FINAL REPORT

Feasibility Study
Dambrose Cleaners Site
Schenectady, New York

New York State Department of
Environmental Conservation
Division of Environmental Remediation
Albany, New York

January 2007

O'BRIEN & GERE

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Executive Summary

The Dambrose Cleaners site, located at 1517 Van Vranken Avenue in Schenectady, New York, had a dry cleaning operation since the 1950s and was closed in 2000. It is now used as a dry cleaner drop off location. A Phase II Environmental Site Assessment in 1997 and a subsequent Preliminary Site Assessment in 1999 revealed the presence of tetrachloroethene (perchloroethene, or PCE) and its degradation products (trichloroethene (TCE), dichloroethene (DCE) and vinyl chloride (VC)) in soil, groundwater and soil vapor. O'Brien & Gere completed a Remedial Investigation (RI) in 2005, the results of which form the basis for this Feasibility Study (FS).

The highest levels of volatile organic contamination [up to 11,000 micrograms per kilogram (μg/Kg) PCE] were found in the sub-slab soils. An estimated 300 cubic yards of soil appears to be contaminated with chlorinated volatile organic compounds (VOCs) in excess of New York State Department of Environmental Conservation's (NYSDEC's) Technical and Administrative Guidance Memorandum (TAGM) 4046 soil cleanup objectives. Individual chlorinated VOCs ranged from 5 to 800 micrograms per liter (μg/L) in groundwater. The plume of groundwater contamination is about 75 feet wide near the source and extends approximately west from the dry cleaner building. Downgradient wells had relatively lower concentrations of PCE than source area wells, but higher levels of degradation products. Workers in the building and residents in and around the building were identified in the qualitative exposure assessment as being potentially exposed to the chlorinated VOCs as they migrate from groundwater and soil vapor to ambient air.

Remedial action objectives (RAOs) for the site include prevention of exposure (through inhalation, ingestion or direct contact) to contaminated soil and groundwater, prevention of migration of contaminants, removal of the source of contamination, and restoration of the groundwater to pre-release conditions to the extent possible.

Technologies for site remediation were evaluated and those surviving the screening process were combined into four individual alternatives each for soil (S1 to S4) and groundwater (G1 to G4), and two alternatives (S5/G5 and S6/G6) that provide combined treatment of soil and groundwater. The alternatives were evaluated against seven of the eight criteria as set forth in NYSDEC's DER-10 technical guidance.

1. Introduction

1.1. Purpose and Organization of Report

O'Brien & Gere completed a Remedial Investigation (RI) at the Dambrose Cleaners site, and identified potential risks that necessitate remedial measures to render the site safe for human health and the environment. The purpose of this Feasibility Study (FS) was to:

- Establish specific goals for remedial action
- Identify remedial technologies and process options
- Develop and evaluate remedial alternatives to address the goals
- Recommend the alternatives best suited for reaching these goals

The generalized process for developing remedial alternatives at a hazardous waste site is shown on Figure 1. This report presents the FS and is organized as follows:

Section 1:	Summarizes site background and RI results
Section 2:	Presents Standards, Criteria and Guidance (SCGs)
Section 3:	States the Remedial Action Objectives and identifies general response actions
Section 4:	Identifies remedial technologies and process options
Section 5:	Combines technologies and processes into remedial alternatives
Section 6:	Provides estimated quantities and costs for soil and groundwater remediation
Section 7:	Describes the detailed analysis of remedial alternatives

1.2. Site Description and History

The 0.11-acre Dambrose Cleaners site is located at 1517 Van Vranken Avenue in Schenectady, New York (see Figure 2), and is surrounded by residential and commercial properties encircling the square block with backyards on the inside of the block (see aerial photo on Figure 3 and site layout on Figure 4). Dambrose Cleaners operated in a two-story wood and masonry building on the property. The first floor was used for dry cleaning operations, and the second floor was an apartment residence. The back of the building was the former location of the dry cleaning machine, distillation tank, air filter unit and PCE storage tanks. An apartment now exists on the first floor, in the rear of the building, and has an inaccessible dirt-floor crawl space beneath it. The garage formerly located behind the building was used for hazardous waste storage.

As part of a 1997 Phase I Environmental Site Assessment (ESA), areas of recognized environmental conditions were identified. These included staining noted in the areas of the storage tank fill pipes and solvent distillation tank. Based upon these results, a Phase II ESA was initiated by the owner in 1997. Chlorinated VOCs ranging from 600 micrograms per kilogram (µg/Kg) vinyl chloride (VC) to 15,000 µg/Kg PCE were identified in soils close to the hazardous waste storage area. PCE contamination [up to 6,565 parts per billion (ppb), or 44,500 micrograms per cubic meter (µg/m3)] was found in soil vapor samples during the Preliminary Site Assessment in 1999, which was conducted pursuant to an Order on Consent with NYSDEC dated September 8, 1998. In 1999 and

2001, the New York State Department of Health (NYSDOH) found elevated PCE concentrations in indoor air, as high as 550 µg/m3 and in excess of the NYSDOH guideline of 100 µg/m3 in air. The site is currently listed as a Class 2 site in the New York State's Registry of Inactive Hazardous Waste Disposal sites.

O'Brien and Gere prepared a Remedial Investigation/Feasibility Study (RI/FS) Work Plan in July 2004 and subsequently initiated the RI in September 2004. The RI results are presented in a Final RI Report dated March 2006. During this time, the New York State Department of Environmental Conservation (NYSDEC) also installed a sub-slab depressurization system consisting of three system suction points at the Dambrose building.

1.3. Summary of Investigations

The RI began with a preliminary screening program in September 2004, and was followed by a second phase of groundwater investigation in December 2004. Table 1 provides a summary of the RI sampling program. Site samples were analyzed for VOCs. The initial screening program included soil vapor and groundwater sampling to evaluate volatile organic compound (VOC) contamination in groundwater. Indoor air, ambient air and sub-slab vapor were sampled and analyzed for VOCs. The second phase of investigation extended the soil vapor and groundwater sampling with the installation of additional permanent groundwater monitoring wells. *In situ* hydraulic conductivity tests were performed on the monitoring wells to estimate hydraulic conductivity of the geologic materials underlying the site.

1.3.1. Site Stratigraphy and Hydrogeology

With the exception of fill, unconsolidated deposits of glacial origin overlie the bedrock throughout most of the Site. The Site's unconsolidated deposits consist of fill material, glaciolacustrine deposits, and till. Based on the soil borings, the total thickness of the unconsolidated deposits ranges from 11 to 16 feet.

The discontinuous cultural fill layer observed throughout the majority of the site predominantly consists of brown silt, sand and gravel mixed with varying amounts of brick, cobbles, cinders, and coal. The fill material ranged in thickness from 2.8 to 6.5 feet. The fill materials are underlain by a mottled, brown-gray glaciolacustrine unit, generally consisting of silt and clay fining downward to silty clay. A discontinuous layer of weathered till was observed underneath the glaciolacustrine deposits.

The primary groundwater unit at the site is an unconfined aquifer located within the unconsolidated fill and the glaciolacustrine unit, extending downward to the interface between the glaciolacustrine unit and the gray silty clay or till of lower permeability. Monitoring wells at the Site are screened across both the unconsolidated fill and the underlying glaciolacustrine unit, where present, with the exception of MW-4.

The results of the hydraulic conductivity testing ranged from 2.8x10-4 cm/sec (0.80 ft/day) to 1.6x10-2 cm/sec (45.41 ft/day), with a geometric mean of 3.1x10-3 cm/sec (8.64 ft/day). The relatively higher hydraulic conductivity appears to be the influence of the highly weathered material overlying bedrock. Groundwater flow is generally to the west (see RI Figures 5-1 and 5-2), with an estimated average linear velocity of 0.96 to 1.3 ft/day.

1.3.2. Groundwater and Basement Sump

Groundwater samples were collected in two rounds of sampling, first during the preliminary screening and then as part of the second phase. Two of the sixteen groundwater screening samples from September 2004 had cis-1,2 dichloroethene (cis-1,2 DCE) at 5 ppb (near the building) and 13 ppb (downgradient), exceeding the NYSDEC's groundwater standards. The downgradient well also had trichloroethene (TCE) at 5 ppb and PCE at 7 ppb. The basement sump water sample collected at the same time had 960 ppb of cis-1,2 DCE, as well as other chlorinated VOCs ranging in concentrations from 3 ppb (trans-1,2 DCE) to 97 ppb (VC).

During the second round of sampling, in December 2004, chlorinated VOCs were detected in five of the eleven permanent monitoring wells. Individual VOC concentrations are reproduced on Table 2 and Figure 4, and the maximum and minimum concentrations are shown in Table 3. PCE was detected in MW-2, MW-4 and MW-6 at concentrations of 670 ppb, 10 ppb and 5.0 ppb, respectively. TCE was detected in MW-1, MW-2, MW-4 and MW-6 at concentrations of 0.9 ppb, 54 ppb, 4.0 ppb and 6.0 ppb, respectively. Cis-1,2 DCE was detected in MW-1, MW-2, MW-4, MW-6 and MW-7 at 45 ppb, 56 ppb, 21 ppb, 70 ppb, and 5.0 ppb, respectively. VC was detected in MW-1, MW-4, MW-6 and MW-7 at 110 ppb, 9.0 ppb, 0.7 ppb and 5.0 ppb, respectively.

1.3.3. Sub-slab Soil

The sub-slab soil samples which were collected from three locations in the basement of the former Dambrose cleaners building in December 2004, had detected PCE concentrations ranging from 220 μg/Kg to 11,000 μg/Kg, while TCE (maximum 130 μg/Kg) and cis-1,2-DCE (maximum 80 μg/Kg) were detected at lower concentrations. Of these detected concentrations, the NYSDEC's Technical and Administrative Guidance Memorandum (TAGM) 4046 soil cleanup objectives (SCOs) were exceeded in one sample (SS-3) near the basement staircase, where PCE (at 11,000 μg/Kg) exceeded the SCO of 1,400 μg/Kg.

1.3.4. Indoor Air and Soil Vapor

Indoor air samples collected from the Dambrose building in September 2004 had PCE ranging from 64 $\mu g/m^3$ to 360 $\mu g/m^3$. The highest concentrations were in the first floor drop off area and the lowest concentrations were in the basement. The single sub-slab vapor sample collected in September 2004 had detected concentrations of PCE at 1,200,000 $\mu g/m^3$, TCE at 13,000 $\mu g/m^3$and cis-1,2-DCE at 7,400 $\mu g/m^3$. The VOC concentrations in soil vapor samples were lower outside of the building. These detected concentrations ranged from 0.97 $\mu g/m^3$ to 410 μg/m3, with the exception of SG-2 where PCE was detected at 38,000 μg/m3 and TCE was detected at 2400 μg/m3.

1.4. Nature and Extent of Contamination

This former dry cleaner site has soil, groundwater and sub-slab soil vapor contamination with chlorinated VOCs, mostly PCE and its degradation byproducts – TCE, DCE and VC.

1.4.1. Soil

Historically, the basement and first floor of the building were used for dry cleaning since the 1950s while the second floor served as a residential apartment. The dry cleaning operations were discontinued in 2000. The site investigation data show the contaminant source area appears to be limited to the sub-slab soils. The highest concentrations of chlorinated VOCs in exterior soil vapor were found at locations close to the former dry cleaner building. Low levels of soil vapor contamination in the vadose zone appear to correlate with the groundwater that contains detectable concentrations of chlorinated VOCs.

1.4.2. Groundwater

The groundwater plume extends approximately 200 feet west from the dry cleaner building, following the groundwater flow direction, and is approximately 75 feet in width near the source. VOCs were detected at concentrations exceeding groundwater standards in five wells within the plume of contamination shown on Figure 4. Individual chlorinated VOCs ranged from 5 micrograms per liter (µg/L) to 800 µg/L. Downgradient wells had relatively lower concentrations of PCE than the source area wells, but higher concentrations of degradation products. The contamination appears to extend across the fill, glaciolacustrine and the underlying weathered till/bedrock. As Figure 4 illustrates, groundwater chlorinated VOC concentrations are higher in the vicinity of the building with detected concentrations greater than 100 ppb, and decrease with distance downgradient, downgradient, with detected concentrations less than 100 ppb.

1.5. Summary of Qualitative Exposure Assessment

The chlorinated VOCs have relatively higher mobilities (than non-polar VOCs of similar molecular weight) in groundwater and soil vapor, and also tend to attenuate naturally. The volatility of the chlorinated VOCs decreases and the soil adsorption coefficient tends to increase with increasing molecular size. The building now has a business with a seamstress and dry-cleaning drop-off, and apartments. Workers and residents in the building are potential receptors through contaminants in ambient air associated with the existing dry cleaning drop-off business and with soil vapor intrusion. The VOCs in groundwater and soil vapor also present a potential exposure pathway for off-site residents via vapor migration to nearby residences. The site location is in an urbanized residential and commercial district. Groundwater is not used as the source of drinking water in the area. No ecological receptors are adversely impacted.

2. Standards, Criteria and Guidance

An inactive hazardous waste disposal site must be remediated to conform, to the extent practicable, to standards and criteria consistently applied and officially promulgated that are directly applicable, or relevant and appropriate to the site conditions. The remedial program for the site should also be designed with consideration to state and federal guidance determined on a case-specific basis. Standards, Criteria and Guidance (SCGs) also include those federal requirements which are more stringent than state requirements.

2.1. Chemical Specific Standards, Criteria and Guidance

Chemical specific SCGs are health or risk based that limit the concentration of a chemical found in or discharged to the environment. These are generally numerical values set for a single compound or group of closely related compounds. They govern the site remediation by providing either actual clean-up levels, or the basis for calculating such levels.

2.1.1. Soil

There are currently no specific standards for soil contaminants in New York State other than for hazardous waste characterization. However, through an administrative guidance document, the NYSDEC has established goals for acceptable cleanup levels in soil based on a combination of human health risk factors and potential groundwater impacts.

- NYSDEC's TAGM for the Determination of SCOs and cleanup levels (TAGM 4046, revised 1994) provides guidance relative to remedial action at contaminated sites in New York State. Under the TAGM 4046 guidelines, a remediated site would qualify for unrestricted use if the residual contaminant concentrations are below the corresponding SCOs. Otherwise, suitable environmental easements would have to be in place for site closure and its future use.

2.1.2. Groundwater

The site groundwater is not used as a primary source of drinking water. However, the groundwater can be considered a potential future source of water supply.

- NYSDEC Groundwater Classification, Quality Standards and Groundwater Effluent Standards – NYSDEC promulgated a groundwater classification system and groundwater quality standards for each class of groundwater. Maximum allowable contaminant concentrations have been established for discharges to groundwater (6 NYCRR Chapters 701 [amended 1998] and 703 [amended 1999]). The ambient groundwater quality standards are applicable to the site.

- NYSDOH Drinking Water Supplies – The NYSDOH regulates public water supplies in this state (10 NYCRR Chapter 5, Subpart 5-1). These regulations are similar to the federal Safe Drinking Water Act (SDWA) regulations. Public drinking water supplies shall not exceed the NYSDOH Maximum Contaminant Levels (MCLs).

- National Primary Drinking Water Regulations – The SDWA MCLs for primary and secondary contaminants are applicable to aquifers and related groundwater used as a potable water supply source (40 CFR 141). The SDWA MCLs are applicable to groundwater considered as a future water supply source. Maximum Contaminant Level Goals (MCLGs) are considered health-based goals in cases in which multiple contaminants or pathways of exposure present extraordinary risks to human health. MCLGs are not considered potential SCGs for the Dambrose site since groundwater is currently not used as a potable water supply.

2.1.3. Air

Commercial business activities in the building can result in worker and patron exposure to contaminants in ambient air. In addition, remedial alternatives may include treatment or construction activities that cause air emissions of toxic contaminants or particulates. Chemical-specific SCGs would be applicable for air emissions at the Dambrose Cleaners site.

- Clean Air Act (40 CFR Part 50) - The National Ambient Air Quality Standards (NAAQS) are applicable to site remediation activities, including particulate emissions.

- NYSDEC Ambient Air Quality Standards (6 NYCRR Part 257) – These are applicable to remedial activities involving air emissions, including settleable particulates or dustfalls.

- New York Air Guide 1 – The NYSDEC's Guidelines for the Control of Toxic Ambient Air Contaminants are used for the evaluation of sources of air pollution for both contaminants with and without ambient air quality standards. The guidelines are intended for use in conjunction with all applications and permits reviewed under 6 NYCRR Part 212. Although a formal NYSDEC permit would not be required for cleanup under the State Superfund program, the substantive requirements of the regulation would have to be met including the procedures in this guidance for determining emissions rates.

2.2. Location Specific Standards, Criteria and Guidance

Location specific SCGs govern features such as wetlands, floodplains, wilderness areas and endangered species, and place restrictions on concentrations of hazardous substances or the conduct of activities on the site's particular characteristics or location. Based on a review of site features , the groundwater is identified as a site feature for which location specific SCGs are relevant to the remediation at this site. As with chemical specific SCGs, the water quality standards set forth in 6 NYCRR Part 703 would be potentially applicable to this site to prevent pollution of groundwater.

2.3. Action Specific Standards, Criteria and Guidance

Action specific SCGs are technology or activity based requirements which determine how remedial actions would be achieved. Action specific SCGs generally set performance or design standards, controls or restrictions on particular types of activities. To develop alternatives, applicable performance or design standards must be considered during the development and screening of alternatives. Certain action specific SCGs include permit requirements. Under the NYSDEC's hazardous waste site remedial program, permits and other formal approvals may not be required for remedial actions conducted entirely on site. However, the substantive requirements of such SCGs must be complied with.

Potential remedial activities for this site may include extraction and treatment of groundwater and soil vapor, and their subsequent discharge to the sanitary sewer or ambient air, respectively. Excavated soils may need off-site disposal as solid or hazardous waste depending on the chemical constituents and their concentrations. These activities would have to comply with specific regulations that include:

- NYSDEC Use and Protection of Waters, Excavation and Placement of Fill in Navigable Waters (6 NYCRR Part 608)
- Resource Conservation And Recovery Act (RCRA) Treatment Storage and Disposal Requirements (40 CFR Parts 262 and 264)
- New York State Land Disposal regulations (6 NYCRR Part 376)
- Occupational Safety and Health Administration Regulations (29 CFR Parts 1904. 1910 and 1916)
- NYSDEC State Pollutant Discharge Elimination System (SPDES, 6 NYCRR Parts 750-756)
- NYSDEC Hazardous Waste Management and Facility Regulations (6 NYCRR Parts 370-373)
- NYSDEC Division of Air Resources Regulations (6 NYCRR Parts 200-202 and 257)
- New York State Air Pollution Control Regulations (6 NYCRR Chapter 3, Part 212)
- New York State Air Guide-1, Guidelines for the Control of Toxic Air Contaminants
- National Emissions Standards for Hazardous Air Pollutants (NESHAPs)
- Office Of Solid Waste And Emergency Response (OSWER) Directive 9355.0-28, Control of Air Emissions from Superfund Air Strippers at Superfund Groundwater Sites
- New York State Department Of Transportation (NYSDOT) Rules for Transportation of Hazardous Materials (49 CFR Parts 107, 171 and 172)

3. Identification of General Response Actions

The identification and screening of technologies is used to develop an appropriate range of options for a specific site. This initial step in the development of alternatives includes the following three steps.

3.1. Remedial Action Objectives

Remedial Action Objectives (RAOs) are media specific or operable-unit specific, and are established to protect human health and the environment. The goal for remedial actions undertaken pursuant to NYSDEC's DER-10 Technical Guidance for Site Investigation and Remediation, is the restoration of the site to pre-disposal/pre-release conditions, to the extent feasible and authorized by law. At a minimum, the remedy should eliminate or mitigate significant threats to public health and the environment presented by the chlorinated VOCs disposed at the site through the proper application of scientific and engineering principles.

The RAOs for the site are established by:

a) Identifying the contaminants exceeding applicable SCGs and the environmental media impacted by the contaminants

b) Identifying applicable SCGs taking into consideration the current and, where applicable, future land use for the site

c) Identifying the actual or potential public health and/or environmental exposures resulting from contaminants in environmental media at, or impacted by, the site

d) Identifying site-specific cleanup levels.

Contaminated media identified at the site include soil and groundwater. The site currently houses a commercial business surrounded by other commercial businesses and residential homes. Taking these and the exposure assessment into consideration, the following RAOs are established for this site:

Soil RAOs:

- Prevent ingestion/direct contact with contaminated soil
- Prevent inhalation of or exposure to contaminants volatilizing from contaminants in soil
- Prevent migration of contaminants that would result in groundwater or surface water contamination.

Groundwater RAOs:

- Prevent ingestion of groundwater with contaminant levels exceeding drinking water standards
- Prevent contact with, or inhalation of volatiles, from contaminated groundwater

- Restore groundwater aquifer to pre-disposal/pre-release conditions to the extent practicable
- Remove the source of groundwater contamination.

3.2. General Response Actions

General response actions (GRAs) are medium-specific actions that could be taken to address the RAOs. SCGs for the media of concern are listed in Table 3. The following general response actions have been identified for the contaminated media at the site.

Soil

No Action - A no action response, required by the National Contingency Plan (NCP) for the FS process, provides a baseline for comparison with other alternatives

Institutional Controls - Institutional controls are applied when active remedial measures do not achieve cleanup limits. Human exposure and potential health risk are reduced by limiting public access to site contaminants.

Containment - This GRA includes remedial measures that contain or isolate contaminants onsite. Containment prevents migration from or direct human exposure to, contaminated media without treating, disturbing or removing the contamination from the site.

Removal - Removal measures provide for the removal of contaminants or contaminated materials from their existing location for treatment (on-site or off-site) or disposal.

Treatment/Disposal - Treatment and disposal measures reduce the toxicity, mobility and/or volume of contaminants or contaminated materials by directly altering, isolating or destroying those contaminants.

Groundwater

No Action - A no action response, required by the NCP for the FS process, provides a baseline for comparison with other alternatives. This action may also rely on natural processes for contaminant reduction in the absence of remediation.

Institutional Controls - Institutional controls are applied when active remedial measures do not achieve cleanup limits. Human exposure and potential health risk are reduced by limiting public access to site contaminants. Institutional controls such as environmental easements can also apply through an extended remediation period, or to sites where cleanups are completed up to feasible levels but still leave residual contamination above background levels.

Containment - Containment includes remedial measures that contain or isolate contaminants onsite. Containment prevents migration from or direct human exposure to contaminated media without treating, disturbing or removing the contamination from the site.

Removal - Removal measures provide for the removal of contaminants or contaminated materials from their existing location for treatment (on-site or off-site) or disposal.

Treatment/Disposal - Treatment and disposal measures reduce the toxicity, mobility and/or volume of contaminants or contaminated materials by directly altering, isolating or destroying those contaminants.

3.3. Extent of Remediation

The extent of remediation is evaluated by the extent of contamination present and from the RAOs that are determined for the site. Portions of the site to be remediated consist of soil and groundwater as outlined below.

Soil

Soil remediation should include the area in the vicinity of the dry cleaner building with the highest chlorinated VOC levels in both soil and soil vapor. One sub-slab soil sample exceeded the TAGM-4046 SCO for PCE. The highest concentrations of chlorinated VOCs in exterior soil vapor were found at locations close to the former dry cleaner building. The required extent of soil remediation is limited to contaminated soils under the basement slab and to a limited extent, the area outside contiguous to the footprint of the rear of the building. For purposes of the cost estimates, the quantity of contaminated soil requiring remediation has been estimated to be 300 cubic yards, based on a 900 square feet area (30ft x 30ft) straddling the basement in the rear, and a fill layer less than 10ft in that area.

To prevent potential human exposure to the contaminants, the NYSDEC installed a sub-slab depressurization system during the RI. It has been in operation since the summer of 2005. The system consists of three system suction points and a vacuum blower running at 1.5 in. of water column (WC). The sub-slab depressurization system could be made part of or integrated into the final remedy for site soils and groundwater.

Groundwater

The plume of groundwater contamination in excess of groundwater standards extends 200 ft to the west from the building and is approximately 75 ft wide as shown on Figure 4. The contamination appears to extend across the fill, glaciolacustrine and the underlying weathered till/bedrock. With the groundwater table just above the interface between the upper fill and lower glaciolacustrine layers, much of the groundwater column is within the unconsolidated deposits of glacial origin.

Groundwater flow calculations were made to preliminarily size the hydraulic containment and capture system for the plume of dissolved contaminants that was defined in the RI. Hydraulic conductivity tests performed during the RI indicated hydraulic conductivities ranging from of 2.8×10^{-4} to 1.6×10^{-2} cm/s, with a geometric mean of 3×10^{-3} cm/s. The hydraulic conductivities are large for the geologic formations and may be attributable to the fact that the monitoring wells were screened across several geological units, particularly the highly weathered material overlying bedrock.

4. Identification and Screening of Remedial Technologies

In keeping with guidance provided in the NYSDEC's Technical Guidance for Site Investigation and Remediation (DER-10, 2002) and the United States Environmental Protection Agency's (USEPA's) Guidance for Conducting Feasibility Studies under CERCLA (1988), the identification and screening of remedial technology and process options is a three step process directed towards the NYSDEC's and USEPA's preference for seeking remedial action(s) that would result in a permanent and significant decrease in the toxicity, mobility and volume of hazardous substances in media adversely impacted by the site.

In the first step, potentially applicable remedial technologies and process options which meet the RAOs developed for the site, are identified. In the second step, technology types and process options are screened with respect to technical implementability. This evaluation is based on information from the site characterization, such as contaminant concentrations and characteristics (e.g,, geology, hydrogeology). The third step evaluates the technologies and process options with respect to effectiveness, implementability and relative cost. One representative process option is selected, if possible, for each technology type for use in the development and evaluation of alternatives.

4.1. Identification of Remedial Technologies

General response actions and remedial technologies identified for soil and groundwater at the site are summarized in Tables 4A and 4B for each of the general response actions associated with the media of concern. Process options are shown on Tables 5A and 5B and described below for available remedial technologies.

4.1.1. Remedial Technologies for Soil

A. No Action - "No Action" is included as required by the NCP (40 CFR 300). It establishes baseline conditions against which other remedial alternatives may be compared.

B. Access Restrictions - The purpose of access restrictions on future use of the site would be to reduce potential human exposure and health risk by limiting public access to these contaminants. Implementation of this action would allow future use of the site, but certain types of activities (e.g. intrusive, groundwater use) would be managed by environmental easements.

C. Monitoring - Environmental monitoring of the affected media would be included as appropriate to evaluate environmental conditions.

D. Containment/Capping - A low permeability cap over the contaminated soil area would prevent exposure to the contaminants, enhance runoff and minimize groundwater recharge in the capped area.

E. Excavation and Off-site Disposal - Under this action, part or all of the contaminated soil present at the site would be excavated and transported to a suitable, permitted off-site disposal facility.

F. Excavation and Treatment –This action involves the excavation of contaminated soils for treatment on-site or off-site. The treated soils may be used as backfill at the site or disposed off-site. PCE from dry cleaner operations and its degradation products (TCE, DCE and VC) are the contaminants of concern in soil. Feasible treatment technologies for these contaminants depend on clean up goals (Section 3). Several physical/chemical treatment methods are available for the VOCs in excavated soil, either on-site or at an off-site facility.

- Stabilization/Solidification – The soil can be solidified chemically and the contaminants stabilized (i.e. prevent leaching) within the soil matrix by mixing it with suitable binding agents. This method has been proven for metals contamination using conventional chemicals (e.g. lime, cement, fly-ash) but has varying degrees of success on VOCs. The practical application of stabilization/solidification to VOCs is still subject to field verification, and often requires proprietary chemicals developed for the purpose.

- Solvent Extraction/Soil Washing – This is a physical process in which the soil is mixed with a solvent (typically non-polar organic solvent such as hexane) that dissolves the organic contaminants in the soil. Soil washing with water is a form of solvent extraction. After physical separation from the soil, the organic solvent is recovered. Organic solvents also require a closed system to prevent solvent loses.

- Chemical Oxidation – The soil is treated with powerful oxidants (e.g. peroxide, perchlorate, permanganate, ozone) to convert the VOCs to inert byproducts.

- Bioremediation – The VOCs can be oxidized biologically by mixing the soil with suitable microorganisms and appropriate nutrients in a controlled environment.

- Thermal Desorption – VOCs with relatively lower volatility can be desorbed from the soil with the application of heat. Low temperature desorption uses temperatures in the 100oC range. Higher molecular weight VOCs require relatively higher operating temperatures.

G. *In Situ* Treatment - A number of *in situ* treatment technologies are potentially applicable to contaminated soils:

- Stabilization/Solidification – Chemical contaminants can be stabilized *in situ* with deep soil mixing techniques and the direct application of agents. This process consists of the introduction and *in situ* mixing of solidifying agents to the soil and encapsulation and chemical binding of the contaminants within the media. It does not achieve the destruction of hazardous waste. Depths of up to 30 feet can be treated provided the contaminated areas are accessible to mixing equipment. New solidifying agents (e.g. silicates and organic polymers) have made solidification/stabilization a feasible option for many types of hazardous wastes. With proper additives formulated for the contaminants of concern at this site, *in situ* stabilization would be an effective method for limiting the mobility of the constituents. A vacuum shroud over the augering/delivery tool would be needed to collect VOCs that volatilize from the soil as the stabilization/solidification reagents are mixed into the soil.

- Soil Vapor Extraction (SVE) – This process is used extensively for the treatment of soils contaminated with VOCs. SVE systems involve the extraction of air containing volatile contaminants from unsaturated soils. By virtue of their physical properties, VOCs are present in the soil vapor at concentrations in equilibrium with their corresponding soil phase concentration. The chlorinated VOCs are relatively more volatile and therefore higher in vapor phase concentration in relation to the soil concentration. As the organic saturated soil vapor is extracted with the application of a vacuum, fresh clean air enters the pore space in the vadose zone and drives the volatilization of the contaminants into the soil vapor. The SVE process has been one of the most effective *in situ* process technologies for vadose zone soils contaminated with chlorinated VOCs and gasoline compounds.

Clean air is sometimes injected into the contaminated soils to accelerate or enhance the process. A vacuum is applied through a series of properly placed wells or trenches to extract the soil vapor. The established air flows are a function of the equipment used and of soil characteristics, including soil porosity. Relatively small quantities of liquid condensate are normally encountered in the air stream and may require some pretreatment prior to discharge or disposal at an off-site facility. The off-gas from the SVE system may require treatment for VOCs prior to its discharge to the atmosphere. Available processes include carbon adsorption and thermal treatment.

This process option may be further enhanced by injecting steam rather than ambient air into the soil. The increase in the soil temperature would substantially increase the rate of volatilization of the organic contaminants. This process is especially suitable for soil contaminated with gasoline, diesel and jet fuel, solvents such as TCE, trichloroethane, and dichlorobenzene, or a mixture of these compounds. The SVE system can be extended below the water table to simultaneously withdraw soil vapor and groundwater from the same well. A post-extraction air-liquid separator would be required for this dual phase extraction (DPE).

Chemical Oxidation – *In situ* chemical oxidation has shown promise in destroying hazardous chemical in soil and groundwater. Powerful chemical oxidants such as hydrogen peroxide (H_2O_2), potassium permanganate ($KMnO_4$) and ozone (O_3) are readily available and can be injected through a series of wells into the vadose zone. Potassium permanganate is stable and can be easily handled in solid or liquid form, while hydrogen peroxide requires protective measures because of its volatility. Ozone has a relatively shorter half-life and requires a generator on-site for its production from oxygen.

- Bioremediation – This is the process of using indigenous microorganisms or injected bacteria supplemented with nutrients to accelerate the breakdown of VOCs in contaminated soils. It is not intended to strip or volatilize, but to biodegrade contaminants in the subsurface. Off gas collection/treatment is therefore not required with this process.

  In bioventing, the soil and groundwater is aerated by forced air through vent wells to introduce oxygen, stimulate *in situ* biological activity and promote the bioremediation of organic contaminants in the soil. Bioventing systems are designed to enhance biodegradation while minimizing volatile emissions. Bioventing systems generally include a series of blowers and air injection wells. The introduction of an aqueous phase for nutrients and oxygen to support/enhance biological growth may promote the migration of contaminants further underneath the adjoining buildings in its urban environment. The effectiveness of this measure depends on how well the injected media is recaptured or contained.

4.1.2. Remedial Technologies for Groundwater

Remedial technologies for groundwater are listed in Tables 5A and 5B and the rationale for their identification is presented below.

A. No Action - “No Action” is included to establish baseline conditions against which other remedial alternatives may be compared.

B. Access Restrictions - With access restrictions, future use of the site would be possible, but the use of groundwater would be prohibited. Permanent environmental easements prohibiting groundwater use would be included.

C. Monitoring - Environmental monitoring would be included as appropriate to evaluate environmental conditions.

D. Vertical Barriers - Hydraulic vertical barriers restricting the horizontal movement of groundwater could be established around the plume of contamination at the site. The off-site migration of contaminants from the site would be reduced or eliminated with this option. When used in conjunction with a groundwater pump and treat system, it would reduce the inflow of groundwater into the zone of contamination and reduce the amount of groundwater to be extracted. Sheet piles (with or without partial or complete grouting) and slurry walls (soil-bentonite or cement-bentonite) are available options for vertical barriers. The construction of vertical barriers may require excavation in contaminated soils which would have to be disposed appropriately.

E. Groundwater Collection - Absent a means of containing the plume of groundwater contamination, the interception and collection of the contaminated groundwater would be necessary to prevent the migration of contaminants off-site. Groundwater could be intercepted and collected by several methods including extraction wells or a subsurface collection trench. Extraction wells could be placed at appropriate locations in the source area and downgradient for the removal of groundwater along with the contaminants of concern. The number of wells and their spacing depends on the hydrogeologic factors including the height of the water column, hydraulic gradient and hydraulic conductivity. A subsurface groundwater collection trench could be another effective method for intercepting groundwater migrating from the site.

F. On-site (Aboveground) Treatment - Groundwater extracted from a contaminated aquifer would require above-ground treatment as necessary to meet requirements for discharge to a surface water body or to a publicly owned wastewater treatment plant (POTW). It could also be pumped (if nearby) or hauled to an off-site facility for treatment. Treatment and discharge requirements would vary depending on cleanup goals, contaminant concentrations and the ultimate point of discharge/disposal.

Various physical, chemical, and biological processes are available for the treatment of VOCs. The chlorinated VOCs in groundwater at the site may require a process train consisting of components using one or more treatment methods. Air stripping and carbon adsorption are common physical treatment processes for VOCs removal. In air stripping, the contaminants are transferred from groundwater to air in an enclosed vessel. The off-gas from the air stripper may require treatment (e.g. activated carbon and catalytic oxidation) to meet air discharge limits. With carbon adsorption, the spent carbon has to be regenerated for reuse or disposed off-site. Vapor phase catalytic oxidation of the off-gas is very effective for chlorinated VOCs, particularly when VC is present. The use of a catalyst, which accelerates the oxidation process, allows operation at lower temperatures, in the range of 600 to 1200°F. Aerobic and anaerobic degradation are biological processes that use microorganisms to oxidize the VOCs.

G. *In Situ* Treatment - Similar to onsite treatment, feasible technologies for *in situ* treatment depend on clean up goals and the discharge requirements.

The VOCs can be allowed to attenuate naturally using indigenous bacteria in the soils. This is however a very slow process. The *in situ* bioremediation process would typically use the injection of appropriate nutrients to promote bacterial activity. The biological activity can be enhanced by introducing microorganisms along with the nutrients. Proprietary bacteria are now available for the *in situ* treatment of specific VOCs in soil and groundwater. Air sparging is a technique of volatilizing the contaminants from the groundwater with the introduction of air through wells suitably placed across the contamination zone. The off-gas would be collected through another set of wells and piped for further treatment on-site. Soil flushing is a mechanism by which the contaminants are flushed out from the aquifer with the addition of agents (solvents, surfactants, etc.). As with the soil medium, *in situ* chemical oxidation with powerful chemicals such as hydrogen peroxide (H_2O_2), potassium permanganate ($KMnO_4$) and ozone (O_3) has been shown to be effective in destroying or degrading VOCs in groundwater.

H. Discharge - The extracted groundwater could be discharged to a nearby sanitary sewer subject to compliance with the requirements of the local POTW which may include pretreatment. The groundwater could also be discharged to a surface water body subject to treatment requirements for environmental compliance prior to discharge.

I. Reinjection - Reinjection of treated groundwater in the vicinity of the site could be an available option. If reinjected upgradient of the site, it would become a process of flushing the contaminants. Depending on site conditions, the treated groundwater could also be reinjected at appropriate intervals down or side gradient to groundwater flow.

4.2. Screening of Remedial Technologies

The purpose of this medium-specific screening step is to develop a set of technologies that are technically implementable and can meet the RAOs for the medium of concern. The preference is for remedial technologies and process options that result in a permanent and significant decrease in the toxicity, mobility, or volume of the hazardous substances to the maximum extent practicable. At a minimum, the remedial technology should eliminate or mitigate the significant threat to public health and the environment. Preference is also given to technologies with a documented history of successful performance.

Process options are screened based on effectiveness, implementability and cost. The evaluation of process options for effectiveness focuses upon:

- Potential effectiveness in handling the estimated areas or volumes of media.
- Meeting RAOs.
- Potential impacts on human health and the environment during the construction and implementation phases.
- Estimated success and reliability when applied to the contaminants and conditions at the site.

4.2.1. Technology Screening for Soil

A. No Action - No action at the site would not meet RAOs nor would it be protective of human health. It is still included for comparison and as required by the NCP.

B. Access Restrictions - Access restrictions would not meet RAOs nor would they be protective of human health. However, environmental easements would limit human contact with the contaminants of concerns and therefore are considered potentially applicable.

C. Containment/Capping - Capping or in-place containment of contaminated soils would not be a feasible option since the plume of soil contamination extends under the basement slab in the rear of the building and below the groundwater table. The volume of contaminated soil is also relatively small for this option to be technically viable. This option will not be retained for further evaluation.

D. Excavation and Off-site Disposal - Excavation and off-site disposal would be a potentially effective permanent remedy for the complete removal of contamination from accessible areas of the site, particularly for small volumes of contaminated soils. The existing building limits accessibility to contaminated soils under the basement slab below the buildings. The building foundation may require shoring prior to excavation of soils outside the foundation walls. The excavation of soils would also create a potential risk of human exposure to VOCs during construction which would require additional control measures. Due to the inherent technical difficulties with this option, it will not be considered further.

E. Excavation and Onsite Treatment - On-site treatment methods would include solidification/stabilization, solvent extraction, soil washing, chemical oxidation and other processes as listed on Table 5A. This option will not be considered further for the same reasons associated with the excavation and off-site disposal option above.

F. *In Situ* Stabilization/Solidification – As discussed in the section on excavation and off-site disposal, the implementability of this technology would be limited by the proximity of the building and limited accessibility to soils under the basement slab. Therefore, stabilization will not be considered further.

G. Soil Vapor Extraction -
In situ SVE would achieve a permanent reduction in the toxicity of the contaminated materials. The use of vapor extraction systems is typically limited to permeable unsaturated soils such as sands, gravels, and coarse silts. Diffusion rates through dense soils, such as compacted clays, are much lower than through sandy soils. The extraction wells could be

extended to soils both outside and inside the building. As previously discussed, a sub-slab depressurization system is already in operation in the basement at the site. Given these benefits, SVE will be retained for further consideration.

H. *In situ* Chemical Oxidation - The destruction or degradation of the VOCs with chemical oxidants is a viable technology at locations where the oxidants can be efficiently distributed to all areas of soil contamination. Hydrogen peroxide with iron as a catalyst (Fenton's Reagent) has been the subject of several field pilot tests at dry cleaner sites. Hydrogen peroxide is volatile and needs protective measures particularly at this site since the building is still being used. Distribution of the chemicals to areas of hot-spot soil contamination under the building may be limited. Since other more effective options are available, this option will not be considered further.

I. *In situ* Bioremediation - This method is considered to be effective in permanently reducing the toxicity and volume of contaminated soils to an acceptable level and is easily implemented. The effectiveness of this measure depends on how well the injected media is recaptured or contained. At the site, the exact distribution of contamination in the soils beneath the basement slab is not well established. The introduction of an aqueous phase containing the nutrients may tend to distribute or further spread the contamination before the indigenous bacteria have the opportunity to breakdown the chlorinated VOCs. The required clean up time would be considerably longer than other comparable treatment systems (e.g. SVE). Therefore, bioremediation will not be considered further.

4.2.2. Technology Screening for Groundwater

A. No Action - No action at the site would not be protective of human health nor would it achieve RAOs. However, it is required to establish baseline conditions per NCP.

B. Access Restrictions - Access restrictions would not achieve the RAOs for groundwater cleanup, and groundwater contaminants would remain in place. They could, however, be protective of human health with environmental easements limiting exposure to contaminated soils.

C. Vertical Barriers - Vertical barriers are generally appropriate in open areas with easy equipment access and where the barrier wall is continuous. Equipment access is limited at the site because the highest levels of groundwater contamination reside in the area around and under the building. In addition, the site is located in an urban area on a busy street. Utilities surrounding the building would also limit the installation of continuous barriers around the plume. Due to these site restrictions, vertical barriers will not be considered further.

D. Groundwater Collection - Groundwater extraction can be used at the site to reduce the level of contamination in the affected areas, and prevent the migration of contaminated groundwater. Groundwater is typically collected through extraction wells, stone filled interceptor trenches, or a combination of both, suitably placed in the contaminant source areas or downgradient of the plume. Groundwater at the site straddles three layers – overburden fill, unconsolidated glaciolacustrine, and weathered till. The water table is generally at the fill and glaciolacustrine interface, and the bulk of the relatively shallow water column is below the fill layer.

- Extraction Wells - Extraction of water from the overburden aquifer could be accomplished through a series of strategically placed withdrawal wells. The extraction wells would be used to create a positive flow gradient towards the well, thus reversing downgradient flow direction Groundwater flow modeling calculations indicate that 5 wells may be required to capture the groundwater across the entire plume of contamination. Extraction wells appear to be an effective means of groundwater collection, subject to confirmation of the required number of wells through more accurate evaluation of groundwater extraction through a pump test. Extraction wells will be retained for further consideration.

- Interceptor Trench - Subsurface trenches would intercept the contaminated groundwater. At the site, the interceptor trench would extend well into the lower weathered till and weathered bedrock layer to effectively capture contaminated groundwater. The plume of contamination straddles several residential and commercial properties in close proximity to each other which poses limitations on the placement of a trench to intercept the contaminant plume. The excavation of contaminated soils would require protective measures to minimize health risks to workers from exposure. Also, contaminated soil excavated from the trench location would require appropriate off-site disposal depending on its location and contaminant levels. At this site, wells would likely be a more effective means of collecting groundwater than in trenches. Based on these considerations, groundwater collection trenches will not be retained for further consideration.

E. Onsite Treatment - The degree of aboveground treatment depends on discharge requirements. Although a number of options are available for VOCs removal, air stripping and carbon adsorption would be appropriate for this site since chlorinated VOCs are the contaminants of concern and their concentrations are relatively low. The use of carbon adsorption could be limited due to the presence of VC at concentrations greater than 100 ppb. An air stripper would provide for countercurrent contact between contaminated groundwater and air thereby transferring the VOCs from the aqueous phase to air. Off-gas from the air stripper would require treatment prior to discharge to the atmosphere. Used carbon would require off-site disposal or regeneration. Biological processes such as aerobic and anaerobic degradation are typically more effective at higher influent concentrations than encountered at this site. Onsite treatment with air stripper or carbon adsorption will be considered for further evaluation.

F. *In situ* Chemical Oxidation - Chemical oxidants (e.g. hydrogen peroxide, potassium permanganate, ozone) are effective in breaking down chlorinated VOCs in groundwater. Hydrogen peroxide, with an iron catalyst, has seen the most common field application at pilot tests around the country. The oxidant is distributed in an aqueous solution through a series of injection wells. This process can be effective only if the oxidant and its rate-enhancing catalyst are distributed uniformly throughout the zone of contamination. At this site, the chemicals cannot be easily distributed into weathered till and bedrock. Field pilot testing would be required to demonstrate the effectiveness of this process for this site. Based on these considerations, *in situ* chemical oxidation will not be considered further.

G. Bioremediation - Bioremediation can be an effective *in situ* method of reducing VOCs contamination in the saturated zone and has been demonstrated with varying degrees of success in recent years. However, chlorinated VOCs are slow to biodegrade anaerobically, and even more under aerobic conditions. Bacteria, nutrient and oxygen addition would be required with the installation of wells. Given these potential considerations, bioremediation will not be considered further.

H. Air Sparging - Air sparging is used for the *in situ* removal of and/or bioremediation of VOCs in saturated soils and groundwater by injecting air under pressure. Nutrients may be injected along with the air stream to promote and sustain biodegradation. Treatment is accomplished by volatilization and, to a limited extent, by enhanced bioremediation. A SVE system may be required to collect off-gases produced during this process.

Air sparging may not be easily implemented at the site since the contaminated groundwater is mostly below the fill layer, which retards the extent to which air can be distributed throughout the plume of contamination. Therefore, air sparging will not be considered further.

I. Soil Flushing - This process involves the addition of a suitable solvent supplemented by chemicals (e.g. surfactants). Due to the geologic characteristics in the unconsolidated layers, the effectiveness of this technology is questionable. Pilot testing would be required prior to its implementation. The injected aqueous solution of surfactants may spread the contaminants further out if not effectively captured within the plume of contamination. Given these considerations, this option will not be considered further.

J. Discharge to POTW - Contaminated groundwater could be discharged to the sanitary sewer at the site under a permit from and subject to acceptance by the City of Schenectady. The groundwater could be pretreated on-site so that the discharged groundwater would not adversely affect the POTW's performance. Based on the above assessment, discharge to a POTW will be considered further.

K. Discharge to Surface Water - The Mohawk River is the nearest surface water body, but is at least half a mile from the site. Installation of a discharge pipe from the site to the River through an urban environment would not be practical. Also, this option would require treatment of the groundwater to surface water discharge standards. This option is therefore not considered further.

L. Reinjection - Upgradient reinjection of extracted water after treatment could be an effective method of achieving groundwater SCGs and meeting remedial objectives. Reinjection could, however, change localized groundwater flow patterns. Therefore, this disposal method will not be considered further.

4.3. Summary

The remedial technologies selected for contaminated soil and groundwater at the site are identified in Table 5A and 5B.

5. Development of Alternatives

5.1. General

Remedial alternatives were developed based on technologies and associated processes which, when combined and implemented, would achieve the remediation goals for the site. Table 6 lists the remedial alternatives developed for remediation of contaminated soil and groundwater. Based on the screening presented in Section 4, one technology process option was selected for each alternative. This approach limits the number of alternatives for consideration and yet maintains the flexibility of modifying the process option if necessary. Alternatives developed for soil and groundwater are listed in Table 6 and presented below. They include separate sets of alternatives for soil (S1 through S4) and groundwater (G1 through G4) that can be implemented individually. These individual soil and groundwater alternatives could also be combined to meet the RAOs. Also, alternatives S5/G5 and S6/G6 provide for the combined treatment of soil and groundwater.

5.2. Soil

The following four alternatives are for soil, ranging from No Action to treatment of the soils beneath and outside the building with VOC contamination.

Alternative S1 - No Action: The No Action alternative is included for the soil medium in accordance with DER-10 and the NCP. Under this alternative, the site would require review every five years because contaminants would remain onsite. Alternative S1 would not reduce the leaching of soil contaminants into groundwater, nor would it prevent the release of contaminants into ambient air. Therefore it would not achieve the RAOs or be protective of human health.

Alternative S2 – Institutional Controls: This alternative would employ environmental easements to prevent human exposure to contaminated subsurface soil. The alternative may be protective of human health with environmental easements limiting future construction or intrusive activities at the site without appropriate controls.

Alternative S3 – Soil Vapor Extraction (Hot Spot): Alternative S3 addresses contaminated soils in the hot spot area beneath the basement slab. A sub-slab depressurization system was installed by the NYSDEC in the summer of 2005. It consists of three system suction points and a vacuum blower operating at a vacuum of 1.5 in. water column (WC). Under this alternative, the existing sub-slab system will continue to be used to remove the chlorinated VOCs in the soil below the basement. A vapor phase carbon adsorption system could be used for off-gas treatment, if necessary. VOCs in the off-gas from the sub-slab system and its flow rate would be monitored on a regular basis to track the mass of contaminants removed. The sub-slab depressurization system is anticipated to run for a period of five years to remove the hot spot soil contamination assuming the source area beneath the basement is accessible.

Alternative S4 - Soil Vapor Extraction (Plume): Alternative S4 addresses contaminated soils in the entire plume of soil contamination including areas outside the building as well as the hot spot area beneath the basement slab. The SVE system involves extraction of air containing the chlorinated VOCs from approximately 300 cy of unsaturated soil. This soil lies partly outside the building foundation and partly under the building basement. A vacuum system would be utilized to induce a negative pressure gradient within the soil matrix through a set of three SVE wells installed outside the building. The existing sub-slab depressurization system installed in 2005 would be integrated with the new SVE system. A vapor phase carbon adsorption system could be used for off-gas treatment, if necessary.

The performance of the system would be monitored regularly through flow measurements and analysis of off-gas from the SVE system. For cost estimation purposes, it is assumed that the anticipated duration of treatment is less than 5 years based on the relatively small volume of soil requiring treatment.

5.3. Groundwater

The following four alternatives are for groundwater, ranging from No Action to full treatment of the entire plume of VOC contamination in the groundwater.

Alternative G1 - No Action: The No Action alternative is included for groundwater as required by DER-10 and the NCP. Under this alternative, the site would require review every five years because contaminants would remain onsite. Alternative G1 would not reduce the migration of contaminants in groundwater. Therefore it would not achieve the RAOs or be protective of human health.

Alternative G2 - Institutional Controls: This alternative would use permanent environmental easements prohibiting groundwater use to prevent human exposure and prohibit future construction or intrusive activities at the site without proper consideration and management. Long term monitoring for a period of thirty years would be required to determine when such restrictions might no longer be required or to assess the need for further action. The duration of long-term monitoring could be reduced if significant reduction in contaminant levels by natural attenuation is observed.

Alternative G3 – Groundwater Extraction/Treatment (Groundwater Hot Spot): This alternative would provide for extraction of groundwater from areas of high concentrations of chlorinated VOCs near the rear of the building. For conceptual design and cost estimation, two wells and a total collection rate of 5 gpm are assumed. Groundwater would then be treated onsite with activated carbon. The treatment system is assumed to include an equalization tank, bag filters for solids removal, and carbon adsorption for chlorinated VOCs removal. The treated groundwater would be discharged to the nearby sanitary sewer. For cost estimation purposes, it is assumed that the anticipated duration of treatment would be thirty years. To measure the effectiveness of the remedy and for the protection of human health and the environment, groundwater would be monitored regularly over the thirty year duration.

Alternative G4 – Groundwater Extraction/Treatment (Groundwater Plume): In this alternative, the entire plume of groundwater contamination would be targeted, extending west, approximately 200’ downgradient from the rear of the building. Groundwater flow model calculations indicate 5 extraction wells would be required to capture the plume. For conceptual design and cost estimation, five wells and a total collection rate of 10 gpm are assumed. The exact number of wells and flow rate should be determined through pump tests. The groundwater extraction wells would be staggered along the axis of the plume, with two wells located in the source area, two wells located downgradient and one well located in the western portion of the plume. The treatment system is assumed to include an equalization tank, bag filters for solids removal, and carbon adsorption for chlorinated VOCs removal. The treated groundwater would be discharged to the nearby sanitary sewer. For cost estimation purposes, it is assumed that the anticipated duration of treatment would be thirty years.

5.4. Combined Soil/Groundwater Treatment

Alternative S5/G5 – Dual Phase Extraction/Treatment (Soil Plume/Groundwater Hot Spot): In this alternative both soil vapor and groundwater would be collected using DPE and treated. This alternative would target the complete removal of contaminants from the contaminated soils and the area of groundwater contamination with higher concentrations of chlorinated VOCs. Since both soil and groundwater are targeted in the same area, a set of two DPE wells are assumed appropriate to collect both soil vapor and groundwater. The soil vapor entrained with groundwater in the DPE system would be sent to a treatment system consisting of an air/water separator, followed by a carbon adsorber for the vapor phase, and bag filters and carbon adsorbers for the aqueous phase. The existing sub-slab system would be connected to the vapor phase treatment system at the air/water separator outlet.

For cost estimation purposes, a groundwater collection rate of 5 gpm and air flow rate of 300 scfm are assumed. The exact number of wells and collection rates should be determined during the pre-design phase through pump tests. Treated groundwater meeting discharge limits would be pumped to the nearby sanitary sewer, and the off-gas would be treated to meet ambient air quality standards for discharge. For cost estimation purposes it is assumed that the anticipated duration of treatment would be thirty years.

Alternative S6/G6 – Dual Phase Extraction/Treatment (Soil Plume/Groundwater Plume): In alternative S6/G6 soil vapor and groundwater would be collected by DPE, and treated in the same system. This alternative would target the removal of contaminants in the contaminated soils and the entire plume of groundwater contamination. The plume of groundwater contamination extends west, approximately 200 ft downgradient from the rear of the building. Since the groundwater plume extends beyond the area of soil contamination, a combination of three groundwater only extraction wells and two DPE wells would be used. The DPE wells would be installed in the area of soil contamination to collect both soil vapor and groundwater. The groundwater only extraction wells would be installed in the downgradient plume where contaminant levels are relatively lower.

Soil vapor entrained with groundwater from the DPE wells would be sent to a treatment system consisting of an air/water separator, followed by a carbon adsorber for the vapor phase, and bag filters and carbon adsorbers for the aqueous phase. The existing sub-slab system would be connected to the vapor phase treatment system at the air/water separator outlet. Groundwater from the downgradient plume would be pumped to the groundwater portion of the treatment system. For cost estimation purposes, a groundwater collection rate of 10 gpm and air flow rate of 300 scfm are assumed. The exact number of wells and collection rates should be determined during the pre-design phase through pump tests. Treated groundwater meeting discharge limits would be pumped to the nearby sanitary sewer, and the off-gas would be treated to meet ambient air quality standards for discharge. For cost estimation purposes it is assumed that the anticipated duration of treatment would be thirty years.

6. Estimation of Costs

6.1. Development of Costs

Preliminary capital and annual operating and maintenance costs were developed to facilitate the evaluation of the alternatives in Section 7. The design criteria assumptions for the soil and groundwater treatment systems are included as Table 7. Cost estimate tables are provided in Tables 8A for soil remedial alternative S4, Tables 8B through 8D for the groundwater remedial alternatives (G2 to G4), and Tables 8E and 8F for the combined soil/groundwater remedial alternatives (S5/G5 and S6/G6).

Capital costs are based on newly purchased equipment. Having completed remediation at numerous inactive hazardous waste sites around the state, the NYSDEC may have treatment systems that are not in use and could be used for this site with significantly reduced capital costs. For present worth calculations, the ground water and dual phase extraction and treatment systems are assumed to have thirty years of operation, and long-term monitoring of up to 30 years. The SVE extraction and treatment system is assumed to have five years of operation, and long-term monitoring of up to 30 years. Actual durations required to attain the RAOs for each alternative could be different.

Capital, annual O&M and present worth cost estimates for the remedial alternatives are summarized in Table 9.

7. Detailed Analysis of Alternatives

7.1. General

The alternatives developed in Section 5 and summarized in Table 6 were subjected to a detailed evaluation.

The detailed evaluation of alternatives consisted of two steps. In the first step, each alternative was evaluated against the following criteria as set forth in DER-10:

- Overall protection of public health and the environment
- Compliance with SCGs
- Short-term impacts and effectiveness
- Long-term effectiveness and permanence
- Reduction of toxicity, mobility or volume with treatment
- Implementability
- Cost

An eighth criterion, community acceptance, will be considered as part of the public comment and review process. In the second step, a comparative analysis was performed in which the alternatives were compared to each other with respect to the factors listed above.

7.2. Individual Evaluation of Alternatives

7.2.1. Alternatives S1 and G1 - No Action

A. Overall Protection of Public Health and the Environment

Implementation of the No-Action alternatives for soil and groundwater would allow existing conditions to continue. It provides no means of preventing human exposure to contaminants at this site and the resulting health risk. Under existing conditions, contaminant loading into the groundwater would continue. The exposure pathway for VOCs in soil and groundwater via incidental ingestion, direct contact and vapor migration to indoor air and subsequent inhalation is considered complete. The No-Action alternative would not address these human health exposure pathways.

B. Compliance with SCGs

These alternatives would not comply with chemical or action-specific SCGs.

C. Short-term Impacts and Effectiveness

There would be no remedial construction activities under these alternatives and therefore no risks associated with it to the community, environment or workers.

D. Long-term Effectiveness and Permanence

The No-Action alternatives could be effective due to natural attenuation under existing conditions.

E. Reduction of Toxicity, Mobility and Volume of Hazardous Waste

Natural attenuation under existing conditions would tend to lower contaminant concentrations, albeit at a slow rate.

F. Implementability

These alternatives would be easily implemented. Future remedial actions could be implemented to supplement these no-action alternatives without interfering with existing on-site controls.

G. Cost

There would be no cost associated with these alternatives.

7.2.2. Alternatives S2 and G2

A. Overall Protection of Public Health and the Environment

The exposure pathway for VOCs in soil and groundwater via incidental ingestion, direct contact and vapor migration to indoor air and subsequent inhalation is considered complete. If alternatives were implemented, the risks to human health would continue with exposure to contaminants in the soil. Environmental easements with limitations on future intrusive work on the site and groundwater use would minimize human exposure. However, contaminant loadings to the aquifer from the soil would continue.

B. Compliance with SCGs

Implementation of these alternatives would not result in compliance with chemical or location-specific SCGs.

C. Short-term Impact and Effectiveness

There would be no remedial construction activities associated with these alternatives for soil or groundwater. Therefore there would be no associated risks to the community, environment, or workers.

D. Long-term Effectiveness and Permanence

These alternatives could be effective due to natural attenuation under existing conditions.

E. Reduction of Toxicity, Mobility or Volume with Treatment

Natural attenuation under existing conditions would tend to lower contaminant concentrations, albeit at a slow rate.

F. Implementability

These alternatives could be implemented without difficulty as there would be no construction issues involved and no administrative difficulties that would be posed by the implementation of the monitoring program. The need for future remedial action may be implemented without interfering with long-term groundwater monitoring.

G. Cost

These alternatives have the lowest relative cost compared to the other alternatives, excluding no-action. There are no capital costs. The estimated present worth of the annual O&M cost over 30 years is $0 for Alternative S2 and $61,000 for Alternative G2.

7.2.3. Alternative S3

A. Overall Protection of Public Health and the Environment

The exposure pathway for VOCs in soil and groundwater via incidental ingestion, direct contact and vapor migration to indoor air and subsequent inhalation is considered complete. The continued treatment of soil beneath the basement in the hot-spot area with the sub-slab depressurization system would reduce the bulk of the source of contamination, and thereby reduce human health and environmental risks. This is the area with one of the soil samples exceeding the TAGM-4046 guidance values for PCE. Treatment of the soil hot-spot area would reduce contaminant releases from the soil into the groundwater. Residual risk to health and the environment would be lower than current conditions. Potential inhalation exposure, not mitigated by the existing sub-slab depressurization system, would need to be managed via institutional controls.

B. Compliance with SCGs

Over time, the hot-spot sub-slab system would be expected to attain chemical-specific SCGs for VOCs in subsurface soils at the site. Off-gas treatment may be required to provide compliance with action-specific SCGs. This alternative would also be in compliance with location specific SCGs.

C. Short-term Impact and Effectiveness

This alternative would not require intrusive work since the sub-slab system has already been installed and is operating.

D. Long-term Effectiveness and Permanence

By removing the chlorinated VOCs arising from the past dry cleaner operations, SVE would permanently reduce the volume of contaminated soils and the toxicity associated with the presence of these constituents. It would not remove all the contamination in the soils particularly those outside the building which have relatively lower levels of chlorinated VOCs. The alternative would be permanent for the hot-spot soils targeted under this alternative. It would reduce risks to residents and workers in the building. Periodic monitoring would be conducted to monitor its effectiveness.

E. Reduction of Toxicity, Mobility or Volume with Treatment

SVE has been demonstrated to permanently and significantly reduce the toxicity, mobility and volume of hazardous wastes. This process would irreversibly remove the contaminants from the hot-spot soil. Residual contamination would remain in the soils beyond the radius of influence of the wells outside of the building.

F. Implementability

This alternative would be easily implemented by continuing the existing sub-slab system.

G. Cost

There would be no additional capital costs since the sub-slab system is already installed and operating. O&M costs would be low as they would be limited to maintenance of the blower, and routine monitoring of the system. Therefore, no significant O&M costs are anticipated.

7.2.4 Alternative S4

A. Overall Protection of Public Health and the Environment

The exposure pathway for VOCs in soil and groundwater via incidental ingestion, direct contact and vapor migration to indoor air and subsequent inhalation is considered complete. This alternative extends the treatment of soils to include the entire plume of contamination, both the inside and outside of the building. SVE wells would be installed outside the building and integrated into the existing sub-slab depressurization system. One SVE well would be installed to address potential contaminants and the potential inhalation exposure pathway in the crawlspace area located under the existing apartment. The treatment of the entire plume of contaminated soil would reduce human health and environmental risks. It would also reduce any contaminant release from the soil into the groundwater.

B. Compliance with SCGs

Over time, the SVE system would be expected to attain chemical -specific SCGs for VOCs in subsurface soils at the site. The off-gas treatment would provide compliance with action-specific SCGs. This alternative would also be in compliance with location specific SCGs.

C. Short-term Impact and Effectiveness

The installation of the SVE system would require minimal intrusive work consisting of drilling wells and trenches to accommodate piping. Some disruption of local businesses may be expected during remedial construction but the duration of field work should be not more than a month. Control measures for fugitive dust and worker exposure would be minimal since there would be no bulk excavation of contaminated soils.

D. Long-term Effectiveness and Permanence

By removing chlorinated VOCs arising from past dry cleaner operations, SVE would permanently reduce the volume of contaminated soils and the toxicity associated with the presence of these constituents. The alternative would be permanent because it would reduce existing risks associated with the contaminated soil, and minimize the migration of the hazardous substances. Periodic monitoring would be conducted to monitor the effectiveness of the remedial action.

E. Reduction of Toxicity, Mobility or Volume with Treatment

SVE has been demonstrated to permanently and significantly reduce the toxicity, mobility and volume of hazardous wastes. This technology would irreversibly remove the contaminants from the soil.

F. Implementability

This alternative would be easily implemented as it is a well-established technology. Equipment required for this system is developed and commercially available through many vendors. The overburden soil is well suited to vapor extraction and the entire plume of soil contamination can be targeted with strategically placed extraction wells and by establishing a negative air pressure gradient through portions of contaminated soil.

G. Cost

Capital costs would include the extraction wells and treatment systems for soil vapor. Operating and maintenance are generally limited to system monitoring and periodic sampling. This system would not require full-time operator attention. The long-term monitoring of soil vapor would end once the soils are treated. The estimated total capital cost is $133,000 and the estimated present worth of the annual O&M cost over 30 years is $102,000.

7.2.5. Alternative G3

A. Overall Protection of Public Health and the Environment

The exposure pathway for VOCs in soil and groundwater via incidental ingestion, direct contact and vapor migration to indoor air and subsequent inhalation is considered complete. The hot-spot area has groundwater at levels of up to 1000 ppb total chlorinated VOCs, while the downgradient plume has 11 to 82 ppb total chlorinated VOCs. Targeting the hot-spot area of groundwater contamination would reduce risks to human health and the environment. By removing contaminants from the source area, this alternative would reduce further migration of the contaminants in groundwater.. Potential inhalation exposure, associated with the crawlspace, would need to be managed via institutional controls.

B. Compliance with SCGs

Contaminant-specific groundwater SCGs would be met over time. Action-specific SCGs would be met for the discharge of treated water to the sanitary sewer.

C. Short-term Impact and Effectiveness

The implementation of this remedy would require intrusive activities consisting of the installation of extraction wells and below ground piping from the wells to the treatment system. Remedial construction activities would have a minimal impact on workers, the community or the environment**.** Field work for remedial construction of this alternative is anticipated to take two to three months.

D. Long-term Effectiveness and Permanence

The collection of groundwater in the hot-spot source area would effectively remove the contaminants and reduce the further migration of contaminants in groundwater. The groundwater treatment system would be monitored to assess the effectiveness of the remedy. Also, groundwater quality would be monitored. Long-term environmental easements would apply beyond the duration of this remedy so long as off-site groundwater contamination remains above groundwater standards.

E. Reduction of Toxicity, Mobility or Volume with Treatment

The groundwater collection and treatment system under this alternative would reduce the volume and toxicity of contaminated groundwater through extraction and treatment. The toxicity of the extracted groundwater would be reduced to acceptable levels before discharge to the sanitary sewer.

F. Implementability

This alternative could be implemented with relative ease as the components are proven technologies and equipment is readily available from many vendors. Besides the wells, installation of underground piping from the wells to the treatment system and from the treatment system to the sanitary sewer would entail excavation of soils potentially requiring off-site disposal. Long term O&M would include system monitoring and maintenance, all of which could be done with part-time support. This alternative would be subject to acceptance by the City of Schenectady's wastewater treatment plant.

G. Cost

Capital costs associated with this alternative include the installation of two extraction wells, treatment system components (bag filters and carbon adsorbers) and underground piping. For cost estimation purposes, it is assumed that the system would be operated for a period of thirty years. O&M costs include system monitoring and groundwater sampling. The estimated total capital cost is $159,000 and the estimated present worth of the annual O&M cost is $526,000.

7.2.6. Alternative G4

A. Overall Protection of Public Health and the Environment

The exposure pathway for VOCs in soil and groundwater via incidental ingestion, direct contact and vapor migration to indoor air and subsequent inhalation is considered complete. Targeting the entire plume of groundwater contamination would reduce the risks to human health and the environment. Extraction wells would be staggered along the axis of the plume to capture the plume. This would address both the hot-spot area (with up to 780 ppb total chlorinated VOCs) and the downgradient plume (with up to 82 ppb total chlorinated VOCs). Besides preventing off-site migration of the contaminants, it would remediate the off-site areas as well. Potential inhalation exposure, associated with the crawlspace, would need to be managed via institutional controls.

B. Compliance with SCGs

This alternative would meet contaminant-specific SCGs for groundwater following groundwater extraction and treatment. Action-specific SCGs include POTW requirements for discharge of treated water to the sanitary sewer. The onsite treatment system would meet these SCGs. Spent carbon from the treatment system would be sent to an off-site facility for regeneration and subsequent reuse.

C. Short-term Impact and Effectiveness

Remedial construction activities for this alternative are expected to have a relatively greater impact on workers, the community or the environment. Several of the wells would be installed on adjacent properties requiring access agreements, and the concurrence and approval of the community. Field work for remedial construction of this alternative is anticipated to take two to three months.

D. Long-term Effectiveness and Permanence

The collection of contaminated groundwater from the entire plume is a very effective way of meeting the RAOs over the long term. The effectiveness of this groundwater remediation alternative would be evaluated through groundwater monitoring over the duration of operation of the groundwater treatment and extraction system.

E. Reduction of Toxicity, Mobility or Volume with Treatment

This alternative would reduce the volume and toxicity of contaminated groundwater by extraction and treatment. An aqueous phase carbon treatment system would remove the VOCs from the groundwater.

F. Implementability

Extraction wells and discharge piping should be constructed with little difficulty provided access to the off-site properties is granted by the owners. Construction of the treatment system itself is not anticipated to pose any difficulty since conventional methods would be used. A permit would be required for discharge to the sanitary sewer which would include monitoring of the effluent to determine the effectiveness of treatment. The technologies proposed in this alternative - extraction wells, bag filters and carbon adsorption - are proven and reliable. Since the proposed groundwater treatment processes would be neither complex nor specialized, routine long-term plant O&M are anticipated and could be accomplished with part-time support.

G. Cost

The capital costs for this alternative include the installation of five extraction wells, the treatment system and piping. O&M costs include maintenance of system components (e.g. pumps), replacement of carbon for soil vapor and groundwater, electricity, POTW discharge fees, and routine monitoring of the treatment system. Groundwater quality would be monitored until the remedial goals are met for this environmental medium. For cost estimation purposes, it is assumed that the system would be operated for a period of thirty years. The estimated total capital cost is $223,000 and the estimated present worth of the annual O&M cost is $726,000.

7.2.7. Alternative S5/G5

A. Overall Protection of Public Health and the Environment

The exposure pathway for VOCs in soil and groundwater via incidental ingestion, direct contact and vapor migration to indoor air and subsequent inhalation is considered complete. In this alternative, the hot-spot area of contamination would be targeted with the combined extraction of both soil vapor and groundwater using DPE wells. This alternative would remove contamination from the entire plume of soil contamination and the hot-spot area of groundwater contamination. It would reduce risks to human health and the environment. By removing contaminants from the source area, this alternative would minimize further migration of the contaminants in groundwater.

B. Compliance with SCGs

Contaminant-specific groundwater SCGs would be met over time for contaminated soils and for groundwater in the hot-spot area. Action-specific SCGs would be met for the discharge of treated water to the sanitary sewer, and off-gas to the atmosphere.

C. Short-term Impact and Effectiveness

The implementation of this remedy would require intrusive activities within the property boundary, consisting of the installation of extraction wells and below ground piping from the wells to the treatment system. Remedial construction activities would have minimal impact on workers, the community or the environment. Field work for remedial construction of this alternative would be anticipated to take around three months.

D. Long-term Effectiveness and Permanence

The treatment of the source of contaminants in site soils and the interception of the groundwater in the hot-spot source area would permanently remove contaminants and prevent further migration of contaminants in groundwater. Groundwater extraction would be effective in meeting the RAOs over the long term for the site groundwater. The groundwater treatment system would be monitored to assess the effectiveness of the remedy. Also, the downgradient groundwater quality would need monitoring beyond the duration of on-site remediation. Long-term environmental easements would apply beyond the duration of this pump-and-treat alternative so long as downgradient groundwater contamination remains above groundwater standards.

E. Reduction of Toxicity, Mobility or Volume with Treatment

This alternative would reduce the volume and toxicity of contaminated soil and hot-spot area groundwater through dual phase vapor and groundwater extraction and treatment. The toxicity of the extracted soil vapor and groundwater would be reduced to acceptable levels before discharge.

F. Implementability

This alternative could be implemented with relative ease as the components are proven technologies and equipment is readily available from many vendors. Besides the DPE wells, installation of underground piping from the wells to the treatment system and from the treatment system to the sanitary sewer would entail excavation of limited quantities of contaminated soil potentially requiring off-site disposal. Long term O&M would include system monitoring and maintenance, all of which could be done with part-time support. Treated groundwater discharge to the sanitary sewer would be subject to acceptance by the City of Schenectady's wastewater treatment plant.

G. Cost

The capital costs associated with this alternative would include the installation of two DPE wells, treatment system components (bag filters, and vapor and aqueous phase carbon adsorbers) and underground piping. For cost estimation purposes, it is assumed that the system would be operated for a period of thirty years. O&M costs include maintenance of system components (especially pumps), replacement of carbon for soil vapor and groundwater, electricity, POTW discharge fees, system monitoring and groundwater sampling. The estimated total capital cost is $235,000 and the estimated present worth of the annual O&M cost is $927,000.

7.2.8. Alternative S6/G6 – Dual Phase Extraction/Treatment (Soil/GW Plume)

A. Overall Protection of Public Health and the Environment

The exposure pathway for VOCs in soil and groundwater via incidental ingestion, direct contact and vapor migration to indoor air and subsequent inhalation is considered complete. Targeting the entire plume of soil and groundwater contamination would reduce risks to human health and the environment. An estimated five wells (number subject to confirmation during pre-design phase with pump tests) would be staggered along the axis of the plume to capture the plume; two of these wells located near the building would be DPE wells for combined soil vapor and groundwater extraction, and the remaining three would be groundwater only extraction wells for the downgradient plume.

B. Compliance with SCGs

This alternative would meet contaminant-specific SCGs for both soil and groundwater onsite and off-site following the completion of remediation. Action-specific SCGs would be met by the combined on-site extraction and treatment system, including POTW requirements for discharge of treated water to the sanitary sewer, and Air-Guide I for treated off-gas discharge to the environment. Spent carbon from vapor and aqueous phase treatment would be sent to an off-site facility for regeneration and subsequent reuse

C. Short-term Impact and Effectiveness

Remedial construction activities for this alternative would not be expected to have an impact on workers, the community or the environment. Intrusive activities would extend to the adjacent properties where the groundwater only extraction wells and associated piping need to be installed. This would require access agreements, and community concurrence and acceptance. Field work for remedial construction of this alternative would be anticipated to take around three months.

D. Long-term Effectiveness and Permanence

Alternative S6/G6 would be a permanent long-term remedial solution for this site. The extraction of soil vapor and contaminated groundwater from the entire plume would achieve the RAOs over the long term. The effectiveness of this alternative would be evaluated through monitoring.

E. Reduction of Toxicity, Mobility or Volume with Treatment

The volume and toxicity of both soil and groundwater across the site and downgradient locations would be significantly reduced by the implementation of this alternative. It would reduce further migration of contaminants beyond the current plume, and the treatment system would irreversibly remove the chlorinated VOCs. The spent carbon from the two phases (vapor and aqueous) would be regenerated off-site where the contaminants would be stripped and destroyed before the used carbon is rendered suitable for reuse.

F. Implementability

The DPE wells and discharge piping could be constructed with little difficulty once access is granted by the off-site property owners. Conventional methods would be used for the construction of the dual phase treatment system. The technologies proposed in this alternative - extraction wells, bag filters and carbon adsorption - are proven and reliable. With these technologies, soil vapor and groundwater can be treated to meet air and sewer discharge standards respectively. Since the proposed groundwater treatment processes are neither complex nor specialized, routine long-term plant O&M with part-time staff would be anticipated.

G. Cost

The capital costs for this alternative would include the installation of multiple extraction wells, the treatment system and piping. For cost estimation purposes, it is assumed that the system would be operated for a period of thirty years. O&M costs include maintenance of system components, especially pumps, and routine monitoring of the treatment system and groundwater quality over the of this remedial alternative. The estimated total capital cost $279,000 and the estimated present worth of the annual O&M cost is $1,210,000.

7.3. Comparative Analysis of Alternatives

The following documents the comparative evaluation among the alternatives described above. The individual alternatives are compared below by medium (soil or groundwater) with respect to medium specific RAOs. Comparison of the cost estimates was made assuming each alternative was implemented with new equipment where appropriate. Mention is then made of the possible use of compatible existing treatment systems that may be available from other sites in the State where remediation has been completed by the NYSDEC. The cost benefit of this approach could be significant.

7.3.1. Soil

A. Overall Protection of Public Health and the Environment

Alternatives S4, S5 and S6 would provide the greatest overall protection of public health and the environment since all three address the entire area of soil contamination. A lesser degree of protection would be provided by Alternative S3 which targets the hot-spot soil contamination under the building basement. Alternative S2 would use environmental easements to limit human contact with contaminants but other potential health and environmental risks would remain. Alternative S1 would not provide any protection.

B. Compliance with SCGs

Alternatives S4, S5 and S6 would eventually comply with SCGs since contaminated soils would be remediated. With alternative S3, SCGs would be met since soils currently exceeding SCGs are targeted, but contaminant loadings to the aquifer could potentially continue from relatively less contaminated soils outside the building. There would be no compliance with SCGs by Alternatives S1 and S2.

C. Short-Term Impact and Effectiveness

Alternatives S1 and S2 would have no short term impact on the community and the environment since there would be no activity at the site. Similarly, Alternative S3 would have no short term impact, since the sub-slab depressurization system is already installed and in operation. Alternatives S4, S5 and S6 would have the most, albeit relatively moderate, short term impact on the business on the property and adjacent community since wells and a treatment system would have to be installed.

D. Long-Term Effectiveness and Permanence

The alternatives that target the entire area of soil contamination (i.e. S4, S5 and S6) would permanently and irreversibly remove contaminants and therefore potentially have the most long-term effectiveness. In the long-term, these three alternatives would continue to meet the RAOs for site soils. Alternative S3 would be equally effective in the hot-spot area below the basement slab but does not address contaminated soils that are outside the building. Alternatives S1 and S2 would rely on natural attenuation..

E. Reduction of Toxicity, Mobility or Volume with Treatment

With the removal of chlorinated VOCs by SVE, the toxicity of the contaminated soil would be irreversibly reduced by alternatives S4, S5 and S6. This would also be the case for alternative S3 with respect to the hot-spot soils. With the three alternatives S4, S5 and S6, the off-gas would also be treated with activated carbon before discharge to the atmosphere. The spent vapor phase carbon would be regenerated at an off-site facility where the desorbed VOCs are thermally destroyed. With alternatives S1 and S2, the contaminated soils would remain in place with no reduction in toxicity, mobility or volume, except as provided by natural attenuation.

F. Implementability

Each of the alternatives would be readily implementable.

G. Cost

AlternativeS1 would have no costs. The costs associated with alternative S2 would be low. Alternative S3 would have no costs, since the system is installed and O&M costs are not significant. Alternatives S4 and S6 have the highest costs associated with soil remediation since the entire plume is addressed. The costs for alternative S5 are between S5 and S6. SVE and DPE systems have been used by the NYSDEC to remediate several State Superfund sites. If available for reuse at this site, they could significantly reduce capital costs associated with alternatives involving soil treatment.

7.3.2. Groundwater

A. Overall Protection of Public Health and the Environment

Alternatives G4 and G6 would provide the greatest overall protection of public health and the environment since these two would address the plume of groundwater contamination. A lesser degree of protection would be provided by Alternatives G3 and G5 which would target groundwater in the hot-spot area on the site. Alternative G2 would rely on environmental easements to limit human contact with contaminants in the groundwater but health and environmental risks remain. Alternative G1 would not provide any protection.

B. Compliance with SCGs

Alternatives G4 and G6 would eventually provide potential compliance with SCGs since groundwater within the plume of contamination would be intercepted, extracted and treated. With Alternatives G3 and G5, the groundwater standards would be met in the hot-spot area on the site but the downgradient plume would rely on natural attenuation to achieve SCGs. There would be no compliance with SCGs by alternatives G1 and G2, until such time as natural attenuation reduced the groundwater concentrations.

C. Short-Term Impact and Effectiveness

Alternatives G1 and G2 would have no short term impact on the community and the environment since there would be no activity at the site. Similarly, Alternatives G3 and G5 would have relatively low short-term impact from the installation of the extraction wells and treatment system on the property. Equipment access to the property may have to be from an adjacent property because of the narrow driveway entrance (see Figure 3). Alternatives G4 and G6 would have the greatest, albeit small, short-term impact, since wells and a treatment system would be installed on the site and adjacent properties.

D. Long-Term Effectiveness and Permanence

The alternatives that target the entire plume of groundwater contamination (i.e. G4 and G6) would permanently and irreversibly remove contaminants and therefore would be the most effective in the long term. Alternatives G3 and G5 would be equally effective in the hot-spot area on the site but would not address downgradient groundwater, except as provided by natural attenuation.

E. Reduction of Toxicity, Mobility or Volume with Treatment

With the removal of chlorinated VOCs from the plume of groundwater by extraction and treatment, the toxicity of the aquifer would be irreversibly reduced by Alternatives G4 and G6. Alternatives G3 and G5 would reduce the toxicity of the aquifer for the hot-spot area. With these four alternatives, the off-gas would also be treated with activated carbon before discharge to the atmosphere. The spent vapor phase carbon would be regenerated at an off-site facility where the desorbed VOCs are thermally destroyed. With Alternatives G1 and G2, the contaminated ground water would remain in place with no reduction in toxicity, mobility or volume, except as provided by natural attenuation.

F. Implementability

Each of the alternatives would be readily implementable. Coordination with other agencies and property owners would be necessary for each of the groundwater alternatives to implement use and access restrictions, gain property access and for discharge of treated water.

G. Cost

Alternative G2 would have the lowest cost (aside from the No Action alternative which has no cost) of the alternatives. Alternative G6 would have the highest cost associated with groundwater remediation, while alternatives G3, G4 and G5 would be in between with respect to costs. Groundwater pump-and-treat, (including DPE) systems have been used by the NYSDEC to remediate several State Superfund sites. If available for reuse at this site, existing systems could significantly reduce capital costs.

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NYSDEC, 2002. Draft DER-10, Technical Guidance for Site Investigation and Remediation.

O'Brien & Gere Engineers, Inc., 2005. Remedial Investigation Report, Dambrose Cleaners Site, Schenectady, New York.

Tables

TABLE 1
DAMBROSE CLEANERS SITE
SUMMARY OF RI SAMPLING AND ANALYSIS

Matrix	Number of Samples	ANALYTICAL SCHEDULE VOC
PRELIMINARY SCREENING (9/04)		
Groundwater screening	16	X
Sub-slab soil vapor	1	X
Indoor air	4	X
SECOND PHASE (12/04)		
Groundwater monitoring wells	11	X
Exterior soil vapor	10	X
Sub-slab soil	3	X
Basement sump	1	X

TABLE 2
DAMBROSE CLEANERS SITE
CHLORINATED ORGANICS IN GROUNDWATER

A. GROUNDWATER SCREENING RESULTS

COMPOUND	GW STANDARDS	MINIMUM	MAXIMUM	GWS-1	GWS-2	GWS-3	GWS-4	GWS-5	GWS-6	GWS-7	GWS-8	GWS-9	GWS-10	GWS-11	GWS-12	GWS-13	GWS-14	GWS-15	GWS-16	SUMP
1,1-Dichloroethene	0.7	**0.9**	**0.9**																	**0.9**
Acetone	50	2	4			3	3	2				2	2						4	2
cis- 1,2-Dichloroethene	5	5	**960**								5		**13**							**960**
Methyl acetate	--	2	2		2															
Methyl tert-butyl ether	10	2	2		2															
Methylene chloride	5	1	2	2	2	2	2	2	1	1	1	1	1	1	2	2	1	2	1	2
Tetrachloroethene	5	0.5	**79**										**7**			0.5				**79**
trans- 1,2-Dichloroethene	5	3	3																	3
Trichloroethene	5	5	**26**										5							**26**
Vinyl chloride	2	1	**97**								1									**97**
TOTAL VOCs	--	1	1170	2	6	5	5	4	1	1	7	3	28	1	2	3	1	2	5	1,170

B. MONITORING WELL SAMPLE RESULTS

COMPOUND	GW STANDARDS	MINIMUM	MAXIMUM	MW-1	MW-2	MW-3	MW-4	MW-5	MW-6	MW-7	MW-8	MW-9	MW-10	MW-11
Chloroethane	5	0.7	0.7							0.7				
cis- 1,2-Dichloroethene	5	5	**70**	**45**	**56**		**21**		**70**	5				
Tetrachloroethene	5	5	**670**		**670**		**10**		5					
trans- 1,2-Dichloroethene	5	0.7	0.7				0.7							
Trichloroethene	5	0.9	**54**	0.9	**54**		4		**6**					
Vinyl chloride	2	0.7	**110**	**110**			**9**		0.7	**5**				
TOTAL VOCs	--	10.7	**780**	156	780		45		82	11				

Notes:
a. All values are in µg/L; Only detected compounds are shown
b. Groundwater screening samples are from September 2004, and monitoring well samples are from December 2004 (see RI Report, December 2005, for details)
c. Values exceeding NYSDEC groundwater standards (6 NYCRR Part 703) are shown in bold

TABLE 3

DAMBROSE CLEANERS SITE

CHEMICAL SPECIFIC STANDARDS, CRITERIA AND GUIDANCE VALUES

Parameter	Class	GROUNDWATER STANDARDS (µg/L)	SOIL CLEANUP OBJECTIVES (µg/Kg) TAGM-4046[a]	Air Guide 1[b] ($\mu g/m^3$)		RCRA Toxicity Characteristics (µg/L)
				SCG	ACG	
Tetrachloroethene (PCE)	VOC	5	1,400	1,000	1	700
Trichloroethene (TCE)	VOC	5	700	54,000	0.5	--
1,2-Dichloroethene (DCE)	VOC	5	300 (total)	--	190,000	--
Vinyl Chloride (VC)	VOC	2	200	180,000	0.11	200

NOTES:

a. TAGM-4046: Recommended Soil Cleanup Objectives from NYSDEC's TAGM-4046, January 1994 (currently in effect)

b. NYSDEC's Air Guide 1 (DAR-1) tables for Short-term (SCG) and Annual (ACG) Guideline Concentrations

TABLE 4A
DAMBROSE CLEANERS SITE
IDENTIFICATION OF GENERAL RESPONSE ACTIONS AND REMEDIAL TECHNOLOGIES
SOILS

REMEDIAL ACTION OBJECTIVES	GENERAL RESPONSE ACTIONS	REMEDIAL TECHNOLOGIES

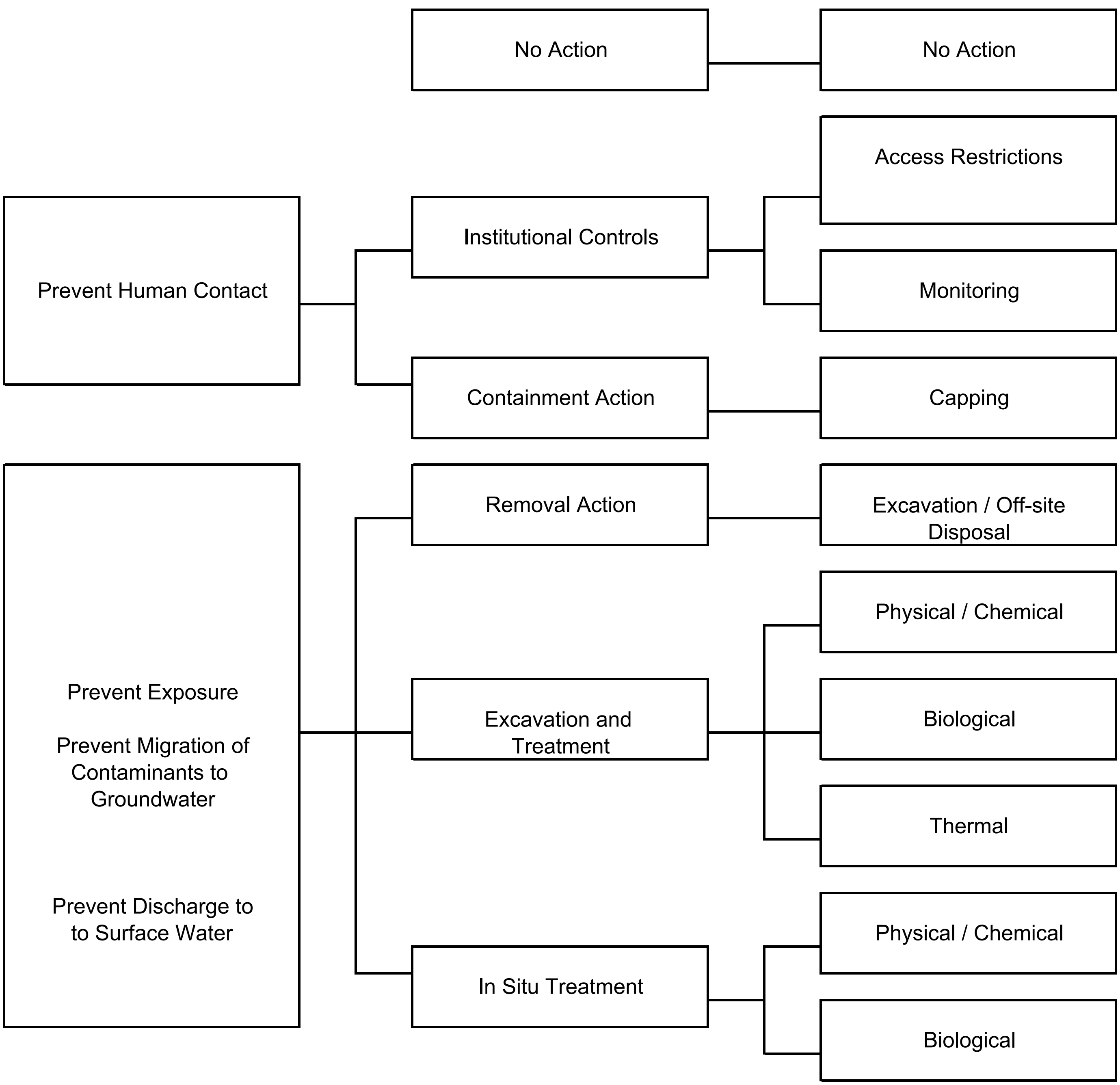


TABLE 4B
DAMBROSE CLEANERS SITE
IDENTIFICATION OF GENERAL RESPONSE ACTIONS AND REMEDIAL TECHNOLOGIES
GROUNDWATER

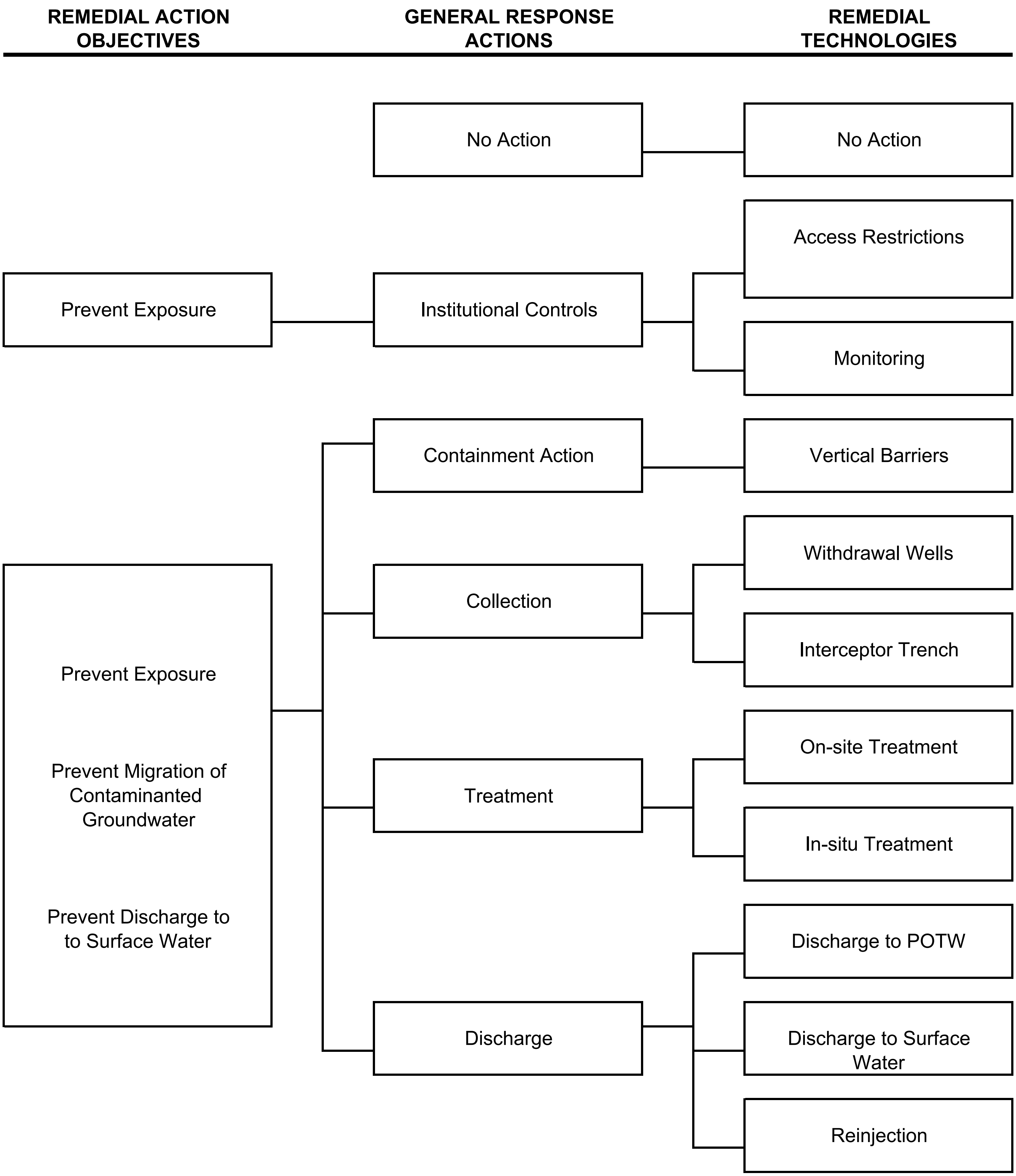


TABLE 5A
DAMBROSE CLEANERS SITE
SCREENING OF REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS
SOILS

GENERAL RESPONSE ACTIONS	REMEDIAL TECHNOLOGIES	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS
No Action	No Action	None	No Action.	Required for consideration by NCP.
Institutional Control	Access Restrictions	Environmental Easements	Environmental easements preventing intrusive activities and contact with soil.	Potentially Applicable.
Containment Action	Capping	Soil Cap	Soil over contaminated area.	Not feasible due to residential/commercial location. Not considered further.
Removal Action	Excavation and Off-site Disposal or Treatment	Excavate and Treat or Dispose Excavated Soil in an Offsite facility	Building demolition required to access sub-base soil.	Excavation is practical and cost-effective in open, accessible areas. Cannot access sub-slab soil. Fugitive emissions during construction phase. Not considered further.
On-site Treatment	Physical / Chemical	Solidification / Stabilization	Addition of materials that combine with soil to physically solidify and / or chemically stabilize contaminants.	Excavation is practical and cost-effective in open, accessible areas, however, sub-slab soil cannot be accessed. Treatment is typically very expensive for small quantities of soil. Not considered further.
		Solvent Extraction/ Soil Washing	Desorption of contaminants from soil by passing water or other solvent through it.	Excavation is practical and cost-effective in open, accessible areas, however, sub-slab soil cannot be accessed. Treatment is typically very expensive for small quantities of soil. Not considered further.
	Biological	Bioremediation	Bioremediation of organic contaminants by mixing microorganisms and/or nutrients into soil.	Excavation is practical and cost-effective in open, accessible areas, however, sub-slab soil cannot be accessed. Treatment is typically very expensive for small quantities of soil. Not considered further.
	Thermal	Low Temperature Thermal Desorption	Volatile organics are desorbed from soil with the application of heat in a controlled reactor.	Excavation is practical and cost-effective in open, accessible areas, however, sub-slab soil cannot be accessed. Treatment is typically very expensive for small quantities of soil. Not considered further.
		Incineration	Contaminants are destroyed by controlled oxidation at high temperature (combustion).	Excavation is practical and cost-effective in open, accessible areas, however, sub-slab soil cannot be accessed. Treatment is typically very expensive for small quantities of soil. Requires significant mobilization and agency approval. Not considered further.
In situ Treatment	Physical / Chemical	Solidification / Stabilization	Application of stabilization agents in situ by geotechnical soil mixing techniques.	Used largely for metals. Potentially applicable to organics, although not proven to be very effective. Restricts future use of site, may interfere with utilities. Not considered further.
		Soil Vapor Extraction	System of properly spaced vapor injection and extraction wells.	Especially suited for this site since contaminant is primarily volatile organics, and soil is highly permeable. Will be considered further.
		Chemical Oxidation	Destruction of chlorinated organics with oxidants (e.g. H_2O_2, $KMnO_4$, ozone) injected through a series of wells	Difficult for oxidant reach all areas of contamination. Inaccessible areas tend to increase treatment duration and leave residuals. Not considered further.
	Biological	Bioremediation	Enhanced bioremediation of soil contaminants by injecting bacteria, nutrients and air into vadose zone.	Extended cleanup duration. Not considered further.

TABLE 5B
DAMBROSE CLEANERS SITE
SCREENING OF REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS
GROUNDWATER

GENERAL RESPONSE ACTIONS	REMEDIAL TECHNOLOGIES	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS
No Action	No Action	None	No Action.	Required for consideration as per NCP.
Institutional Controls	Access Restrictions	Environmental Easments	Environmental easements preventing intrusive activities and use/contact with groundwater.	Potentially Applicable.
	Monitoring	Monitoring Wells	Groundwater monitoring program.	Potentially Applicable.
Containment Action	Vertical Barriers	Slurry Wall	Full or partial slurry wall to prevent contaminant migration in groundwater.	Implementation is difficult in an urban area with residential homes and commercial property. Not considered further.
		Sheetpile Wall	Full or partial sheetpile wall to prevent contaminant migration in groundwater.	Implementation is difficult in an urban area with residential homes and commercial property Not considered further.
Collection Action	Groundwater Collection	Extraction Wells	Wells placed in saturated zone across multiple geologic layers to capture contaminant plume.	Potentially applicable for both source and downgradient areas.
		Extraction Trench	Trench filled with porous media across plume of contamination to intercept contaminated groundwater.	Potentially applicable, however, is limited due to the property location. Not considered further.
Treatment	On-site (above ground) Treatment	Air Stripping	Mixing clean air with groundwater in a packed column.	Potentially applicable for organics, particularly volatiles.
		Carbon Adsorption	Adsorption of contaminants on activated carbon by passing water through carbon beds.	Potentially applicable for organics, particularly volatiles but may have limited effectiveness on vinyl chloride at high concentrations.
		Aerobic Degradation	Biological degradation of organics in an aerobic environment.	Extensive cleanup duration, not appropriate for site specific contaminants. Not considered further.
		Anaerobic Degradation	Biological degradation of organics in an anaerobic environment.	Extensive cleanup duration, not appropriate for site specific contaminants. Not considered further.
	In-situ Treatment	Chemical Oxidation	System of injection wells to introduce powerful oxidants (H_2O_2, $KMnO_4$, O_3) into ground water to destroy contaminants.	Distribution of oxidant to all areas is necessary for this process to work. Difficult to distribute through the weathered till/bedrock. Not considered further.
		Bioremediation	System of injection wells to introduce bacteria and nutrients into aquifer to degrade contaminants; extraction wells.	Extensive monitoring and cleanup duration. Distribution of bacteria and nutrients to all areas is necessary for this process to work. Difficult to distribute through the weathered till/bedrock. Not considered further.
		Air Sparging	Injection of steam and hot air into the aquifer and extraction by vacuum. Off-gas treated prior to discharge.	This is effective in removing VOCs, but not easily implemented in the unconsolidated layers at this site. Not considered further.
		Soil Flushing	Removal of contaminants by injection and extraction of solvents or surfactants.	Can result in offsite migration of contaminant plume and solvents / surfactants. Not considered further.
Disposal	Discharge	POTW	Discharge to sanitary sewer.	Feasible but subject to approval by the City of Schenectady for local discharge.
		Surface Water	Discharge to Mohawk River under Class A surface water discharge requirements.	Not practical due to distance (greater than 0.5 miles) from site. Not considered further.
	Reinjection	Wells	Treated water injected upgradient of the site after pretreatment.	Not considered because of urban location and site geology. Sanitary discharge preferred. Not considered further.

TABLE 6

DAMBROSE CLEANERS SITE
SUMMARY OF ALTERNATIVES FOR SOIL AND GROUNDWATER

ALTERNATIVE	COMPONENTS
A. SOIL	
S1: No Action	None
S2: Institutional Controls	• Environmental easements on site use
S3: Soil Vapor Extraction (Hot-Spot)	• Continue to operate existing sub-slab depressurization system
S4: Soil Vapor Extraction (Plume)	• Soil vapor extraction (SVE) wells outside building • Connect new wells with existing sub-slab depressurization system • Carbon adsorption for off-gas treatment • 5-yr SVE system operation and long-term monitoring
B. GROUNDWATER	
G1: No Action	None
G2: Institutional Controls	• Environmental easements on site use • Long-term groundwater monitoring for 30 years
G3: Groundwater Extraction/Treatment (Hot-Spot)	• Extraction wells (2) in source area • Extract groundwater (5 gpm) • Carbon adsorption for groundwater treatment • Discharge treated groundwater to sanitary sewer • 30-yr GW system operation and long-term monitoring
G4: Groundwater Extraction/Treatment (Plume)	• Extraction wells (5) in source and downgradient plume • Extract groundwater (10 gpm) • Carbon adsorption for groundwater treatment • Discharge treated groundwater to sanitary sewer • 30-yr GW system operation and long-term monitoring
C. COMBINED GROUNDWATER AND SOIL	
S5/G5: Dual Phase Extraction/Treatment (Soil Plume/GW Hot-Spot)	• Continue to operate existing sub-slab depressurization system • DPE wells (2) in source area • Extract soil vapor (300 cfm) and groundwater (5 gpm) • Air/water separator for soil vapor and groundwater mixture • Carbon adsorption for groundwater treatment • Carbon adsorption for off-gas treatment • Discharge treated groundwater to sanitary sewer • 30-yr DPE system operation and long-term monitoring
S6/G6: Dual Phase Extraction/Treatment (Soil/GW Plume)	• Continue to operate existing sub-slab depressurization system • DPE wells (2) in source area • GW only extraction wells (3) downgradient • Extract soil vapor (300 cfm) and groundwater (10 gpm) • Air/water separator for soil vapor and groundwater mixture • Carbon adsorption for groundwater treatment • Carbon adsorption for off-gas treatment • Discharge treated groundwater to sanitary sewer • 30-yr DPE system operation and long-term monitoring

NOTES:
1. GW = groundwater; SV = soil vapor; DPE = dual phase extraction (i.e. soil vapor and groundwater)
2. Assumed soil vapor and ground water flow rates are preliminary, subject to confirmation during design

TABLE 7

DAMBROSE CLEANERS SITE
CONCEPTUAL DESIGN CRITERIA FOR SOIL AND GROUNDWATER

COMPONENT	CONCEPTUAL DESIGN CRITERIA	SIZE
A. SOIL		
Soil Vapor extraction wells	Depth	10 feet below grade
	Number of well points	3 outside building
Vacuum blower	Flow (total)	100 cfm for SVE system
		300 cfm for DPE system
	Vacuum	35" water
Vapor phase carbon adsorber	Capacity	1000 lb; rated flow 300 sfcm
B. GROUNDWATER		
Groundwater extraction wells	Depth	20 feet below grade
Equalization Tank	0.5 day retention time @ 10 gpm	8,000 gallon
Liquid phase carbon adsorber	capacity	1000 lb; rated flow 10 gpm

TABLE 8A

DAMBROSE CLEANERS SITE
ALTERNATIVE S4 - SOIL VAPOR EXTRACTION (PLUME)

CAPITAL COST ESTIMATE

CATEGORY / ITEM	QUANTITY	UNIT	UNIT COST	COST	ASSUMPTIONS / COMMENTS
PROJECT INITIATION					
Mobilization / Demobilization	1	LS	$5,000	$5,000	Assume 3 month project duration.
Site Preparation	1	LS	$2,000	$2,000	
Facility, supplies, utilities	2	MO	$1,000	$2,000	
SUBTOTAL				$9,000	
SOIL TREATMENT					
Pre-engineered building	1	EA	$12,000	$12,000	Assume a 10' x 30' trailer; foundation
Vapor Extraction System					Assume 300 cy of soil will be treated
> Soil Vapor extraction wells	3	EA	$4,000	$12,000	Assume 10 ft deep wells
> Vacuum Blower	1	EA	$6,000	$6,000	Regenerative blower, 100 SCFM @35" vacuum
Vapor Treatment System					
> Carbon adsorber	2	EA	$1,000	$2,000	Assume 800 lb total carbon capacity
SUBTOTAL				$32,000	
ADDITIONAL TREATMENT EQUIPMENT COSTS					
Equipment Installation (30 % of Equipment)				$9,600	
Spare Equipment (10 % of Equipment)				$3,200	
Instrument / Controls (20 % of Equipment)				$6,400	
Piping (20 % of Equipment)				$6,400	
Electrical (10 % of Equipment)				$3,200	
SUBTOTAL				$28,800	
System Startup					Assume 1 month operation
> Electricity	10,800	kW hr	$0.12	$1,300	KWhr = Total 20 HP x 24 hr/d x 30 days x 0.747
> Labor	320	MHR	$30	$9,600	Assume 2 laborers 40 hours per week for 1 month
Monitoring					Monitoring, sampling and analysis for 1 month
> Soil Vapor	16	EA	$125	$2,000	2 samples/day 1st wk and 2 per week thereafter
> Groundwater	4	EA	$125	$500	Allow 1 sample per week
SUBTOTAL				$13,400	
TOTAL DIRECT CAPITAL COSTS				$83,000	
INDIRECT CAPITAL COSTS					
Construction, Administration and Design Engineering (20 %)				$16,600	Engineering, environmental easements, permits, meetings
Health & Safety (5 %)				$4,200	HASP development and implementation
Bonds and Insurance (5%)				$4,200	
Management and QA/QC (10 %)				$8,300	Prime contractor management/supervision, QA/QC
Contingency (20 %)				$16,600	Covers bid and site related contingencies
SUBTOTAL				$50,000	
TOTAL - CAPITAL COSTS				**$133,000**	

ANNUAL O&M COST ESTIMATE

ITEM	UNITS	QUANTITY	UNIT COST	COST	BASIS
Treatment System & Long-Term Monitoring (5 yrs)					
Sampling	MH	32	$50	$1,600	Quarterly sampling, 1 person crew, 8 manhours per round for preparation, sampling and reporting.
Carbon replacement/disposal	EA	2	$3,000	$6,000	800 lb per replacement twice/yr
O&M Supplies	EA	1	2000	$2,000	Annual budget for supplies and equipment repair
O&M Labor	MH	192	$50	$9,600	Assume 16 hours/month
Electrical	Month	12	$200	$2,400	Based on 3 HP and $0.12/kwh
Analysis (VOCs)	EA	8	$125	$1,000	1 soil vapor +1 QC samples per quarter for VOCs;
TOTAL ANNUAL O & M				$23,000	
PRESENT WORTH of O & M				**$102,000**	For n=5 years and i=4%; PW=4.45

TABLE 8B

DAMBROSE CLEANERS SITE

ALTERNATIVE G2 - INSTITUTIONAL CONTROL (Groundwater)

CAPITAL COST ESTIMATE

NONE

ANNUAL O&M COST ESTIMATE

ITEM	UNITS	QUANTITY	UNIT COST	COST	BASIS
Long-term Monitoring (30 years)					
Sampling	MH	30	$50	$1,500	Annual sampling, 2 person crew, 30 manhours for preparation, sampling and reporting.
Analysis	EA	16	$125	$2,000	11 wells + 5 QA/QC per year for VOCs
TOTAL ANNUAL O & M				$3,500	
PRESENT WORTH of O & M				**$61,000**	For n=30 years and i=4%; PW=17.29

TABLE 8C

DAMBROSE CLEANERS SITE

ALTERNATIVE G3 - GROUNDWATER EXTRACTION/TREATMENT (HOT-SPOT)

CAPITAL COST ESTIMATE

CATEGORY / ITEM	QUANTITY	UNIT	UNIT COST	COST	ASSUMPTIONS / COMMENTS
PROJECT INITIATION					
Mobilization / Demobilization	1	LS	$5,000	$5,000	Assume 3 month project duration.
Site Preparation	1	LS	$2,000	$2,000	
Facility, supplies, utilities	2	MO	$1,000	$2,000	
SUBTOTAL				$9,000	
GROUNDWATER TREATMENT					5 GPM Flow
Pre-engineered steel building	1	EA	$12,000	$12,000	Use 10' x 30' trailer, foundation
Extraction wells/submersible pump	2	EA	$5,000	$10,000	20' deep wells; 1 HP
Equalization / Storage Tank	8,000	GAL	$0.70	$5,600	0.5 day retention time; 8,000 gallon
Carbon adsorber	2	EA	$5,000	$10,000	1000 lb total carbon capacity
Feed Pump	1	EA	$2,500	$2,500	2 HP
SUBTOTAL				$40,100	
ADDITIONAL TREATMENT EQUIPMENT COSTS					
Equipment Installation (30 % of Equipment)				$12,030	
Spare Equipment (10 % of Equipment)				$4,010	
Instrument / Controls (20 % of Equipment)				$8,020	
Piping (20 % of Equipment)				$8,020	
Electrical (10 % of Equipment)				$4,010	
SUBTOTAL				$36,090	
System Startup					Assume 1 month operation
> Electricity	21,500	kW hr	$0.12	$2,600	KWhr = Total 40 HP x 24 hr/d x 30 days x 0.747
> Labor	320	MHR	$30	$9,600	Assume 2 laborers 40 hours per week for 1 month
Monitoring					Includes monitoring, sampling and analysis for 1 month
> Groundwater	16	EA	$125	$2,000	2 samples/day 1st wk and 2 per week thereafter
SUBTOTAL				$14,200	
TOTAL DIRECT CAPITAL COSTS				$99,000	
INDIRECT CAPITAL COSTS					
Construction, Administration and Design Engineering (20 %)				$19,800	Engineering, environmental easements, permits, public meetings
Health & Safety (5 %)				$5,000	HASP development and implementation
Bonds and Insurance (5%)				$5,000	
Management and QA/QC (10 %)				$9,900	General contractor management/supervision and QA/QC
Contingency (20 %)				$19,800	Covers bid and site related contingencies
SUBTOTAL				$60,000	
TOTAL - CAPITAL COSTS				**$159,000**	

ANNUAL O&M COST ESTIMATE

ITEM	UNITS	QUANTITY	UNIT COST	COST	BASIS
Treatment System & Long-term Monitoring (30 years)					
Sampling	MH	60	$50	$3,000	Assume semi-annual sampling, 2 person crew, 30 manhours per round for preparation, sampling and reporting.
Carbon replacement	EA	2	$3,000	$6,000	1000 lb per replacement twice/yr
O&M Supplies	EA	1	2000	$2,000	Annual budget for supplies and equipment repair
O&M Labor	MH	240	$50	$12,000	Assume 20 hours/month
Electrical	Month	12	$200	$2,400	Based on 3 HP and $0.12/kwh
Analysis (VOCs)	EA	40	$125	$5,000	Assume 2 samples per quarter for VOCs; (Influent/Effluent); 11 wells+ 5 QA/QC semi-annually for VOCs;
TOTAL ANNUAL O & M				$30,400	
PRESENT WORTH of O & M				**$526,000**	For n=30 years and i=4%; PW=17.29

TABLE 8D

DAMBROSE CLEANERS SITE

ALTERNATIVE G4 - GROUNDWATER EXTRACTION/TREATMENT (PLUME)

CAPITAL COST ESTIMATE

CATEGORY / ITEM	QUANTITY	UNIT	UNIT COST	COST	ASSUMPTIONS / COMMENTS
PROJECT INITIATION					
Mobilization / Demobilization	1	LS	$5,000	$5,000	Assume 3 month project duration.
Site Preparation	1	LS	$2,000	$2,000	
Facility, supplies, utilities	3	MO	$1,000	$3,000	
SUBTOTAL				$10,000	
GW COLLECTION/TREATMENT					30 GPM Flow
Pre-engineered steel building	1	EA	$12,000	$12,000	Use 10' x 30' trailer, foundation
Extraction well/submersible pump	5	EA	$5,000	$25,000	20' deep wells; 1 HP
Bag Filters	2	EA	$1,000	$2,000	
Equalization / Storage Tank	12,000	GAL	$0.70	$8,400	0.5 day retention time; 8,000 gallon
Carbon adsorber	2	EA	$5,000	$10,000	1000 lb total carbon capacity
Feed Pump	1	EA	$2,500	$2,500	2 HP
SUBTOTAL				$59,900	
ADDITIONAL TREATMENT EQUIPMENT COSTS					
Equipment Installation (30 % of Equipment)				$17,970	
Spare Equipment (10 % of Equipment)				$5,990	
Instrument / Controls (20 % of Equipment)				$11,980	
Piping (20 % of Equipment)				$11,980	
Electrical (10 % of Equipment)				$5,990	
SUBTOTAL				$53,910	
System Startup					Assume 1 month operation
> Electricity	26,900	kW hr	$0.12	$3,200	KWhr = Total 50 HP x 24 hr/d x 30 days x 0.747
> Labor	320	MHR	$30	$9,600	Assume 2 laborers 40 hours per week for 1 month
Monitoring					Includes monitoring, sampling and analysis for 1 month
> Groundwater	16	EA	$125	$2,000	2 samples/day 1st wk and 2 per week thereafter
SUBTOTAL				$14,800	
TOTAL DIRECT CAPITAL COSTS				$139,000	
INDIRECT CAPITAL COSTS					
Construction, Administration and Design Engineering (20 %)				$27,800	Engineering, environmental easements, permits, meetings
Health & Safety (5 %)				$7,000	HASP development and implementation
Bonds and Insurance (5%)				$7,000	
Management and QA/QC (10 %)				$13,900	General contractor management/supervision and QA/QC
Contingency (20 %)				$27,800	Covers bid and site related contingencies
SUBTOTAL				$84,000	
TOTAL - CAPITAL COSTS				**$223,000**	

ANNUAL O&M COST ESTIMATE

ITEM	UNITS	QUANTITY	UNIT COST	COST	BASIS
Treatment System & Long-Term Monitoring (30 yrs)					
Sampling	MH	60	$50	$3,000	Assume semi-annual sampling, 2 person crew, 30 manhours per round for preparation, sampling and reporting.
Carbon replacement	EA	3	$3,000	$9,000	1000 lb per replacement thrice/yr
O&M Supplies	EA	1	2000	$2,000	Annual budget for supplies and equipment repair
O&M Labor	MH	384	$50	$19,200	Assume 32 hours/month
Electrical	Month	12	$350	$4,200	Based on 5 HP and $0.12/kwh
Analysis (VOCs)	EA	40	$125	$5,000	Assume 2 samples per quarter for VOCs; (Influent/Effluent); 11 wells+ 5 QA/QC semi-annually for VOCs;
TOTAL ANNUAL O & M				$42,000	
PRESENT WORTH of O & M				**$726,000**	For n=30 years and i=4%; PW=17.29

TABLE 8E
DAMBROSE CLEANERS SITE
ALTERNATIVE S5/G5 - DUAL PHASE EXTRACTION/TREATMENT (SOIL PLUME/GW HOT-SPOT)

CAPITAL COST ESTIMATE

CATEGORY / ITEM	QUANTITY	UNIT	UNIT COST	COST	ASSUMPTIONS / COMMENTS
PROJECT INITIATION					
Mobilization / Demobilization	1	LS	$5,000	$5,000	Assume 3 month project duration.
Site Preparation	1	LS	$2,000	$2,000	
Facility, supplies, utilities	4	MO	$1,000	$4,000	
SUBTOTAL				$11,000	
SOIL/GW COLLECTION/TREATMENT					
Pre-engineered building	1	EA	$12,000	$12,000	Assume a 10' x 30' trailer; foundation
Extraction System					Assume 300 cy of soil will be treated
> DPE wells	2	EA	$4,000	$8,000	Assume 10 ft deep wells
> Vacuum Blower	1	EA	$9,000	$9,000	Regenerative blower, 300 SCFM @35" vacuum
Air/Water Separator	1	EA	$8,000	$8,000	Assume 100 gallon capacity
Vapor Phase Treatment System					
> Carbon adsorber	2	EA	$1,000	$2,000	Assume 800 lb total carbon capacity
Groundwater Treatment					5 GPM Flow
> Bag Filters	2	EA	$1,000	$2,000	
> Equalization / Storage Tank	8,000	GAL	$0.70	$5,600	0.5 day retention time; 8,000 gallon
> Carbon adsorber	2	EA	$5,000	$10,000	1000 lb total carbon capacity
Feed Pump	1	EA	$2,500	$2,500	
SUBTOTAL				$59,100	
ADDITIONAL TREATMENT EQUIPMENT COSTS					
Equipment Installation (30 % of Equipment)				$17,730	
Spare Equipment (10 % of Equipment)				$5,910	
Instrument / Controls (20 % of Equipment)				$11,820	
Piping (20 % of Equipment)				$11,820	
Electrical (10 % of Equipment)				$5,910	
SUBTOTAL				$53,190	
System Startup					Assume 1 month operation
> Electricity	10,800	kW hr	$0.12	$1,300	KWhr = Total 20 HP x 24 hr/d x 30 days x 0.747
> Labor	320	MHR	$30	$9,600	Assume 2 laborers 40 hours per week for 1 month
Monitoring					Monitoring, sampling and analysis for 1 month
> Soil Vapor	24	EA	$125	$3,000	1 influent sample/week; 1 effluent sample/day
> Groundwater	8	EA	$125	$1,000	Allow 2 sample per week
SUBTOTAL				$14,900	
TOTAL DIRECT CAPITAL COSTS				$138,000	
INDIRECT CAPITAL COSTS					
Construction, Administration and Design Engineering (25 %)				$34,500	Engineering, environmental easements, permits, meetings
Health & Safety (10 %)				$13,800	HASP development and implementation
Bonds and Insurance (5%)				$6,900	
Management and QA/QC (10 %)				$13,800	Prime contractor management/supervision, QA/QC
Contingency (20 %)				$27,600	Covers bid and site related contingencies
SUBTOTAL				$97,000	
TOTAL - CAPITAL COSTS				**$235,000**	

ANNUAL O&M COST ESTIMATE

ITEM	UNITS	QUANTITY	UNIT COST	COST	BASIS
Treatment System & Long-term Monitoring (30 years)					
Sampling	MH	60	$50	$3,000	Assume semi-annual sampling, 2 person crew, 30 manhours per round for preparation, sampling and reporting.
Carbon replacement	EA	4	$3,000	$12,000	1800 lb per replacement twiceyr (GW/SV)
O&M Supplies	EA	1	2000	$2,000	Annual budget for supplies and equipment repair
O&M Labor	MH	528	$50	$26,400	Assume 44 hours/month
Electrical	Month	12	$350	$4,200	Based on 5 HP and $0.12/kwh
Analysis (VOCs)	EA	48	$125	$6,000	Assume 4 samples per quarter for VOCs; (GW/SV Influent/Effluent); 11 wells+ 5 QA/QC semi-annually for VOCs;
TOTAL ANNUAL O & M				$53,600	
PRESENT WORTH of O & M				**$927,000**	For n=30 years and i=4%; PW=17.29

TABLE 8F

DAMBROSE CLEANERS SITE

ALTERNATIVE S6/G6 - DUAL PHASE EXTRACTION/TREATMENT (SOIL/GW PLUME)

CAPITAL COST ESTIMATE

CATEGORY / ITEM	QUANTITY	UNIT	UNIT COST	COST	ASSUMPTIONS / COMMENTS
PROJECT INITIATION					
Mobilization / Demobilization	1	LS	$5,000	$5,000	Assume 3 month project duration.
Site Preparation	1	LS	$2,000	$2,000	
Facility, supplies, utilities	4	MO	$1,000	$4,000	
SUBTOTAL				$9,000	
SOIL/GW COLLECTION/TREATMENT					
Pre-engineered building	1	EA	$12,000	$12,000	Assume a 10' x 30' trailer; foundation
Extraction System					Assume 300 cy of soil will be treated
> DPE wells	2	EA	$4,000	$8,000	Assume 10 ft deep wells
> Vacuum Blower	1	EA	$9,000	$9,000	Regenerative blower, 300 SCFM @35" vacuum
> GW Wells with pumps	3	EA	$5,000	$15,000	20' deep wells; drilling, casing, screening, etc.
Air/Water Separator	1	EA	$8,000	$8,000	Assume 100 gallon capacity
Vapor Phase Treatment System					
> Carbon adsorber	2	EA	$1,000	$2,000	Assume 800 lb total carbon capacity
Groundwater Treatment					10 GPM Flow
> Bag Filters	2	EA	$1,000	$2,000	
> Equalization / Storage Tank	8,000	GAL	$0.70	$5,600	0.5 day retention time; 8,000 gallon
> Carbon adsorber	2	EA	$5,000	$10,000	1000 lb total carbon capacity
Feed Pump	1	EA	$2,500	$2,500	
SUBTOTAL				$74,100	
ADDITIONAL TREATMENT EQUIPMENT COSTS					
Equipment Installation (30 % of Equipment)				$22,230	
Spare Equipment (10 % of Equipment)				$7,410	
Instrument / Controls (20 % of Equipment)				$14,820	
Piping (20 % of Equipment)				$14,820	
Electrical (10 % of Equipment)				$7,410	
SUBTOTAL				$66,690	
System Startup					Assume 1 month operation
> Electricity	10,800	kW hr	$0.12	$1,300	KWhr = Total 20 HP x 24 hr/d x 30 days x 0.747
> Labor	320	MHR	$30	$9,600	Assume 2 laborers 40 hours per week for 1 month
Monitoring					Monitoring, sampling and analysis for 1 month
> Soil Vapor	24	EA	$125	$3,000	1 influent sample/week; 1 effluent sample/day
> Groundwater	4	EA	$125	$500	Allow 1 sample per week
(Soil/GW Plume)				$14,400	
TOTAL DIRECT CAPITAL COSTS				$164,000	
INDIRECT CAPITAL COSTS					
Construction, Administration and Design Engineering (25 %)				$41,000	Engineering, environmental easements, permits, meetings
Health & Safety (10 %)				$16,400	HASP development and implementation
Bonds and Insurance (5%)				$8,200	
Management and QA/QC (10 %)				$16,400	Prime contractor management/supervision, QA/QC
Contingency (20 %)				$32,800	Covers bid and site related contingencies
SUBTOTAL				$115,000	
TOTAL - CAPITAL COSTS				**$279,000**	

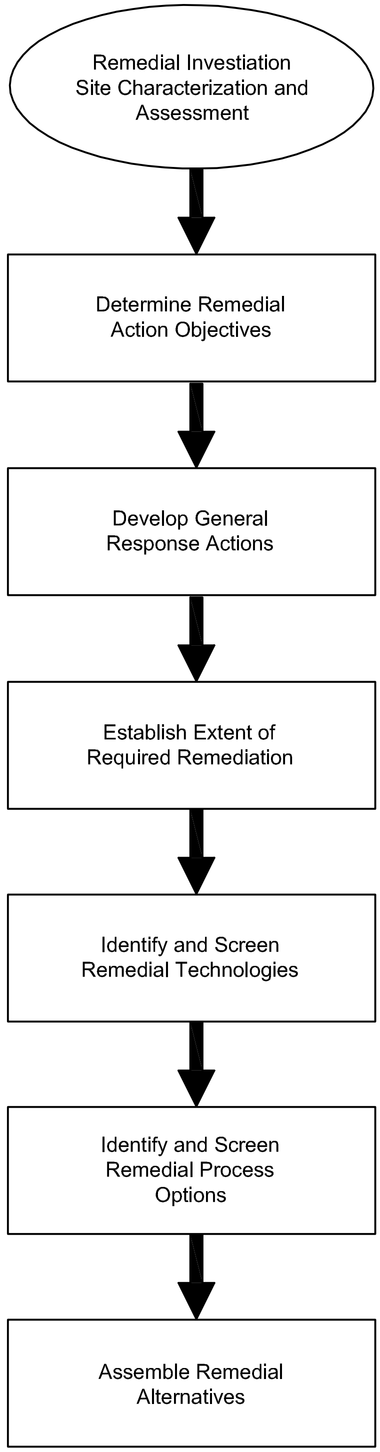
ANNUAL O&M COST ESTIMATE

ITEM	UNITS	QUANTITY	UNIT COST	COST	BASIS
Treatment System & Long-Term Monitoring (30 yrs)					
Sampling	MH	60	$50	$3,000	Assume semi-annual sampling, 2 person crew, 30 manhours per round for preparation, sampling and reporting.
Carbon replacement	EA	6	$3,000	$18,000	1800 lb per replacement thrice/year (GW/SV)
O&M Supplies	EA	1	2000	$2,000	Annual budget for supplies and equipment repair
O&M Labor	MH	720	$50	$36,000	Assume 60 hours/month
Electrical	Month	12	$400	$4,800	Based on 6 HP and $0.12/kwh
Analysis (VOCs)	EA	48	$125	$6,000	Assume 4 samples per quarter for VOCs; (GW/SV Influent/Effluent); 11 wells+ 5 QA/QC semi-annually for VOCs;
TOTAL ANNUAL O & M				$70,000	
PRESENT WORTH of O & M				**$1,210,000**	For n=30 years and i=4%; PW=17.29

TABLE 9
DAMBROSE CLEANERS SITE
REMEDIAL ALTERNATIVES COST SUMMARY

ALTERNATIVE	CAPITAL COST	ANNUAL O&M COST	PRESENT WORTH O&M	PRESENT WORTH CAPITAL+O&M
SOIL				
S1 - NO ACTION	$0	$0	$0	$0
S2 - INSTITUTIONAL CONTROLS	$0	$0	$0	$0
S3 - SOIL VAPOR EXTRACTION (HOT-SPOT)	$0	$0	$0	$0
S4 - SOIL VAPOR EXTRACTION (PLUME)	$133,000	$23,000	$102,000	$235,000
GROUNDWATER				
G1 - NO ACTION	$0	$0	$0	$0
G2 - INSTITUTIONAL CONTROLS	$0	$3,500	$61,000	$61,000
G3 - GROUNDWATER EXTRACTION/TREATMENT (HOT-SPOT)	$159,000	$30,400	$526,000	$685,000
G4 - GROUNDWATER EXTRACTION/TREATMENT (PLUME)	$223,000	$42,000	$726,000	$949,000
COMBINATION OF SOIL & GROUNDWATER ALTERNATIVES				
S2 + G2 - INSTITUTIONAL CONTROLS	$0	$3,500	$61,000	$61,000
S3 + G3 - SOIL SVE (HOT-SPOT) & GW EXTRACTION/TREATMENT (HOT-SPOT)	$159,000	$30,400	$526,000	$685,000
S4 + G3 - SOIL SVE (PLUME) & GW EXTRACTION/TREATMENT (HOT-SPOT)	$292,000	$53,400	$628,000	$920,000
S4 + G4 - SOIL SVE (PLUME) & GW EXTRACTION/TREATMENT (PLUME)	$356,000	$65,000	$828,000	$1,184,000
COMBINED SOIL & GROUNDWATER TREATMENT				
S5/G5 - DUAL PHASE SV/GW EXTRACTION/TREATMENT (HOT-SPOT)	$235,000	$53,600	$927,000	$1,162,000
S6/G6 - DUAL PHASE SV/GW EXTRACTION/TREATMENT (PLUME)	$279,000	$70,000	$1,210,000	$1,489,000

Figures



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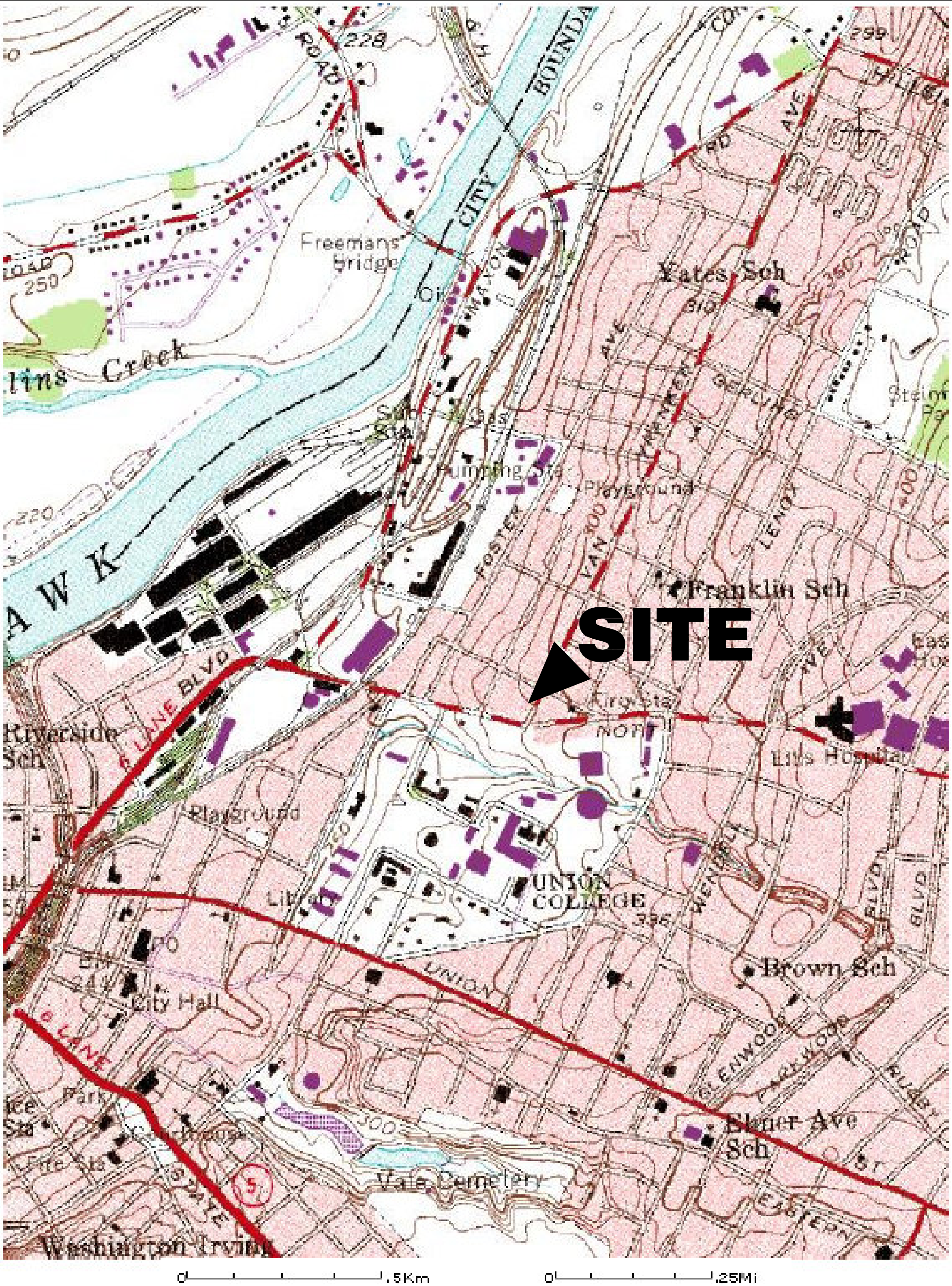
DAMBROSE CLEANERS

REMEDIAL ALTERNATIVE
DEVELOPMENT PROCESS

FILE NO.	106531/34253
DATE	JANUARY 2007
DWG NO.	FIGURE 1



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Scale: 1"=0.25mi.

SITE LOCATION MAP

DAMBROSE CLEANERS
SCHENECTADY, NEW YORK

FILE NO. 106531/34253

DATE JANUARY 2007

DWG NO. FIGURE 2

FIGURE 3

NYS DEC
DAMBROSE CLEANERS
SCHENECTADY, NEW YORK

AERIAL PHOTO OF SITE

106531/34253
JANUARY 2007

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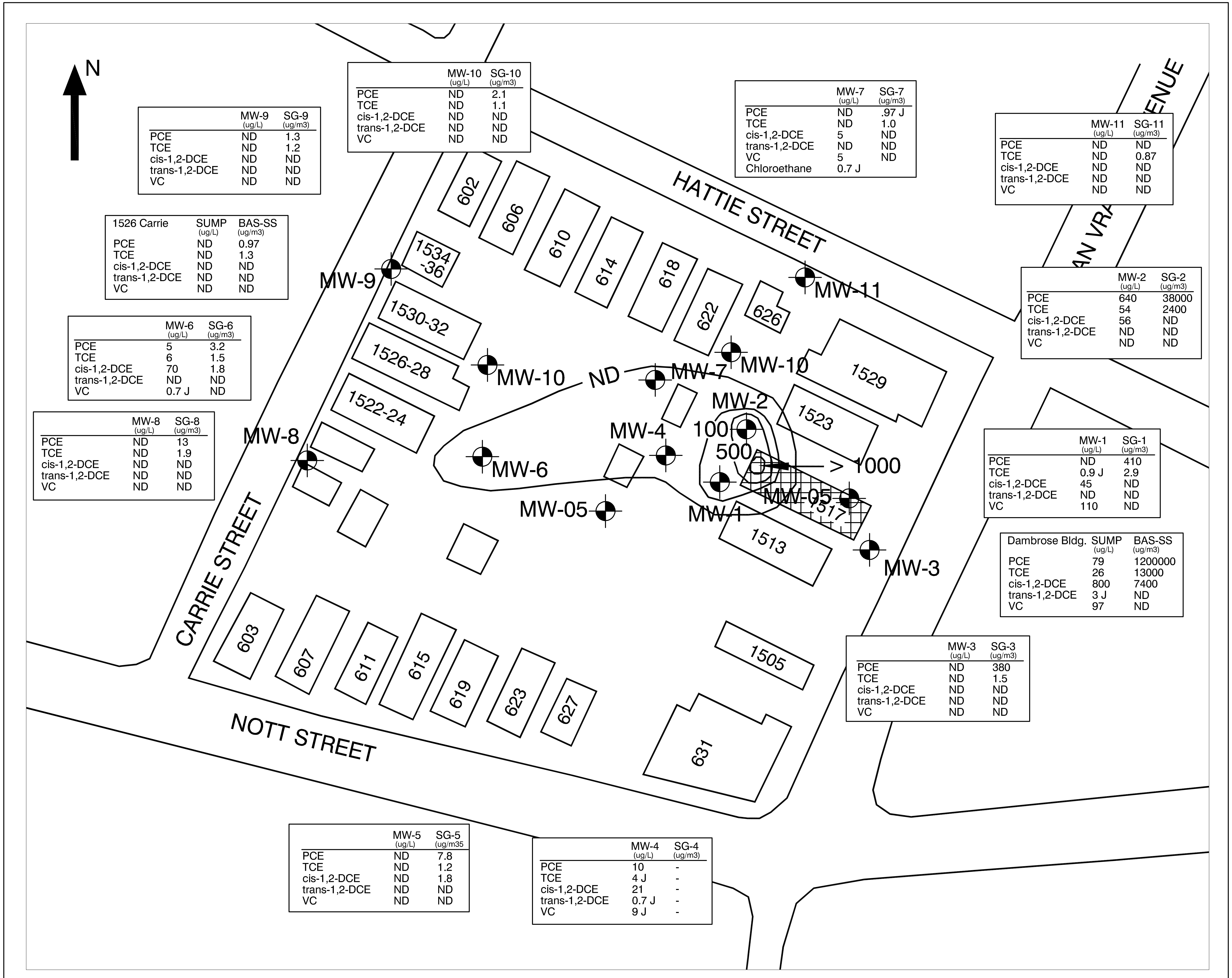

	MW-10 (ug/L)	SG-10 (ug/m3)
PCE	ND	2.1
TCE	ND	1.1
cis-1,2-DCE	ND	ND
trans-1,2-DCE	ND	ND
VC	ND	ND

	MW-7 (ug/L)	SG-7 (ug/m3)
PCE	ND	.97 J
TCE	ND	1.0
cis-1,2-DCE	5	ND
trans-1,2-DCE	ND	ND
VC	5	ND
Chloroethane	0.7 J	

	MW-11 (ug/L)	SG-11 (ug/m3)
PCE	ND	ND
TCE	ND	0.87
cis-1,2-DCE	ND	ND
trans-1,2-DCE	ND	ND
VC	ND	ND

	MW-9 (ug/L)	SG-9 (ug/m3)
PCE	ND	1.3
TCE	ND	1.2
cis-1,2-DCE	ND	ND
trans-1,2-DCE	ND	ND
VC	ND	ND

1526 Carrie	SUMP (ug/L)	BAS-SS (ug/m3)
PCE	ND	0.97
TCE	ND	1.3
cis-1,2-DCE	ND	ND
trans-1,2-DCE	ND	ND
VC	ND	ND

	MW-6 (ug/L)	SG-6 (ug/m3)
PCE	5	3.2
TCE	6	1.5
cis-1,2-DCE	70	1.8
trans-1,2-DCE	ND	ND
VC	0.7 J	ND

	MW-8 (ug/L)	SG-8 (ug/m3)
PCE	ND	13
TCE	ND	1.9
cis-1,2-DCE	ND	ND
trans-1,2-DCE	ND	ND
VC	ND	ND

	MW-2 (ug/L)	SG-2 (ug/m3)
PCE	640	38000
TCE	54	2400
cis-1,2-DCE	56	ND
trans-1,2-DCE	ND	ND
VC	ND	ND

	MW-1 (ug/L)	SG-1 (ug/m3)
PCE	ND	410
TCE	0.9 J	2.9
cis-1,2-DCE	45	ND
trans-1,2-DCE	ND	ND
VC	110	ND

Dambrose Bldg.	SUMP (ug/L)	BAS-SS (ug/m3)
PCE	79	1200000
TCE	26	13000
cis-1,2-DCE	800	7400
trans-1,2-DCE	3 J	ND
VC	97	ND

	MW-3 (ug/L)	SG-3 (ug/m3)
PCE	ND	380
TCE	ND	1.5
cis-1,2-DCE	ND	ND
trans-1,2-DCE	ND	ND
VC	ND	ND

	MW-5 (ug/L)	SG-5 (ug/m35
PCE	ND	7.8
TCE	ND	1.2
cis-1,2-DCE	ND	1.8
trans-1,2-DCE	ND	ND
VC	ND	ND

	MW-4 (ug/L)	SG-4 (ug/m3)
PCE	10	-
TCE	4 J	-
cis-1,2-DCE	21	-
trans-1,2-DCE	0.7 J	-
VC	9 J	-

FIGURE 4

Ground Water Monitoring Well and Soil Gas Sampling Point

Contoured Total VOC Concentration in Ground Water

NYS DEC
STATE SUPERFUND
STANDBY SITE
WA #D004090–15

DAMBROSE CLEANERS

SITE LAYOUT AND
AREAL EXTENT OF
CONTAMINATION
DECEMBER 2004

1"=60' 60 0 60

FILE NO. 106531/34253
JANUARY 2007

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