soil vapor extraction system.	▪ High capital and O&M cost.	Yes
14. Discharge – on-site or off-site handling	▪ Extracted groundwater could be handled on-site or off-site by a variety of techniques.	▪ The effectiveness of each discharge management option would depend on proper design.	▪ Easy to implement.	▪ Moderate capital and high O&M.	Yes

Table 6-2
Identification and Screening of Remedial Technologies
Operable Unit 2, Deep Groundwater
Pride Solvents and Chemical Company
Babylon, New York

Remedial Technology	Description	Effectiveness	Implementability	Cost	Retained? (Y/N)
Groundwater – Saturated Zone					
1. No Action	▪ The No Action alternative is not a technology. ▪ The No Action alternative is considered as a basis for comparison.	▪ This alternative is used as a baseline against which other technologies will be compared.	▪ It is implementable given there is no action required.	▪ Does not require any capital cost.	Yes
2. Environmental Easements	▪ Environmental easements are regulatory actions that may be used to prevent intrusive activities within the contaminated plume.	▪ Effectively restrict or eliminate use of contaminated groundwater, thereby reducing risks to human health. ▪ It will not restrict the migration of contaminant and its impact on groundwater.	▪ Easily implementable through existing administrative system.	▪ Low administrative cost and long term monitoring.	Yes
3. Well Drilling Restrictions	▪ Well drilling restrictions are regulatory actions that are used to regulate installation of groundwater drinking water wells.	▪ May effectively meet RAOs through restriction of future site use or activities which could create human exposure pathways to contaminated groundwater. ▪ It will not restrict the migration of contaminant and its impact on groundwater.	▪ Implementable via existing permitting process.	▪ Low administrative cost.	Yes
4. Long Term Monitoring	▪ Long-term monitoring includes periodic sampling and analysis of groundwater samples.	▪ Long-term monitoring alone would not be effective in meeting the RAOs. ▪ It will not alter the effects of contamination on human exposure but it is a proven and reliable process for tracking the migration of contaminants during and following treatment.	▪ Easily implementable.	▪ Low capital and moderate O&M cost.	Yes
5. Monitored Natural Attenuation (MNA)	▪ MNA refers to the remedial action that relies on naturally occurring attenuation processes to achieve site-specific RAOs within a reasonable time frame.	▪ Evidence of significant biodegradation has not been observed at the Site.	▪ Easily implementable.	▪ Low capital cost and moderate O&M.	Yes
6. Slurry Walls	▪ Slurry walls are constructed by pumping a low-permeability slurry, typically consisting of either a soil-bentonite or cement-bentonite mixture, into an excavated trench.	▪ Slurry walls would effectively achieve hydraulic control if properly built.	▪ Slurry walls are not implementable due to site constraints, very deep groundwater table and very large (80-200 ft bgs) contaminated saturated zone.	▪ High capital cost.	No
7. Sheet Pile Barriers	▪ Sheet pile barriers are constructed by driving or vibrating sections of steel sheet piling into the ground. Each sheet pile section is interlocked at its edges, and the seams are often grouted to prevent leakage.	▪ Sheet Piles would effective achieve hydraulic control if properly built.	▪ Sheet pile barriers are not implementable due to site constraints, very deep groundwater table and very large (80-200 ft bgs) contaminated saturated zone.	▪ High capital cost.	No

Table 6-2
Identification and Screening of Remedial Technologies
Operable Unit 2, Deep Groundwater
Pride Solvents and Chemical Company
Babylon, New York

Remedial Technology	Description	Effectiveness	Implementability	Cost	Retained? (Y/N)
8. Groundwater Extraction Wells	▪ This technology involves the installation of groundwater extraction wells within areas of contamination to provide hydraulic control and to capture contaminants.	▪ The on-site hydrogeologic conditions favor groundwater extraction technology for this site.	▪ Challenges due to large foot print requirement of groundwater treatment system.	▪ Moderate capital cost and moderate O&M cost.	Yes
9. Permeable Reactive Barriers (PRB)	▪ Permeable reactive barriers (PRBs) provide in situ treatment of groundwater and are designed to intercept contaminated groundwater flow. ▪ When the contaminated groundwater passes through the reactive zone of the barrier, the contaminants are either immobilized or chemically degraded to less harmful product(s).	▪ PRBs have been effective in degrading chlorinated solvents.	▪ A vertical PRB is not feasible due to the thickness of the saturated zone. ▪ A horizontal PRB over the contaminated clay layer would be implementable.	▪ High capital cost and low O&M cost. ▪ High replacement cost.	Yes
10. In Situ Chemical Oxidation (ISCO)	▪ Contaminants are destroyed through chemical oxidation reactions. ▪ Oxidants can be injected into the treatment area using injection wells, direct push technology, and fracturing. ▪ Oxidant type is dictated by the contaminant. ▪ Repeat application of oxidant is generally required due to mass transfer from areas of low permeability into areas of high permeability.	▪ Effectiveness of ISCO depends on adequate contact between oxidants and contaminants. ▪ Oxidants that could effectively oxidize PCE include, but are not limited to Fenton's reagent, activated persulfate, ozone, and potassium permanganate etc.	▪ Oxidants can be delivered through injections. Given the length of the plume, multiple injection points would be required	▪ High capital cost and low O&M cost.	Yes
11. In Situ Air Sparging/Soil Vapor Extraction	▪ Air sparged into the groundwater removes organic contaminants by volatilization and stripping. A Soil Vapor Extraction (SVE) system collects the volatilized contaminants.	▪ AS/SVE has been shown to be effective in removing VOCs from shallow groundwater zones.	▪ AS/SVE is not implementable for the deep groundwater/clay zone due to the difficulty of capturing the vaporized contaminants. ▪ AS/SVE is implementable for the shallow groundwater and vadose zone contamination adjacent to 78 Lamar St.	▪ High capital cost and moderate O&M cost.	Yes
12. Enhanced Anaerobic Bioremediation (EAB)	▪ Enhanced Anaerobic Biodegradation (EAB) is a remedial technology designed to facilitate the in situ biological destruction of chlorinated VOCs over a wide range of concentrations. ▪ EAB involves the injection of an electron donor and potentially nutrients or dechlorinating microorganisms (i.e., bioaugmentation) into the subsurface.	▪ EAB can be effective in a heterogeneous subsurface environment because once produced, the dechlorination conditions and bacteria would persist for some time, and contaminants diffusing out of low permeable zones can be treated.	▪ In the Upper Glacial Aquifer, it would be difficult to maintain the reducing environment necessary for anaerobic biodegradation. ▪ EAB in the clay layer via fracturing would likely be implementable and effective	▪ Moderate capital and O&M cost.	Yes

Table 6-2
Identification and Screening of Remedial Technologies
Operable Unit 2, Deep Groundwater
Pride Solvents and Chemical Company
Babylon, New York

Remedial Technology	Description	Effectiveness	Implementability	Cost	Retained? (Y/N)
13. In Situ Thermal Remediation (ISTR)	▪ Heat is applied to the subsurface soils and groundwater using technologies such as electrical resistivity heating (ERH). ▪ For chlorinated solvents, vaporization is the driving mechanism for mass removal. ▪ Typically applied in conjunction with soil vapor extraction (SVE).	▪ Extremely rapid remediation. Case studies have shown large percentage of mass is removed on a time frame of months. ▪ Process is easily maintained with little supervision once high temperature is reached. ▪ System is only effective if vaporized chlorinated solvents are captured and treated.	▪ The vaporized contaminants would rise from the clay and then re-dissolve into the overlying aquifer. ▪ With appropriate modeling, a groundwater extraction and treatment system could be implemented to capture the re-dissolved contamination.	▪ High capital and O&M cost.	Yes
14. Discharge – on-site or off-site handling	▪ Extracted groundwater could be handled on-site or off-site by a variety of techniques.	▪ The effectiveness of each discharge management option would depend on proper design.	▪ Easy to implement.	▪ Moderate capital and high O&M.	Yes

Figures

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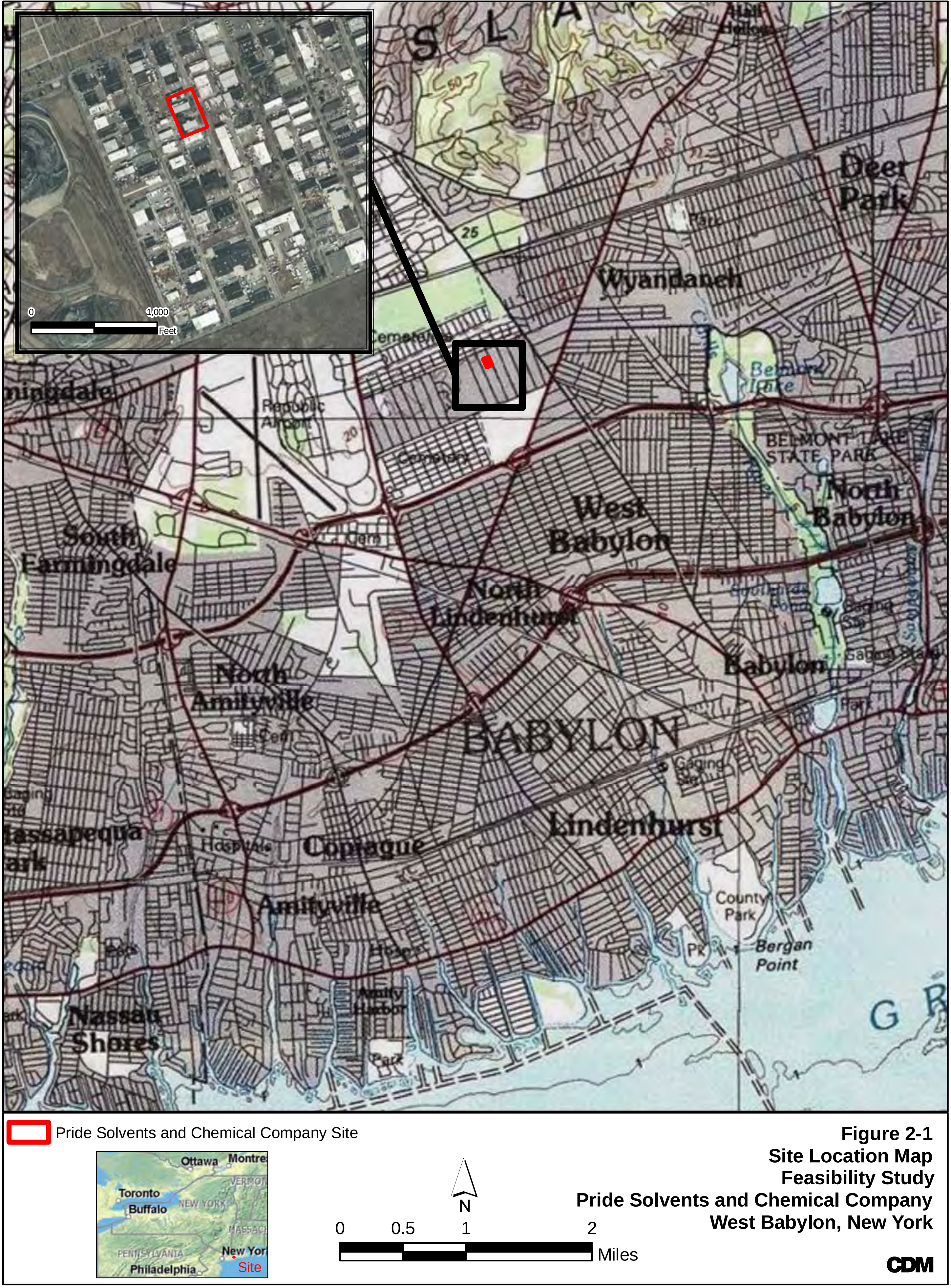


Figure 2-1
Site Location Map
Feasibility Study
Pride Solvents and Chemical Company
West Babylon, New York

CDM

Legend

🟥 Pride Solvents and Chemical Company

▨ Buildings

— 5-ft Topographic Contour

— 1-ft Topographic Contour

Note: Topographic elevation data is in feet above mean sea level (datum is NAVD88)

Detailed Site Features:

● DW-01	Dry Well
○ LP-01	Leaching Pool
Ⓢ ST-0	Septic Tank
— — — —	Buried Underground Pipe
⊙	Tree

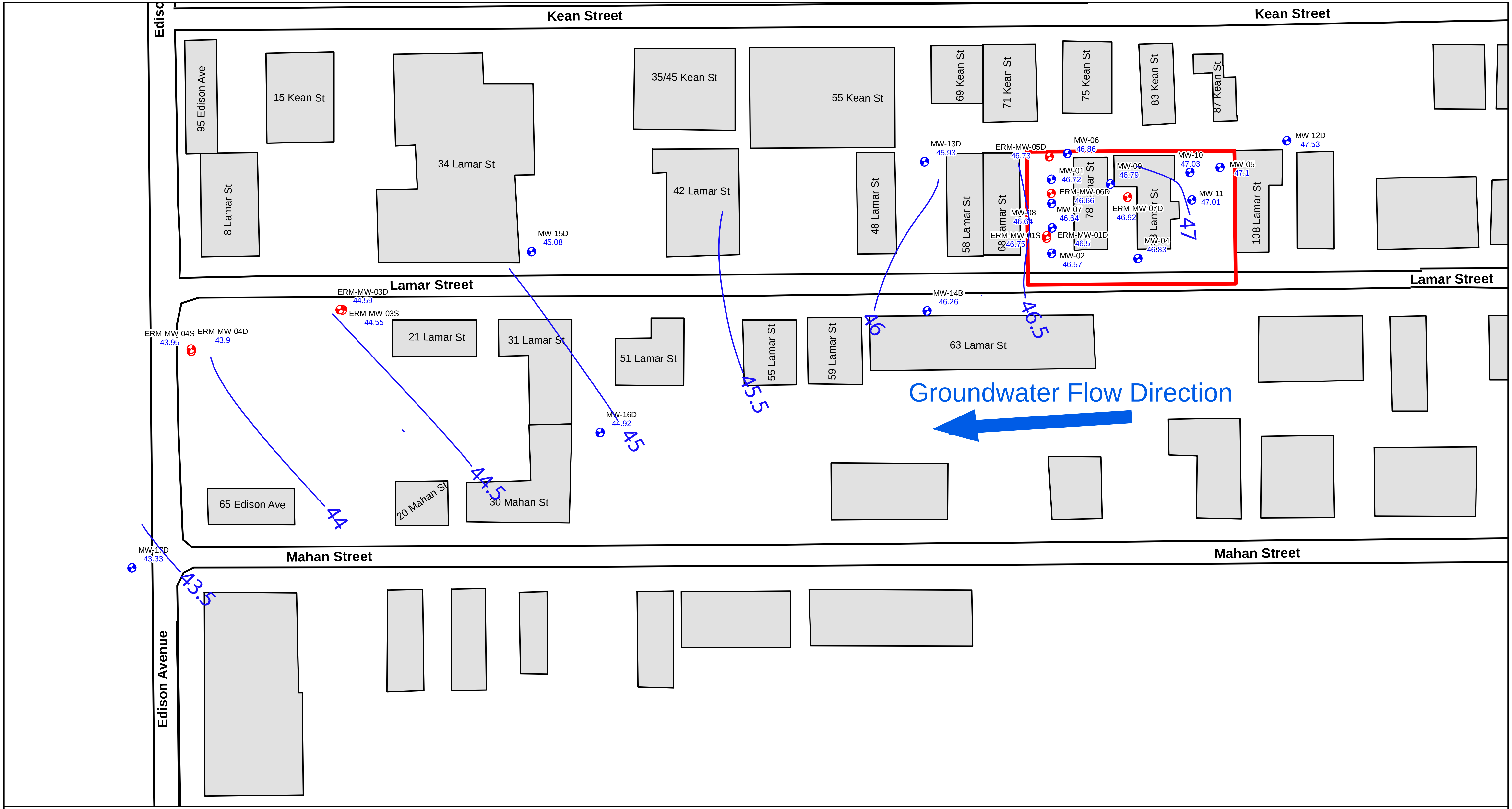
Source: ERM 2004 RIR, modified from survey by Nelson & Pope and YEC, Inc. Monitoring Well and Boring Location Plan (drawing revised 8/13/2002).

N

0 75 150 300 Feet

Figure 2-2
Site Map
Feasibility Study
Pride Solvents and Chemical Company
West Babylon, New York

CDM



Legend

●	Monitoring Well	🟥	Pride Solvents and Chemical Company
●	ERM Monitorig Well	▨	Buildings
—	Potentiometric Contour		

MW-16D - Well Name
44.92 - Groundwater Elevation
Note: All elevations are presented in feet above mean sea level.

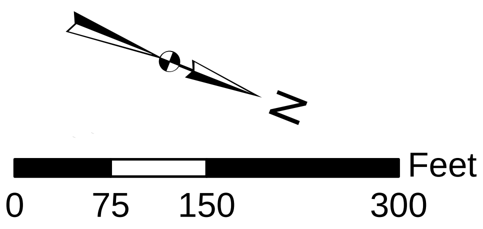


Figure 2-3
Upper Glacial Aquifer - Potentiometric Surface Map
February 18, 2009
Feasibility Study
Pride Solvents and Chemical Company
West Babylon, New York
CDM

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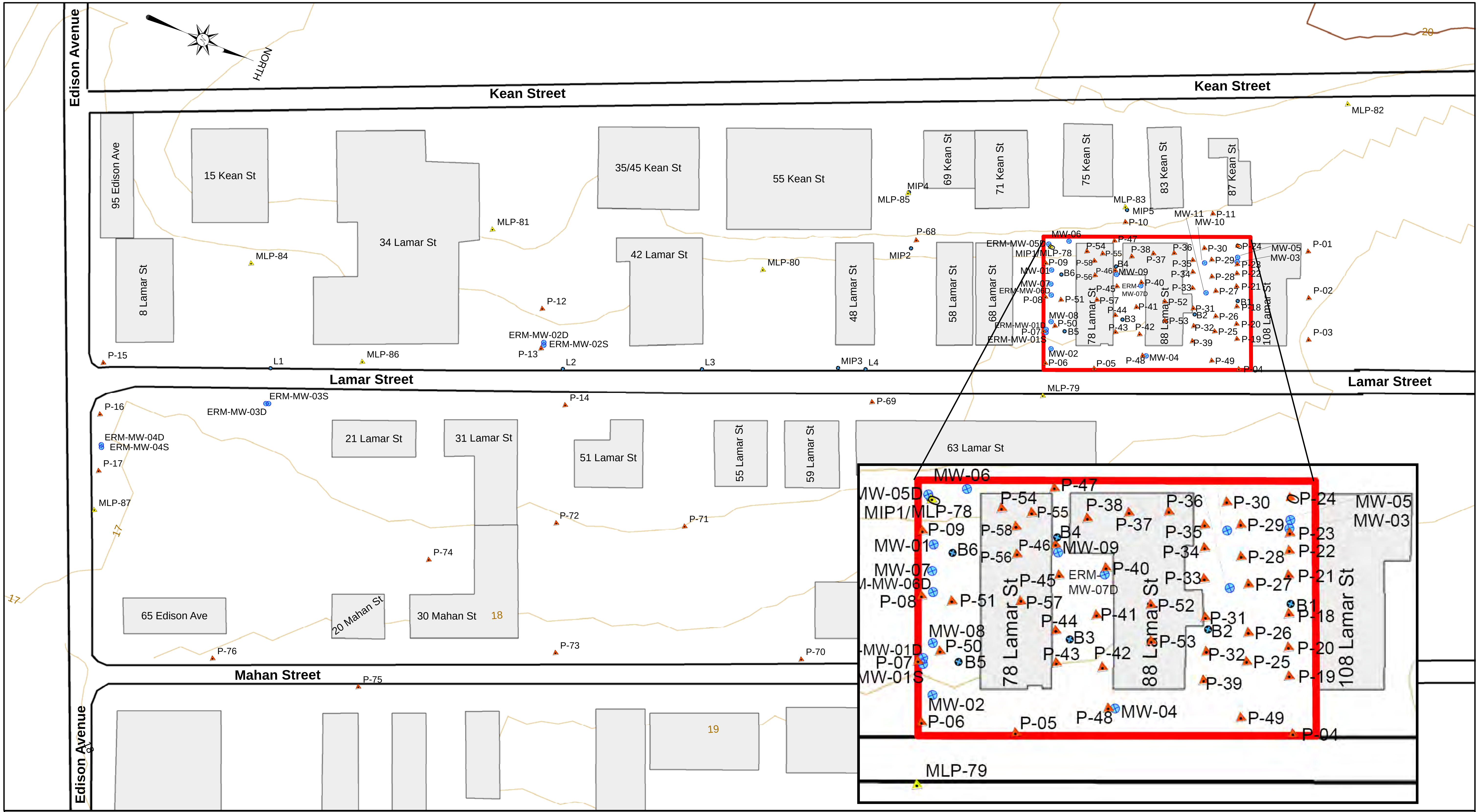


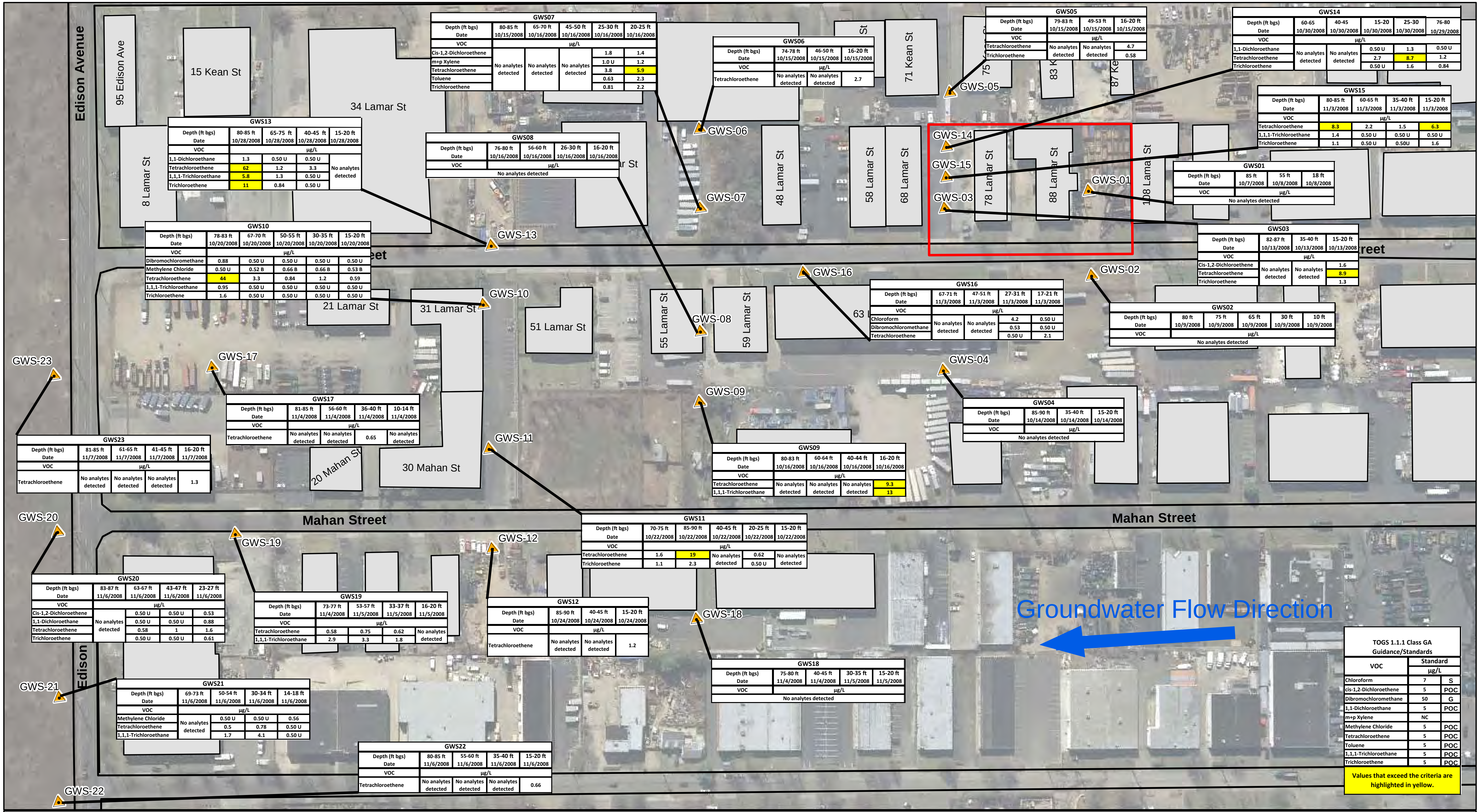
Historic sample Locations

- Groundwater Profile and On-site Boring
- ERM Monitoring Well
- Mobile Laboratory Groundwater Screening
- MIP/Boring Location

0 75 150 300
Feet

Figure 2-4
Historic Subsurface Investigation Locations
Feasibility Study
Pride Solvents and Chemical Company
West Babylon, New York

CDM



GWS01

Depth (ft bgs) Date	85 ft 10/7/2008	55 ft 10/8/2008	18 ft 10/8/2008
VOC	µg/L		
No analytes detected			

GWS02

Depth (ft bgs) Date	80 ft 10/9/2008	75 ft 10/9/2008	65 ft 10/9/2008	30 ft 10/9/2008	10 ft 10/9/2008
VOC	µg/L				
No analytes detected					

GWS03

Depth (ft bgs) Date	82-87 ft 10/13/2008	35-40 ft 10/13/2008	15-20 ft 10/13/2008
VOC	µg/L		
Cis-1,2-Dichloroethene	No analytes detected	No analytes detected	1.6
Tetrachloroethene			8.9
Trichloroethene			1.3

GWS04

Depth (ft bgs) Date	85-90 ft 10/14/2008	35-40 ft 10/14/2008	15-20 ft 10/14/2008
VOC	µg/L		
No analytes detected			

GWS05

Depth (ft bgs) Date	79-83 ft 10/15/2008	49-53 ft 10/15/2008	16-20 ft 10/15/2008
VOC	µg/L		
Tetrachloroethene	No analytes detected	No analytes detected	4.7
Trichloroethene			0.58

GWS06

Depth (ft bgs) Date	74-78 ft 10/15/2008	46-50 ft 10/15/2008	16-20 ft 10/15/2008
VOC	µg/L		
Tetrachloroethene	No analytes detected	No analytes detected	2.7

GWS07

Depth (ft bgs) Date	80-85 ft 10/15/2008	65-70 ft 10/16/2008	45-50 ft 10/16/2008	25-30 ft 10/16/2008	20-25 ft 10/16/2008
VOC	µg/L				
Cis-1,2-Dichloroethene	No analytes detected	No analytes detected	No analytes detected	1.8	1.4
m+p Xylene				1.0 U	1.2
Tetrachloroethene				3.8	5.9
Toluene				0.63	2.3
Trichloroethene				0.81	2.2

GWS08

Depth (ft bgs) Date	76-80 ft 10/16/2008	56-60 ft 10/16/2008	26-30 ft 10/16/2008	16-20 ft 10/16/2008
VOC	µg/L			
No analytes detected				

GWS09

Depth (ft bgs) Date	80-83 ft 10/16/2008	60-64 ft 10/16/2008	40-44 ft 10/16/2008	16-20 ft 10/16/2008
VOC	µg/L			
Tetrachloroethene	No analytes detected	No analytes detected	No analytes detected	9.3
1,1,1-Trichloroethane				13

GWS10

Depth (ft bgs) Date	78-83 ft 10/20/2008	67-70 ft 10/20/2008	50-55 ft 10/20/2008	30-35 ft 10/20/2008	15-20 ft 10/20/2008
VOC	µg/L				
Dibromochloromethane	0.88	0.50 U	0.50 U	0.50 U	0.50 U
Methylene Chloride	0.50 U	0.52 B	0.66 B	0.66 B	0.53 B
Tetrachloroethene	44	3.3	0.84	1.2	0.59
1,1,1-Trichloroethane	0.95	0.50 U	0.50 U	0.50 U	0.50 U
Trichloroethene	1.6	0.50 U	0.50 U	0.50 U	0.50 U

GWS11

Depth (ft bgs) Date	70-75 ft 10/22/2008	85-90 ft 10/22/2008	40-45 ft 10/22/2008	20-25 ft 10/22/2008	15-20 ft 10/22/2008
VOC	µg/L				
Tetrachloroethene	1.6	19	No analytes detected	0.62	No analytes detected
Trichloroethene	1.1	2.3		0.50 U	

GWS12

Depth (ft bgs) Date	85-90 ft 10/24/2008	40-45 ft 10/24/2008	15-20 ft 10/24/2008
VOC	µg/L		
Tetrachloroethene	No analytes detected	No analytes detected	1.2

GWS13

Depth (ft bgs) Date	80-85 ft 10/28/2008	65-75 ft 10/28/2008	40-45 ft 10/28/2008	15-20 ft 10/28/2008
VOC	µg/L			
1,1-Dichloroethane	1.3	0.50 U	0.50 U	No analytes detected
Tetrachloroethene	62	1.2	3.3	
1,1,1-Trichloroethane	5.8	1.3	0.50 U	
Trichloroethene	11	0.84	0.50 U	

GWS14

Depth (ft bgs) Date	60-65 10/30/2008	40-45 10/30/2008	15-20 10/30/2008	25-30 10/30/2008	76-80 10/29/2008
VOC	µg/L				
1,1-Dichloroethane	No analytes detected	No analytes detected	0.50 U	1.3	0.50 U
Tetrachloroethene			2.7	8.7	1.2
Trichloroethene			0.50 U	1.6	0.84

GWS15

Depth (ft bgs) Date	80-85 ft 11/3/2008	60-65 ft 11/3/2008	35-40 ft 11/3/2008	15-20 ft 11/3/2008
VOC	µg/L			
Tetrachloroethene	8.3	2.2	1.5	6.3
1,1,1-Trichloroethane	1.4	0.50 U	0.50 U	0.50 U
Trichloroethene	1.1	0.50 U	0.50U	1.6

GWS16

Depth (ft bgs) Date	67-71 ft 11/3/2008	47-51 ft 11/3/2008	27-31 ft 11/3/2008	17-21 ft 11/3/2008
VOC	µg/L			
Chloroform	No analytes detected	No analytes detected	4.2	0.50 U
Dibromochloromethane			0.53	0.50 U
Tetrachloroethene			0.50 U	2.1

GWS17

Depth (ft bgs) Date	81-85 ft 11/4/2008	56-60 ft 11/4/2008	36-40 ft 11/4/2008	10-14 ft 11/4/2008
VOC	µg/L			
Tetrachloroethene	No analytes detected	No analytes detected	0.65	No analytes detected

GWS18

Depth (ft bgs) Date	75-80 ft 11/4/2008	40-45 ft 11/4/2008	30-35 ft 11/5/2008	15-20 ft 11/5/2008
VOC	µg/L			
No analytes detected				

GWS19

Depth (ft bgs) Date	73-77 ft 11/4/2008	53-57 ft 11/5/2008	33-37 ft 11/5/2008	16-20 ft 11/5/2008
VOC	µg/L			
Tetrachloroethene	0.58	0.75	0.62	No analytes detected
1,1,1-Trichloroethane	2.9	3.3	1.8	

GWS20

Depth (ft bgs) Date	83-87 ft 11/6/2008	63-67 ft 11/6/2008	43-47 ft 11/6/2008	23-27 ft 11/6/2008
VOC	µg/L			
Cis-1,2-Dichloroethene	No analytes detected	0.50 U	0.50 U	0.53
1,1-Dichloroethane		0.50 U	0.50 U	0.88
Tetrachloroethene		0.58	1	1.6
Trichloroethene		0.50 U	0.50 U	0.61

GWS21

Depth (ft bgs) Date	69-73 ft 11/6/2008	50-54 ft 11/6/2008	30-34 ft 11/6/2008	14-18 ft 11/6/2008
VOC	µg/L			
Methylene Chloride	No analytes detected	0.50 U	0.50 U	0.56
Tetrachloroethene		0.5	0.78	0.50 U
1,1,1-Trichloroethane		1.7	4.1	0.50 U

GWS22

Depth (ft bgs) Date	80-85 ft 11/6/2008	55-60 ft 11/6/2008	35-40 ft 11/6/2008	15-20 ft 11/6/2008
VOC	µg/L			
Tetrachloroethene	No analytes detected	No analytes detected	No analytes detected	0.66

GWS23

Depth (ft bgs) Date	81-85 ft 11/7/2008	61-65 ft 11/7/2008	41-45 ft 11/7/2008	16-20 ft 11/7/2008
VOC	µg/L			
Tetrachloroethene	No analytes detected	No analytes detected	No analytes detected	1.3

TOGS 1.1.1 Class GA Guidance/Standards

VOC	Standard µg/L	
Chloroform	7	S
cis-1,2-Dichloroethene	5	POC
Dibromochloromethane	50	G
1,1-Dichloroethane	5	POC
m+p Xylene	NC	
Methylene Chloride	5	POC
Tetrachloroethene	5	POC
Toluene	5	POC
1,1,1-Trichloroethane	5	POC
Trichloroethene	5	POC

Values that exceed the criteria are highlighted in yellow.

Legend

▲	Groundwater Screening Sampling Location
☐	Pride Solvents and Chemical Company
▨	Buildings

ft bgs - Feet below ground surface
ug/L - Micrograms per liter
VOC - Volitile Organic Compound
GWS - Groundwater Screening
S - Standard
G - Guidance Value

N

Feet
0 75 150 300

Figure 3-1
Groundwater Screening
Volatile Organic Compound Detection
Pride Solvents & Chemical Company
Babylon, New York

CDM

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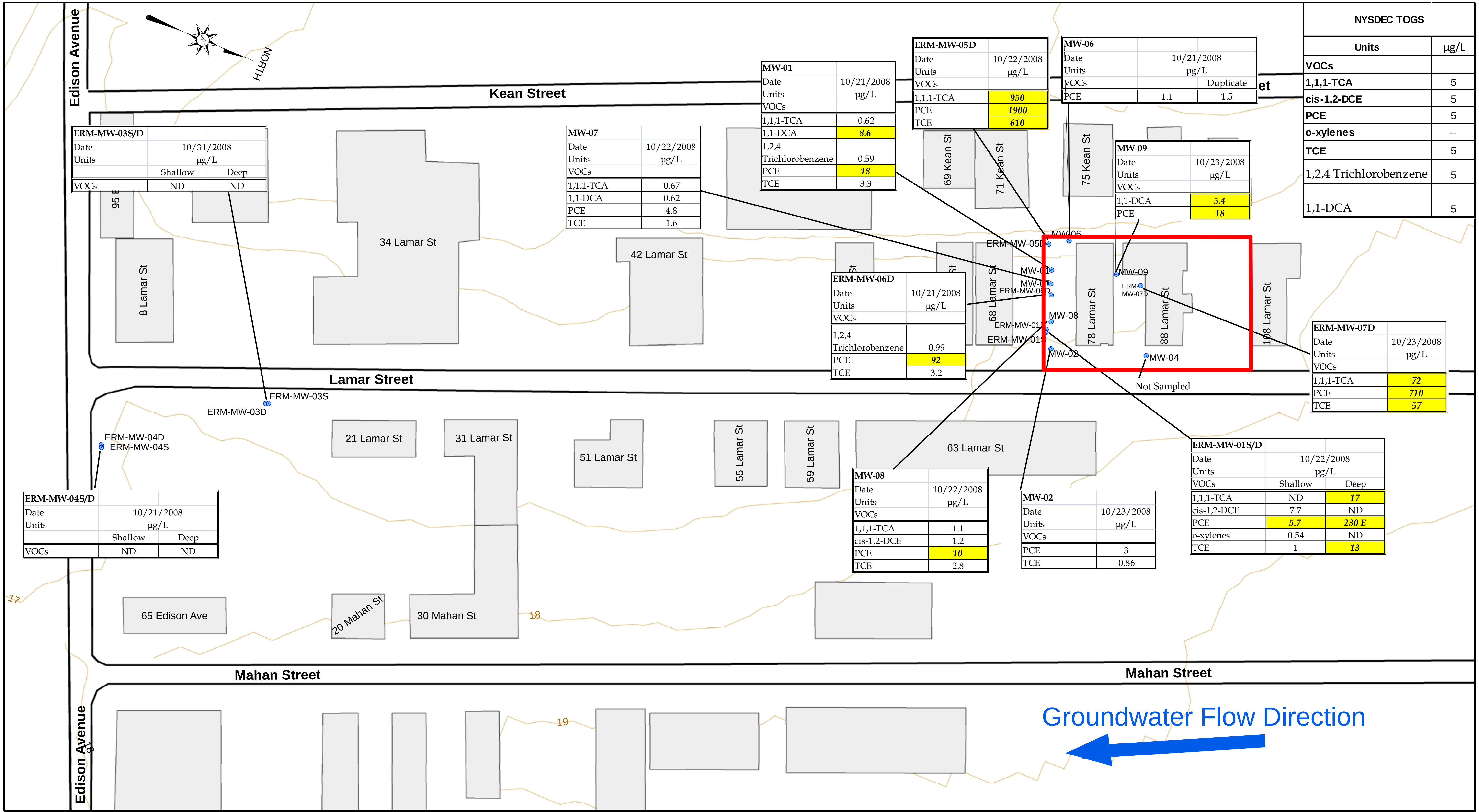

NYSDEC TOGS	
Units	µg/L
VOCs	
1,1,1-TCA	5
cis-1,2-DCE	5
PCE	5
o-xylenes	--
TCE	5
1,2,4 Trichlorobenzene	5
1,1-DCA	5

ERM-MW-03S/D		
Date	10/31/2008	
Units	µg/L	
	Shallow	Deep
VOCs	ND	ND

MW-07	
Date	10/22/2008
Units	µg/L
VOCs	
1,1,1-TCA	0.67
1,1-DCA	0.62
PCE	4.8
TCE	1.6

MW-01	
Date	10/21/2008
Units	µg/L
VOCs	
1,1,1-TCA	0.62
1,1-DCA	***8.6***
1,2,4 Trichlorobenzene	0.59
PCE	***18***
TCE	3.3

ERM-MW-05D	
Date	10/22/2008
Units	µg/L
VOCs	
1,1,1-TCA	***950***
PCE	***1900***
TCE	***610***

MW-06		
Date	10/21/2008	
Units	µg/L	
VOCs		Duplicate
PCE	1.1	1.5

MW-09	
Date	10/23/2008
Units	µg/L
VOCs	
1,1-DCA	***5.4***
PCE	***18***

ERM-MW-06D	
Date	10/21/2008
Units	µg/L
VOCs	
1,2,4 Trichlorobenzene	0.99
PCE	***92***
TCE	3.2

ERM-MW-07D	
Date	10/23/2008
Units	µg/L
VOCs	
1,1,1-TCA	***72***
PCE	***710***
TCE	***57***

ERM-MW-04S/D		
Date	10/21/2008	
Units	µg/L	
	Shallow	Deep
VOCs	ND	ND

MW-08	
Date	10/22/2008
Units	µg/L
VOCs	
1,1,1-TCA	1.1
cis-1,2-DCE	1.2
PCE	***10***
TCE	2.8

MW-02	
Date	10/23/2008
Units	µg/L
VOCs	
PCE	3
TCE	0.86

ERM-MW-01S/D		
Date	10/22/2008	
Units	µg/L	
VOCs	Shallow	Deep
1,1,1-TCA	ND	***17***
cis-1,2-DCE	7.7	ND
PCE	***5.7***	***230 E***
o-xylenes	0.54	ND
TCE	1	***13***

Historic sample Locations

- ▲ Groundwater Profile and On-site Boring
- ⊗ ERM Monitoring Well
- ▲ Mobile Laboratory Groundwater Screening
- ⊕ MIP/Boring Location

Concentrations highlighted in bold italics exceed standards.

0 75 150 300 Feet

Figure 3-2
October 2008 Groundwater Sampling Results
Feasibility Study
Pride Solvents and Chemical Company
West Babylon, New York

CDM

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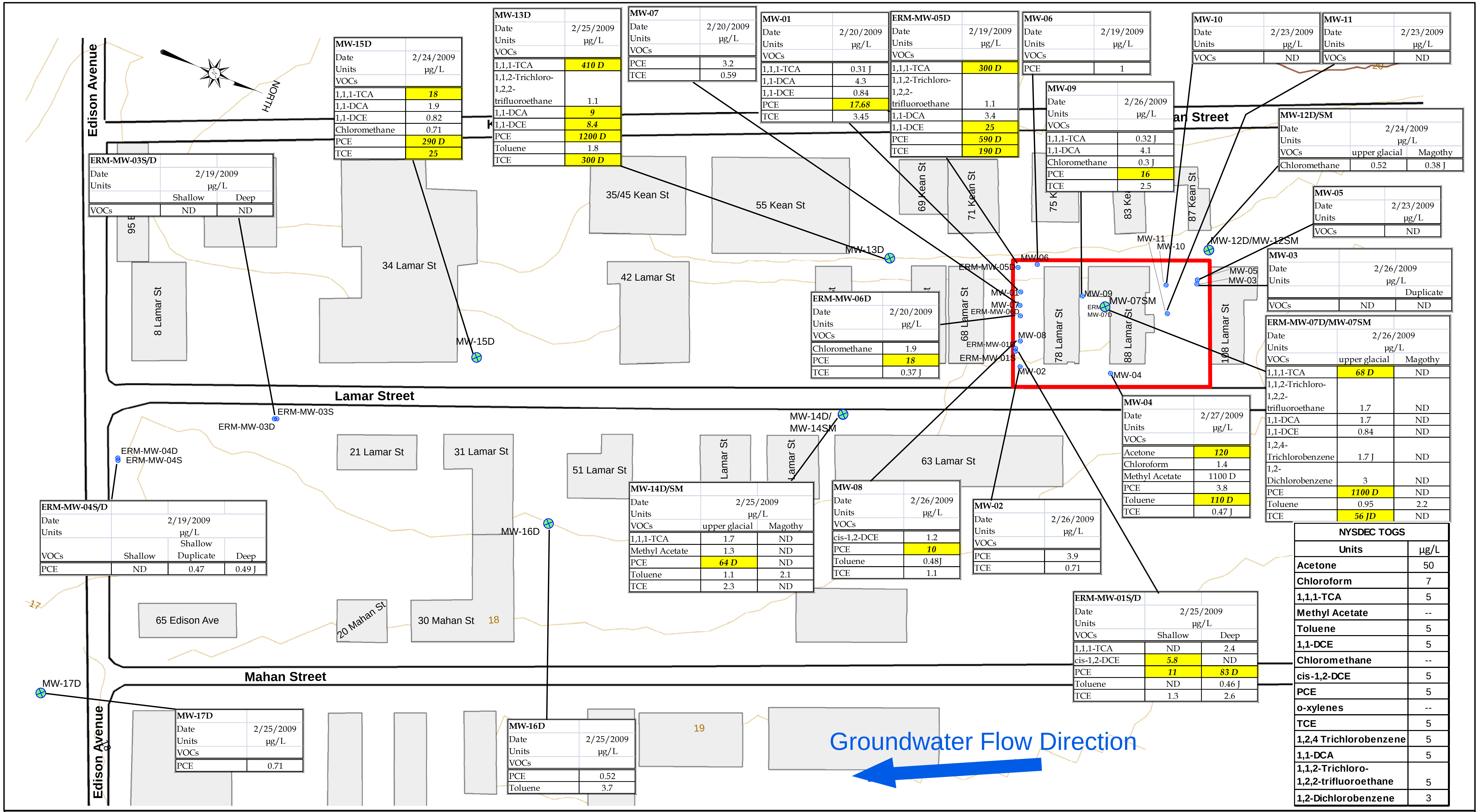


MW-15D	
Date	2/24/2009
Units	µg/L
VOCs	
1,1,1-TCA	***18***
1,1-DCA	1.9
1,1-DCE	0.82
Chloromethane	0.71
PCE	***290 D***
TCE	***25***

MW-13D	
Date	2/25/2009
Units	µg/L
VOCs	
1,1,1-TCA	***410 D***
1,1,2-Trichloro-1,2,2-trifluoroethane	1.1
1,1-DCA	***9***
1,1-DCE	***8.4***
PCE	***1200 D***
Toluene	1.8
TCE	***300 D***

MW-07	
Date	2/20/2009
Units	µg/L
VOCs	
PCE	3.2
TCE	0.59

MW-01	
Date	2/20/2009
Units	µg/L
VOCs	
1,1,1-TCA	0.31 J
1,1-DCA	4.3
1,1-DCE	0.84
PCE	***17.68***
TCE	3.45

ERM-MW-05D	
Date	2/19/2009
Units	µg/L
VOCs	
1,1,1-TCA	***300 D***
1,1,2-Trichloro-1,2,2-trifluoroethane	1.1
1,1-DCA	3.4
1,1-DCE	***25***
PCE	***590 D***
TCE	***190 D***

MW-06	
Date	2/19/2009
Units	µg/L
VOCs	
PCE	1

MW-09	
Date	2/26/2009
Units	µg/L
VOCs	
1,1,1-TCA	0.32 J
1,1-DCA	4.1
Chloromethane	0.3 J
PCE	***16***
TCE	2.5

MW-10	
Date	2/23/2009
Units	µg/L
VOCs	ND

MW-11	
Date	2/23/2009
Units	µg/L
VOCs	ND

MW-12D/SM		
Date	2/24/2009	
Units	µg/L	
VOCs	upper glacial	Magothy
Chloromethane	0.52	0.38 J

MW-05	
Date	2/23/2009
Units	µg/L
VOCs	ND

MW-03		
Date	2/26/2009	
Units	µg/L	
		Duplicate
VOCs	ND	ND

ERM-MW-03S/D		
Date	2/19/2009	
Units	µg/L	
	Shallow	Deep
VOCs	ND	ND

ERM-MW-06D	
Date	2/20/2009
Units	µg/L
VOCs	
Chloromethane	1.9
PCE	***18***
TCE	0.37 J

ERM-MW-07D/MW-07SM		
Date	2/26/2009	
Units	µg/L	
VOCs	upper glacial	Magothy
1,1,1-TCA	***68 D***	ND
1,1,2-Trichloro-1,2,2-trifluoroethane	1.7	ND
1,1-DCA	1.7	ND
1,1-DCE	0.84	ND
1,2,4-Trichlorobenzene	1.7 J	ND
1,2-Dichlorobenzene	3	ND
PCE	***1100 D***	ND
Toluene	0.95	2.2
TCE	***56 JD***	ND

MW-04	
Date	2/27/2009
Units	µg/L
VOCs	
Acetone	***120***
Chloroform	1.4
Methyl Acetate	1100 D
PCE	3.8
Toluene	***110 D***
TCE	0.47 J

ERM-MW-04S/D			
Date	2/19/2009		
Units	µg/L		
VOCs	Shallow	Shallow Duplicate	Deep
PCE	ND	0.47	0.49 J

MW-14D/SM		
Date	2/25/2009	
Units	µg/L	
VOCs	upper glacial	Magothy
1,1,1-TCA	1.7	ND
Methyl Acetate	1.3	ND
PCE	***64 D***	ND
Toluene	1.1	2.1
TCE	2.3	ND

MW-08	
Date	2/26/2009
Units	µg/L
VOCs	
cis-1,2-DCE	1.2
PCE	***10***
Toluene	0.48J
TCE	1.1

MW-02	
Date	2/26/2009
Units	µg/L
VOCs	
PCE	3.9
TCE	0.71

ERM-MW-01S/D		
Date	2/25/2009	
Units	µg/L	
VOCs	Shallow	Deep
1,1,1-TCA	ND	2.4
cis-1,2-DCE	***5.8***	ND
PCE	***11***	***83 D***
Toluene	ND	0.46 J
TCE	1.3	2.6

MW-17D	
Date	2/25/2009
Units	µg/L
VOCs	
PCE	0.71

MW-16D	
Date	2/25/2009
Units	µg/L
VOCs	
PCE	0.52
Toluene	3.7

NYSDEC TOGS	
Units	µg/L
Acetone	50
Chloroform	7
1,1,1-TCA	5
Methyl Acetate	--
Toluene	5
1,1-DCE	5
Chloromethane	--
cis-1,2-DCE	5
PCE	5
o-xylenes	--
TCE	5
1,2,4 Trichlorobenzene	5
1,1-DCA	5
1,1,2-Trichloro-1,2,2-trifluoroethane	5
1,2-Dichlorobenzene	3

⊕ New Monitoring Wells

Historic sample Locations
- ▲ Groundwater Profile and On-site Boring
- ⊗ ERM Monitoring Well
- △ Mobile Laboratory Groundwater Screening
- ⊕ MIP/Boring Location

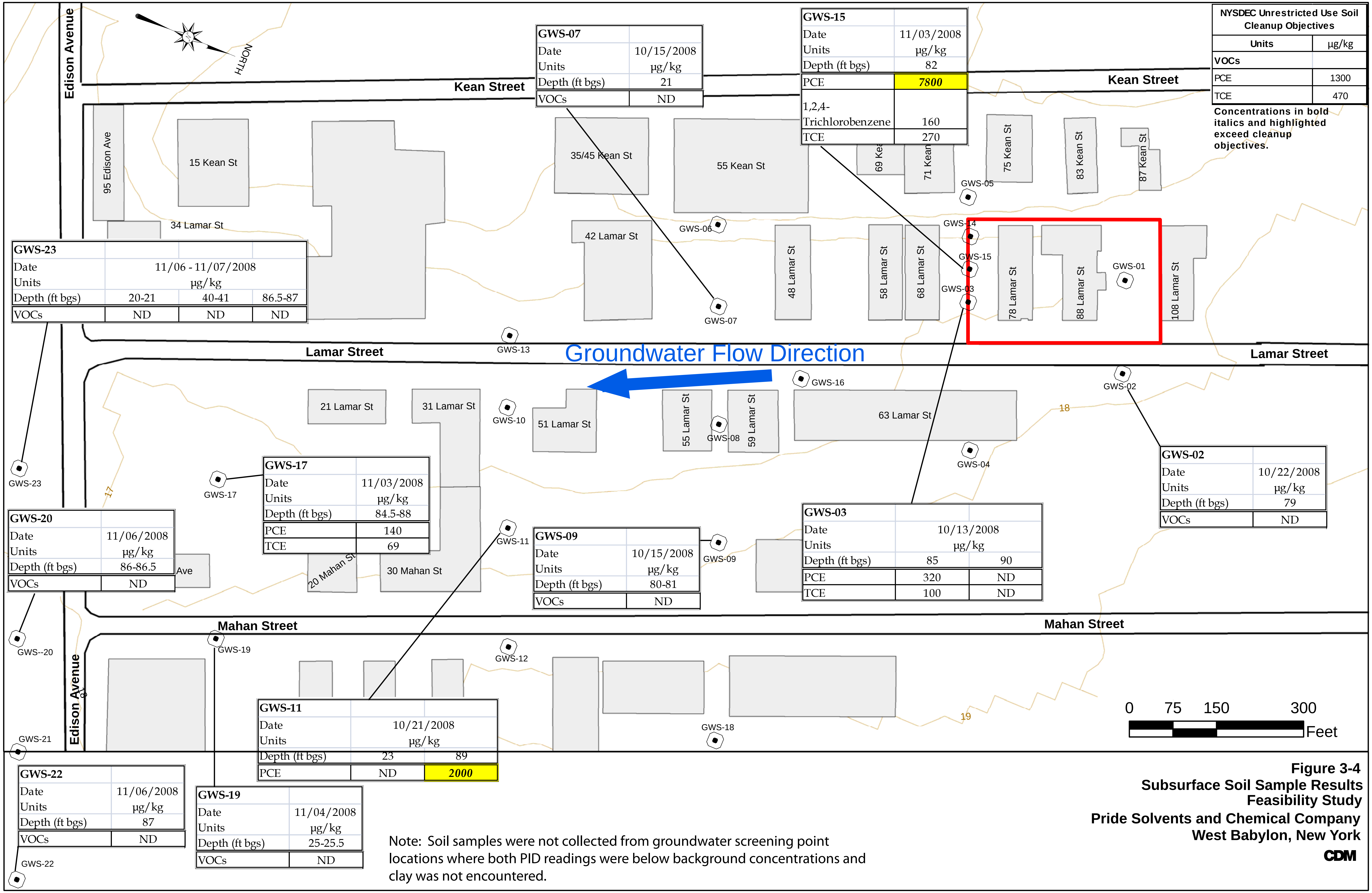
Concentrations highlighted in bold italics exceed standards.

0 75 150 300
Feet

Figure 3-3
February 2009 Groundwater Sampling Results
Feasibility Study
Pride Solvents and Chemical Company
West Babylon, New York

CDM

C:\IMS\GIS\Pride\Project Files\Fig4_MW_Locs.mxd



NYSDEC Unrestricted Use Soil Cleanup Objectives	
Units	µg/kg
VOCs	
PCE	1300
TCE	470

Concentrations in bold italics and highlighted exceed cleanup objectives.

GWS-07	
Date	10/15/2008
Units	µg/kg
Depth (ft bgs)	21
VOCs	ND

GWS-15	
Date	11/03/2008
Units	µg/kg
Depth (ft bgs)	82
PCE	***7800***
1,2,4-Trichlorobenzene	160
TCE	270

GWS-23			
Date	11/06 - 11/07/2008		
Units	µg/kg		
Depth (ft bgs)	20-21	40-41	86.5-87
VOCs	ND	ND	ND

GWS-17	
Date	11/03/2008
Units	µg/kg
Depth (ft bgs)	84.5-88
PCE	140
TCE	69

GWS-20	
Date	11/06/2008
Units	µg/kg
Depth (ft bgs)	86-86.5
VOCs	ND

GWS-09	
Date	10/15/2008
Units	µg/kg
Depth (ft bgs)	80-81
VOCs	ND

GWS-03		
Date	10/13/2008	
Units	µg/kg	
Depth (ft bgs)	85	90
PCE	320	ND
TCE	100	ND

GWS-02	
Date	10/22/2008
Units	µg/kg
Depth (ft bgs)	79
VOCs	ND

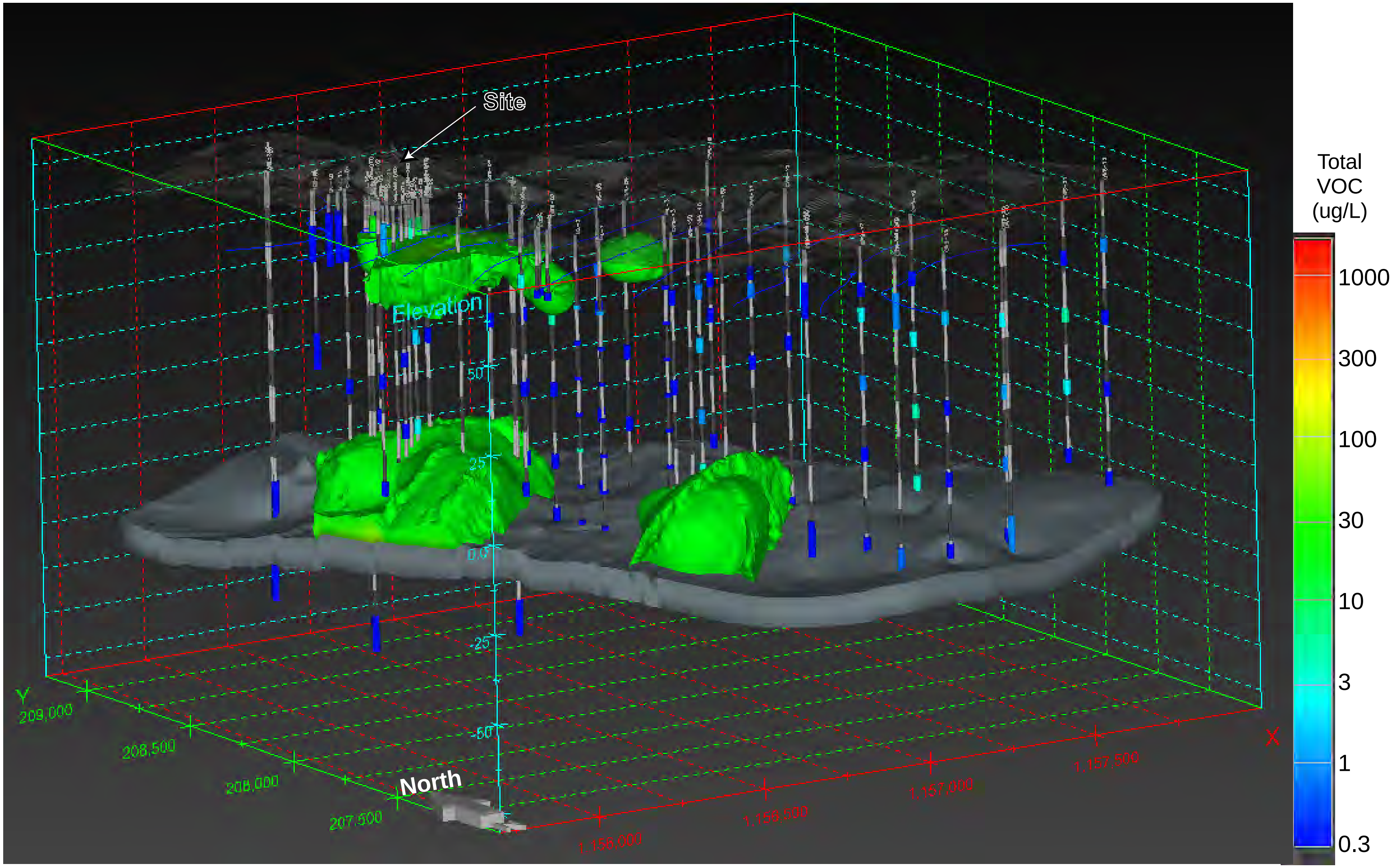
GWS-11		
Date	10/21/2008	
Units	µg/kg	
Depth (ft bgs)	23	89
PCE	ND	***2000***

GWS-22	
Date	11/06/2008
Units	µg/kg
Depth (ft bgs)	87
VOCs	ND

GWS-19	
Date	11/04/2008
Units	µg/kg
Depth (ft bgs)	25-25.5
VOCs	ND

Note: Soil samples were not collected from groundwater screening point locations where both PID readings were below background concentrations and clay was not encountered.

Figure 3-4
Subsurface Soil Sample Results
Feasibility Study
Pride Solvents and Chemical Company
West Babylon, New York
CDM



LEGEND

🟩 Total VOCs in groundwater greater than 5ppb

⬛ Clay layer between upper glacial and Magothy aquifers

Figure 3-5
Conceptual Site Model
Feasibility Study
Pride Solvents and Chemical Company
West Babylon, New York

Legend

▭ Areal extent of OU1 and OU2

▭ Vadose treatment zone

▭ Pride Solvents and Chemical Company

100 Feet

N

Figure 7-1
Operable Units
Feasibility Study
Pride Solvents and Chemical Company
West Babylon, New York

Appendix A
November 9 and December 24, 2001
Geophysical Survey Reports

ADVANCED GEOLOGICAL SERVICES
3 Mystic Lane
Malvern, PA 19355
(610) 722-5500
(610) 722-0250

November 9, 2001
Reference: 00-218-1

John Sheehan
Environmental Resources Management
520 Broad Hollow Road
Suite 210
Melville, NY 11747

Subject: Geophysical Investigation Results
Pride Solvent and Chemical Company, Inc.
78 and 88 Lamar Street
West Babylon, New York

Dear Mr. Sheehan:

Advanced Geological Services (AGS) presents this letter report to Environmental Resources Management (ERM) of Melville, New York detailing the methods and results of a geophysical investigation conducted at the Pride Solvents and Chemical Company, Inc. facility located at 78 and 88 Lamar Street, West Babylon, New York. All field activities were completed on October 29 and 30, 2001. The primary objective of the investigation was to locate possible buried pipes, underground storage tanks (USTs), and/or cover drywells. A secondary objective was to clear of buried utilities proposed drilling locations within the interior of the buildings.

To achieve the project objective, AGS used a combination of time domain electromagnetic (EM) metal detection and the ground penetrating radar (GPR) geophysical methods.

Survey Methods

A geophysical survey grid was established at the site prior to the collection of geophysical data. EM data were collected across the portions of the site which were not covered with metal reinforced concrete. EM data were along grid lines spaced approximately 5 feet apart and EM measurements were made every 2.5 feet along each survey grid line. Following EM data collection, data were transferred to a laptop computer and contoured to identify potential areas of concern. GPR data were collected along traverses spaced between 5 and 10 feet apart to further characterize EM anomalies and to identify any potential features of concern in areas where EM data could not be collected.

Time Domain EM Metal Detection Method

Time domain EM metal detection data were collected using a Geonics EM61 instrument. This instrument generates a pulsed primary EM field into the earth, which induces eddy currents in nearby metallic objects. The eddy current decay produces a secondary magnetic field which is measured by the receiver coil. By taking measurements at a relatively long time after the start of the decay, the current induced in the ground has been fully dissipated and only the current in the metal is still producing a secondary field. In scanning mode, the instrument produces an audible response indicating the presence of buried metal beneath the antenna. The response is measured in millivolts (mV) which can also be displayed and recorded by an integrated data logger. The instrument uses two antenna coils separated by 0.5 meters (1.6 feet) to provide potential depth information and to both minimize and quantify effects from above ground metallic objects. This instrument is very sensitive to metal objects, but relatively insensitive to variations in soil conductivity and geologic features. The standard EM61 configuration used during this investigation is capable of detecting metal targets the size of a 55-gallon drum up to depths of 10 feet or more depending upon site conditions.

Ground Penetrating Radar (GPR) Method

The ground penetrating radar (GPR) method was used to further characterize EM anomalies and to determine if the EM anomalies were caused by the presence of any USTs. The GPR method is based upon the transmission of repetitive, radio-frequency EM pulses into the subsurface. When the transmitted energy of the down-going wave contacts an interface of dissimilar electrical character, part of the energy is returned to the surface in the form of a reflected signal. This reflected signal is detected by a receiving transducer and is displayed on the screen of the GPR unit as well as being recorded on the internal hard-drive. The received GPR response remains constant as long as the electrical contrast between media is present and constant. Lateral or vertical changes in the electrical properties of the subsurface results in equivalent changes in the GPR response. The system records a continuous image of the subsurface by plotting two-way travel time of the reflected EM pulse versus distance traveled along the ground surface. Two-way travel time values are then converted to depth using known soil velocity functions.

The GPR field procedure involved (1) instrument calibration, (2) test run completion, (3) production profile collection and recording, and (4) data storage for subsequent processing and analysis in the office. Each radar profile was examined for characteristic GPR signatures that indicate the presence of features such as a pipe or UST.

Typically, features such as pipes or USTs exhibit a strong, continuous, radar reflection that occurs at the soil/feature interface. The reflection is present along the upper boundary of the feature, and diffracts, or tails off, at the edges of the feature. Generally, the GPR signature possesses a high signal amplitude, and either a hyperbolic reflection shape (perpendicular to the long axis of the pipe or UST) or a horizontal reflection shape (parallel to the long axis of the pipe or UST).

A Geophysical Survey Systems SIR System 2 and a 400 megahertz (MHz) antenna were used with a recording window of 60 nanoseconds (ns) to provide the required depth penetration (approximately 10 feet) and subsurface detail.

Results and Discussion

A site map and contoured EM results are presented on Figure 1. EM data were collected across the parking lot to the south of building 78, the asphalt portions of the parking lot to the north of building 88, and the area between Lamar Street and the front of the buildings (see Figure 1). EM data were not collected between buildings 78 and 88 because the area was primarily covered with metal reinforce concrete. The area between buildings 78 and 88, and the reinforced concrete area north of building 88 were investigated using GPR methods only.

The EM results shown on Figure 1 clearly identified the locations of the drywells, monitoring wells, water meters, four heating oil UST on the south side of building 78, and one heating oil UST in front of building 88. The septic system on the south side of building 78 is identifiable in the EM results and is identified on Figure 1. This septic system was further investigated with GPR methods to better delineate the leach pools associated with it. Prior to the geophysical investigation, portions of asphalt had been removed, by others, from the suspected leach pool locations. Because of the uneven and discontinuous ground surface above the potential leach pool locations, it was difficult to resolve the leach pools in the GPR data. GPR result did verify the presence of two leach pools associated with the septic system. One leach pool was located to the south of the septic tanks, and the other was to the southwest of the septic tanks. The locations of the leach pools were marked on the ground surface with spray paint.

A second septic system is located in the grass immediately east of the office in building 88. Two manholes are visible at the ground surface. GPR data collected in this area also identified two leach pools beneath the grass. One is located next to the curb of the driveway entrance, and the other is located immediately to the north of the first leach pool, on the west-northwest side of the tree. The locations of the leach pools were marked on the ground surface with spray paint.

The combined geophysical investigation also identified a total of 13 USTs which are shown on Figure 1. The USTs have been numbered 1 through 13 in this report for reference purposes. The table below provides a summary of the USTs identified.

Table 1. Summary of identified USTs

UST Reference Number	Estimated Size (gallons)	Comments
1	3,000	Partially beneath ramp into storage area. Previously known to exist.
2	3,000	Previously known to exist.
3	3,000	Previously known to exist.
4	3,000	Previously known to exist.
5	5,000	Previously unknown. The long axis is oriented east-west.
6	3,000	Partially beneath ramp into storage area, and beneath building foundation. Previously known to exist.
7	3,000	Beneath building foundation. Previously known to exist.
8	3,000	Previously known to exist.
9	1,000	Heating oil UST in front (east) of building 88.
10	550	Heating oil UST on south side of building 78.
11	550	Heating oil UST on south side of building 78.
12	550	Heating oil UST on south side of building 78.
13	550	Heating oil UST on south side of building 78.

The locations of all USTs were marked on the ground surface with spray paint. UST 1 is partially covered by the ramp on the north side of the storage area. USTs 1 through 4 are all located beneath a chain link fence and the overhanging roof of the storage area. It does not appear that these USTs extend beneath the foundation wall of the storage area, but it was not possible to verify that because of the limited working space.

UST 5 was not documented previously. Limited working space made it difficult to delineate UST 5 with a high degree of confidence, however it appears that UST

5 is a 5,000 gallon UST with the approximate dimensions of 14 feet long by 8 feet in diameter. Figure 2 shows a GPR record collected across USTs 1 through 5.

UST 6 is partially beneath the ramp at the southeast corner of the storage area. Both USTs 6 and 7 extend beneath the foundation wall of the storage area. Figure 3 shows a GPR record collected across USTs 6 and 7 inside the storage area. UST 8 is situated between the ramp into the storage area and the ramp into building 88. UST 8 does not appear to be beneath either ramp.

The storage area was investigated with GPR to determine if any drywells existed beneath the concrete floor slab. It was believed that two potential dry wells may be present near the southeast corner of the storage area. GPR data were collected inside the storage area along orthogonal traverses spaced 5 feet apart. No features were identified which could be attributed to the presence of a drywell, or a backfilled drywell.

The Distillation room in building 78 was investigated using the GPR method to identify any potential buried utilities or drilling hazards which may be present beneath the floor slab. No buried utilities or potential drilling hazards were identified beneath the Distillation room floor.

Additional buried utilities identified during this investigation included the water lines leading to building 78 and 88, a buried electric line extending across the lot on the north side of building 88 and PVC pipes which connected several drywells together. The locations of all identified features were marked on the ground surface with the appropriate color spray paint.

Summary

In summary, two leach pools were identified at the septic system on the south side of building 78. Two leach pools were identified at the septic system in front of building 88. A total of 13 USTs were identified on site, including four heating oil UST on the south side of building 78, one heating oil UST in front of building 88, three USTs on the south side of building 88, two of which extend beneath the foundation wall of the storage area, four previously documented USTs on the north side of the storage area, and one previously undocumented UST on the north side of building 88.

No drywells were identified beneath the floor slab of the storage area. No buried utilities or potential drilling hazards were identified beneath the floor of the Distillation room in building 78. Several utilities, including water, an electrical conduit and PVC pipes connecting together several drywells were identified and marked on site.

All geophysical data and field notes collected as a part of this investigation will be archived at the AGS office. The data collection and interpretation used in this investigation are consistent with standard practices applied to similar geophysical investigations. The correlation of geophysical responses with probable subsurface features is based on the past results of similar surveys although it is possible that some variation could exist at this site. Due to the nature of geophysical data, no guarantees can be made or implied regarding the presence or absence of additional objects or targets beyond those identified.

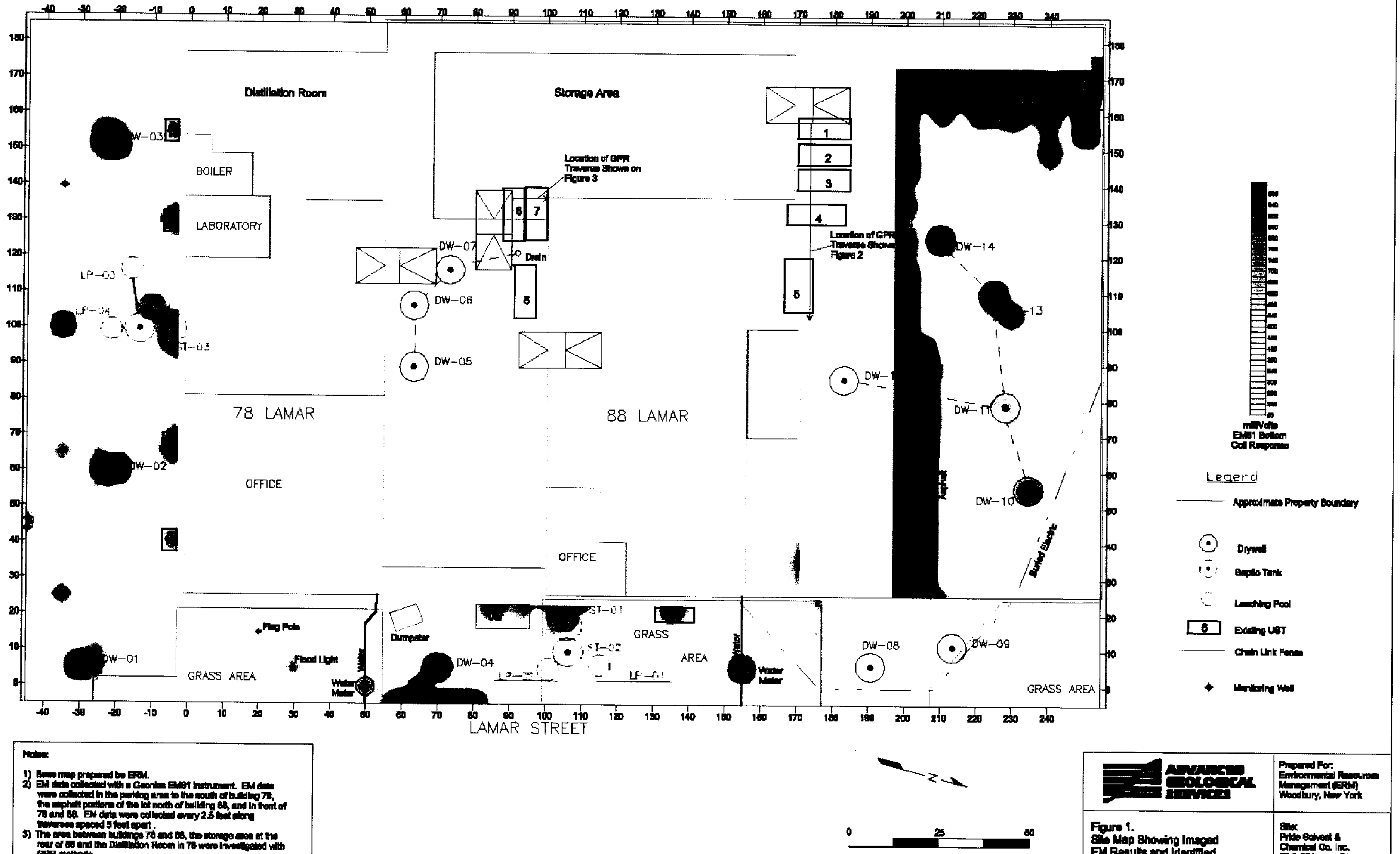
If you have any questions regarding the methods or results of this investigation, please contact me at 610-722-5500. It was a pleasure working with you on this project, and I look forward to working with you in the future.

Sincerely,

Donald Jagel

Donald Jagel, P.G.
Geophysicist

Enclosures: Figure 1 - Site Map and Contoured EM Results.
Figure 2 - GPR Record Across USTs 1, 2, 3, 4 and 5.
Figure 3 - GPR Record Across USTs 6 and 7.



Notes:

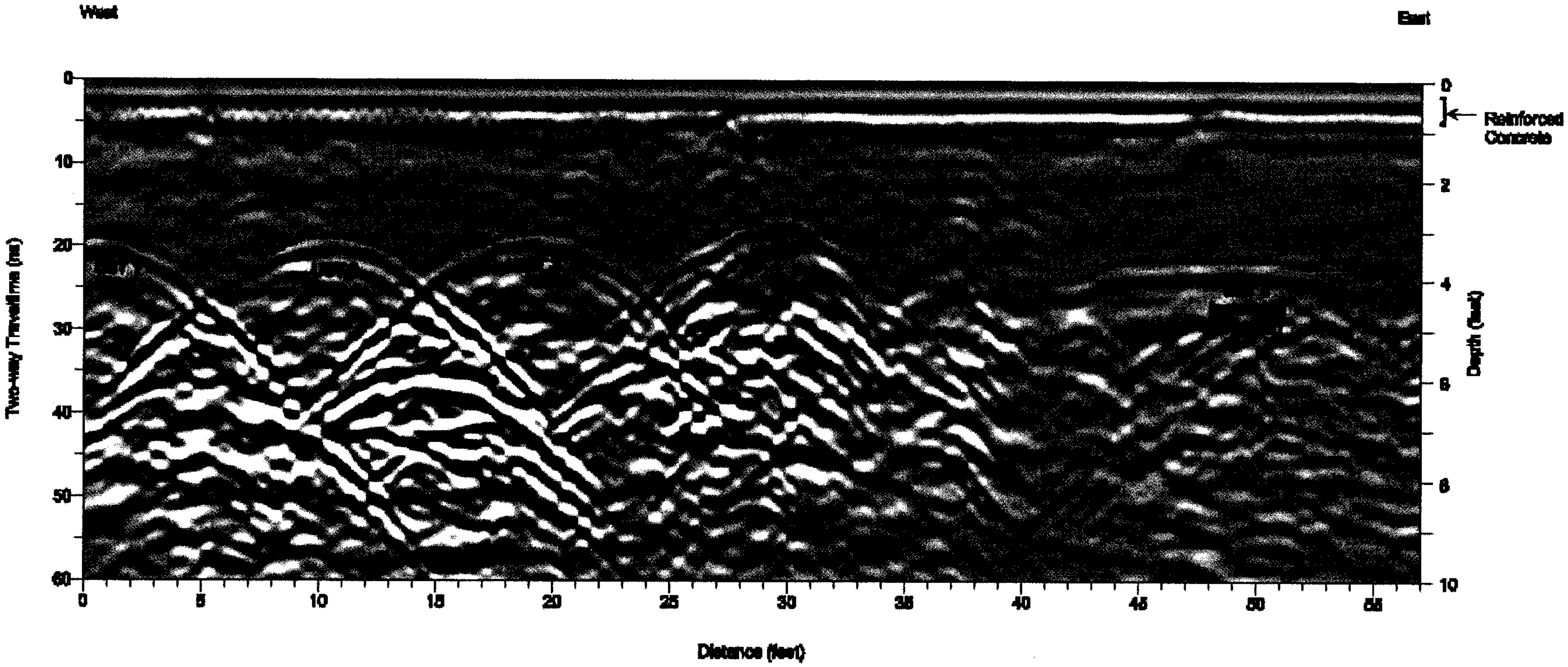
1) Base map prepared be ERM.
2) EM data collected with a Geonics EM61 instrument. EM data were collected in the parking area to the south of building 78, the asphalt portions of the lot north of building 88, and in front of 78 and 88. EM data were collected every 2.5 feet along traverses spaced 5 feet apart .
3) The area between buildings 78 and 88, the storage area at the rear of 88 and the Distillation Room in 78 were investigated with GPR methods.

ADVANCED GEOLOGICAL SERVICES

Prepared For:
Environmental Resources
Management (ERM)
Woodbury, New York

Figure 1.
Site Map Showing Imaged EM Results and Identified Features

Site:
Pride Solvent &
Chemical Co. Inc.
78 & 88 Lamar St.
West Babylon, NY



Note: 1) GPR image was collected using a GSSI SIR-2 system and a 400 MHz antenna
2) UST 1 is located partially beneath a ramp.
3) The locations of the USTs were marked on the ground surface with spray paint

Figure 2
GPR Image Collected
Across USTs 1, 2, 3, 4 and 5

Environmental Resources Management
Pride Solvent & Chemical Company
78 and 88 Lamar Street
West Babylon, New York

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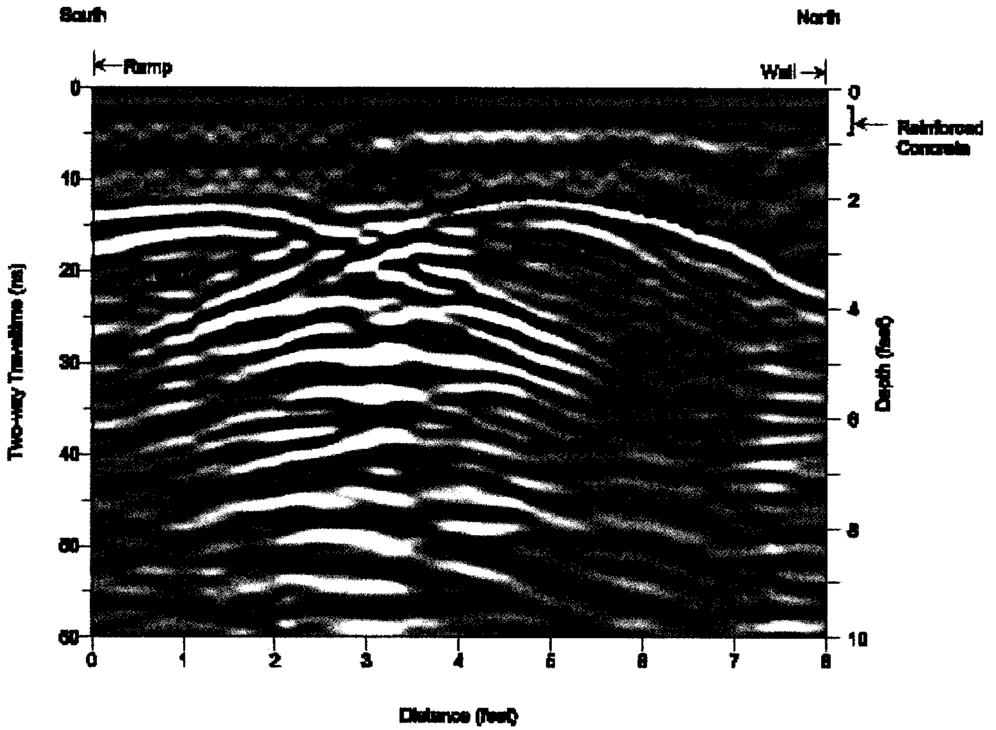

Note: 1) GPR image was collected using a GSSI SIR-2 system and a 400 MHz antenna.
2) UST 6 is located partially beneath a ramp.
3) The locations of the USTs were marked on the ground surface with spray paint.

Figure 3 GPR Image Collected Inside Storage Area, Across USTs 6 and 7	Environmental Resources Management Pride Solvent & Chemical Company 78 and 88 Lamar Street West Babylon, New York	ADVANCED GEOLOGICAL SERVICES

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SERVICES

3 Mystic Lane
Malvern, PA 19355
(610) 722-5500
(610) 722-0250

December 24, 2001
Reference: 00-218-2

Thomas Dwyer
Environmental Resources Management
520 Broad Hollow Road
Suite 210
Melville, NY 11747

Subject: Additional Geophysical Investigation Results from December 17, 2001 Field Investigation
Pride Solvent and Chemical Company, Inc.
78 and 88 Lamar Street
West Babylon, New York

Dear Mr. Dwyer:

Advanced Geological Services (AGS) presents this letter report to Environmental Resources Management (ERM) of Melville, New York detailing the methods and results of a geophysical investigation conducted at the Pride Solvents and Chemical Company, Inc. facility located at 78 and 88 Lamar Street, West Babylon, New York. All field activities were completed on December 17, 2001. This geophysical investigation was a follow-up to a previous geophysical investigation conducted in October, 2001. The primary objective of the present investigation was to better determine the extent and further characterize a subsurface void in the parking lot of 78 Lamar which was discovered during soil boring activities, and to determine if any additional voids may be present which were not detected during the previous geophysical investigation. A secondary objective of the investigation was to clear additional boring locations inside the warehouse areas of 78 and 88 Lamar.

During the previous geophysical investigation conducted by AGS, an electromagnetic (EM) survey of the parking lot of 78 Lamar was completed. At that time, EM data were collected at 2.5 feet intervals along geophysical traverses spaced 5 feet apart. Results from that investigation identified the existing dry wells, the locations of monitoring wells, the known septic system, and four heating oil USTs. GPR data collected during the previous investigation clearly identified the USTs and two leaching pools for the known septic system. No additional features were identified at that time based on the EM and GPR results.

To achieve the primary objective, AGS completed a detailed GPR grid along orthogonal traverses spaced 5 feet apart across the parking lot on the south side of 78 Lamar.

Survey Methods

The geophysical survey grid which was established at the site during the previous investigation was used for this investigation. GPR data were collected in the parking lot on the south side of 78 Lamar Street along orthogonal traverses spaced 5 feet to provide additional detail of subsurface features.

Ground Penetrating Radar (GPR) Method

The GPR method is based upon the transmission of repetitive, radio-frequency EM pulses into the subsurface. When the transmitted energy of the down-going wave contacts an interface of dissimilar electrical character, part of the energy is returned to the surface in the form of a reflected signal. This reflected signal is detected by a receiving transducer and is displayed on the screen of the GPR unit as well as being recorded on the internal hard-drive. The received GPR response remains constant as long as the electrical contrast between media is present and constant. Lateral or vertical changes in the electrical properties of the subsurface results in equivalent changes in the GPR response. The system records a continuous image of the subsurface by plotting two-way travel time of the reflected EM pulse versus distance traveled along the ground surface. Two-way travel time values are then converted to depth using known soil velocity functions.

The GPR field procedure involved (1) instrument calibration, (2) test run completion, (3) production profile collection and recording, and (4) data storage for subsequent processing and analysis in the office. Each radar profile was examined for characteristic GPR signatures that indicate the presence of features such as a pipe or UST.

Typically, features such as pipes or USTs exhibit a strong, continuous, radar reflection that occurs at the soil/feature interface. The reflection is present along the upper boundary of the feature, and diffracts, or tails off, at the edges of the feature. Generally, the GPR signature possesses a high signal amplitude, and either a hyperbolic reflection shape (perpendicular to the long axis of the pipe or UST) or a horizontal reflection shape (parallel to the long axis of the pipe or UST).

A Geophysical Survey Systems SIR System 2 and a 400 megahertz (MHz) antenna were used with a recording window of 60 nanoseconds (ns) to provide the required depth penetration (approximately 10 feet) and subsurface detail.

Results and Discussion

A GPR record collected across the B5a boring location, where the void was identified, does indicate the presence of a subtle reflector that may be the top of buried leaching pool or dry well (see Figure 1). This feature was not identified during the previous geophysical investigation because of the very subtle nature of the reflector. Review of previous GPR data indicates that this reflector was even more difficult to distinguish than it was during this investigation. It is believed that the difficulty of identifying this previously may be because of the extremely dry soil conditions. Because of the dry soil conditions, the contrast of the relative dielectric permittivity between the dry soil and the void were minimal, there by reducing the reflection coefficient. Rain which occurred since the previous investigation served to moisten the soil and subsequently increase the contrast in the relative dielectric permittivity.

The GPR data collected during this investigation indicates the void is approximately 7 feet in diameter, and buried approximately 2.5 feet below grade. The location of the void was marked on the surface of the parking lot with spray paint. Based on the EM response from the previous investigation, the cap covering this void has minimal amount of metal associated with it. The location of this void is shown on Figure 2.

GPR data collected across the remainder of the parking lot confirmed the features identified during the previous investigation. Another subtle feature was identified immediately east of dry well DW-03 (Figure 2). The GPR response across this location was not as distinctive as that of the confirmed void at the B5a location, but may also represent the cover of a void. The location of this feature was marked on the ground surface with spray paint.

Based on the locations of the confirmed void, and the potential void in the parking lot south of 78 Lamar, it is possible that these features are leaching pools/drywells which may be connected to the adjacent drywells that are visible on the ground surface. It was not possible to confirm the location of any pipes leading to these features. If pipes are present that connect these voids to the visible drywells they are likely made from non-metallic pipe. Excavation would be required to verify the presence and construction of these features.

Because of the locations of the features identified during this investigation with respect to the drywells in the parking lot on the south side of 78 Lamar, AGS further reviewed previously collected data in the parking lot on the north side of 88 Lamar. The EM responses at drywells DW-11 and DW-13 are slightly irregular in shape, and may possibly indicate the presence of features similar to that encountered at the B5a boring location. Review of the GPR data collected across these locations was non-definitive about the existence of an anomalous reflective surface at these locations. Based on the EM response, the locations of which may represent potential voids near DW-11 and DW-13 are shown on Figure 2.

Following completion of the investigation in the parking lot to the south of 78 Lamar, 11 proposed drilling locations inside 78 and 88 Lamar were cleared of utilities and potential drilling hazards. Five proposed borings were located in the distillation room of 78 Lamar, three were located in the warehouse portion of 78 Lamar, and three were located inside 88 Lamar. The locations of any potential pipes or utilities identified near the proposed drilling locations were marked on the floor with spray paint. If the location of the proposed boring was too close to a potential utility, the location was moved to an area free from drilling hazards.

Summary

In summary, the void which was penetrated by boring B5a was determined to be approximately 7 feet in diameter. Another subtle feature was identified near drywell DW-3 which could be similar to the void identified at B5a. The locations of these features were marked on the ground surface with spray paint.

Based on the results of this investigation, a review of previously collected EM and GPR data was conducted in the parking lot to the north of 88 Lamar. That review indicates that similar void features may be present near drywells DW-11 and DW-13. Excavation would be required to verify the presence of such features.

A total of 11 proposed boring locations were cleared of utilities and drilling hazards inside 78 and 88 Lamar.

All geophysical data and field notes collected as a part of this investigation will be archived at the AGS office. The data collection and interpretation used in this investigation are consistent with standard practices applied to similar geophysical investigations. The correlation of geophysical responses with probable subsurface features is based on the past results of similar surveys although it is possible that some variation could exist at this site. Due to the nature of geophysical data, no guarantees can be made or implied regarding the presence or absence of additional objects or targets beyond those identified.

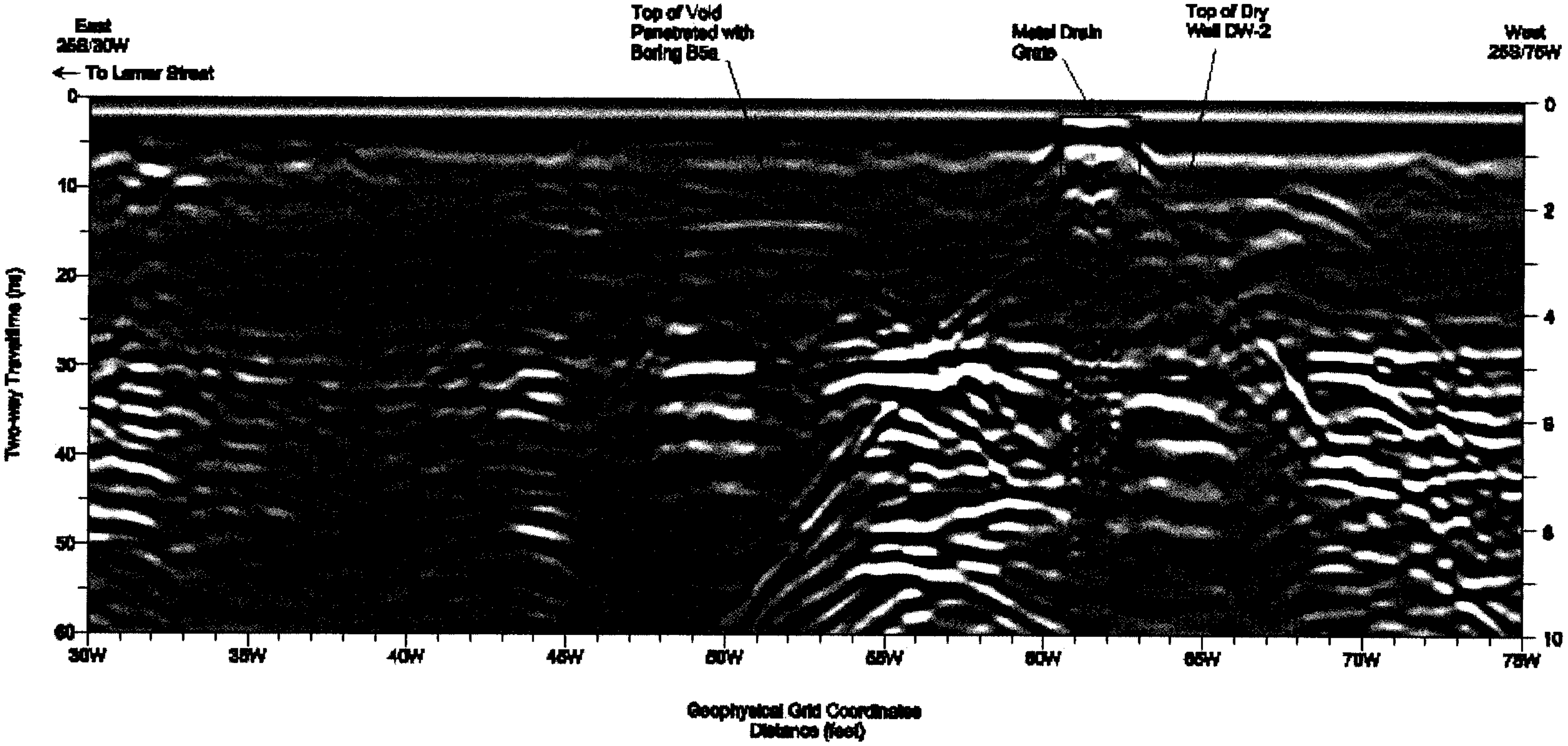
If you have any questions regarding the methods or results of this investigation, please contact me at 610-722-5500. It was a pleasure working with you on this project, and I look forward to working with you in the future.

Sincerely,

Donald Jagel

Donald Jagel, P.G.
Geophysicist

Enclosures: Figure 1 - GPR Record Across Void
Figure 2 - Site Map.



Notes: 1) GPR image was collected using a GSSI SIR-2 system and a 400 MHz antenna.
2) The location of the GPR image is shown on Figure 2.
3) The void penetrated by boring B5a is flat on top, consistent with a concrete top of cesspool or leaching pool cover.

Figure 1
GPR Image Collected
Across Void,
Along Traverse 25S

Environmental Resources Management
Pride Solvent and Chemical Co., Inc
78 Lamar Street
West Babylon, New York

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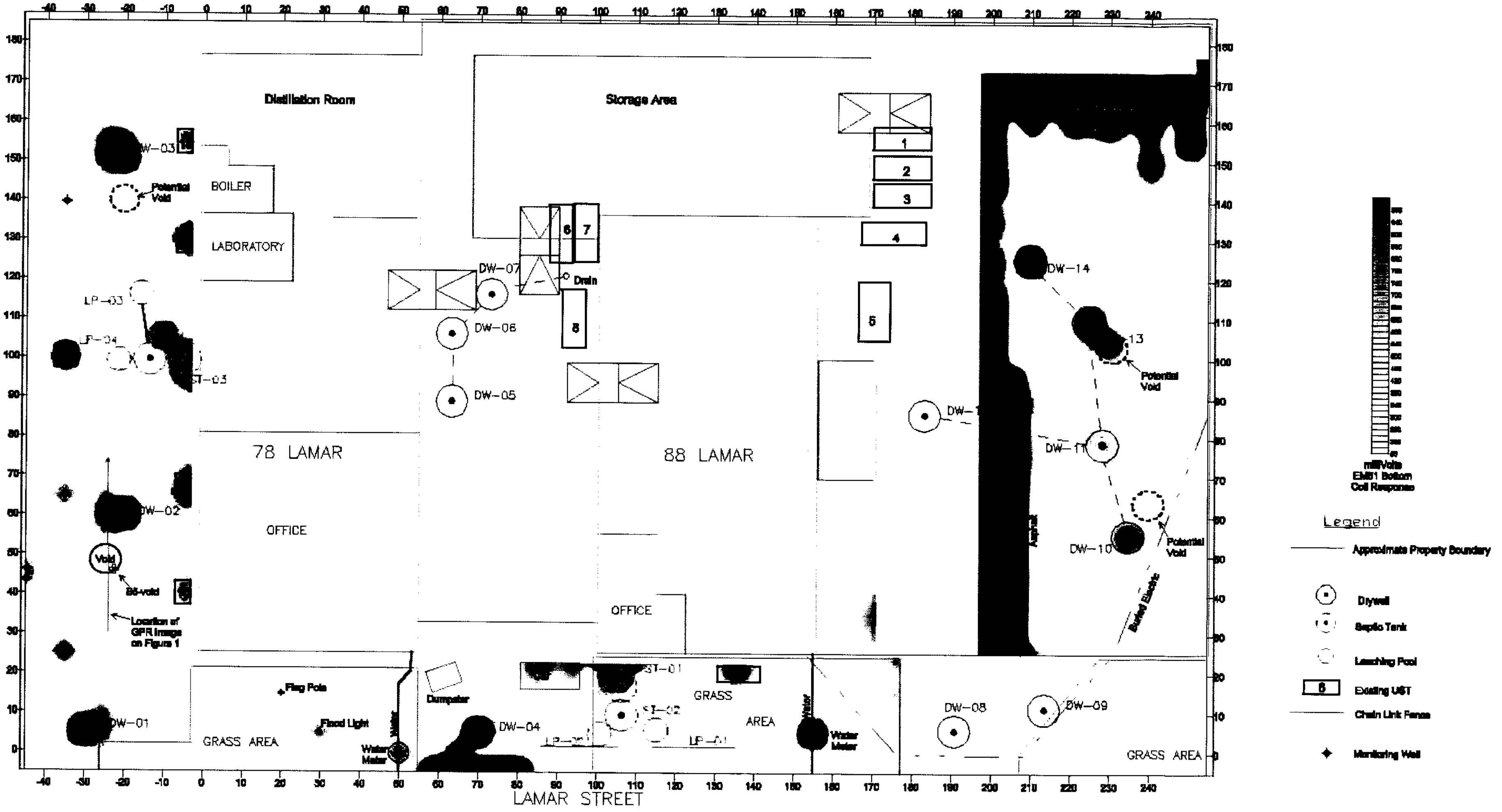

Notes:

1) Base map prepared be ERM.
2) EM data collected with a Geonics EM61 instrument. EM data were collected in the parking area to the south of building 78, the asphalt portions of the lot north of building 88, and in front of 78 and 88. EM data were collected every 2.5 feet along traverses spaced 5 feet apart .
3) The area between buildings 78 and 88, the storage area at the rear of 88 and the Distillation Room in 78 were investigated with GPR methods.

ADVANCED GEOLOGICAL SERVICES

Prepared For:
Environmental Resources
Management (ERM)
Woodbury, New York

Figure 2.
Site Map Showing Imaged EM Results and Identified Features

Site:
Pride Solvent &
Chemical Co. Inc.
78 & 88 Lamar St.
West Babylon, NY

Appendix B

Detailed Cost Estimates

Alternative OU1-2 - Long Term Monitoring Cost Estimate Summary
Pride Solvents

Item No.	Item Description	Quantity	Unit Cost	Unit	Extension
CAPITAL COSTS					
	Work Plan/Health and Safety Plan	1	$ 42,800	LS	$ 42,800
QUARTERLY/ANNUAL MONITORING COSTS					
	Labor	48	$ 115	per hour	$ 5,520
	per diem	4	$ 190	per day	$ 760
	sample shipping	2	$ 200	per day	$ 400
	H&S	2	$ 30	per day	$ 60
	car rental	4	$ 100	per day	$ 400
	Equipment	4	$ 300	per day	$ 1,200
	Analysis	12	$ 140	each	$ 1,680
	Data Evaluation & Reporting	50	$ 115	per hour	$ 5,750
FIVE-YEAR REVIEW					
	Five-Year Review Report	1	$ 41,600	LS	**$ 41,600**
PRESENT WORTH OF COSTS					
	Total Capital Costs				$ 42,800
	Total Monitoring Costs (20 year duration)				$ 360,937
	Total Five-Year Reviews Costs (20 year duration)				$ 76,636
	TOTAL PRESENT WORTH				**$ 480,372**
				Rounded to	**$ 480,000**

Work Plan/Health and Safety Plan

This occurs at the beginning					
Project Manager	$ 150	per hour x	40	hours =	$ 6,000
Engineer	$ 115	per hour x	200	hours =	$ 23,000
Scientist	$ 115	per hour x	120	hours =	$ 13,800
					$ 42,800
				Assume:	**$ 42,800**

Monitoring

Assumptions					
Number of sampling rounds			1		
Days per sampling round			2		
# of people for sampling			2		
# of wells to be sampled			10		
QA/QC Samples			2		
Monitoring, 10 samples each round, 2 people for 2 days					
Labor		$115	48	per hour	$ 5,520
per diem		$190	4	per day	$ 760
sample shipping		$200	2	per day	$ 400
H&S		$30	2	per day	$ 60
car rental		$100	4	per day	$ 400
Equipment		$300	4	per day	$ 1,200
Analysis		$140	12	each	$ 1,680
Data Evaluation & Reporting		$115	50	per hour	$ 5,750
				Assume:	**$ 16,000**

Five-Year Review

Assume a review will be conducted every 5 years.					
Work includes review of groundwater monitoring data and preparation of report					
Project Manager	$ 150	per hour x	32	hours =	$ 4,800
Engineer	$ 115	per hour x	200	hours =	$ 23,000
Scientist	$ 115	per hour x	120	hours =	$ 13,800
					$ 41,600
				Assume:	**$ 41,600**

Percent Worth Calculations

Assume discount rate is 7%

Total Monitoring Costs

Total Quarterly Monitoring Costs

This cost occurs every quarter for the first 5 years

$$P = A \text{ x } \frac{(1+i)^n - 1}{i(1+i)^n}$$

n = 20

quarterly rate i = 1.75%

The multiplier for $(P/A)_1$ = 16.753

Total Annual Monitoring Costs

This is a recurring cost every year for the following 10years (years 3-20)

$$P = A \text{ x } \frac{(1+i)^n - 1}{i(1+i)^n}$$

n = 10

i = 7%

The multiplier for $(P/A)_2$ = 7.024

Future cost

$$P = F \text{ x } \frac{1}{(1+i)^n}$$

n = 2

i = 7%

The multiplier for (P/F) = 0.873

The total multiplier for (P/A) = $(P/A)_1 + (P/F) \text{ x } (P/A)_2$ = 22.887549

Total 5-year review costs

This cost occurs every 5 years for 15 years

need to calculate the effective interest rate i_e

Given

i = nominal interest rate = 7%

m = # of compounding periods = 5 years

$i_e = (1+i)^m - 1$ = 0.403 or 40% / 5 years

$$P = A \text{ x } \frac{(1+i_e)^n - 1}{i_e(1+i_e)^n}$$

in this case, there are 4 five-year periods

n = 4

i = 0.403

The multiplier for (P/A) = 1.842

Alternative OU1-3 - SVE/AS Cost Estimate Summary
Pride Solvents

Item No.	Item Description	Quantity	Unit Cost	Unit	Extension
CAPITAL COSTS					
1. General Requirements					
1a.	Mobilization	1	$ 8,000	LS	$ 8,000
1b.	Work Plan/Health and Safety Plan	1	$ 51,800	LS	$ 51,800
1c.	Subsurface Utility Clearance	1	$ 3,500	LS	$ 3,500
1d.	Construction Management	1	$ 45,800	LS	$ 45,800
1e.	Surveying	1	$ 6,500	LS	$ 6,500
2. Construction Costs					
2a.	Pilot Study	1	$ 50,000	LS	$ 50,000
2a	Erosion Control	1	$ 3,800	LS	$ 3,800
2b.	Staging Area	1	$ 10,000	LS	$ 10,000
2c.	Air Sparge Well Installation	1	$ 82,800	LS	$ 82,800
2d.	Soil Vapor Extraction Well Installation	1	$ 9,900	LS	$ 9,900
2e.	Trenching and Compressed Air Hose	1	$ 22,600	LS	$ 22,600
2d.	Trench Installation	1	$ 20,000	LS	$ 20,000
2f.	Miscellaneous	1	$ 5,000	LS	$ 5,000
3. Transportation & Disposal					
3a.	Non Hazardous, Subtitle D	1	$ 10,500	LS	$ 10,500
4. Treatment System					
4a.	SVE and AS System	1	$ 68,400	LS	$ 68,400
4b.	Vapor Treatment	1	$ 2,800	LS	$ 2,800
4c.	Hookup/Setup/Startup Testing	1	$ 29,000	LS	$ 29,000
	SUBTOTAL CAPITAL COSTS				**$ 430,400**
5.	General Contractor Profit (10% capital)				$ 43,040
6.	Design Engineering (15% capital)				$ 64,560
7.	Contingency (15% capital)				$ 64,560
	TOTAL CAPITAL COSTS				**$ 602,560**
OPERATION & MAINTENANCE (O&M) COSTS					
8.	O&M Costs	1	$ 178,980	LS	$ 178,980
9.	Quarterly/Annual monitoring costs	1	$ 16,000	LS	$ 16,000
	TOTAL O&M COSTS				**$ 194,980**
FIVE-YEAR REVIEW					
15.	**Five-Year Review Report**	1	$ 41,600	LS	**$ 41,600**
PRESENT WORTH OF COSTS					
16.	Total Capital Costs				$ 602,560
17.	O&M Costs				$ 733,853
18.	Long Term Monitoring Costs (20 years duration)				$ 112,377
19.	Total Five-Year Review Costs (20 years duration)				$ 68,071
20	**TOTAL PRESENT WORTH**				**$ 1,516,862**
				Assume:	**$ 1,520,000**

CDM

General Requirements

1a	**Mobilization**					
	Equipment mob and demob					$ 8,000
					Assume:	**$ 8,000**
1b	**Work Plans/Health and Safety Plan**					
	This occurs at the beginning					
	Project Manager	$ 150	per hour x	40	hours =	$ 6,000
	Engineer	$ 115	per hour x	200	hours =	$ 23,000
	Scientist	$ 115	per hour x	120	hours =	$ 13,800
	Air Permitting	$ 90	per hour x	100	hours =	$ 9,000
						$ 51,800
					Assume:	**$ 51,800**
1c	**Subsurface Utility Clearance**					
	Assume 2 workers for 1 day					
	Mobilization	$ 1,000				$ 1,000
	Labor	$ 90	per hour x	16	hours =	$ 1,440
	Analysis/reporting	$ 1,000				$ 1,000
						$ 3,440
					Assume:	**$ 3,500**

1d	**Construction Management**					
	Assume 4-week duration					
	Project Manager (20 hrs/week)	$ 150	per hour x	80	hours =	$ 12,000
	On-site Engineer (1 @ full-time)	$ 90	per hour x	160	hours =	$ 14,400
	Off-site Engineer (1 @ full-time)	$ 90	per hour x	160	hours =	$ 14,400
	Miscellaneous	$ 5,000	LS			$ 5,000
						$ 45,800
					Assume:	**$ 45,800**
1e	**Surveying**					
	aerial, 1 acres					$ 5,500.00
	01107-700-1500, costworks 2003					
	Drafter	60	per hour x	16	hours =	$ 960.00
						$ 6,460.00
					Assume:	**$ 6,500**

Construction Costs

2a	**Pilot Study**					
	Assume $50,000 based on past experience					$ 50,000
					Assume:	**$ 50,000**
2b	**Erosion Control**					
	Assume silt fence around West, South, and East perimeter of work area					
	Silt fence	$ 0.58	per foot x	200	feet =	$ 116
	2 laborers 1 day to install	$ 75	per hour x	16	hours =	$ 1,200
	1 laborer 2 hrs/wk to maintain	$ 75	per hour x	16	hours =	$ 1,200
	2 laborers 1 day to remove	$ 75	per hour x	16	hours =	$ 1,200
						$ 3,716
					Assume:	**$ 3,800**
2c	**Staging Area**					
	Equipment set-up					$ 10,000
					Assume:	**$ 10,000**
2d	**Air sparge well installation**					
	Assume 40 AS wells, 30' deep each, ROI = 10 feet					
	Air sparge well installation	$ 46	per foot x	1200	feet =	$ 55,200
	Well vault	$ 500	each x	40	=	$ 20,000
	Well development	$ 190	per hour x	40	hours =	$ 7,600
						$ 82,800
					Assume:	**$ 82,800**
2e	**Soil Vapor Extraction Well Installation**					
	Assume 12 SVE wells, 7' deep each, ROI = 20 feet					
	Extraction well installation	$ 46	per foot x	84	feet =	$ 3,864
	Well vault	$ 500	each x	12	=	$ 6,000
						$ 9,864
					Assume:	**$ 9,900**
2f	**Trenching and Compressed Air Hose**					
	Side trenching to AS wells	$ 10.70	per foot x	2000	feet =	$ 21,400
	Compressed air hose	$ 0.60	per foot x	2000	feet =	$ 1,200
						$ 22,600
	Must buy 500-ft minimum of hose					
	Trenching G1030-805-1310, RSMeans 2008, $2.14/LF, includes backfill/compaction					
	Multiply trenching cost by 5 for small job					
					Assume:	**$ 22,600**
2g	**Trench Installation**					
	Assume 2.5 feet wide, 2.5 feet deep					
	Trenching, backfill, compact	$ 6.47	per foot x	400	feet =	$ 2,588
	4" PVC pipe	$ 8.18	per foot x	400	feet =	$ 3,272
	Bedding/filter pack	$ 50	per CY x	44	CY =	$ 2,200
	Plastic liner	$ 2.03	per SF x	1000	SF =	$ 2,030
	Clay backfill	$ 50	per CY x	50	CY =	$ 2,500
	Asphalt paving (cap)	$ 2.82	per SF x	2600	SF =	$ 7,332
						$ 19,922
	Asphalt paving 32-12-16.14.0020, RSMeans 2008, includes base and binder					
	Trenching G1030-805-1410, RSMeans 2008, includes backfill/compaction					
	Plastic liner 07-13-53.10.2700, RSMeans 2008, includes installation					
	4" PVC, 33-26-0430, RSMeans 2005, assume double for slotted					
					Assume:	**$ 20,000**
2h	**Miscellaneous**					
	Transducer, wiring, other					$ 5,000
					Assume:	**$ 5,000**

Transportation and Disposal

3	**Non Hazardous, Subtitle D**					
	300' long x 2.5' wide x 2.5' deep = 1875 CF = 69 CY					
	69 CY x 1.5 TON/CY = 103.5 TONS					
		$ 100	per ton x	104	tons =	$ 10,417
	Subtitle D Landfill Transportation & Disposal of Trench Spoils					
					Assume:	**$ 10,500**

Treatment System

4a	**SVE and AS System**					
	Engineer's estimate based on experience w/ recent costs					
	Blower	$ 2,000	each x	1	=	$ 2,000
	Compressor	$ 6,500	each x	1	=	$ 6,500
	KO tank	$ 2,300	each x	1	=	$ 2,300
	Liquid GAC Unit	$ 2,000	each x	1	=	$ 2,000
	Discharge pump	$ 270	each x	1	=	$ 270
	Control panel	$ 5,000	each x	1	=	$ 5,000
	PLC/Autodialer	$ 5,000	each x	1	=	$ 5,000
	Instrumentation	$ 2,000	LS			$ 2,000
	Piping	$ 2,000	LS			$ 2,000
	Wiring	$ 5,000	LS			$ 5,000
	Solenoid valves	$ 100	each x	50	=	$ 5,000
	Gauges	$ 75	each x	50	=	$ 3,750
	Flowmeters	$ 150	each x	50	=	$ 7,500
	Skid and mounting	$ 20,000	LS			$ 20,000
						$ 68,320
					Assume:	**$ 68,400**
4b	**Vapor Treatment**					
	Engineer's estimate based on experience w/ recent costs					
	Assume two 125-lb VPGAC drums and two 400-lb PPZ drums					
	125- lb VPGAC drums	$ 1.5	per lbs x	250	=	$ 375
	400-lb PPZ drums	$ 3	per lbs x	800	=	$ 2,400
						$ 2,775
					Assume:	**$ 2,800**
4c	**Hookup/Setup/Startup Testing**					
	For electrical, mechanical hookup, PLC programming, and testing					
	2 electricians for 1 week	$ 85	per hour x	80	hours =	$ 6,800
	2 plumbers for 1 week	$ 80	per hour x	80	hours =	$ 6,400
	1 programmer for 1 week	$ 90	per hour x	40	hours =	$ 3,600
	2 engineers for 1 week	$ 90	per hour x	80	hours =	$ 7,200
	Miscellaneous	$ 5,000	LS			$ 5,000
						$ 29,000
					Assume:	**$ 29,000**

Operation and Management Costs

	Vapor Treatment Media Replacement					
	Monthly GAC changeout of lead unit - 125 lbs	$ 1.5	per lb x	1500	lbs =	$ 2,250
	Quarterly PPZ changeout of lead unit - 400 lbs	$ 3	per lb x	1600	lbs =	$ 4,800
	Characterization Testing	$ 300	each x	16	=	$ 4,800
						$ 11,850
	O&M Labor and Reporting					
	Technician (8 hours per week)	$ 720	per week x	52	weeks =	$ 37,440
	Engineer - Reporting (2 hours per month)	$ 180	per month x	12	months =	$ 2,160
	Expenses	$ 50	per week x	52	weeks =	$ 2,600
	Equipment and Supplies	$ 25	per week x	52	weeks =	$ 1,300
	Sampling (quarterly condensate water sample)	$ 200	per event x	4	events =	$ 800
	Sampling (quarterly influent/effluent vapor samples)	$ 500	per event x	8	events =	$ 4,000
	Electric costs	$ 750	per month x	12	months =	$ 9,000
						$ 57,300
	Reporting	$ 80,000	once			**$ 80,000**
	Subtotal Annual O&M Cost					$ 149,150
	Contingency at 20%					$ 29,830
	TOTAL ANNUAL O&M COST					**$ 178,980**

Monitoring

Assumptions					
Number of sampling rounds			1		
Days per sampling round			2		
# of people for sampling			2		
# of wells to be sampled			10		assuming only shallow wells
QA/QC samples			2		
Monitoring, 15 samples each round, 2 people for 5 days					
Labor	$115	per hour x	48	hours=	$5,520
sample shipping	$200	per day x	2	days=	$ 400
H&S	$30	per day x	2	days=	$ 60
car rental	$100	per day x	4	days=	$ 400
per diem	$190	per day x	4	days=	$760
Equipment	$300	per day x	4	days=	$1,200
Analysis	$140	each x	12	=	$1,680
Data Evaluation & Reporting	$115	per hour x	50	hours=	$ 5,750
				Assume:	**$ 16,000**

Five-Year Review

	Assume a review will be conducted every 5 years.					
	Work includes review of groundwater monitoring data and preparation of report					
	Project Manager	$ 150	per hour x	32	hours =	$ 4,800
	Engineer	$ 115	per hour x	200	hours =	$ 23,000
	Scientist	$ 115	per hour x	120	hours =	$ 13,800
						$ 41,600
					Assume:	**$ 41,600**

Assume discount rate is 7%

Total Annual Monitoring Costs

This is a recurring cost every year for the following 10 years (years 1-10)

$$P = A \times \frac{(1+i)^n - 1}{i(1+i)^n}$$

n = 10

i = 7%

The multiplier for $(P/A)_2$ = **7.024**

Total Annual O&M Costs

This is a recurring cost every year for the following 5 years

$$P = A \times \frac{(1+i)^n - 1}{i(1+i)^n}$$

n = 5

i = 7%

The multiplier for $(P/A)_2$ = **4.100**

17 Total 5-year review costs

This cost occurs every 5 years for 10 years

need to calculate the effective interest rate i_e

Given

i = nominal interest rate = 7%

m = # of compounding periods = 2 years

$i_e = (1+i)^m - 1 =$ 0.145 or 14% / 5 years

$$P = A \times \frac{(1+i_e)^n - 1}{i_e(1+i_e)^n}$$

in this case, there are 4 five-year periods

n = 2

i = 0.145

The multiplier for (P/A) = 1.636

Alternative OU2-2 - Long Term Monitoring Cost Estimate Summary
Pride Solvents

Item No.	Item Description	Quantity	Unit Cost	Unit	Extension
CAPITAL COSTS					
	Work Plan/Health and Safety Plan	1	$ 42,800	LS	$ 42,800
QUARTERLY/ANNUAL MONITORING COSTS					
	Labor	120	$ 115	per hour	$ 13,800
	per diem	10	$ 190	per day	$ 1,900
	sample shipping	5	$ 200	per day	$ 1,000
	H&S	5	$ 30	per day	$ 150
	car rental	10	$ 100	per day	$ 1,000
	Equipment	10	$ 300	per day	$ 3,000
	Analysis	44	$ 140	each	$ 6,160
	Data Evaluation & Reporting	200	$ 115	per hour	$ 23,000
FIVE-YEAR REVIEW					
	Five-Year Review Report	1	$ 41,600	LS	**$ 41,600**
PRESENT WORTH OF COSTS					
	Total Capital Costs				$ 42,800
	Total Monitoring Costs (20 year duration)				$ 1,144,606
	Total Five-Year Reviews Costs (20 year duration)				$ 76,636
	TOTAL PRESENT WORTH				**$ 1,264,042**
				Rounded to	**$ 1,260,000**

Work Plan/Health and Safety Plan

This occurs at the beginning					
Project Manager	$ 150	per hour x	40	hours =	$ 6,000
Engineer	$ 115	per hour x	200	hours =	$ 23,000
Scientist	$ 115	per hour x	120	hours =	$ 13,800
					$ 42,800
				Assume:	**$ 42,800**

Monitoring

Assumptions					
Number of sampling rounds			1		
Days per sampling round			5		
# of people for sampling			2		
# of wells to be sampled			30		
QA/QC Samples			14		
Monitoring, 30 samples each round, 2 people for 5 days					
Labor		$115	120	per hour	$ 13,800
per diem		$190	10	per day	$ 1,900
sample shipping		$200	5	per day	$ 1,000
H&S		$30	5	per day	$ 150
car rental		$100	10	per day	$ 1,000
Equipment		$300	10	per day	$ 3,000
Analysis		$140	44	each	$ 6,160
Data Evaluation & Reporting		$115	200	per hour	$ 23,000
				Assume:	**$ 50,010**

Five-Year Review

Assume a review will be conducted every 5 years.					
Work includes review of groundwater monitoring data and preparation of report					
Project Manager	$ 150	per hour x	32	hours =	$ 4,800
Engineer	$ 115	per hour x	200	hours =	$ 23,000
Scientist	$ 115	per hour x	120	hours =	$ 13,800
					$ 41,600
				Assume:	**$ 41,600**

Percent Worth Calculations

Assume discount rate is 7%

Total Monitoring Costs

Total Quarterly Monitoring Costs

This cost occurs every quarter for the first 5 years

$$P = A \times \frac{(1+i)^n - 1}{i(1+i)^n}$$

n = 20

quarterly rate i = 1.75%

The multiplier for $(P/A)_1$ = 16.753

Total Annual Monitoring Costs

This is a recurring cost every year for the following 10years (years 3-20)

$$P = A \times \frac{(1+i)^n - 1}{i(1+i)^n}$$

n = 10

i = 7%

The multiplier for $(P/A)_2$ = 7.024

Future cost

$$P = F \times \frac{1}{(1+i)^n}$$

n = 2

i = 7%

The multiplier for (P/F) = 0.873

The total multiplier for (P/A) = $(P/A)_1$ + (P/F) x $(P/A)_2$ = 22.887549

Total 5-year review costs

This cost occurs every 5 years for 15 years

need to calculate the effective interest rate i_e

Given

i = nominal interest rate = 7%

m = # of compounding periods = 5 years

$i_e = (1+i)^m - 1 =$ 0.403 or 40% / 5 years

$$P = A \times \frac{(1+i_e)^n - 1}{i_e(1+i_e)^n}$$

in this case, there are 4 five-year periods

n = 4

i = 0.403

The multiplier for (P/A) = 1.842

Alternative OU2-3: In Situ Thermal Remediation
Cost Estimate Summary
Pride Solvents

Item Description	
IN SITU THERMAL REMEDIATION SYSTEM	
348 - day run time	
Pre-design investigation	$ 500,000
Fate and Transport Model and Groundwater Flow Model	$ 150,000
Drilling and Installation Costs	$ 572,700
Electrical Power Costs	$ 701,568
Subcontractor Costs	$ 1,386,000
SUBTOTAL ISTR COSTS	**$ 3,310,268**
GROUNDWATER EXTRACTION AND TREATMENT	
CAPITAL COSTS	
Pump and Treat System Construction Costs	
Work Plan/Health and Safety Plan	$ 42,800
Surveying	$ 6,500
Drilling and Installation	$ 52,500
Well Vault	$ 15,000
Treatment Building	$ 254,500
Treatment Components	$ 1,140,000
Earthwork	$ 13,220
	$ 1,524,520
General Contractor Fee (10% construction)	$ 152,452
Design Engineering (15% capital)	$ 228,678
Contingency (15% capital)	$ 228,678
SUBTOTAL CAPITAL COSTS	**$ 2,134,329**
OPERATION & MAINTENANCE (O&M) COSTS	
Annual O&M Costs	
Groundwater (GW) Treatment Plant O&M (20 yrs of operation)	$ 408,629
Long-term Monitoring (20 yr Annual GW Sampling)	$ 50,010
SUBTOTAL O&M COSTS	**$ 458,639**
PRESENT WORTH OF 30 YEAR COSTS	
In Situ Thermal Remediation Costs	$ 3,310,268
Total Groundwater Extraction and Treatment Capital Costs	$ 2,134,329
Groundwater Extraction and Treatment O&M Costs	$ 738,808
Total Five-Year Reviews Costs (20 year duration)	$ 76,636
Long-tern Monitoring Cost (20 year duration)	$ 529,807
TOTAL PRESENT WORTH OF 30 YEAR COSTS	**$ 6,790,000**

Work Plan/Health and Safety Plan

This occurs at the beginning					
Project Manager	$ 150	per hour x	40	hours =	$ 6,000
Engineer	$ 115	per hour x	200	hours =	$ 23,000
Scientist	$ 115	per hour x	120	hours =	$ 13,800
					$ 42,800
				Assume:	**$ 42,800**
Surveying					
aerial, 1 acres					$ 5,500
01107-700-1500, costworks 2003					
Drafter	$ 60.00	per hour x	16	hours =	$ 960
					$ 6,460
				Assume:	**$ 6,500**

Pre-Design Investigation to Determine the Nature and Extent of the Clay Contamination

One groundwater screening sample will be collected from the Upper Glacial Aquifer						
immediately above the clay.						
The thickness of contamination in the clay will be determined by collecting clay samples every						
six inches for a minimum of five feet.						
Area to be investigated				360,000	SF	
Distance between borings				80	Ft	
Number of borings				72	points	
Installation/Injections per day				2.0	points per day	
Days per sampling round				36		
# of people for sampling				2		
Clay samples				720		
Groundwater samples				72		
QA/QC Samples				47		
Geoprobe contractor						
Daily geoprobe rate			$5,000	36	days	$ 180,000
Mobilization/demobilization			$2,500	1	events	$ 2,500
Sampling personnel						
Labor			$115	720	per hour	$ 82,800
per diem			$190	72	per day	$ 13,680
sample shipping			$200	36	per day	$ 7,200
H&S			$30	36	per day	$ 1,080
car rental			$100	36	per day	$ 3,600
Equipment			$300	36	per day	$ 10,800
Analysis			$200	839	each	$ 167,760
Data Evaluation & Reporting			$115	120	per hour	$ 13,800
					Total	*$ 483,220*
					Assume:	**$ 500,000**

Elecrical Resistance Heating (ERH) System

Drilling costs								
Treatment area	14,000	SF						
Electrode radius of influence	9.5	ft						
Number of electrodes	50	electrodes						
Total depth of electrode	91	ft bgs						
Temperature monitoring points	7	points						
Total number of 12-inch outside diameter borings	57							
Borings	5,187	FT	x	$100	per foot	=	$	518,700
Construction-derived waste disposal	180	tons	x	$300	per ton	=	$	54,000
TOTAL DRILLING COSTS							**$**	**572,700**

Power costs for ERH system operation								
Average electrical heating power input per electrode	12	kW						
Total electrical heating power input	600	kW						
Total heating treatment time	348	days						
Design remediation energy	5,011,200	kWh	x	$0.14	per kWh	=	$	701,568
TOTAL POWER COSTS							**$**	**701,568**

ERH Subcontractor costs								
Design, workplan, permits	$65,000	LS					$	65,000
Mobilization and Materials	50	electrodes	x	$4,000	per electrode	=	$	200,000
Subsurface Installation	50	electrodes	x	$4,500	per electrode	=	$	225,000
Surface Installation and Startup	50	electrodes	x	$3,000	per electrode	=	$	150,000
System operation - 950 kW control unit and labor	348	days	x	$2,000	per day		$	696,000
Demobilization and Final Report	$50,000	LS						$50,000
TOTAL SUBCONTRACTOR COSTS							**$**	**1,386,000**

Groundwater Extraction and Treatment System

Extraction well radius of influence	100	FT
Number of extraction wells	1	wells

	Quantity	Unit		Unit Cost			Cost
a1. Extraction Well							
Assume three wells, 90 ft depth each							
6" Extraction Well Installation	90	FT	x	$450	=	$	40,500
Well development	5	HR	x	$400	=	$	2,000
Pump installation and testing	1	EA	x	$5,000	=	$	5,000
Construction-derived waste	1	EA	x	$5,000	=	$	5,000
Total for Extraction Wells						**$**	**52,500**
TOTAL WELL DRILLING AND INSTALLATION COSTS						**$**	**52,500**

WELL VAULTS

Well Vault	1	EA	x	$15,000	$	15,000
TOTAL WELL VAULT FOR OPTION 1					**$**	**15,000**

TREATMENT BUILDING

Assume a building footprint 1000 SF

Concrete & Soil Testing	1	LS	x	$5,000	=	$	5,000
Site preparation	1000	SF	x	$3	=	$	3,000
Concrete foundation with 6" slab	1	LS	x	$25,000	=	$	25,000
Pre-engineered steel building	1	LS	x	$200,000	=	$	200,000
Fence and gate	400	LF	x	$25	=	$	10,000
Driveway	1	LS	x	$5,000		$	5,000
Erosion control	1	LS	x	$2,000	=	$	2,000
Site Grading	1	LS	x	$1,000	=	$	4,500
TOTAL COST FOR ONE BUILDING						**$**	**254,500**

TREATMENT COMPONENTS

3hp Extraction Pump	1	EA	x	$6,000	=	$	6,000
Green Sand Filter or Bag Filter	1	LS	x	$21,000	=	$	21,000
Influent and effluent Tanks (2000 Gal)	2	EA	x	$3,200	=	$	6,400
Transfer Pump (centrifugal); includes spare	2	EA	x	$3,000	=	$	6,000
Air Stripper package	1	LS	x	$110,000	=	$	110,000
Sump w/pump	1	EA	x	$500	=	$	500
Off gas treatment system	1	EA	x	$40,000	=	$	40,000
Piping, fitting and support within building	2000	LF	x	$40	=	$	80,000
Valves	100	EA	x	$100	=	$	10,000
I&C	1	LS	x	$50,000	=	$	50,000
HVAC	1	LS	x	$25,000	=	$	25,000
Light	1	LS	x	$5,000	=	$	5,000
Electrical power supplies, wiring, cable	1	LS	x	$20,000	=	$	20,000
Subtotal Equipment Cost						$	379,900
Assume 100% of cost for installation						$	379,900
Assume 20% of cost for shipping and handling						$	75,980
Total treatment facility cost						$	835,780
Startup (Initial Testing Period)	1	LS	x	$50,000	=	$	50,000
TREATMENT COMPONENTS						**$**	**1,140,000**

EARTHWORK

Trenching and piping

Assume 1000 ft pipe required to treatment plant 1000 ft

Assume discharge to sewer

Excavated for 4" PVC pipe (trench is 5 ft deep 2 ft wide)	370	CY	x	$7.00	=	$2,593
4-inch PVC pressure piping (RSMeans 02500.750.4040)	1000	LF	x	$6.85	=	$6,850
Backfill	185	CY	x	$15.00	=	$2,778
Electrical	500	LF	x	$2.00	=	$1,000
Trenching and piping total for Option 1						**$13,220**

Total	**$**	**1,475,220**

Annual Groundwater Treatment Plant O Cost

Labor Cost:

Assume one operator at 20 hours/week	$85	per hr	1,040	hrs/yr
Labor Cost:	$88,400			
Supervision @20%	$17,680			
Home office support at 20%	$17,680			
Total Annual Labor Cost	**$123,760**	**per year**		

Analysis Cost:

Assume treated groundwater and off-gas will be sampled once a week.
samples will be analyzed for VOCs, metals, wet chemistry (TSS, TDS, Alk, pH)

Cost of samples $1200 per week x 52 weeks = $62,400

Total Annual Cost for Sample Analysis	**$**	**62,400**	**per year**

Power Cost:

Total pumping horsepower			6	hp
Total power draw			5	kW
Unit cost of Power per KW/hr.	$0.14	x	5	KW/hr
Total power consumption per year			39,420	kWh
Total Power Cost		**$**	**5,519**	**per year**

Maintenance Cost:

Carbon Changeout per year	$	50,000	
Parts and supplies (5% of equipment cost)	$	18,845	
Estimated Maintenance Cost	**$**	**68,845**	**per year**

Reporting	**$**	**80,000**	**per year**

Subtotal Annual O&M Cost	$	340,524
Contingency at 20%	$	68,105
TOTAL ANNUAL O&M COST	**$**	**408,629**

Monitoring

Assumptions					
Number of sampling rounds			1		
Days per sampling round			5		
# of people for sampling			2		
# of wells to be sampled			30		
QA/QC Samples			14		
Monitoring, 30 samples each round, 2 people for 5 days					
Labor		$115	120	per hour	$ 13,800
per diem		$190	10	per day	$ 1,900
sample shipping		$200	5	per day	$ 1,000
H&S		$30	5	per day	$ 150
car rental		$100	10	per day	$ 1,000
Equipment		$300	10	per day	$ 3,000
Analysis		$140	44	each	$ 6,160
Data Evaluation & Reporting		$115	200	per hour	$ 23,000
				Assume:	**$ 50,010**

Five Year Review

Assume a review will be conducted every 5 years.					
Work includes review of groundwater monitoring data and preparation of report					
Project Manager	$ 150	per hour x	32	hours =	$ 4,800
Engineer	$ 115	per hour x	200	hours =	$ 23,000
Scientist	$ 115	per hour x	120	hours =	$ 13,800
					$ 41,600
				Assume:	**$ 41,600**

Present Worth Calculations

Assume discount rate is 7%

Total Annual Monitoring Costs

This is a recurring cost every year for the following 20 years (years 1-20)

$$P = A \times \frac{(1+i)^n - 1}{i(1+i)^n}$$

$n =$ 20

$i =$ 7%

The multiplier for $(P/A)_2 =$ **10.594**

Total Annual O&M Costs

This is a recurring cost every year for the following 2 years

$$P = A \times \frac{(1+i)^n - 1}{i(1+i)^n}$$

$n =$ 2

$i =$ 7%

The multiplier for $(P/A)_2 =$ **1.808**

12 Total 5-year review costs

This cost occurs every 5 years for 20 years

need to calculate the effective interest rate i_e

Given

i = nominal interest rate = 7%

m = # of compounding periods = 5 years

$i_e = (1+i)^m - 1 =$ 0.403 or 40% / 5 years

$$P = A \times \frac{(1+i_e)^n - 1}{i_e(1+i_e)^n}$$

in this case, there are 6 five-year periods

$n =$ 4

$i =$ 0.403

The multiplier for (P/A) = 1.842

Alternative OU2-4 - Fracturing and Injection
Pride Solvents

Item No.	Item Description	Quantity	Unit Cost	Unit	Extension
CAPITAL COSTS					
General Requirements					
	Work Plan/Health and Safety Plan	1	$ 42,800	LS	$ 42,800
	Pre-design investigation	1	$ 500,000	LS	$ 500,000
	Surveying	1	$ 6,500	LS	$ 6,500
	Bench-Scale Study	1	$ 45,500	LS	$ 45,500
	Fracturing and Injection of Oxidant	1	$ 967,000	LS	$ 967,000
	Contingency (15% capital)				$ 234,270
	SUBTOTAL CAPITAL COSTS				**$ 1,797,000**
FIVE-YEAR REVIEW					
	Five-Year Review Report	1	$ 41,600	LS	**$ 41,600**
PRESENT WORTH OF COSTS					
	Total Capital Costs				$ 1,797,000
	Total Monitoring Costs (20 year duration)				$ 809,714
	Total Five-Year Review Costs (20 year duration)				$ 76,636
	TOTAL PRESENT WORTH				**$ 2,683,350**
				Assume:	**$ 2,690,000**

Pre-Design Investigation to Determine the Nature and Extent of the Clay Contamination

One groundwater screening sample will be collected from the Upper Glacial Aquifer				
immediately above the clay.				
The thickness of contamination in the clay will be determined by collecting clay samples every				
six inches for a minimum of five feet.				
Area to be investigated		360,000	SF	
Distance between borings		80	Ft	
Number of borings		72	points	
Installation/Injections per day		2.0	points per day	
Days per sampling round		36		
# of people for sampling		2		
Clay samples		720		
Groundwater samples		72		
QA/QC Samples		47		
Geoprobe contractor				
Daily geoprobe rate	$5,000	36	days	$ 180,000
Mobilization/demobilization	$2,500	1	events	$ 2,500
Sampling personnel				
Labor	$115	720	per hour	$ 82,800
per diem	$190	72	per day	$ 13,680
sample shipping	$200	36	per day	$ 7,200
H&S	$30	36	per day	$ 1,080
car rental	$100	36	per day	$ 3,600
Equipment	$300	36	per day	$ 10,800
Analysis	$200	839	each	$ 167,760
Data Evaluation & Reporting	$115	120	per hour	$ 13,800
			Total	*$ 483,220*
			Assume:	**$ 500,000**

This occurs at the beginning					
Project Manager	$ 150	per hour x	40	hours =	$ 6,000
Engineer	$ 115	per hour x	200	hours =	$ 23,000
Scientist	$ 115	per hour x	120	hours =	$ 13,800
					$ 42,800
				Assume:	**$ 42,800**
Surveying					
aerial, 1 acres					$ 5,500
01107-700-1500, costworks 2003					
Drafter	$ 60.00	per hour x	16	hours =	$ 960
					$ 6,460
				Assume:	**$ 6,500**
Bench-Scale Study					
This occurs prior to the treatment					
Contractor	$ 15,000	per study	1	each	$ 15,000
Project Manager	$ 150	per hour x	12	hours =	$ 1,800
Engineer	$ 115	per hour x	200	hours =	$ 23,000
Scientist	$ 115	per hour x	180	hours =	$ 20,700
					$ 45,500
				Assume:	**$ 45,500**

Injection Estimates

Area to be treated		14,000	SF	
Radius of influence		10	Ft	
Number of injection points		45	points	
Installation/Injections per day		2.0	points per day	
Number of injection rounds		2	rounds	
Volume injected per borehole		3,000	Liters	
Oxidant concentration		200	g/L	
Mass oxidant injected per borehole		600,000	grams	
Cost of oxidant and activator		$4.00	per pound	
Cost of oxidant and activator per borehole		$1,320	per borehole	
Number of sampling rounds		3		
Days per sampling round		5		
# of people for sampling		2		
# of wells to be sampled		30		
QA/QC Samples		14		
Fracturing and Injection Contractor				
Daily Frac/injection contractor rate	Unit Cost	Quantity	Unit	
Mobilization/demobilization	$39,500	1	events	$ 39,500
Tilt meter/geophysics	$3,000	45	boreholes	$ 135,000
Daily contractor rate	$23,500	23	days	$ 528,750
Oxidant	$1,320	45	boreholes	$ 59,400
Geoprobe contractor				
Daily geoprobe rate	$5,000	23	days	$ 112,500
Mobilization/demobilization	$2,500	1	events	$ 2,500
Completion as reusable injection points	$1,000	45	points	$ 45,000
Injection oversight				
Eng	$115	270	per hour	$ 31,050
H&S/QC	$115	23	per hour	$ 2,588
Car Rental	$100	23	per day	$ 2,250
per diem	$350	23	per day	$ 7,875
			Assume:	**$ 967,000**

Assumptions

Number of sampling rounds			1		
Days per sampling round			5		
# of people for sampling			2		
# of wells to be sampled			30		
QA/QC Samples			14		
Monitoring, 30 samples each round, 2 people for 5 days					
Labor		$115	120	per hour	$ 13,800
per diem		$190	10	per day	$ 1,900
sample shipping		$200	5	per day	$ 1,000
H&S		$30	5	per day	$ 150
car rental		$100	10	per day	$ 1,000
Equipment		$300	10	per day	$ 3,000
Analysis		$140	44	each	$ 6,160
Data Evaluation & Reporting		$115	200	per hour	$ 23,000
				Assume:	**$ 50,010**

Five Year Review

Assume a review will be conducted every 5 years.						
Work includes review of groundwater monitoring data and preparation of report						
Project Manager	$ 150	per hour x	32	hours =	$	4,800
Engineer	$ 115	per hour x	200	hours =	$	23,000
Scientist	$ 115	per hour x	120	hours =	$	13,800
					$	41,600
				Assume:	**$**	**41,600**

Alter Assume discount rate is 7%

Pride Solvents

Total Monitoring Costs

Total Quarterly Monitoring Costs

This cost occurs every quarter for the first 2 years (years 1 and 2)

$$P = A \times \frac{(1+i)^n - 1}{i(1+i)^n}$$

n = 8

quarterly rate i = 1.75%

The multiplier for $(P/A)_1$ = 7.405

Total Annual Monitoring Costs

This is a recurring cost every year for the following 18 years (years 3-20)

$$P = A \times \frac{(1+i)^n - 1}{i(1+i)^n}$$

n = 18

i = 7%

The multiplier for $(P/A)_2$ = 10.059

Future cost

$$P = F \times \frac{1}{(1+i)^n}$$

n = 2

i = 7%

The multiplier for (P/F) = 0.873

The total multiplier for (P/A) = $(P/A)_1 + (P/F) \times (P/A)_2$ = 16.191

Total 5-year review costs

This cost occurs every 5 years for 15 years

need to calculate the effective interest rate i_e

Given

i = nominal interest rate = 7%

m = # of compounding periods = 5 years

$i_e = (1+i)^m - 1$ = 0.403 or 40% / 5 years

$$P = A \times \frac{(1+i_e)^n - 1}{i_e(1+i_e)^n}$$

in this case, there are 3 five-year periods

n = 4

i = 0.403

The multiplier for (P/A) = 1.842

Alternative OU2-5 - Enhanced Anaerobic Bioremediation
Pride Solvents

Item No.	**Item Description**	**Quantity**	**Unit Cost**	**Unit**	**Extension**
CAPITAL COSTS					
1. General Requirements					
1a.	Work Plan/Health and Safety Plan	1	$ 42,800	LS	$ 42,800
1b.	Pre-design investigation	1	$ 500,000	LS	$ 500,000
1c.	Surveying	1	$ 6,500	LS	$ 6,500
2a	EOS	1	$ 122,610	LS	$ 122,610
2b	Drilling Costs	1	$ 365,701	LS	$ 365,701
2c	Total Injection Costs for 5 rounds	1	$ 955,478	LS	$ 955,478
3.	Contingency (15% capital)				$ 298,963
	SUBTOTAL CAPITAL COSTS				**$ 2,292,051**
FIVE-YEAR REVIEW					
4.	**Five-Year Review Report**	1	$ 41,600	LS	**$ 41,600**
PRESENT WORTH OF COSTS					
5.	Total Capital Costs				$ 2,292,051
6.	Total Monitoring Costs (20 year duration)				$ 1,235,651
7.	Total Five-Year Reviews Costs (15 year duration)				$ 65,885
8.	**TOTAL PRESENT WORTH**				**$ 3,593,588**
				Assume	**$ 3,590,000**

Pre-Design Investigation to Determine the Nature and Extent of the Clay Contamination

One groundwater screening sample will be collected from the Upper Glacial Aquifer						
immediately above the clay.						
The thickness of contamination in the clay will be determined by collecting clay samples every						
six inches for a minimum of five feet.						
Area to be investigated				360,000	SF	
Distance between borings				80	Ft	
Number of borings				72	points	
Installation/Injections per day				2.0	points per day	
Days per sampling round				36		
# of people for sampling				2		
Clay samples				720		
Groundwater samples				72		
QA/QC Samples				47		
Geoprobe contractor						
Daily geoprobe rate			$5,000	36	days	$ 180,000
Mobilization/demobilization			$2,500	1	events	$ 2,500
Sampling personnel						
Labor			$115	720	per hour	$ 82,800
per diem			$190	72	per day	$ 13,680
sample shipping			$200	36	per day	$ 7,200
H&S			$30	36	per day	$ 1,080
car rental			$100	36	per day	$ 3,600
Equipment			$300	36	per day	$ 10,800
Analysis			$200	839	each	$ 167,760
Data Evaluation & Reporting			$115	120	per hour	$ 13,800
					Total	*$ 483,220*
					Assume:	**$ 500,000**

1a.	**Work Plan/Health and Safety Plan**					
	This occurs at the beginning					
	Project Manager	$ 150	per hour x	40	hours =	$ 6,000
	Engineer	$ 115	per hour x	200	hours =	$ 23,000
	Scientist	$ 115	per hour x	120	hours =	$ 13,800
						$ 42,800
					Assume:	**$ 42,800**
1b.	**Surveying**					
	aerial, 1 acres					$ 5,500
	01107-700-1500, costworks 2003					
	Drafter	$ 60.00	per hour x	16	hours =	$ 960
						$ 6,460
					Assume:	**$ 6,500**

EAB Amendment Injection

2a.	**Substrate used**							
	Brand and Product ID	EOS	Sodium lactate and soybean oil formulation					
	Price/lb			1.50	$			
	Purchased concentration			60	%			
	Injected concentration			10	%			
	Price per lb for 100% solution			2.50	$/lb			
	Length of treatment zone			900	ft			
	Width of treatment zone			400	ft			
	Area of treatment zone			14,000	sq. ft			
	Depth to top of injection zone			83	ft			
	Depth to bottom of injection zone			85	ft			
	Radius of influence			10	ft			
	Thickness of treatment zone			2	ft			
	Treatment volume per location			628	cu.ft			
	Effective Porosity			0.18				
	Volume per well			113	cu.ft	856.84	gallons	
	No. of injection wells			45	wells			
	Total volume			5,040	cu.ft	38,203	gallons	
	Volume of EOS required at purchased concn			6,367	gallons			
	Total number of drums			128	drums			
	Assume 40 drums per truck load			4	trucks			
	Delivery price per truckload			2,000	$/truckload	4	trucks	$ 8,000.00
	Total price of EOS (gallons)			18	$/gallon	6,367	gallons	$ 114,609.60
	TOTAL EOS MATERIAL COST							**$ 122,609.60**
2b.	***Injection well installation***							
	Assuming wells will be installed by hollow stem auger							
	Time required to install one well to 85 feet			7	hours			
	Injection rate			10	gpm			
	Time required for injection in each location			86	minutes	1.43	hours	
	Assuming one well can be installed and injected in one day,total time for all wells			45	days			
	Well casing			46	$/foot	3790	feet	$ 174,331
	Well vault (if permanent wells)			500	$/well	45	vaults	$ 22,293
	Well development			500	$/well	45	wells	$ 22,293
	Number of injection rounds			5	rounds			
	Number of sampling rounds effectiveness monitoring			1	round			
	Days per sampling round			1	day			
	# of people for sampling			2	people			
	# of wells to be sampled			3	wells			
	QA/QC Samples			2	samples			
	Drilling Costs							
	Geoprobe contractor							
	Mobilization/demobilization			5,000	$/event	1	event	$ 5,000
	Daily injection contractor rate			2,500	$/day	45	days	$ 111,465
	Drilling oversight							
	Geologist			115	$/day	45	days	$ 5,127
	H&S/QC			115	$/day	45	days	$ 5,127
	Car Rental			100	$/day	45	days	$ 4,459
	per diem			350	$/day	45	days	$ 15,605
	TOTAL DRILLING COSTS							**$ 365,701**
2c.	***Injection Costs:***							
	Injection Contractor							
	Mobilization/demobilization			10,000	$/event	1	event	$ 10,000
	Daily injection contractor rate			4,000	$/day	8	days	$ 31,836
	Total price of EOS (gallons)			122,610	$/event	1	event	$ 122,610
	Effectiveness Monitoring							
	Labor			115	$/hour	16	hour	$ 1,840
	per diem			190	$/day	2	man-days	$ 380
	sample shipping			200	$/day	1	day	$ 200
	H&S			30	$/day	1	day	$ 30
	car rental			100	$/day	2	man-days	$ 200
	Equipment			300	$/day	1	day	$ 300
	Analysis			140	$/sample	5	samples	$ 700
	Data Evaluation & Reporting			115	$/hour	200	hours	$ 23,000
	TOTAL INJECTION COSTS							**$ 955,478**

Monitoring

Assumptions					
Number of sampling rounds			1		
Days per sampling round			5		
# of people for sampling			2		
# of wells to be sampled			30		
QA/QC Samples			14		
Monitoring, 30 samples each round, 2 people for 5 days					
Labor		$115	120	per hour	$ 13,800
per diem		$190	10	per day	$ 1,900
sample shipping		$200	5	per day	$ 1,000
H&S		$30	5	per day	$ 150
car rental		$100	10	per day	$ 1,000
Equipment		$300	10	per day	$ 3,000
Analysis		$140	44	each	$ 6,160
Data Evaluation & Reporting		$115	200	per hour	$ 23,000
				Assume:	**$ 50,010**

Five-Year Review

Assume a review will be conducted every 5 years.					
Work includes review of groundwater monitoring data and preparation of report					
Project Manager	$ 150	per hour x	32	hours =	$ 4,800
Engineer	$ 115	per hour x	200	hours =	$ 23,000
Scientist	$ 115	per hour x	120	hours =	$ 13,800
					$ 41,600
				Assume:	**$ 41,600**

Assume discount rate is 7%

11 Total Monitoring Costs

Total Quarterly Monitoring Costs

This cost occurs every quarter for the first 5 years

$$P = A \times \frac{(1+i)^n - 1}{i(1+i)^n}$$

n = 20

quarterly rate i = 1.75%

The multiplier for $(P/A)_1$ = 16.753

Total Annual Monitoring Costs

This is a recurring cost every year for the following 15 years (years 5-20)

$$P = A \times \frac{(1+i)^n - 1}{i(1+i)^n}$$

n = 15

i = 7%

The multiplier for $(P/A)_2$ = 9.108

Future cost

$$P = F \times \frac{1}{(1+i)^n}$$

n = 2

i = 7%

The multiplier for (P/F) = 0.873

The total multiplier for (P/A) = $(P/A)_1 + (P/F) \times (P/A)_2$ = 24.708086

12 Total 5-year review costs

This cost occurs every 5 years for 15 years

need to calculate the effective interest rate i_e

Given

i = nominal interest rate = 7%

m = # of compounding periods = 5 years

$i_e = (1+i)^m - 1$ = 0.403 or 40% / 5 years

$$P = A \times \frac{(1+i_e)^n - 1}{i_e(1+i_e)^n}$$

in this case, there are 4 five-year periods

n = 3

i = 0.403

The multiplier for (P/A) = 1.584