FEASIBILITY STUDY REPORT
FINAL REPORT

Photocircuits/Pall Corp
OU2 (Deep Groundwater) RI/FS

Photocircuits (#130009),
Pall Corporation (#130053B)

Work Assignment No. D004436-04

Prepared for:

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

DECEMBER 2011

Prepared by:

AECOM Technical Services Northeast
40 British American Boulevard
Latham, New York

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and 1-30-053B

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Photocircuits/Pall Corporation Feasibility Study

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1.0 INTRODUCTION

This report presents the results of a Feasibility Study prepared by AECOM Technical Services Northeast (AECOM; formerly Earth Tech) of alternatives for the environmental remediation of the Photocircuits Corporation Site and Pall Corporation Site deep groundwater (Operable Unit 02) located in Glen Cove, Nassau County, New York. The Photocircuits Corporation Site and the Pall Corporation Sites are each listed as a Class 2 site on the New York State Department of Environmental Conservation (NYSDEC) Registry of Inactive Hazardous Waste Sites, Site No. 130009; and Site 130053B, respectively. The general location of the individual sites and the OU2 area are shown on Figure 1-1. The specific properties (tax blocks and lots) comprising each site are listed on Table 1-1 and shown on Figure 1-2.

1.1 Background

In response to documented groundwater contamination at the Site, NYSDEC commissioned a Remedial Investigation/Feasibility Study (RI/FS) for deep groundwater, identified as Operable Unit 2 (OU-2). The deep groundwater includes groundwater deeper than 100 feet (ft) below ground surface (bgs) within the property boundaries of the Photocircuits Corporation Site and groundwater deeper than 60 ft bgs below the Pall Corporation property and off-site. NYSDEC has issued Records of Decision (RODs) for OU-1 (shallow soils and groundwater, defined as "…all contamination above 60 ft bgs") at the Pall Corporation Site (NYSDEC, 2004), for OU-1 at the Photocircuits Site (NYSDEC, 2008a; OU-1 is defined as "on-site soils and groundwater to a depth of approximately 100 ft bgs"), and for the former Pass and Seymour Site (NYSDEC; 2008b). (The RODs for these sites are included in **Appendix A**.) The OU-2 RI and FS were completed on behalf of NYSDEC under Superfund Standby Contract Work Assignment #D004436-04 (NYSDEC, 2006) to Earth Tech Northeast (now AECOM).

The objective of the RI was to characterize the nature and extent of contamination of deep groundwater, and to provide data for completing the FS. The scope of work for the RI is described in work plan documents approved by the NYSDEC (see Section 1.3). The RI included a qualitative risk assessment to identify potential risks to human health and the environment due to contaminants present on Site. The results of the RI (Draft Remedial Investigation Report, Photocircuits/Pall Corporation Deep Groundwater, Glen Cove, Nassau County, NY; AECOM, October 2009) are summarized in, and serve as the basis for, this FS report. The locations of the monitoring wells and general Site features are presented on Figure 1-3.

This FS report addresses groundwater contamination and remediation issues for OU-2 at the Photocircuits and Pall Corporation Sites (including the August Thomsen property) and areas located near the Site (i.e., Sea Cliff Avenue, and the Glen Cove property north of the Pall Corporation Site) potentially impacted by site-related contamination.

This FS initially focused on the presumptive remedies identified by NYSDEC (2006). However, as discussed subsequently in this FS, not all the presumptive remedies were determined to be appropriate; additional technologies were reviewed and additional alternatives were developed.

For the purposes of this FS, remedial systems located on-site (Photocircuits and Pall Corporation/August Thomsen) are described and evaluated. Additional details regarding the criteria used during preliminary screening and the components of these remedial alternatives are presented in Section 6.0.

1.2 Purpose and Organization of Report

The purpose of the FS is to identify and evaluate technologies that are available to remediate the contaminated groundwater as identified in the RI. The technologies most appropriate for the Site conditions are then developed into Remedial Action Alternatives that are evaluated based on their environmental benefits and cost. The information presented in the FS will be used by NYSDEC to select remedial action(s). The remedial action(s) selected for the Site will be summarized by NYSDEC in a Proposed Remedial Action Plan (PRAP), which will be released for public comment. After receipt of public comments, NYSDEC will issue a Record of Decision (ROD).

The FS is organized in accordance with the outline provided in Section 4.3 of DER-10 (NYSDEC, 2002)[1]:

Executive Summary

1. Purpose (Other introductory material has been included in this section)
2. Site Description and History (includes summary of previous investigations)
3. Summary of Remedial Investigation and Qualitative Risk/Exposure Assessment (Implementation and Results)
4. Remedial Goals and Remedial Action Objectives
5. General Response Actions
6. Identification and Screening of Technologies
7. Development and Analysis of Alternatives (includes assembly of technologies into alternatives and evaluation against the seven FS criteria)
8. Recommended Remedy and Rationale for Selection

Additional supporting material is provided in the Appendices.

1.3 Scope of Work

AECOM completed the following scope of work for the FS, in accordance with DER-10 Guidance.

- Established the remedial goals. For the State Superfund program, the default goal is to restore the site to pre-release conditions, to the extent feasible and authorized by law. The remedy must mitigate or eliminate all significant threats to human health and the environment, and (to the extent feasible) remove identifiable sources of contamination at the site.
- Established Remedial Action Objectives (RAOs). This includes identifying Standards, Criteria and Guidelines (SCGs) that may apply to the specific conditions at the Site, including both current and, where applicable, future use. These generally include State requirements that are used as a basis for establishing cleanup goals for the Site and other regulatory requirements that may apply to proposed remedial actions. As part of this task, public health and environmental exposures, and any site-specific cleanup goals to eliminate ecological impacts are identified.

[1] During the preparation of this FS, NYSDEC issued a proposed revision of DER-10 (November 3, 2009) which was finalized in May 2010. This FS, which was already in preparation, follows the format of the 2002 version of DER-10.

- Identification of general response actions (e.g., treatment, containment, extraction, institutional controls). Preference is given to presumptive remedies. For this site, no action (groundwater monitoring); groundwater extraction and treatment; and *in situ* chemical oxidation (ISCO) via permanganate have been established presumptive remedies (NYSDEC, 2006). However, the existence of presumptive remedies does not preclude the evaluation of other technologies.
- Identification and screening of remedial technologies. In this step, general technology types such as chemical treatment and air stripping are identified and evaluated relative to site-specific conditions. Specific technology process options are also identified. The technologies and process options are screened to identify those that appear implementable and effective in meeting the RAOs. As specified in the scope of work, presumptive remedies evaluated included groundwater extraction and treatment, ISCO, and no further action and long-term monitoring.
- Assembled technologies into remedial alternatives. As required by NYSDEC (2002), remedial alternatives included a "no action" alternative, and an alternative which would restore the site to pre-disposal (pre-release) conditions. The presumptive remedies were assessed for compliance with this requirement. Development of other alternatives included consideration of current and reasonably anticipated future site use; removal of source areas; and containment of contamination. Each alternative was developed to a level of detail that allowed for detailed analysis. Alternatives were defined with respect to:
    1. Size and configuration of process options
    2. Time (expected duration) of remediation
    3. Area requirements
    4. Disposal options
    5. Significant technical permit requirements
    6. Limitations or other factors necessary for alternative evaluation; and
    7. Beneficial or adverse impacts on fish and wildlife resources.
- Each remedial alternative was subject to detailed evaluation on the basis of:
    1. Compliance with applicable or relevant and appropriate SCGs and remediation goals;
    2. Overall protection of human health and the environment;
    3. Short-term impacts and effectiveness;
    4. Long-term effectiveness and permanence;
    5. Reduction of toxicity, mobility and volume through treatment;
    6. Implementability;
    7. Cost effectiveness; and
    8. Land use.

  The detailed evaluation also included a comparative analysis of each alternative (relative to each other) based on the same eight criteria identified above.

  The final criterion for remedial selection is:

    9. Community Acceptance.

This FS study and report was completed in general accordance with:

- The scope of work described in the Work Assignment (State Superfund Contract Work Assignment, Remedial Investigation/Feasibility Study, Photocircuits Corporation Site No. 130009 Operable Unit 02, Pall Corporation, Site 130053B, Operable Unit 02 (Deep Groundwater], Nassau County, New York) (NYSDEC, 2006);
- Technical Guidance for Site Investigation and Remediation (Draft), NYSDEC DER-10, December 2002;
- USEPA Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA, EPA/540/G-89/004, October 1988.
- Additional guidance from the NYSDEC project team based on comments and meetings during the course of the FS.

The scope of work for the Photocircuits/Pall Corporation Site was prepared by Earth Tech (now AECOM) and submitted to NYSDEC for review and approval.

- Work Plan (Earth Tech 2006); submitted in November 2006 and approved in February 2007, which included the Field Activity Plan (Appendix A), Quality Assurance Project Plan (Appendix B), and Health and Safety Plan, submitted in December 2006 as Appendix C to the Work Plan.

2.0 SITE DESCRIPTION AND HISTORY

Site description and historical information developed from the RI (AECOM, 2009) is presented below.

2.1 Site Description

The study area for this Deep Groundwater RI/FS is focused primarily on two Sites, from south to north: Photocircuits Corporation (for the purpose of this FS, excluding the former Pass and Seymour site [1-30-053A] for which a separate ROD has been issued [NYSDEC, 2008b]) and Pall Corporation (which includes the August Thomsen property formerly owned by Pall Corporation) and property owned by the City of Glen Cove to the north, which includes the Well No. 21 and the Carney Street Wellfield, along with other structures and uses, including a day care center. The study also includes the part of Sea Cliff Avenue, located between the Photocircuits and Pall Corporation Sites.

Both of these sites (Photocircuits and Pall Corporation) are part of the "Sea Cliff Avenue Industrial Area," which also includes the former Pass and Seymour, the Carney Street Wellfield, and additional industries on Sea Cliff Avenue and other streets on the east side of the Glen Cove Arterial Highway.

Photocircuits

The Photocircuits facility occupies an irregularly-shaped parcel reportedly about 10 acres at 31 Sea Cliff Avenue. Photocircuits is on the south side of the street, directly across from the Pall Corporation Site; it is a documented source of chlorinated VOCs and is listed as a NYSDEC Class 2 site (1-30-009). The Photocircuits Site is listed in the NYSDEC Registry of Inactive Hazardous Waste Sites as having an area of 9.97 acres (NYSDEC, 2001). However, the actual size of the site is slightly larger (about 10.55 acres), as the registry listing apparently did not include the area of two of the lots which comprise the site (see Table 1-1 and Figure 1-2). At the time of the issuance of the work assignment (2006), Photocircuits also occupied the adjacent former Pass and Seymour site at 45 Sea Cliff Avenue. Manufacturing activities at the site ceased in 2007. Photocircuits is bounded to the east by the Glen Cove Arterial highway; to the south by the Glen Head Country Club; to the west by Pass and Seymour and Glen Cove Creek; and to the north by Sea Cliff Avenue and the Pall Corporation property.

There are four primary buildings on the Photocircuits site (see Figure 1-2). Fronting Sea Cliff Avenue is the main building. To the south of the main building, along the east side of the site, are two buildings identified as Butler No. 1 and Butler No. 2. On the western side of the site, the part of the site between Pass and Seymour and the Glen Head Country Club, is Butler No. 3.

Pall Corporation / August Thomsen

The Pall Corporation Site, located at 30 Sea Cliff Avenue, consists of approximately 5 acres of property. The Pall Corporation Site is listed in the NYSDEC Registry of Inactive Hazardous Waste Sites as having an area of 4.66 acres (NYSDEC, 2001). However, the actual size of the site is slightly larger (about 5.17 acres), as the registry listing apparently did not include the area of two of the lots in the southeast corner which comprise the site (see Table 1-1 and Figure 1-2). The Site is mostly covered with asphalt pavement except for small landscaped areas around the main Pall building and parking area. Grass and trees border Glen Cove Creek along its entire length where it is present on the west side of the Pall site. The Pall Corporation site topography is relatively flat with an estimated slope across the site of less than 3 percent. Locally, the Pall

Corporation site is situated in a low valley at an approximate elevation of 60 feet above mean sea level (amsl). East and west of the Site, the topography rises to elevations of 160 to 180 ft amsl.

The Pall Corporation Site includes another industrial facility, August Thomsen, located on the northwest part of the site. The August Thomsen property (36 Sea Cliff Avenue) was once owned by the Pall Corporation (operating as Glen Components). The Pall Corporation facility is currently (as of 2009) inactive, although August Thomsen is an active company. The Pall Corporation site is bordered to the east by the Glen Cove Arterial Highway, with residences and commercial areas situated further to the east. The site is bordered to the south by Sea Cliff Avenue. Industrial property, the Photocircuits Corporation site and the Pass and Seymour site, are south of Sea Cliff Avenue. The west side of the site borders on Glen Cove Creek. An industrial facility, Associated Drapery and Equipment Company, is situated west of the Creek at 40 Sea Cliff Avenue.

Surrounding Area/Other Sites

The immediate surrounding area is generally industrial/commercial. The Glen Cove Arterial highway (Route 107) defines the eastern edge of the study area, and Glen Cove Creek (a slow-moving Class C surface water body) forms the western edge of the study area north of Sea Cliff Avenue. To the east of the arterial are both residential and commercial properties (car dealer, bowling alley, warehouse/office facilities, and single family homes). To the west along Sea Cliff Avenue are additional commercial properties, with Long Island Railroad (LIRR) tracks and Sea Cliff LIRR station about 800 ft to the west of Glen Cove Creek.

The surrounding area includes property owned by the City of Glen Cove to the north, which includes the Well No. 21 and the Carney Street Wellfield, along with other structures and uses, including a day care center. The study also includes the part of Sea Cliff Avenue, located between the Photocircuits and Pall Corporation Sites.

Pass and Seymour/Slater Electric

The former Pass and Seymour site, on the west side of Glen Cove Creek at 45 Sea Cliff Avenue, occupies about 7.5 acres (MKA, 1996) and is also a NYSDEC Class 2 site (130053A). The Pass and Seymour site was formerly Slater Electric; and many of the historic and previous documents refer to it as Slater Electric. Slater Electric was purchased by Pass and Seymour in 1988. The site is primarily flat with no slopes, depressions or rolling hills. The site has been graded for industrial use with slopes ranging from 0 to 3 percent (MKA, 1996). The site is bounded on the south by a Photocircuits building and the Glen Cove Country club; to the east by Glen Cove Creek and Photocircuits; to the north by Sea Cliff Avenue (with the former Associated Draperies and August Thomsen buildings across the street), and to the west by the former Tweezerman site building.

The Phase I ESA for Pass and Seymour (MKA, 1996) states that the site is occupied by eight buildings. However, seven of these buildings are contiguous (Buildings 1-6 and 8) and comprise the main site building. One additional structure (Building 7 as identified in the ESA) is located to the southwest of the main building.

City of Glen Cove / Carney Street Wellfield

The property north of the Pall site is occupied by the City of Glen Cove and includes the Carney Well Field, a childcare (day care) facility, and garage, maintenance, and equipment storage facilities used by Glen Cove DPW, among others. Vehicular access to this area is only from the southbound shoulder of the Glen Cove Arterial Highway (Route 107), located to the east of the property. Glen Cove Creek is to the west, with the Pall/August Thomsen property to the south. In addition to the Carney Street Well No. 21 (N8326), there are two permanently abandoned public supply wells on this property (N3466 and N8327). Several monitoring wells (used in this RI/FS) are also located on this property (in addition to the new wells installed for this RI/FS). NYSDOH collected indoor air samples at the Glen Cove Child Day Care Facility on February 12, 2004; the samples were analyzed by (NYSDOH) Wadsworth Center for Laboratories and Research in Albany, New York. NYSDOH reported "[t]he results indicate that the groundwater contamination beneath the building is not affecting indoor air quality in the building" (NYSDOH, 2004).

2.2 Site and Vicinity History

The Photocircuits and Pall Corporation Sites are located in the Sea Cliff Avenue Industrial Area, which has been documented as an area of variable industrial use from the 1940s to the present. Historic Sanborn maps show that the only facility in this area as of 1931 was the Knickerbocker Ice Company, and a similar level of development shown on the 1947 Sanborn map (TAMS/GZA, 1999); NYSDEC reports the ice house as having been constructed in 1918 (NYSDEC, 2004). Industrial activities have occurred in the past and are currently occurring on neighboring properties which include Photocircuits Corporation, Pass and Seymour (Slater Electric; currently occupied by Photocircuits), and Associated Draperies. These industrial properties are subject to NYSDEC regulatory enforcement action. The Pall Corporation, Photocircuits Corporation, and the former Pass and Seymour properties are listed as Class 2 Inactive Hazardous Waste Disposal Sites (IHWDS) by the NYSDEC.

Photocircuits Corporation Site

Based on the limited available Sanborn maps, the Photocircuits site was undeveloped as of 1947. Industrial activity began in 1954, when the site was owned by Powers Chemco (previously known as Powers Photoengraving [Glen Cove Record-Pilot, 2005]). Powers Chemco apparently still exists as corporation, and is a supplier of graphic design equipment to printers and newspapers (NY Daily News, 2008); however, the specific activities of Powers Chemco and/or Powers Photoengraving at 31 Sea Cliff Avenue are not known. Kollmorgen Corporation purchased the site in 1971 and used the site to produce printed circuit boards. Photocircuits purchased the site in 1986, and continued to use the site for printed circuit board manufacture. Photocircuits filed for Chapter 11 bankruptcy in 2005. American Pacific Financial Corp. purchased the company in 2006. Manufacturing activities ceased at the site in 2008. The Photocircuits site (along with the Pass and Seymour site) also has documented histories of chlorinated solvent use and discharges to the environment.

Pall Corporation Site

The first structure on the Pall Corporation site was the Knickerbocker Ice company, whose occupancy pre-dated 1931 (possibly 1918; NYSDEC, 2004). Based on the footprint of the building, it appears that the original (pre-1931) structure is still extant. The same structure is the only building in the area as of 1941, although it is now identified as F.R. Hormann, manufacturer of metal tanks. The Pall Corporation has operated the facility at Sea Cliff Avenue since the early 1950s. (However, the 1990 NCDPW investigation states that Photocircuits had been at the 30 Sea Cliff Avenue location since 1946 [NCDPW, 1990 - Appendix A, Table 2].) The Pall Corporation facility was previously used as a research and development facility for the manufacture of filtration products, but is currently (2008) inactive and unoccupied. The August

Thomsen property was owned by the Pall Corporation until 1971, when August Thomsen bought the property; the August Thomsen property is part of the Pall Corporation Site. During the period that the Pall Corporation owned the August Thomsen property, it was used by its subsidiary, Glen Components, Inc., as a precision machine shop providing parts to Pall's other divisions. Based on a Pall Corporation report, chlorinated solvents were used at the Site until approximately 1971. The operations of Glen Components reportedly were transferred to Florida in 1971 (NCDPW, 1990 [Appendix A, Table 3]).

Surrounding Area/Other Sites

The Pass and Seymour/Slater Electric site, a NYSDEC Registry-listed site (130053A), is adjacent to the Photocircuits Corporation site. Property owned by the city of Glen Cove, which includes the Carney Street Wellfield, is located to the north of the Pall Corporation site. These and other properties in the area are within the Sea Cliff Industrial Area, and their history is summarized below.

Pass and Seymour/Slater Electric

Based on the limited available Sanborn maps, the Pass and Seymour site was undeveloped as of 1947. The 1972 Sanborn map shows the facility as "Slater Electric." The main building at 45 Sea Cliff Avenue was constructed in 1959, with additions in 1981 (Enviro-Science, 2001a). MKA (1996) notes the existence of eight buildings, with four buildings constructed between 1970 and 1981; MKA also cites 1963 (not 1959) as the date of the original construction. However, the number of buildings includes the main building which is divided into four buildings and three other contiguous structures (see Section 2.1.2, above). Slater Electric was purchased by Pass and Seymour in 1988. Pass and Seymour produced plastic electric parts by injection molding; it is reported that the same products were produced for over 20 years by the former owner/occupant, Slater Electric (NCDPW, 1994). The site buildings were reportedly vacant in 1996 (MKA, 1996). In the 2000s, Photocircuits occupied some of the former Pass and Seymour. Currently available information indicates that the site is owned by Alpha Forty Five LLC. A record of decision (ROD) was issued for the Pass and Seymour Site in 2008 (NYSDEC, 2008b).

Glen Cove / Carney Street Wellfield

The three wells at the Carney Street Wellfield were constructed in 1950 or 1951; one structure for the Water Department was also built in 1951. It appears that the wellfield was at the foot (end) of Carney Street when initially built. However, the construction of the Glen Cove Arterial in the mid-1960s isolated the Carney Street Wellfield from Carney Street.

In addition to the Carney Street Wells, this area is also occupied a day care center and two municipal facilities. The former water department building was apparently constructed around the same time as the wells (early 1950s), and the EMS garage constructed in the 1970s (NCDPW, 1994). The Day Care Center was initially constructed in 1989, with an addition constructed in 1992. One of the municipal structures re-opened in October 2008 as the home of the Glen Cove Boxing Club (Record-Pilot, 2008). The day care center and boxing club are currently in use (as of April 2010).

Other Sites in Sea Cliff Industrial Area

With the exception of the predecessors of Pall Corporation, the Sea Cliff Avenue Industrial Area (the portion located west of the Glen Cove Arterial Highway, which was constructed sometime in the mid-1960s [www.nycroads.com, 2009]) was undeveloped through at least 1947.

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3.0 REMEDIAL INVESTIGATION – IMPLEMENTATION AND RESULTS

This Section summarizes the findings of the RI conducted between 2007 and 2008 at the Site. Where applicable and relevant, additional information acquired since the completion of the RI (AECOM, October 2009) is also provided.

Site activities conducted during the RI study were done in several phases. The first phase of the work conducted in July 2007 consisted of surveying and mapping of the existing features (including wells), along with a concurrent existing well condition survey. The next phase of work (conducted In November 2007) consisted of the advancement of three Hydropunch borings and groundwater sampling in the general vicinity of a suspect source area (near MW-13) on the east side of the Photocircuits site. After the Hydropunch data were reviewed, the monitoring well installation program was conducted in December 2007 and completed in January 2008. Finally, two rounds of groundwater sampling were conducted – Round 1 in April 2008, and Round 2 in October 2008.

3.1 Subsurface Conditions (Geology and Hydrogeology)

The site is underlain by the following sequences, in descending order: the Upper Glacial Aquifer; the Port Washington confining unit; the Port Washington aquifer; the Lloyd Aquifer; and bedrock. Depth to groundwater varies between 4 and 10 ft below ground surface (ft bgs) at the site. Monitoring wells in the area, as well as the Carney Street Well No. 21, are screened in the Upper Glacial Aquifer. Hydraulic conductivity is reported to generally vary between 10 and 300 ft/day (NYSDEC, 2006). Measurements from deep wells indicate that groundwater flow is to the northwest. Shallow groundwater also flows predominantly toward the northwest. Therefore, the Photocircuits site is hydraulically upgradient of the Pall site; both sites are upgradient of the former Carney Street Wellfield. Contamination, including PCE, TCE, and their degradation products (e.g., 1,2-DCE and vinyl chloride), along with 1,1,1-TCA and its degradation products (1,1-DCA and chloroethane) and 1,1,2-trichlorotrifluoroethane (Freon-113), have been identified in the saturated soils and groundwater at the site. Previous groundwater investigations have reported groundwater contamination at both Pall and Photocircuits sites, as well as in samples from the Well No. 21 at the Carney Street Wellfield.

Historical reports indicate that several withdrawal and reinjection wells were present and used during the industrial operations of both Photocircuits and Pall Corporation.

3.2 Nature and Extent of Contamination

The nature of the contamination (i.e., the types of contaminants detected) and its areal and vertical extent are summarized below.

3.2.1 Nature of Contamination

Historical data collected at various times for more than thirty years have identified volatile organic compounds (VOCs) as the principle contaminants in groundwater at the Photocircuits/ Pall Corporation site, as well as in groundwater downgradient of the site (e.g., the Carney Street Wellfield). Data collected during the RI is consistent with previous data with regard to the nature of contamination found. (A limited amount of data generated on the Photocircuits site from sampling conducted in June 2008 [AAL, 2008] is also included in the discussion below.) As shown on RI Tables 4-1 through 4-3, the VOCs detected fall into several categories.

- Chlorinated aliphatics

- Chlorinated aromatics
- Chlorofluorocarbons (Freons)
- Non-halogenated aromatics
- Ketones
- Other/Miscellaneous

A summary of the VOCs detected in each of the two sampling rounds is provided on **Tables 3-1 (Round 1 data)** and **3-2 (Round 2 data)**, along with the applicable NY groundwater quality criterion and the monitoring well at which the highest concentration was detected. As discussed in greater detail in the RI report (section 5.3.1), a limited amount of data generated by the Photocircuits PRP's laboratory (AAL, 2008) on samples collected in June 2008 was utilized for contaminant isopleths mapping in the shallow zone to fill data gaps in that area.

Chlorinated Aliphatics

Chlorinated aliphatics are compounds consisting of carbon and hydrogen, with at least chlorine atom substituted for a hydrogen atom. Although there are a number of different types of chlorinated aliphatics, for this RI/FS the two types detected are alkanes (straight chain hydrocarbons with only single carbon-carbon bonds; e.g., 1,1,1-TCA) and alkenes (straight chain hydrocarbons with at least one double carbon-carbon bond; e.g., PCE). About 14 different chlorinated aliphatic VOCs (CVOCs) have been detected in RI groundwater samples. This contaminant class is the most frequently detected group and has been detected at the highest concentrations. Individual CVOC concentrations as high as 10,000 µg/L have been detected in monitoring well samples (TCE in MW-13 during Round 1), and total CVOC concentrations have exceeded 14,000 µg/L (MW-13 during Round 2).

CVOCs detected frequently or at high concentrations include source contaminants (PCE, 1,1,1-TCA), degradation byproducts (cis- and trans-1,2-DCE; vinyl chloride), and other CVOCs which may be source materials or degradation byproducts (TCE, methylene chloride). The same suite of CVOCs was detected in each round of sampling. As noted in the RI, TCE may be a source material; and it may also be a degradation product of PCE.

Chlorinated Aromatics

Five different chlorinated aromatics have been detected in groundwater samples collected during the RI. Three of these compounds (chlorobenzene, dichlorobenzenes, and 1,2,3-trichlorobenzene) were detected rarely (no more than two samples in any event [including the Hydropunch sampling]) and did not exceed the applicable SCG in any sample. The principle chlorinated aromatic detected is 2-chlorotoluene, detected in 10 to 15 samples in each round (25 of 31 samples in the source area Hydropunch sampling) at a maximum concentration of 2,100 µg/L (MW-12 in Round 2).

Freons (Chlorofluorocarbons)

Freon is a DuPont trademark, but commonly used generically for a variety of chlorofluorocarbons (CFCs), a class of chemicals that contain only atoms of carbon, chlorine, and fluorine. As a group, they are nonflammable, unreactive, stable, and relatively insoluble in water. Commercially, the most important CFCs were derivatives of methane and ethane. These include three CFCs which are typically included in target VOC analyses: trichlorofluoromethane (CCl_3F; also known as CFC-11), dichlorodifluoromethane (CF_2Cl_2, also known as CFC-12), and 1,1,2-trichlorotrifluoroethane ($C_2Cl_3F_3$; also known as CFC-113).

Freons detected during the RI in groundwater were dichlorodifluoromethane (CFC-12), detected at a maximum concentration of 160 µg/L (MW-2GS in Round 1) and 1,1,2-trichlorotrifluoroethane (CFC-113), detected at a maximum concentration of 240 µg/L (MW-12PS in Round 2).

Non-Halogenated Aromatics

The principle non-halogenated aromatic detected in groundwater samples collected during the RI is benzene, which was detected in 10 samples during Round 1 and in 13 samples during Round 2. Although the concentrations detected were relatively low (the highest concentration was 15 µg/L in MW-13 in Round 1), most of the detected concentrations exceed the SCG (1 µg/L). Other non-halogenated aromatics detected were detected very infrequently and include toluene (detected in three samples during each round at a maximum concentration of 99 µg/L in MW-14) and xylenes.

Ketones

Ketones detected in RI groundwater samples are acetone, 2-butanone (methyl ethyl ketone), and 2-hexanone. Most of the acetone and 2-butanone data were rejected (found to be unusable) during data validation (see RI section 8). The only valid detection of 2-butanone in each round was at MW-14 (99 µg/L in Round 1, and 100 µg/L in Round 2; in each case exceeding the SCG of 50 µg/L).

Other / Miscellaneous VOCs

Four other VOCs, which do not fit into any of the categories discussed above, were also detected. Two of these compounds – carbon disulfide and naphthalene – were detected only once in groundwater samples (slightly more frequently in the Hydropunch samples) and at concentrations below the applicable SCG (in both monitoring well and Hydropunch samples). Iodomethane was detected in two Hydropunch samples at a maximum concentration of 0.26 µg/L (NYSDEC has not established a SCG for iodomethane), and vinyl acetate was detected once (at 0.22 µg/L). Neither of these two compounds was detected in the Round 1 or Round 2 groundwater samples.

Methyl tert-butyl ether (MTBE), a gasoline additive, was detected in 25 or 26 samples in each round, and in each round the MTBE concentration in six samples exceeded the SCG (10 µg/L). As noted in the RI (AECOM, 2009), MTBE is not considered a site-related contaminant.

3.2.2 Extent of Contamination

This section discusses the distribution of groundwater contamination on all properties from which samples were collected and data are available. The extent of contamination was presented in depth in the draft RI report (AECOM, October 2009). Further review of the figures used to present the extent of contamination by depth in that report suggested that the software used to generate the contours in the submitted document do not adequately represent the areal extent of contamination, and AECOM provided revised figures to NYSDEC in January, 2010. The extent of contamination used in this FS is based on these revised figures.

Inspection of the data and associated figures shows that the distribution is affected by three factors:

- Contaminant class, and in some cases a specific contaminant within a class; e.g., the distribution of cis-1,2-DCE does not necessarily mirror the distributions of total CVOCs;

- Location (areal) – Certain contaminant types (or specific compounds) are limited, or largely so, to specific areas within the overall study area; and
- Depth – At any specific location (well cluster), the contamination varies with depth; however, the concentrations do not show a simple decrease with depth (i.e., it is not generally the case that the shallowest well is the most contaminated, with gradually decreasing concentrations with greater depth).

For this RI/FS, the wells (and groundwater data) have been assigned to one of four depth intervals. It should be noted that the well depth suffix (S, I, D) reflects a relative depth of a well within a cluster, but not necessarily the interval assigned for this RI/FS. In some cases, there may be no well within a specific interval in a given well cluster, but two wells classified in another interval.

Each of the two Photocircuits background wells (01-MW-101S and 01-MW-101D) has been assigned to two intervals (01-MW-101S to both shallow and intermediate; 01-MW-101D as deep and very deep) so that there is a background (zero concentration point) for plotting the contaminant plumes.

- Shallow. This zone is defined as wells with a top of screen elevation of about 55 ft to 35 ft NGVD (typically 3 to 15 ft bgs for wells on the Pall Corporation Site [including August Thomsen] and Photocircuits sites). The reader is reminded that a number of wells with "S" as part of the well ID are screened at greater depths (e.g., 04MW-102S) and are not assigned to the shallow zone. (Wells with an "S" suffix are the shallowest well in a cluster, but not necessarily within the shallow zone as used in this report.)
- Intermediate. This zone is defined as wells with a top of screen elevation of between about 25 ft to about 5 ft NGVD (about 45 to 60 ft bgs). One modification was made to this range for off-site well 06MW-103S; by strict application of the criteria, this well would marginally have been classified as a deep well (along with 06MW-103I). However, based on the analytical data and the fact that this is the shallowest well in the 06MW-103 cluster, this well is more appropriately included with the intermediate zone wells.
- Deep. The deep zone is defined as wells with a top of screen interval ranging from about –10 ft to about –60 ft NGVD (about 80 to 130 ft bgs), with the exception of 06MW-103S, as discussed above. For the purpose of generating contaminant distribution plots, a few wells which were transitional (both in terms of depth interval and contaminant concentrations) between the deep and very deep (D2) zones were not included in either zone in the plots.
- Very deep (referred to as D2). These are wells with a top of screen depth of about –75 ft to about –155 ft NGVD).

The depth interval assignments and well construction data for the monitoring wells used in this RI/FS, and the groundwater elevation data for developing groundwater contours, are shown on Table 3-3.

While the major discussion of contaminant migration (transport) is in the following sections of this report, the discussion of contaminant distribution in this chapter does assume that (a) groundwater flow is generally to the north or northwest; and (b) the new monitoring well cluster installed at Photocircuits (01MW-101S and 101D) and existing well pair MW-GC-2S and MW-GC-2D are "background" wells relative to the Pall/Photocircuits site.

Contaminant distribution maps (by contaminant type and by depth interval) presented in the RI were developed as an aid in interpreting the data. These maps were developed using Surfer™ and are presented essentially as the output from the program. The only manual changes made to the Surfer output were to eliminate contours to areas in which there were few or no wells (data points), such as to the east of the Photocircuits and Pall Corporation site property lines, and to the west of Glen Cove Creek. For the FS, the contaminant distribution maps were revised manually to eliminate some of the apparent anomalous contour lines generated by the computer algorithm. The revised figures are included as Figures 3-1 through 3-4 in this report.

The distribution of the principle contaminant types detected within the study area is discussed below.

3.2.2.1 Distribution of CVOCs by Location

An overview of the distribution of contamination by contaminant type, and in some cases specific individual chemical, is presented below, relative to the site (e.g., Pall Corporation, Photocircuits) and individual locations where particularly high concentrations were observed.

CVOCs were not detected in background wells, suggesting that these compounds are not migrating into the study area from an upgradient source (to the south or southwest). Very high total CVOC concentrations (10,000 µg/L or greater) have been detected in monitoring wells on Photocircuits (MW-13 and MW-14; with even higher concentrations in the Hydropunch borings near these two wells) and on the Pall Corporation Site (MW-11PD, MW-13PD), but high concentrations (greater than 1,000 µg/L) are pervasive on both sites, and also in wells within Sea Cliff Avenue (MW-14PC series). CVOCs were detected, although at much lower concentrations (less than 100 µg/L), in the Sea Cliff Avenue wells located farther to the west (west of Glen Cove Creek, and north of the former Pass and Seymour/Slater Electric Site).

As discussed in greater detail in the RI, non-halogenated contaminants (including ketones, BTEX compounds, and MTBE) are not significant at the site and the discussion of those compounds is not included in the FS.

Tetrachloroethene (PCE)

Tetrachloroethene, a source contaminant (i.e., not a degradation or ‘daughter’ contaminant), in general, is a relatively small component of the overall CVOC concentration. In Round 1, PCE was detected at or above 1,000 µg/L in only two samples (1,500 µg/L in MW-13 [Photocircuits] and 1,000 µg/L in MW-12PI [Pall Corporation]); results were similar in Round 2. The highest concentration detected in the RI sampling was 2,900 µg/L in Hydropunch sample 01-HP2-50.

1,1,1-Trichloroethane

1,1,1-Trichloroethane (1,1,1-TCA), another source contaminant was detected at or above 1,000 µg/L in only two Round 2 samples on the Photocircuits site (2,000 µg/L in MW-14 and 1,000 µg/L in 01MW-104S); concentrations in both wells were much lower in Round 1 (430 µg/L and 79 µg/L, respectively). The highest concentration detected in the RI sampling was 13,000 µg/L in Hydropunch sample 01-HP3-69.

Trichloroethene

Trichloroethene (TCE) may have been a source contaminant, but is also a degradation (daughter) product of PCE. In both rounds of sampling, the highest concentrations of TCE were detected in MW-13 (9,300 and 10,000 µg/L) on the Photocircuits site. The highest TCE concentration detected in the RI sampling was 59,000 µg/L in Hydropunch sample 01-HP3-69. High concentrations, between 2,100 and 6,100 µg/L, were detected in both rounds of sampling in Pall wells MW-11PD; MW-13PD; and MW-4PD. TCE was also detected at 2,900 µg/L in off-site well MW-2GI (on Glen Cove property, north of August Thomsen) in Round 1. (Due to grading activities being conducted by the Glen Cove DPW, MW-2GI was not sampled during Round 2.)

Dichloroethenes (cis- and trans-1,2-Dichloroethene and 1,1-Dichloroethene)

Cis-1,2-Dichloroethene (cis-1,2-DCE), whose presence is likely only due to degradation of TCE and/or PCE, is the CVOC most frequently detected over the two sampling rounds, and most frequently at high concentrations (over 1,000 µg/L). Cis-1,2-DCE was detected at high concentrations in both rounds of sampling in Pall wells 04MW-102S (5,500 and 4,600 µg/L), 04MW-102I (1,900 and 1,500 µg/L), MW-4PD (3,000 and 2,400 µg/L), MW-6P (1,400 µg/L in both rounds), MW-11PD (4,400 and 4,200 µg/L), and MW-13PD (5,600 and 5,900 µg/L).

At Photocircuits, cis-1,2-DCE was detected in at high concentrations only in MW-13 (1,500 and 2,400 µg/L in Round 1 and Round 2, respectively). However, a much higher concentration was detected in the source area Hydropunch borings (maximum 19,000 µg/L cis-1,2-DCE in 01-HP3-69).

Sea Cliff Avenue wells were sampled only during Round 2; cis-1,2-DCE was detected at high concentrations in MW-14PCI (1,200 µg/L) and MW-14PCD (1,800 µg/L).

Cis-1,2-DCE was also detected in off-site monitoring well MW-2GI (1,600 µg/L) during Round 2 (this well was not sampled during Round 1).

Vinyl Chloride

Vinyl chloride is a bulk chemical commonly used in industry; however, it is not a chemical suspected of having been used as a raw material at Photocircuits or Pall Corporation. Rather, its presence is most likely due to the degradation of source materials (PCE to TCE to cis-1,2-DCE to vinyl chloride). The only sample in which a high concentration of vinyl chloride was detected was in Sea Cliff Avenue well MW-14PCI (1,200 µg/L), which was only sampled during Round 2. The highest concentration of vinyl chloride detected during Round 1 monitoring well sampling was 360 µg/L in Pall well MW-11PD. Vinyl chloride was detected at a maximum concentration of 610 µg/L in Hydropunch sample 01-HP3-69, the same sample in which the maximum concentrations of TCE and cis-1,2-DCE were also detected.

Chloroethane and Dichloroethanes

The presence of chloroethane and dichloroethanes (primarily 1,1-dichloroethane [1,1-DCA]) is most likely due to degradation of 1,1,1-TCA. The highest detected concentrations of these compounds were in Photocircuits wells MW-14 (3,200 µg/L chloroethane and 3,200 µg/L 1,1-DCA in Round 2) and 01MW-104S (1,800 µg/L 1,1-DCA in Round 2); these were also the two wells with the highest concentrations of 1,1,1-TCA. Although the 1,1,1-TCA concentration was lower in MW-14 in Round 1 (430 µg/L), the concentrations of chloroethane (6,700 µg/L) and 1,1-DCA (5,700 µg/L) were higher than in Round 2. However, MW-14 is the only monitoring sampled in either round in which the chloroethane concentrations were significant (i.e., were high relative to the 1,1-DCA concentration).

Higher 1,1-DCA concentrations were detected in Hydropunch samples (maximum concentration of 12,000 µg/L in 01-HP046), although the highest concentration of chloroethane (600 µg/L) in Hydropunch samples was lower than concentrations detected in monitoring well samples.

Chloroethane concentrations in the Hydropunch samples were consistently much lower (typically by a factor of 20) than the corresponding 1,2-DCA concentration.

Halogenated Aromatics (2-Chlorotoluene)

The only halogenated aromatic of significance at the Photocircuits/Pall Corporation site is 2-chorotoluene (although concentrations of 4-chlorotoluene exceeded SCGs in a few samples, it is always detected in conjunction with, and at lower concentrations than, 2-chlorotoluene). High concentrations of 2-chlorotoluene were detected in Photocircuits well MW-12 in Round 1 and in Round 2 (2,000 and 2,100 µg/L, respectively). Analytical data provided by Photocircuits' consultant confirmed the presence of 2-chorotoluene in MW-12 (at 2,100 µg/L) in a sample collected in June 2008 (AAL, 2008).

During Round 2, 2-chlorotoluene was detected at 1,400 µg/L in Sea Cliff Avenue well MW-14PCI, located about 50 ft north of MW-12. Detections in other wells were fairly infrequent and at much lower concentration in other wells (at a maximum concentration of 38 µg/L and 32 µg/L in Rounds 1 and 2, respectively, at MW-13, and 15 µg/L in MW-14); these data match very well with June 2008 data provided by Photocircuits' consultant (AAL, 2008).

Chlorotoluenes were detected, but at relatively low concentrations (maximum 58 µg/L at 01-HP3-69), in Hydropunch samples collected near the former tank farm (east side of the site) on the Photocircuits property.

The June 2008 Photocircuits sampling conducted by Photocirucuits' consultant also included three recovery wells at the northern edge of the east side plant, along Sea Cliff Avenue. 2-Chlorotoluene was detected in RW-2 (480 µg/L) and at a very low concentration (1.3 µg/L) in RW-3, and not detected in RW-1 (AAL, 2008).

Chlorofluorocarbons

Detections of CFCs were, for the most part, limited to the Pall Corporation site. CFCs were detected in MW-10PS (CFC 11 at 81 µg/L and CFC TICs 60 µg/L in Round 1; CFC-11 at 9.7 µg/L and CFC-113 at 11 µg/L in Round 2); MW-12PI (CFC-113 at 230 µg/L in Round 2 only); MW-12PS (CFC-11 at 7.8 µg/L in Round 1 and CFC 113 at 240 µg/L in Round 2; an additional CFC TIC was also reported in Round 2); MW-4PS (CFC-113 at 160 µg/L in Round 2); MW-4PI (estimated CFC-113 [as a TIC] at 47 µg/L in Round 1; CFC-113 at 130 µg/L); and MW-2A (CFC-113 at 81 µg/L - Round 2 only). The MW-2G cluster, on Glen Clove property just north of August Thomsen, was only sampled during Round 1; CFC-11 was detected at 160 µg/L in MW-2GI.

Low concentrations of CFC-12 were detected in seven of the samples from Hydropunch boring HP-1 (but not in HP-2 or HP-3) at very low concentrations (all detections less than 1 µg/L).

3.2.2.2 Contaminant Distribution by Depth

Contaminant isopleths have been developed for total CVOCs for each of the four depth intervals discussed above, and for each groundwater sampling event (Round 1 and Round 2). The assignment of samples to specific depth intervals is, to an extent, arbitrary; in that there are not four distinct geologic strata. Rather, the assignment is based on review of the data and cross sections, and assigning samples to intervals that appear reasonable, based on inspection of the field and laboratory data. Therefore, in a few cases samples that are near the boundary between two intervals may have been assigned (for the purpose of developing the isopleths) to the interval adjacent to the one to which they would have otherwise been assigned based on a strict application of the depth criteria. These exceptions are addressed in the discussion below**.**

In addition to developing isopleths for total CVOCs, isopleths were also developed for several subsets of CVOCs in the RI. Due to the large number of figures, these additional figures are not included in the FS.

Contaminant Distribution in the Shallow Interval

The Shallow interval is defined as samples collected from top of screen interval depths from about 55 to 35 ft NGVD (roughly 3 to 19 ft bgs). The shallow interval was not explicitly included in the scope of this RI/FS for OU2 (which is defined as groundwater at depths greater than 60 ft bgs). However, as there is not a discreet “shallow” aquifer, it is not possible to address deeper contamination without some understanding of the shallow zone. Therefore, shallow wells were sampled and the data plotted, although not to the same degree that wells from the deeper intervals were sampled. Additional data were obtained from the Hydropunch data collected in Phase I, with data collected at discrete 5-ft intervals from Photocircuits source area one boring (HP-1) from 6 ft bgs down to 106 ft bgs.

Review of the Round 1 data showed that there was a paucity of data points in the shallow interval on the Photocircuits property (i.e., south of Sea Cliff Avenue). Therefore, AECOM decided to include on the Round 2 isopleths data for two shallow monitoring wells (MW-3S and MW-4S) which Photocircuits’ consultant sampled in June 2008 (AAL, 2008). This decision was made after qualitative comparison of the Photocircuits data for other wells that were sampled in common and a determination that the Photocircuits data were comparable to the data generated for this RI. Use of these data enables better definition of the contaminant distribution on the west side of Photocircuits and also provides better definition in the area of Sea Cliff Avenue west of Glen Cove Creek, near Sea Cliff Avenue wells MW-16PCI. The Hydropunch data are also incorporated into the discussion below, although the Hydropunch data are not plotted on the figures.

Total Chlorinated Aliphatics

Figures 3-1.1 and 3-1.2 show the distribution of total chlorinated aliphatics in the shallow zone wells. High concentrations (from about 100 to 800 µg/L) were observed in the wells on the Photocircuits Site (MW-3S, MW-9) and in Sea Cliff Avenue (MW-14PCS); concentrations were lower in the well on the Pall Corporation site just north of Sea Cliff Avenue (MW-19PS, MW-8PS, MW-17PS, and MW7P) although concentrations were somewhat higher in the October (Round 2) event in these Pall Corporation wells. Shallow zone concentrations are relatively low (not detected to less than 100 µg/L) in the monitoring wells on the east side of Pall Corporation Site and the Glen Cove property (i.e., wells near the Glen Cove Arterial Highway); total chlorinated aliphatics increase toward the center of the Pall Corporation site (e.g., MW-4PS) and the northwest corner of August Thomsen and the western edge of the Glen Cove property (MW-2A, MW2GS).

1,1,1-Trichlorethane and TCA Daughter Products

Concentrations of 1,1,1-TCA (RI Figure 16) were low in the shallow zone, with the highest concentration (29 µg/L) detected in the northernmost well on the Glen Cove property (MW-GC3S). TCA daughter products (chloroethane and dichloroethanes) were somewhat more wide-spread, (Figure 19) but still relatively low; the highest concentration was 90 µg/L at MW-14PCS.

Chloroethene Parent and Daughter Products

The shallow zone distribution of chloroethene parents (TCE and PCE; RI Figure 22) is similar to that observed for TCA and its daughter products. TCE concentrations are somewhat higher (between about 100 and 150 µg/L in MW-14PCS, MW-4PS, MW-3S, and MW-GC3S), and higher concentrations (about 600 µg/L) of daughter products in two wells (MW-14PCS and MW-2GS) (Figure 25). The most significant difference is a parent product hot spot (mostly PCE) at MW-2A at the northwest corner of August Thomsen; and chloroethene daughter product hot spot (over 600 µg/L) in the probable downgradient (relative to MW-2A) well MW-2GS on the Glen Cove property.

Contaminant Distribution in the Intermediate Interval

The Intermediate interval is defined as samples from wells with the top of screen elevations ranging from about +25 to +5 ft NGVD (about 35 to 50 ft bgs). In addition, data from the upgradient well 01-MW-101S was assigned to the both the shallow interval and intermediate interval for plotting purposes.

Total Chlorinated Aliphatics in the Intermediate Zone

Figures 3-2.1 and 3-2.2 show the distribution of total chlorinated aliphatics in the intermediate zone wells. High concentrations (greater than 100 µg/L) were observed in almost every intermediate zone well; with concentrations over 10,000 µg/L in the wells near a suspected source area on the Photocircuits Site (MW-13, MW-14). High concentrations (over 5,000 µg/L) were detected in 04-MW102S in the southeast corner of the Pall Corporation Site in both rounds of sampling; with another hot spot (5462 µg/L) at MW-2GI on the Glen Cove property. (As discussed previously, this well was only sampled during Round 1.) Concentrations greater than 1,000 µg/L were also detected in intermediate zone wells in the center of the Pall Corporation Site (MW-4PI and MW-12PI) and Pall Corporation wells near the southeast part of the Pall Site (MW-18PI, MW6P, and MW-17PI) as well as in MW-14PCI in Sea Cliff Avenue.

1,1,1-Trichlorethane and TCA Daughter Products in the Intermediate Zone

Intermediate zone concentrations of 1,1,1-TCA (RI Figure 17) were low (less than 5 µg/L) in almost all the monitoring wells sampled. There is a distinct "hot spot" in the Photocircuits source area (concentrations between 250 and 2,000 µg/L in MW-13, MW-14, and MW-104S; with another isolated high concentration (170 µg/L) detected in the Round 1 sample from MW-2GI on the Glen Cove property.

Concentrations of TCA daughter products were higher than TCA concentrations throughout the study area (RI Figure 20), with the highest concentrations (up to 6,500 µg/L) in the three Photocircuits source area wells, with concentrations gradually decreasing downgradient (i.e., toward the northwest) in the wells in Sea Cliff Avenue and on the Pall Corporation Site. Another minor TCA hot spot (about 300 µg/L) was detected in the sample from MW-2GI.

Chloroethene Parent and Daughter Products in the Intermediate Zone

The intermediate zone distribution of chloroethene parents (TCE and PCE) is shown on RI Figure 23 (not reproduced in this FS report). The highest parent product concentrations (greater than 10,000 µg/L in both Round 1 and Round 2) are in Photocircuits Site source area well MW-13; however, concentrations are much lower (21 to 290 µg/L) in the two other source area wells (01-MW104S and MW-13); this phenomenon was observed in both rounds of sampling and therefore is likely real (not an artifact or sampling/ analytical error). TCE/PCE concentrations decrease moving away (downgradient) from MW-13; but concentrations are higher in the center of the Pall site (about 1,100 to 2,100 µg/L in MW-4PI and MW-12P), and a higher concentration (about 3,000 µg/L) in well MW-2GI on the Glen Cove property.

Concentrations of TCE/PCE daughter products show a similar trend (RI Figure 26), but with the highest concentrations shifted slightly to the northwest, with the highest concentration in 04MW-102S in the southeast corner of the Pall Corporation Site. High, but somewhat lower, concentrations were detected in MW-14PCS (about 2,400 µg/L), MW-6PS (about 1,500 µg/L), and Photocircuits source area well MW-13 (about 2,800 µg/L), and MW-2GS (RI Figure 25). The only other well with a PCE/TCE daughter concentration exceeding 1,000 µg/L is at well MW-2GI (about 1,900 µg/L) on the Glen Cove property.

Contaminant Distribution in the Deep Interval

The Deep interval is defined as samples collected from well with top of screen intervals between about –10 to –60 ft NGVD (roughly 70 to 120 ft bgs). In addition, data from the upgradient well 01-MW-101D was assigned to the both the deep (D) interval and very deep (D2) interval for plotting purposes to provide a 'zero' point for plotting contaminant isopleths.

Total Chlorinated Aliphatics in the Deep Zone

Figures 4-3.1 and 4-3.2 show the distribution of total chlorinated aliphatics in the deep zone wells. Data for both rounds are consistent in that the high concentrations (greater than 5,000 µg/L) were observed in the deep wells in the center and eastern part of the Pall Corporation site (greater than 10,000 µg/L in MW-13PD and MW-11PD, and greater than 5,000 µg/L in MW-4PD. Deep zone concentrations generally decreased radially away from this area, despite some inconsistency between Round 1 and Round 2 at Photocircuits source area well 01MW-104I (1,238 µg/L in Round 1 but only 145 µg/L in Round 2). The deep zone data do not show a secondary hot spot in the northwestern part of August Thomsen (MW-2AD) or well MW-2GD.

1,1,1-Trichlorethane and TCA Daughter Products in the Deep Zone

Deep zone concentrations of 1,1,1-TCA (RI Figure 18) follow a similar pattern to the total chlorinated aliphatics concentrations, except that concentrations were low (less than 5 µg/L) in all deep zone wells south MW-13PD. 1,1,1-TCA concentrations are highest in MW-13PD (350 µg/L) and MW-11 PD (500 µg/L).

Concentrations of TCA daughter products in the deep zone (RI Figure 21) follow a similar pattern to the total chlorinated aliphatics concentrations. 1,1,1-TCA daughter product concentrations are highest in MW-13PD (701 µg/L) and MW-11 PD (637 µg/L), with other moderately high concentrations (between 100 and 400µg/L in nearby wells (MW-4PD; MW-5PD to the north; and 04MW-102I and MW-14PCD to the south).

Chloroethene Parent and Daughter Products in the Deep Zone

The deep zone distribution of chloroethene parents (TCE and PCE) is shown on RI Figure 24. Data are similar to that for total chlorinated aliphatics in that the highest concentrations (greater than 2,000 µg/L) were observed in the deep wells in the center and eastern part of the Pall Corporation Site (greater than 5,000 µg/L in MW-13PD and MW-11PD, and 2,250 µg/L in MW-4PD. Deep zone concentrations generally decreased radially away from this area. (Round 1 and Round 2 data for Photocircuits source area well 01MW-104I are consistent for chloroethene parents.) The deep zone data do not show a secondary hot spot in the northwestern part of August Thomsen (MW-2AD) or well MW-2GD.

Concentrations of TCE/PCE daughter products show a similar distribution (RI Figure 27) to the parent compounds. Again, the highest concentrations were in the central and eastern part of the Pall Corporation Site with the highest concentration in MW-13PD (6,500 µg/L), MW-11PD (4,988 µg/L), and MW-4P (2,674 µg/L) in the southeast corner of the Pall Site. High, but somewhat lower, concentrations were detected in wells to the southeast of MW-13PD (about 2,400 µg/L), MW-6PS (about 1,500 µg/L), and Photocircuits source area well MW-13 (about 1,500 µg/L in 04MW-102I and about 1,900 µg/L in MW-14PCD), and about 840 µg/L in MW-5D, about 60 ft north-northwest of MW-11PD.

Contaminant Distribution in the Very Deep (D2) Interval

The Very Deep (D2) interval is defined as wells with top of screen depths greater than –75 ft NGVD (140 ft bgs and deeper). As shown on Figure 3-4 (and Figures 8.1 and 8.2 of the RI), the samples in this interval were generally 'clean' – i.e., contaminant concentrations exceeding SCGs were not detected. The one exception is the Round 1 samples from (Glen Cove) wells 06MW-103D and 06MW-103D2, in which TCE and cis-1,2-DCE were detected at concentrations near or slightly greater than the SCG (e.g., TCE at 5.5 µg/L in 06MW-103D and 3.3 µg/L in 06MW-103D2). In Round 2, TCE was detected at a concentration of 1.8 µg/L in 06MW-103D2, and no other CVOCs were detected in either 06MW-103D or 06MW-103D2. The distribution of chlorinated aliphatics in the D2 interval is shown on FS Figure 4-4.

Two monitoring wells, MW-6PD2 and 04MW-19PD2, have the top of screens at depths in between those assigned for deep and very deep wells. (These wells have top of screen intervals of about –61 to –65 ft NGVD (110 to 120 ft bgs). However, these two wells are at the upper (shallower) end of the range for the D2 well classification, and the data for these two wells are not consistent with the contaminant range of the majority of the wells and would appear as anomalies on figures. Therefore, although the data for these wells are used to establish depth of contamination, they are not shown on figures showing contamination in the D2 interval. These wells are also less contaminated than the wells assigned to the "D" interval in the area in which they are located; and so these two wells are not shown on the deep well isopleths either. These two wells are considered 'transitional' wells both from the perspective of depth interval and contaminant levels.

3.2.2.3 Contamination Distribution Summary

The nature and extent of contaminant distribution is summarized below. The approximate areal (horizontal) extent of contamination (areas in which the groundwater criteria were exceeded by one or more contaminants) targeted for remediation is based on total CVOC contamination greater than 5 mg/L (as shown on Figure 3-3.2), the NYSDEC class GA criterion for most of the major site-related contaminants); and the estimated volume of contaminated groundwater is shown on Table 4-4.

Contaminants Detected

The principle contaminants detected were chlorinated aliphatics. Principle chlorinated aliphatics include PCE, TCE and their degradation products (cis-1,2-DCE and vinyl chloride, although vinyl chloride concentrations were generally low relative to cis-1,2-DCE); and 1,1,1-TCA and its degradation products (1,1-DCA and chloroethane). 2-Chlorotoluene was detected at high concentrations (2,000 µg/L) in two intermediate zone monitoring wells but was not a significant contaminant in deep (OU-2) groundwater. Therefore, the contaminants of concern in OU-2, and those which will drive the remedy selection process, are the chlorinated aliphatics.

Horizontal Extent of Contamination

The historical record does not suggest that site-related contamination extends south of the Photocircuits property, and the data from the background well installed during the RI supports this conclusion. However, due to lack of data points, it cannot be accurately determined how far south on the Photocircuits Site the contamination extents. At Photocircuits and Sea Cliff Avenue, contaminant concentrations trend lower toward the west; however, detectable concentrations of site VOCs were detected in the northwest corner of the Photocircuits Site and the westernmost of the three Sea Cliff Avenue wells.

Vertical Extent of Contamination

The vertical extent of contamination is well-defined. Chlorinated VOC contamination extends from the groundwater table down to about El -20 NGVD; little or no contamination was detected in samples from monitoring wells at greater depths. Only minimal data was generated from shallow wells south of Sea Cliff Avenue during the RI, as the focus of the RI was OU2 (deep groundwater contamination); however, ample data has been generated under previous investigations and ongoing monitoring, as well as from a Hydropunch investigation conducted in the Photocircuits source area (near MW-14) as part of this RI/FS, to characterize the contamination in the shallow zone. The principle contaminants of concern in OU-2 are chlorinated aliphatics; i.e., PCE, TCE and their degradation products (cis-1,2-DCE and vinyl chloride, although vinyl chloride concentrations were generally low relative to cis-1,2-DCE); and 1,1,1-TCA and its degradation products (1,1-DCA and chloroethane). A cross section through the approximate axis of the total CVOC plume from the Round 2 sampling event is included in Figure 3-5.

Uncertainties in Nature and Extent of Contaminant Distribution

The identity of the contaminants is well-established, with data from two rounds of sampling for the current RI confirming data from previous investigations.

The vertical extent of contamination is generally well-defined within the study area. Monitoring wells have been installed at adequate depths to determine the 'clean' zone.

The horizontal (areal) extent of contamination is not fully defined to the north and west (north of Pass and Seymour and west of Glen Cove Creek, and north of the Carney Street Wellfield); and there are some uncertainties in the delineation to the east (under the Glen Cove Arterial Highway) and south (within the Photocircuits site).

3.3 Contamination Fate and Transport

The primary migration pathway identified for deep groundwater (OU-2) at the Site during the RI study is deep overburden groundwater migration.

Groundwater migration is expected to spread the contamination generally to the north-northwest in the direction of groundwater flow. Vertical spreading is also expected through both diffusion/dispersion and also from the vertical (upward) component of groundwater flow (especially at the northern part of the Pall Corporation Site, where artesian conditions are routinely observed).

The available data suggest that biodegradation is occurring at the site (mostly by anaerobic reduction), with the main evidence being the presence of the degradation (daughter) products of PCE/TCE (cis-12,DCE and vinyl chloride) and 1,1,1-TCA (1,1-DCA and chloroethane). However, the high concentrations of the daughter products also suggests that biodegradation of PCE/TCE is not proceeding to completion; i.e., "DCE stall" is occurring (see RI section 6.5).

Volatilization is expected at the Site based on the concentrations of VOCs detected in shallow groundwater (OU-1). The migration of soil gas contaminated with PCE and other VOCs is expected; however, this would occur in the shallow aquifer and is being addressed separately (as OU-1). As the OU1 remedy for the Pall Corporation Site will not necessarily address off-site contamination (i.e., at the Glen Cove property), this OU-2 FS will consider the potential impact to human health of contamination on the Glen Cove property not addressed by remedial actions at Pall Corporation Site OU1.

3.4 Qualitative Risk Assessment

A limited qualitative human health risk assessment was completed based on the information and data obtained during the RI study. The potential for ecological impacts was also assessed.

A qualitative human health risk assessment was completed for the Site. Generally, the human health evaluation involves an exposure assessment, an evaluation of Site occurrence, hazard identification and comparison to Federal and New York State criteria. Exposure scenarios were identified and evaluated based on analytical results of groundwater samples collected. A summary of the results of the risk assessment is presented below.

The potential for exposure to contaminants in the deep groundwater at the Site is minimal under current conditions (i.e., with the potable wells such as Carney Street Well 21 out of service). However, there is a potential for future exposure due to use of overburden groundwater as a drinking water source is considered. Due to the high concentrations of PCE, TCE, and other contaminants detected in overburden groundwater, exposure to on-Site groundwater could pose a significant risk based on the concentrations encountered.

Based on the definition of the scope of this FS (OU-2, consisting of groundwater at depths of 60 ft bgs and greater [100 ft bgs Photocircuits]), there are no potential ecological receptors and an ecological assessment was not conducted.

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4.0 REMEDIAL GOALS AND REMEDIAL ACTION OBJECTIVES

4.1 Remedial Goals

The default remedial goal for all remedial actions undertaken under the State Superfund program using the DER-10 guidance is to restore the site to pre-disposal/pre-release conditions, to the extent feasible.

4.2 Remedial Action Objectives

The first step in identifying the Remedial Action Objectives (RAOs) is to identify the Standards, Criteria and Guidelines (SCGs). This section presents potentially applicable SCGs based on (a) identification of applicable SCGs based on contaminants which exceed applicable SCGs in the environmental media (for this FS, this is limited to the deep groundwater in OU-2); and (b) SCGs which account for the current and (where applicable) future land use for the site.

The following subsections present the three categories of SCGs: chemical-specific, location-specific, and action-specific.

4.2.1 Chemical Specific SCGs

Chemical-specific SCGs are typically technology or health-risk based numerical limitations on the contaminant concentrations in the ambient environment. They are used to assess the extent of remedial action required and to establish cleanup goals for a site. Chemical specific SCGs may be directly used as actual cleanup goals, or as a basis for establishing appropriate cleanup goals for the contaminants of concern at a site. Chemical-specific SCGs for groundwater at the Site are identified in Table 4-1.

4.2.2 Action-specific SCGs

Action-specific SCGs are usually administrative or activity-based limitations that guide how remedial actions are conducted. These may include record-keeping and reporting requirements; permitting requirements; design and performance standards for remedial actions; and treatment, storage and disposal practices. Action-specific SCGs identified for the Site are provided in Table 4-2.

4.2.3 Location-specific SCGs

Location-specific SCGs are applicable to sites that contain features such as wetlands, floodplains, sensitive ecosystems, or historic buildings that are located on, or in close proximity to the Site. Based on the RI, wetlands, floodplains, sensitive ecosystems or historic buildings are not located on, or in close proximity to the Site. Thus, location-specific SCGs were not identified for this Site, as shown on Table 4-3.

4.3 Remedial Action Objectives

This section presents the objectives for on-Site remedial actions that may be taken to protect human health and the environment. To develop the remedial action objectives, AECOM completed the following as part of the RI and FS.

- Identified contaminants present in the environmental media in the study area.
- Evaluated existing or potential exposure pathways in which the contaminants may affect human health and the environment.

- Identified pathways having a moderate to high likelihood for exposure.
- Identified chemical-specific SCGs that apply to the likely exposure routes to establish the contaminants of concern and proposed cleanup goals for purposes of remediation.
- Established remedial action objectives for the contaminants of concern to reduce the potential for future exposure.

Remedial action objectives are presented for the environmental media in the study area, based on the contaminants of concern and SCG Goals. Remedial action objectives are summarized at the end of this section.

4.3.1 Contaminants of Concern and SCG Goals

Tables 3-1 and 3-2 summarize the contaminants detected in samples collected on Site and the chemical-specific SCGs that apply to the likely exposure routes for the environmental media of interest. Potential exposure pathways are discussed in Subsection 3.4. Proposed cleanup goals for each contaminant were developed in accordance with the procedures described below.

Proposed SCGs for organic compounds were selected by comparing the chemical-specific SCGs appropriate to the likely exposure pathways. The cleanup SCG was then selected based on the potential exposure scenarios and contaminated media encountered within the study area.

Contaminants of concern were identified for on-site environmental media by identifying the contaminants that exceeded the proposed cleanup SCGs and then evaluating the frequency that cleanup goals were exceeded and the relative toxicity of the contaminant. In general, contaminants of concern were established based on the exceedance of SCGs, frequency of detection, and being site-related.

As discussed more fully in Section 3.2, the primary contaminants of concern (COCs) are in OU-2 are chlorinated aliphatics; i.e., PCE, TCE and their degradation products (cis-1,2-DCE and vinyl chloride, although vinyl chloride concentrations were generally low relative to cis-1,2-DCE); and 1,1,1-TCA and its degradation products (1,1-DCA and chloroethane). Other contaminants detected in the remedial investigation such as halogenated aromatics (primarily chlorotoluene), non-halogenated aromatics (e.g., BTEX compounds), and chlorofluorocarbons (Freons) were generally limited to OU-1, and were not detected at significant concentrations in OU-2. As such, it is PCE, TCE, and 1,1,1-TCA which are the COCs which will drive the remedy selection.

Tables 3-1 and 3-2 identify the contaminants of concern for the purposes of remediation in on-Site groundwater, the range of concentrations detected, the proposed cleanup SCG, the number of samples that exceed the cleanup SCG, and the number of samples analyzed.

4.3.2 Contaminated Groundwater and Exposure Pathways

This subsection addresses the environmental media in the study area and describes the types of contaminants present and the potential exposure pathways.

Groundwater sampling and laboratory analyses were completed as part of the RI. While the scope of work for this RI/FS was to address the OU-2 groundwater the deep groundwater cannot be adequately addressed without also understanding the contamination in the shallow part of the aquifer.

The potential exposure pathway for overburden groundwater appears to be via contact with contaminated groundwater at points of possible groundwater discharge. The likelihood of exposure to deep groundwater due to construction activity is considered low do to the depth of the groundwater. Also, since a public water system deriving water from deeper aquifers in Nassau County currently services the area, and since operating public or private drinking water wells were not identified within a ½-mile radius of the Site during the RI, exposure to contaminated overburden groundwater associated with the Site (from drinking water supply wells) is currently unlikely. However, several potable wells in the area (the Carney Street Wellfield) were decommissioned in the 1970s due to groundwater contamination, so the aquifer is capable of being a viable potable water source and is a potential future ingestion pathway. Therefore, remediation of groundwater is warranted.

Several structures immediately to the north of the Pall Corporation Site on the Glen Cove property are currently in use by the general public, including a boxing center and a day care center. To the extent that remedial actions conducted at OU-1 (shallow groundwater) are not anticipated to address potential health risks associated with contamination on this property, such risks will be addressed by this FS.

4.3.3 Remedial Action Objectives

This subsection presents the proposed remedial action objectives (RAOs) to reduce the potential for future exposure.

The remedial action objectives for OU-2 groundwater are:

(1) Reduce further off-site migration of contaminated overburden groundwater to the extent practical;

(2) Reduce the levels of contamination in the overburden groundwater at the Site to the extent practical;

(3) Attain the proposed cleanup goals for overburden groundwater quality at the Site boundary (the northern edge of the Pall Corporation Site) to the extent practical; and

(4) Reduce the risk of exposure to overburden groundwater by reducing the potential for ingestion of contaminated groundwater, dermal contact with contaminated groundwater, and inhalation of organic vapors. This may include remedial actions conducted on the Glen Cove property north of the Pall Corporation Site.

The RAOs presented above are applicable to all groundwater at the Site, and are not limited to the deep (OU-2) groundwater.

4.4 Remedial Action Areas and Volumes

This subsection presents the estimates of areas and volumes of contaminated groundwater to assist in evaluating remedial alternatives later in this report. The estimates are based on the information presented in the RI Report. Calculations of the estimated areas and volumes of contaminated groundwater are presented in Table 4-4.

The estimated total volume of deep (OU-2) contaminated groundwater exceeding groundwater criteria (assumed to correspond to the 5 µg/L total CVOC value) is approximately 67 million gallons. This estimate is based on the average saturated thickness of the plume; and the estimated area of contaminated groundwater at the Site (associated with VOC concentrations greater than the applicable SCG, based on RI groundwater data), depicted on RI Figure 4-1. (This estimate includes a portion of the contamination on the Glen Cove property north of

August Thomsen.) The plume appears to be generally limited to the upper 120 ft of the aquifer, based on water level measurements in site monitoring wells and groundwater analytical results; see Figure 3-5. The porosity value is assumed to be 0.30 (USEPA, 1996).

It should be noted that the total volume of water identified as contaminated (based on SCG exceedance) is greater than the volume of groundwater targeted for remediation. (As shown on Table 4-4, about 11.1 million gallons, based on targeting contamination at or above 1 mg/L [1,000 µg/L].) This issue is explored more fully in Chapter 7 of this FS.

5.0 GENERAL RESPONSE ACTIONS

The list of general response actions considered includes those related to the presumptive remedies established by NYSDEC (2006) as described in Section 1.1, and, therefore, is not exhaustive. A select, focused group of general response actions and remedial technologies for groundwater was considered, based on presumptive remedies identified in the scope of work.

To satisfy the remedial action objectives for the Site, remediation will be required for the groundwater. General response actions that are available to meet the remedial action objectives under consideration (as described in Section 4.3.3) are identified below.

General response actions associated with the presumptive remedies for the contaminated groundwater include:

- No Action (with or without Long Term Monitoring);
- *In Situ* Treatment;
- Groundwater Extraction, and
- *Ex Situ* Treatment.
- Any additional measures determined to be necessary or appropriate to safeguard the health of users of properties on the Glen Cove property north of the site.

In addition to the response actions associated with the presumptive remedies, AECOM also assessed containment as a potential general response action.

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6.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

This section presents the presumptive remedies established by NYSDEC (2006) and the results of the preliminary screening of the associated remedial actions that may be used to control the contaminants of concern and to achieve the remedial action objectives. Potential remedial technologies, including general response actions (e.g., groundwater extraction, *in situ* treatment) have been evaluated during the preliminary screening on the basis of effectiveness, implementability, and relative cost. The purpose of the preliminary screening is to eliminate remedial technologies that may not be effective based on anticipated on-site conditions, or that cannot be implemented technically at the site; and, to more narrowly focus the list of alternatives that will be developed and evaluated in greater detail.

In addition to the technologies associated with the presumptive remedies established by NYSDEC (2006), AECOM also reviewed available technologies to identify additional technologies or response actions that might also be appropriate for the site.

6.1 Criteria for Preliminary Screening

In accordance with guidance documents issued by the NYSDEC (DER-10; 2010) and the USEPA (Guidance for Conducting RI/FS Studies under CERCLA; 1988), the criteria used for preliminary screening of general response actions and remedial technologies include the following. The first two criteria are threshold criteria and must be satisfied for an alternative to be considered for selection.

- Overall Protection of Human Health and the Environment. This criterion addresses the remedy's ability to protect public health and the environment, assessing how risks from each exposure pathway are eliminated, reduced, or controlled through removal, treatment, or institutional or engineering controls. The degree to which RAOs are achieved by each remedy is evaluated.
- Compliance with Standards, Criteria, and Guidance (SCGs). Compliance with SCGs addresses the degree to which the remedy meets the applicable environmental laws, regulations, standards, and guidance. The SCGs for the site are listed along with a discussion of whether or not each remedy will achieve compliance. For SCGs which are not met, the impacts of non-compliance are discussed, along with whether or not a waiver would be required.
- Long-term Effectiveness and Permanence. This criterion evaluates the long-term effectiveness of the remedy after implementation. For wastes or treated residuals which remain on site after the remedy has been implemented, the following items are addressed:
    - The magnitude of the remaining risks (will there be any significant threats, exposure pathways, or risks to the community and environment from the remaining risks or treated residuals);
    - The adequacy of the engineering and institutional controls intended to limit risk;
    - The reliability of these controls; and
    - The ability of the remedy to continue to meet RAOs in the future.
- Reduction of Toxicity, Mobility, or Volume through Treatment. The degree to which the remedy reduces the toxicity, mobility, or volume of site contamination is evaluated.

Preference is given to remedies which permanently and significantly reduce the toxicity, mobility, or volume of site wastes.

- Short-Term Effectiveness. The evaluation of short-term effectiveness assesses potential short-term adverse impacts and risks of the remedy on the community, site workers, and the environment during the construction and/or implementation of the remedy. It includes a discussion of how the identified short-term adverse impacts will be controlled, and an assessment of the effectiveness of the controls. It includes a discussion of any engineering controls (e.g., dust suppression) that will be used to mitigate short-term impacts, and an estimate of the time to achieve the remedial objectives.

- Implementability. The implementability evaluation focuses on the technical and administrative feasibility of a remedial action. Technical feasibility refers to the ability to construct and operate a remedial action for the specific conditions at the site and the availability of necessary equipment and technical specialists. Technical feasibility also includes the future maintenance, replacement and monitoring that may be required for a remedial action. Administrative feasibility refers to compliance with applicable rules, regulations, statutes and the ability to obtain permits or approvals from other government agencies or offices; and the availability of adequate capacity at permitted treatment, storage and disposal facilities and related services. Remedial actions that do not appear to be technically or administratively feasible, or that would require equipment, specialists or facilities that are not available within a reasonable period of time, are eliminated from further consideration.

- Cost Effectiveness. The capital, operation, maintenance, and monitoring costs of the remedial actions are estimated and presented on a present-worth basis. A remedial action is eliminated during preliminary screening on the basis of cost if other remedial actions are comparably effective and implementable at a much lower cost.

- Land Use. This criterion is an evaluation of the current, intended, and reasonably foreseeable future use of the site and its surroundings, as it relates to an alternative or remedy. The "Site," as it applies to this RI/FS, is defined as OU-2 (deep groundwater) and does not include a land use component. Land use for the Pall Corporation and Photocircuits Corporation was addressed in the previously-issued RODs for the two sites (see Appendix A), and is therefore not addressed in this FS report.

- Community Acceptance. This criterion includes a summary of the public participation program that was followed for the project, and includes an evaluation of the public's comments, concerns, and overall perception of the remedy. Community concerns are addressed in a format that responds to all questions that are raised (i.e., a responsiveness summary is prepared). This criterion is evaluated after public review of the remedy selection process as part of the final selection of a remedy for the site. As such, evaluation of the community acceptance criterion is not included in this FS report.

6.2 Preliminary Screening

The results of the preliminary screening are summarized below. Those general response actions and remedial technologies, which appear to meet the remedial action objectives for groundwater, are described.

An evaluation of the groundwater data indicates that VOC contamination, primarily halogenated aliphatics, is present in groundwater in OU-2. Several factors, including the limited access to the source area hot spot and lack of a confining layer (to tie in remedial containment systems) limit the potential use of remedial actions such as containment (e.g., cutoff wall). Other innovative technologies (e.g., Fenton's Reagent) may be effective at remediating a portion of the contamination; however, these technologies are unlikely to provide for complete mass reduction without extensive effort and expense.

The following subsections discuss the preliminary screening of various general response actions and remedial technologies that were considered for remediation of OU-2 groundwater.

6.2.1 No Action

The No Action alternative involves taking no further action to remedy groundwater conditions at the Site. NYSDEC and USEPA guidance requires that the No Action alternative automatically pass through the preliminary screening and be compared to other alternatives in the detailed analysis of alternatives.

6.2.2 In Situ Treatment

The following subsections present the results of the preliminary screening of *in situ* treatment technologies for remediation of contaminated groundwater. The NYSDEC presumptive remedy (air sparging) of *in situ* treatment is presented, along with a literature review of other *in situ* technologies including both physical/chemical methods and biological treatment methods.

6.2.2.1 Air Sparging

The technology of air sparging involves contaminant reduction primarily by volatilization and biodegradation. Sparging is conducted by injecting air into the subsurface below the water table under controlled pressure and volume. Contaminants, such as dissolved phase chlorinated aliphatics in the groundwater and adsorbed onto soil are volatilized (or stripped) when in contact with the injected air. Air containing stripped contaminants migrates upward through the groundwater into and through the unsaturated zone, where it is ultimately collected in vacuum/vapor extraction wells, in order to capture volatilized chemicals prior to discharge into the atmosphere. The air is then treated and discharged to the atmosphere.

In addition to the stripping process that occurs on contaminants in the groundwater, it has been shown that air sparging provides for enhanced biodegradation under certain conditions. However, the majority of the contaminants detected at the site (including PCE) are degraded anaerobically in the subsurface environment. Therefore, sparging is not expected to significantly enhance biodegradation of Site contaminants.

Effectiveness - This technology is generally effective in removal of VOCs from groundwater, especially highly volatile compounds such as chlorinated solvents. The effectiveness of this technology is based in part on the Site geology. Higher removal efficiencies are generally accomplished in coarse-grained soils, as airflow channels are more evenly distributed both laterally and vertically. However, existing subsurface heterogeneities may inhibit the sparged air from contacting dissolved phase contamination in groundwater. Air sparging is anticipated to reduce VOC concentrations (by about one order of magnitude), but is not believed to be able to meet the groundwater remediation objective for PCE (5 µg/L).

Implementability - For the subsurface conditions at the site, air sparging wells are an implementable technology for *in situ* treatment of groundwater. (Air sparging, in conjunction with soil vapor extraction, has been established as the remedy in the ROD for the nearby Pass and Seymour Site [NYSDEC, 2008b].) The materials, equipment and labor for installation of a sparging system are available and can be readily implemented. Sparge wells can be reliably installed to the required depth and the screened interval can be installed to meet the subsurface conditions. The system requirements include a blower/air compressor system, and a vapor extraction/treatment system. Pilot testing would be required to evaluate the required design parameters (e.g., sparge well spacing, injection flow rate, etc.), relative to the desired remediation of chlorinated aliphatics in groundwater.

Unlike groundwater extraction wells, air sparging cannot be targeted specifically to the deep groundwater (OU-2). While the sparge points can be placed at the targeted depths within OU-2, by definition the sparging takes place throughout the water column (including OU1). However, NYSDEC (2007) indicates that air sparging has a depth limitation of about 50 ft below the water table, rendering it unusable for the deep (OU2) groundwater.

Installation of the vapor extraction system typically requires at least 5 ft of unsaturated thickness in the overburden aquifer. This condition is not met throughout the Pall Corporation or Photocircuits Sites, where groundwater typically occurs within 5 ft of the ground surface (see RI Table 3-5). Depth to groundwater at the two wells measured at the Pass and Seymour site (MW-2S and MW-3S) are about 6 ft, providing enough room for vapor collection at that site.

Cost - Relative costs are expected to be moderate to high. Capital costs may include the materials and installation of sparge wells and a blower/air compressor system. (Also, installation of a vapor extraction system would be necessary for collection and treatment of volatilized contaminants.) Operation and maintenance costs may include use of electrical power for the compressor system, and routine maintenance of the system.

In summary, air sparging does not appear to be implementable at OU-2 site for *in situ* treatment of contaminated groundwater at the Site, and is eliminated from further consideration in this FS.

6.2.2.2 In Situ Chemical Oxidation

In situ chemical oxidation is a technology whereby an oxidant (i.e., hydrogen peroxide or sodium/potassium permanganate) is injected into an aquifer or subsurface soils. Both oxidants are capable of oxidizing chlorinated organic compounds such as PCE (GWRTAC, TE-99-01); and are, therefore, amenable to remediating the OU-2 COCs (i.e., chlorinated aliphatics). Following the injection of Fenton's Reagent, a reaction with organic compounds occurs, and residual hydrogen peroxide decomposes into water and oxygen, and iron precipitates. Such a reaction is exothermic meaning heat is generated. The reaction of sodium/potassium permanganate with organic compounds produces various compounds including manganese dioxide, carbon dioxide and oxidized intermediate organic compound.

The process includes placing injection points throughout the area to be treated, and injection of the selected oxidant into the aquifer/subsurface. The use of Fenton's Reagent may be complemented by venting or soil vapor extraction to collect off-gases that escape to the vadose zone. Also, *in situ* chemical oxidation may be coupled with groundwater extraction and *ex situ* treatment.

In situ chemical oxidation is the remedy specified in the ROD (NYSDEC 2004) for the shallow groundwater (0-60 ft bgs) underlying the Pall Corporation Site. The use of this technology for treating contaminants in the deep OU-2 groundwater would be complementary to the use chemical oxidants in OU-1.

Effectiveness – *In situ* oxidation using hydrogen peroxide or permanganate would be effective for treatment of the contamination at the Site.

Although *in situ* oxidation is potentially effective for treating halogenated VOCs, subsurface heterogeneities may inhibit the oxidant from contacting the dissolved phase in water, thus preventing full treatment of the groundwater contamination.

As further described below, successful application of this process requires that the reagent be injected through a series of injections (i.e., a phased approach). This approach would attempt to optimize the amount of physical contact between the oxidant and the contaminant mass, as well as generate a manageable amount of heat/off-gases.

Implementability – The use of more dilute solutions of oxidant generate less heat and gas, thus making Fenton's a potentially implementable treatment technology, since normal operations at the Site would only require limited space allocation around the injection points for the *in situ* treatment. In a phased approach, confirmatory sampling is performed in between injection events to monitor the effectiveness of the treatment, and to provide the basis for the next round of injections.

Potassium/sodium permanganate injection is also a potentially implementable treatment technology, as placement of injection wells, and often used recirculation wells, around the site would require limited space. Permanganate is more stable than Fenton's and the reaction does not typically result in the generation of heat and off-gas.

The materials, equipment and labor necessary to implement this technology are available from several vendors. A pilot-scale treatability study would be necessary to assess system design.

Cost – The cost for implementing this technology is documented to be generally less than groundwater extraction and ex situ treatment technologies, when used on a limited basis. The required concentrations and duration/frequency of oxidant injection would be specific to the oxidant selected. *In situ* chemical oxidation will result in limited disruption to the current Site use.

Application of an *in situ* oxidant appears to be a reasonable approach for the treatment of OU-2 groundwater and would be complementary to the OU-1 remedy which uses this technology. Use of this technology is retained in this FS and will be considered further in the detailed analysis.

6.2.2.3 In situ Biological Treatment

The Federal Remedial Technologies Roundtable (FRTR) screening matrix lists enhanced bioremediation, monitored natural attenuation, and phytoremediation as *in situ* biological treatment technologies. Monitored natural attenuation is essentially No Action with Long Term Monitoring, described above (Section 6.2.1), and is not considered in this section. Phytoremediation is the use of plants for remediation but the depth of contaminated groundwater in OU2 is far greater than phytoremediation is capable of treating and is also removed from consideration. Therefore, *in situ* biological treatment discussed in this section refers to enhanced bioremediation.

Enhanced bioremediation refers to the addition of substrates, microbes, and/or electron acceptors to the groundwater through injection wells. Additional data gathering and subsequent pilot testing will be necessary to fully evaluate this alternative. As noted in the RI report (AECOM, 2009; Section 6), "DCE stall" (the phenomenon whereby reductive dechlorination of chlorinated ethenes – PCE and/or TCE – occurs but appears to "stall" at the stage of cis-1,2-DCE, without proceeding to vinyl chloride and mineralization). As noted in the RI, DCE stall can be caused by the lack of sufficient substrate (usually a fermentable carbon source) to achieve the necessary strongly reducing conditions, or that required bacteria that are capable of efficiently dechlorinating DCE to ethene (e.g., *Dehalococcoides ethenogenes)* are not present at the site.

Effectiveness – Bioremediation can be effective for the destruction of chlorinated VOCs in groundwater; and a properly designed enhanced bioremediation system can be effective at the complete oxidation of chlorinated VOCs. However, its effectiveness is best proven for BTEX contamination (NYSDEC, 2007; FRTR, 2009); therefore, extensive pre-design and/or pilot testing is necessary (typically for MNA parameters, including gases, as well as DNA testing for microbial population). As with other *in situ* alternatives, the effectiveness of enhanced bioremediation is affected by subsurface heterogeneities which may inhibit the enhancements from contacting the dissolved phase in water, thus preventing full treatment of the groundwater contamination.

Implementability – Enhanced bioremediation is implementable. However, extensive testing is necessary to establish both its effectiveness and the operational (enhancement) parameters. However, enhanced bioremediation is not compatible with in situ oxidation technologies which have been selected for the overlying OU1 shallow groundwater at the Pall Corporation Site.

Cost – the cost of enhanced bioremediation is highly variable, and is dependent upon both the nature of the enhancement (microbes, carbon source) and the density and frequency of injections (e.g., is a one-time introduction of *Dehalococcoides ethenogenes* sufficient to establish a self-sustaining population and overcome DCE stall, or are repeated injections necessary).

Enhanced bioremediation is not retained for further evaluation as a potential remedial technology in this FS due to the incompatibility with the OU1 remedy (*in situ* chemical oxidation).

6.2.3 Groundwater Extraction

Groundwater extraction is a commonly used method to control the migration of contaminated groundwater and to collect contaminated groundwater for subsequent (*ex situ*) treatment. Groundwater extraction wells are generally installed with a drill rig. Well screens and filter packs are generally installed to intercept the saturated thickness of the contaminated water-bearing zone. Extraction wells can be installed to provide a hydraulic barrier for control of migration of contaminated groundwater, or at specific locations for source area remediation.

Effectiveness – Groundwater extraction wells are an effective remedy that could be used in conjunction with other technologies to meet the remedial action objectives for the OU-2 groundwater. Extraction wells, in conjunction with an ex situ groundwater treatment system (described in Subsection 6.2.4, below), would reduce the mobility, toxicity, and volume of contaminated groundwater. Extraction wells can be installed with limited site disturbance and relatively low potential for impacts to human health and the environment during installation, as compared to other technologies that are more intrusive. Extraction wells are a proven and reliable technology for removal of groundwater for remediation. The effectiveness may be adversely affected by the presence of structures on site (the active August Thomsen facility, as well as multiple unoccupied structures on the Pall and Photocircuits sites), especially along the eastern side of the Photocircuits (along the Glen Cove Arterial Highway, in the areas near the MW-13 and MW-14).

Groundwater extraction can specifically target the OU-2 groundwater by proper placement of the extraction well screens.

Implementability – For the subsurface conditions at the Site, groundwater extraction wells are an implementable technology for removal of groundwater for subsequent treatment. As noted above, there are some difficulties in installing wells near the entire contaminated zone due to the presence of buildings. The materials, equipment and labor necessary to install extraction wells are readily available. Extraction wells can be reliably installed to the required depth and the screened interval can be installed to meet the subsurface conditions.

Cost – The relative costs for extraction wells are expected to be moderate due to the depth of the wells. Capital costs would include materials, equipment and labor to install the extraction wells, submersible pumps, and piping and associated appurtenances. Operation and maintenance costs would include long-term pumping costs to remove groundwater for treatment, routine maintenance on the system, and costs for groundwater monitoring.

In summary, groundwater extraction wells appear to be an effective and implementable technology for removal of contaminated groundwater from the ground for subsequent treatment using other (*ex situ*) remedial technologies (described in Subsection 5.2.2.4). Extraction by extraction wells is retained for consideration for development of alternatives, in conjunction with ex situ treatment alternatives.

6.2.4 Ex Situ Treatment

This general response action involves aboveground treatment of removed groundwater from the subsurface using other technologies for subsequent discharge/disposal. This could involve:

1. treating the groundwater to the cleanup goals and discharging the treated water back into the site groundwater via injection or diffusion wells;
2. treating the groundwater and discharging the treated water to the a stormwater sewer in conformance with State Pollutant Discharge Elimination System (SPDES) permit requirements; or
3. pre-treating the water sufficient to meet the pretreatment standards for the Glen Cove Publicly Owned Treatment Works (POTW) prior to discharge to the existing sanitary sewer system.

According to the Glen Cove Department of Public Works (GCDPW), pretreated groundwater from remediation systems is generally not accepted for discharge into the sanitary sewer system for subsequent treatment at its water treatment facility (POTW). Also, stormwater sewers are located along Sea Cliff Avenue that discharge into the stormwater sewer system. There are additional drains on both the Photocircuits and Pall Corporation sites which connect to the stormwater system. On-site subsurface reinjection of treated groundwater is technically feasible, as both Photocircuits and Pall Corporation formerly had on-site extraction/diffusion wells for cooling water. Issues associated with discharge/disposal of treated groundwater are discussed further in Section 6.2.7.2.

The following subsections describe the results of preliminary screening of technologies that were considered for ex situ treatment of groundwater.

6.2.4.1 Air Stripping

Air stripping involves passing air through the contaminated groundwater to induce volatilization and removal of VOCs. Air that contains organic vapors stripped from the groundwater can be treated by either filtration with activated carbon, or catalytic oxidation, prior to discharge to the atmosphere. Air stripping is most appropriate for situations where the contaminants to be treated are volatile and where there are not significant concentrations of dissolved ions that may precipitate (e.g., iron).

Effectiveness – Air stripping is expected to be an effective technology for treating the groundwater to achieve the stormwater discharge (SPDES) permit standards. This is a proven and reliable technology for treatment of water containing VOCs. A shallow tray air stripper could be used to treat the groundwater prior to discharge to the sanitary sewer system. Air emissions may need to be treated prior to discharge, based on the anticipated levels, for protection of human health and the environment. Metals such as iron and manganese can precipitate onto the trays in the air stripper requiring more frequent maintenance. Therefore, pretreatment of the groundwater for metals may be required.

Implementability – The labor, equipment, and materials for installation of an air stripper at the Site are readily available. Air emissions from the stripper may require treatment by catalytic oxidation, carbon, or appropriate method to meet NYSDEC requirements for allowable concentrations of PCE and other VOCs in air. The use of activated carbon or catalytic oxidation equipment for the air stripper could be used in conjunction with the soil vapor extraction system, if utilized.

The process equipment that would be required to implement an air stripping treatment system includes construction of a shelter building, an electrical power source, instrumentation and controls system equipment, an equalization tank to receive influent water from the groundwater extraction well, potential metals treatment process (e.g., greensands filter), an air stripper unit with an air blower, an off gas treatment system to remove organic vapors from air prior to discharge to the atmosphere, activated carbon for polishing of the groundwater, and discharge piping for effluent water leading to the existing stormwater sewer system. In addition, effluent discharge and SPDES permits will be required from [Nassau County and NYSDEC], which should be attainable. If an air stripper (or strippers) is used at this site for treatment, treatability studies may be required in order to complete the design based on the required discharge limit. In addition, the system will need to substantially comply with appropriate State and Federal air permit requirements.

Technical considerations in stripper design and implementation include the variability in contaminant concentrations at different depths and locations in OU-2 and the expected total influent flow.

Cost – The relative costs for air stripping are expected to be moderate to high as compared to other remedial technologies used to treat contaminated groundwater. Capital costs would include the process equipment noted above and their installation. Operation and maintenance costs would include changing of filters on a regular basis, cleaning and replacing trays or packing media in the air stripper, maintaining the off-gas system, and electrical power consumption.

In summary, air stripping appears to be an effective and implementable technology for ex situ treatment of contaminated groundwater prior to discharge to the existing stormwater sewer system (or on-site reinjection), when used in conjunction with other technologies (e.g., catalytic oxidation or carbon for emission control, liquid-phase carbon adsorption for final polishing). Ex situ treatment by air stripping is retained for further evaluation in this FS.

6.2.4.2 Carbon Adsorption – Liquid Phase

Liquid phase carbon adsorption is used to remove organic compounds from groundwater by adsorbing the organic compounds onto the surface of granular activated carbon. Water is treated as it flows through the granular activated carbon. Granular activated carbon can be packed into a treatment column or placed in properly sized drums or pressure vessels connected in series. On a regular basis, the granular activated carbon must be changed since its adsorption capacity is depleted with use.

Effectiveness – Use of carbon may be an ineffective method of primary groundwater treatment of groundwater, due to the elevated concentrations of chlorinated VOCs detected in the groundwater. The carbon usage rate for groundwater treatment is expected to be high, particularly during initial startup when higher flow rates are anticipated. Thus, significant quantities of activated carbon are anticipated to be consumed, that would result in the need for frequent carbon change-out. Carbon may also be utilized in a treatment process for the purposes of final polishing following the use of one of the other treatment technologies.

Implementability – Granular activated carbon treatment columns or containers are readily available and relatively simple to install and replace.

Cost – The cost of this technology when used as a method of treatment is expected to be high for groundwater, due to labor and materials (carbon usage) needed for frequent carbon change out or regeneration.

The use of liquid phase carbon adsorption for treatment of the groundwater would not be cost-effective for primary groundwater treatment, as compared to other available treatment technologies for chlorinated aliphatics in groundwater. Liquid phase carbon adsorption may be viable as a final polishing step, following removal or treatment of the contamination with another technology.

6.2.4.3 Ex Situ Oxidation

Ex situ oxidation processes include the use of ultraviolet (UV) radiation, ozone, or hydrogen peroxide to destroy organic contaminants as water flows into a treatment tank. If ozone is used as the oxidizer, an ozone destruction unit is used to treat collected off gases from the treatment tank and downstream units where ozone gas may collect, or escape.

UV oxidation is a destruction process that oxidizes organic and explosive constituents in wastewater by the addition of strong oxidizers and irradiation with UV light. Oxidation of target contaminants is caused by direct reaction with the oxidizers, UV photolysis, and through the synergistic action of UV light, in combination with ozone (O_3) and/or hydrogen peroxide (H_2O_2). If complete mineralization is achieved, the final products of oxidation are carbon dioxide, water, and salts. The main advantage of UV oxidation is that it is a destruction process, as opposed to air stripping or carbon adsorption, for which contaminants are extracted and concentrated in a separate phase. UV oxidation processes can be configured in batch or continuous flow modes, depending on the throughput under consideration.

UV oxidation differs from UV photolysis, a related process but one which does not typically fully convert organic contaminants to CO_2, H_2O, and salts (chlorides in the case of chlorinated compounds).

For the discussion below, oxidation by UV radiation in conjunction with peroxide is assumed; however, the specific process options would have to be determined later.

Effectiveness – *ex situ* oxidation is effective, and the *ex situ* treatment is not hindered by subsurface heterogeneities that affect in situ options. Organic compounds with double bonds (e.g., TCE, PCE, and vinyl chloride) are rapidly destroyed in UV/oxidation processes. However, *ex situ* oxidation is subject to the same limitations as all pump and treat options, in that complete remediation is time-consuming and often becomes ineffective (or at least inefficient) as the final remediation criteria are approached.

Implementability – *ex situ* oxidation is readily implemented. It requires groundwater extraction and pumping to one or two treatment locations, followed by discharge of treated water. Ample space for the treatment system is available on both the Photocircuits and Pall Corporation sites. Remediation systems capable of treating as much as 1,000,000 gallons per day (gpd) have been installed. Issues related to UV/oxidation include:

- The aqueous stream being treated must provide for good transmission of UV light (high turbidity causes interference). This factor can be more critical for UV/H_2O_2 than UV/O_3. (Turbidity does not affect direct chemical oxidation of the contaminant by H_2O_2 or O_3).
- Free radical scavengers can inhibit contaminant destruction efficiency. Excessive dosages of chemical oxidizers may act as a scavenger.
- The aqueous stream to be treated by UV/oxidation should be relatively free of heavy metal ions (less than 10 mg/L) to minimize the potential for fouling of the quartz sleeves.
- When UV/O_3 is used on volatile organics such as TCA, which is one of the contaminants at Photocircuits, the contaminants may be volatilized (e.g., “stripped”) rather than destroyed; therefore, off-gas treatment (by activated carbon adsorption or catalytic oxidation) may be necessary.

Cost – UV oxidation is energy-intensive; as a result, costs may be higher than other *ex situ* technologies because of energy requirements.

The use of *ex situ* oxidation for treatment of the groundwater would not be cost-effective as compared to other available treatment technologies for chlorinated aliphatics in groundwater.

6.2.4.4 Additional ex situ Treatment Technologies

The FRTR screening matrix also includes separation (e.g., distillation) and “sprinkler irrigation” as technologies which are potentially effective for halogenated VOCs in groundwater. Separation may be ruled out due to high costs and limited throughput; it provides no real advantages over other *ex situ* technologies that are readily available but at lower cost. Sprinkler irrigation is not feasible due to high contaminant concentrations, large volume of water to be treated, and lack of an appropriate area to discharge the water.

6.2.5 Containment

The purpose of groundwater containment is to restrict the flow of contaminated groundwater. This is generally accomplished by a physical barrier (slurry wall, sheet piling), hydraulic control (removing water from the ground, such as by pumping from extraction wells), or reactive barriers. Containment technologies that rely on groundwater extraction are occasionally supplemented with a low permeability subsurface barrier wall to improve the effectiveness of the extraction system. Another groundwater containment technology includes groundwater collection trenches, which are constructed for the purpose of collecting groundwater.

At the Photocircuits/Pall Corporation site, contamination (concentrations in excess of SCGs) exists throughout the study area. Containment was reviewed as a limited response action to prevent further migration of highly contaminated groundwater from the northwestern end of the study area (i.e., Pall/August Thomsen) onto the Glen Cove property (including the day care center, boxing center, and former potable wellfield). The discussion below assumes that containment would be installed at the northern boundary of the Pall Corporation Site, extending from its eastern end at the Glen Cove Arterial Highway westward to Glen Cove Creek, a distance of about 250 ft.

Physical containment barriers (walls) are limited by the fact that a low permeability formation does not exist within a reasonable depth (i.e., within 100 ft of the ground surface) at the Site, as well as by the fact that the western extent of contamination (on the west side of Glen Cove Creek) is unknown (and to a lesser extent, the extent to which the contaminated groundwater extends to the east under the Glen Cove Arterial Highway. Active barriers (e.g., permeable reactive barriers [PRBs]) are effective at treating halogenated VOCs, but suffer the same limitations in controlling the northward flow of contamination as physical barriers. Physical and reactive barriers are not considered further due to this limitation.

Effectiveness – Groundwater extraction wells may be used to exert hydraulic control to prevent the migration of the groundwater toward the for Glen Clove property. Prior to the design of such a system a thorough analysis of the aquifer properties including pump tests would need to be performed to ensure an adequate array of extraction wells are installed. The extracted groundwater would be routed to in an *ex situ* treatment unit.

Implementability – For the subsurface conditions at the Site, groundwater extraction wells are an implementable technology for exerting hydraulic control to prevent further migration of the plume. The materials, equipment, and labor necessary to install extraction wells are readily available. The installation of physical or reactive barriers would be difficult to implement at the depths required to cut off groundwater in OU-2.

Cost – The relative costs hydraulic control utilizing extraction wells is expected to be less than the cost of installing physical or passive barriers. Capital costs would include materials, equipment and labor to install the extraction wells, submersible pumps, and piping and associated appurtenances. Operation and maintenance costs would include long-term pumping costs to remove groundwater for treatment, routine maintenance on wells and piping, and costs for groundwater monitoring

Physical walls and reactive barrier technologies did not pass preliminary screening and are not evaluated further as stand-alone technologies. Hydraulic control using an extraction well will be carried forward as part of a pump and treat remedy.

6.2.6 In-Well Air Stripping (Groundwater Recirculation)

The in-well groundwater circulation well system creates *in situ* vertical groundwater circulation cells by drawing groundwater from the aquifer through the lower screen of a double-screened well and discharging it through the second screen (upper) section. While groundwater circulates in and out of the stripping cell, no groundwater is removed from the ground. Air is injected into the well through a gas injection line and diffuser, releasing bubbles into the contaminated groundwater. These bubbles aerate the water and form an air-lift pumping system (due to an imparted density gradient) that causes groundwater to flow upward in the well. As the bubbles rise, VOC contamination in the groundwater is transferred from the dissolved state to the vapor state through an air stripping process. Groundwater may be polished at the well head through carbon adsorption or injection of a chemical oxidant prior to recirculation.

The air/water mixture rises in the well until it encounters the dividing device within the inner casing. The divider is designed to maximize volatilization. The air/water mixture flows from the inner casing to the outer casing through the upper screen. A vacuum is applied to the outer casing, and contaminated vapors are drawn upward through the annular space between the two casings. The partially treated groundwater re-enters the subsurface through the upper screen and infiltrates back to the aquifer and the zone of contamination where it is eventually cycled back through the well, thus allowing groundwater to undergo sequential treatment cycles until the remedial objectives are met. Off-gas from the stripping system is collected and treated (e.g., using granular activated carbon; see 6.2.7.1, below). Pilot testing and field measurements would be required to determine the exact well and piping configuration.

Effectiveness – The effectiveness of in-well recirculation is dependent on the groundwater velocity and the contaminant concentrations within the treatment zone along with the air injection rate. The greater the concentrations and velocities, the more recirculation wells will be required along the axis of groundwater flow. A pilot test would be required prior to full scale implementation. Given the vertical heterogeneity of the deep overburden, placement of the intake and discharge screens would have to be strategically designed to optimize recirculation of the groundwater.

Implementability – For the subsurface conditions at the Site, recirculation wells are an implementable technology to treat the plume and prevent further migration of the plume. The materials, equipment, and labor necessary to install extraction wells are readily available. However, this remedy would likely affect the OU-1 remedy and would not specifically target OU-2.

Cost – The relative costs for recirculation wells are expected to be moderate as compared to other remedial technologies used to remove groundwater for treatment (i.e., groundwater extraction). Capital costs would include materials, equipment and labor to install the extraction wells, treatment system, and piping and associated appurtenances. Operation and maintenance costs would include long-term costs for off-gas treatment, routine maintenance on the system, and costs for groundwater monitoring.

In-well recirculation will not be considered further because of the inability to target the OU-2 plume.

6.2.7 Ancillary Technologies [Off-gas treatment]

Some of the response actions evaluated above require additional response actions or technologies. Specifically, some *ex situ* treatment options (air stripping, and in some cases oxidation) will require treatment of contaminated vapors. Also, *ex situ* groundwater treatment options will require a means of discharge. These are discussed below.

6.2.7.1 Vapor Phase Treatment Options

Both oxidation and carbon adsorption are used for control of VOC-contaminated vapors. Although oxidation has the benefit of destroying the contaminants (adsorption just transfers the contaminants to another medium), granular carbon adsorption is cost-effective and most commonly used. (For example, it is identified as the presumptive/preferred off-gas treatment option in DER-15 [NYSDEC, 2007].) Lower molecular weight VOCs with lower carbon partition coefficients (Koc values) such as vinyl chloride do not adsorb as well as other site contaminants, and are subject to being stripped off the carbon as its adsorptive capacity is reached. Therefore, a two (or more) unit system will likely be required, with careful monitoring for breakthrough.

In summary, vapor phase carbon adsorption is retained as the default treatment technology for alternatives which may require vapor phase treatment for chlorinated VOCs.

6.2.7.2 Groundwater Discharge Options

There are two basic options for groundwater discharge: onsite discharge (reinjection), or off-site discharge (City of Glen Cove sewer system, or Glen Cove Creek). Any or all of these options may be useful during the course of site remediation, and all of them will likely require permits or equivalent regulatory review.

On-site Discharge

On-site discharge, specifically re-injection of treated water, is an option for treated water. As noted in the RI report, both the Photocircuits and Pall Corporation sites historically had re-injection wells installed at 120 ft to 180 ft bgs on site for cooling water. Due to the variability of the subsurface lithology mounding may be a concern. Aquifer testing should be conducted prior to designing the injection system, or perhaps as part of the remedy selection process.

Off-site Discharge

Off-site discharge may be directly to Glen Cove Creek (surface water discharge); indirect discharge to surface water through the City of Glen Cove storm sewer system; or discharge to the City of Glen Cove POTW through the sanitary sewer system.

<u>Direct Discharge to Surface Water (Glen Cove Creek)</u>

Glen Cove Creek is a Class C waterbody (6NYCRR 885.6, Table 1), which ultimately discharges to Long Island Sound. Glen Cove Creek typically has very low flow (in at least one previous study, the flow rate was too low to be measurable [Enviro-Sciences, 2001a]). Discharge would also likely need to conform to Nassau County stormwater program requirements, and SPDES requirements. As such, the discharge to Glen Cove Creek would likely need to be fully treated to meet surface water criteria.

<u>Indirect Discharge to Surface Water (Glen Cove Stormwater Sewer system)</u>

Discharge to the Glen Cove stormwater sewer system is addressed by Chapter 237 of the municipal code; and SPDES General Permit GP-02-02 for stormwater discharges from municipal stormwater sewer systems. Other than perhaps greater flexibility in allowable discharge flow rates, discharge to the stormwater sewer system would need to meet the same or similar criteria as the direct discharge to Glen Cove Creek.

<u>Discharge to POTW (through Glen Cove sanitary sewer system)</u>

The City of Glen Cove has its own publicly owned treatment works (POTW), which is operated by a contractor (Severn-Trent as of 2007 [pers. comm. – R Forstner (AECOM)]). Discharges to the POTW through the sanitary sewer system are regulated under Chapter 225 of the Glen Cove municipal code. The regulations include a prohibition on the discharge of groundwater to the POTW [§225-45 (15)]; however, informal discussions with POTW personnel suggest that, subject to specific limitations (including both flow and contaminant loading) indicate that the POTW may accept treated groundwater from a remedial project. Typical limits for discharge to a

POTW is that the total toxic organic concentration must be less than 2.13 mg/L [USEPA, 2007], which should be achievable.

Glen Cove also has specific numeric limitations for some pollutants [§225-45 and -46]; although RI groundwater samples were not analyzed for many of these parameters (metals, sulfide, nitrogen, etc.), initial review of these effluent limits suggests that meeting these limits would not likely be a problem for treated water discharges.

Cost estimates for discharge to a POTW vary widely (USEPA, 2007a). For the purpose of the FS, a low-end estimate of $0.001 per 1,000 gallons has been assumed.

The POTW discharge restrictions also prohibit the discharge of stormwater and unpolluted industrial process water [§225-45 (15)]; suggesting that at some point during the remediation (i.e., when the treated discharge was “clean” or met stormwater/surface water discharge criteria), the treated effluent could be discharged to the stormwater sewer system.

In summary, no specific groundwater discharge option has been identified as the preferred option at this point in the FS. However, the FS assumes on-site discharge (re-injection) as there are fewer administrative issues associated with on-site discharge than with off-site discharge.

6.3 Summary of Technology Screening

Based on the screening of technologies presented in the chapter, the following response actions, technologies, and process options have been retained for consideration in the development of remedial alternatives (presented in Chapter 7).

- No action (with and without groundwater monitoring) is retained as required by USEPA (1988) and NYSDEC (2002)
- Groundwater extraction by extraction wells is retained for use as part of an *ex situ* treatment alternative in conjunction with air stripping.
- Groundwater treatment by chemical oxidation (by Fenton’s reagent or permanganate) is retained for consideration as an *in situ* process option
- A combination of *in situ* groundwater treatment with permanganate in conjunction with groundwater extraction and reinjection will be evaluated.
- Primary technologies/options discussed above may require additional (auxiliary) technologies or process options. These include:
    - Management of (*ex situ*) treated groundwater by
        - On site discharge of treated groundwater by injection wells
        - Off site discharge of treated groundwater to the storm sewer system
        - Off site discharge of treated groundwater to the Glen Cove POTW
    - Treatment of vapor phase contamination by carbon adsorption

7.0 DEVELOPMENT AND ANALYSIS OF ALTERNATIVES

Based on the technology review and screening (as summarized in Section 6.3), four remedial alternatives were initially developed for the remediation of contaminated groundwater in OU-2 at the Site. Subsequent to NYSDEC's review of the draft FS report, NYSDEC requested evaluation of an additional alternative (5A) as described below. The selected alternatives are presumptive remedies as specified in DER-15. These alternatives include readily available technologies which have been proven to be effective at similar sites with VOC contamination in groundwater. The selected alternatives are compatible with the selected OU-1 alternatives for shallow groundwater at the Photocircuits and Pall Corporation sites. The selected alternatives focus on treating the OU-2 groundwater contaminated with total VOC concentrations greater than 1,000 µg/L; most of which underlies the Pall Corporation Site (see Figure 3.3.2). By concentrating on treating the most contaminated groundwater at the Site, the fringe of the plume (total VOC concentrations less than 1,000 µg/L) may attenuate naturally but will require monitoring. The alternatives include technologies targeted to meet the RAOs and SCGs for the Site.

The selected alternatives include:

Alternative 1 – No action. This alternative includes no action of any sort whatsoever; it does not include groundwater monitoring. Inclusion of a no-action alternative is required as a baseline against which other alternatives are evaluated.

Alternative 2 – No Action with groundwater monitoring.

Alternative 3 – Groundwater Extraction in conjunction with *ex situ* treatment consisting of air stripping with carbon polishing, and carbon treatment of off-gases. Treated groundwater will be discharged to the POTW under Alternative 3.

Alternative 4 – *In Situ* Chemical Oxidation by permanganate, considered a presumptive remedy (DER-15; NYSDEC, 2007), with on-site injection wells screened in OU-2.

Alternative 5 – This alternative includes a combination of Alternatives 3 and 4 including the injection of permanganate targeting the OU-2 plume, downgradient extraction wells for containment and *ex situ* groundwater treatment with air stripping and upgradient reinjection of treated groundwater.

Alternative 6 – *In Situ* chemical oxidation by permanganate, with groundwater extraction and reinjection without *ex situ* treatment.

NYSDEC guidance requires that an alternative be developed which restores the site to pre-release conditions, to the extent practical. Based on the extent and depth of contamination at this site, restoration to pre-release conditions (assumed to be detectable contamination) was not considered practical. However, continued operation of any of the active alternatives (3, 4, 5 and 6) beyond the point where SCGs are achieved may more closely approach pre-release conditions.

7.1 Remedial Action Alternatives

As described above, six site remedial action alternatives (including no action) have been assembled using the general response actions and remedial technologies that passed the preliminary screening. An expanded description of each of the alternatives is provided below.

7.1.1 Alternative No. 1 – No Action

The No Action alternative involves taking no further action to remedy impacted groundwater in OU-2. NYSDEC and USEPA guidance requires that the No Action alternative be considered in the detailed analysis of alternatives. However, the No Action alternative is considered an unacceptable alternative, as the site would remain in its present condition and human health and (to a lesser extent) the environment would not be adequately protected.

7.1.2 Alternative No. 2 – No Action with Groundwater Monitoring

This alternative assumes that groundwater sampling would be conducted annually for at least 30 years. These wells are listed in Table 7-1 and shown on Figure 7-1. These wells have been selected to monitor VOC concentrations at the edges of plume (within the limits of existing wells) and also to provide some data regarding contamination within or near suspected source or high concentration areas. During each monitoring event, 21 existing wells will be purged and sampled for VOCs by EPA method 8260, and water levels in the wells will be measured. A subset of the groundwater samples will also be analyzed for monitored natural attenuation parameters. Costs also include an environmental easement/deed restriction and preparation of an annual letter report summarizing the data. It is assumed that this groundwater impacts will not be remediated by this alternative.

7.1.3 Alternative No. 3 – Groundwater Extraction and ex situ Treatment by Air Stripping

Figure 7-2 presents conceptual a conceptual layout of Alternative No. 3. Groundwater extraction and *ex situ* treatment are the primary components of this alternative. Locations of extraction wells (Figure 7-3) would be determined during the design phase after the completion of a pump test. The extraction wells will be installed to target the areas of groundwater contamination with total VOC concentrations greater than 1,000 µg/L. The wells would be screened within the impacted OU-2 aquifer approximately 60 to 100 feet bgs. An additional extraction well would be operated along the leading edge of the plume to both treat and contain impacted OU-2 groundwater.

Approximately 11,100,000 gallons of contaminated groundwater are targeted for treatment by this alternative. Two extraction wells would be installed along the plume axis (i.e., north-south direction) and one well for hydraulic control along the northern border of the Pall/August Thomsen property and the Glen Cove property. Wells would not likely be needed on the Photocircuits site as the dissolved phase COCs would be remediated as part of the OU-1 remedy, based on the depth of contamination on the Photocircuits site and the definition of OU-1 (see Figure 3-5). Operation of this remedy would have to be coordinated with the chemical oxidant injections for Pall Corporation Site OU-1.

This alternative targets the more highly contaminated portion of the OU-2 groundwater plume; specifically, areas with total chlorinated aliphatic concentrations greater than about 1,000 µg/L. The contaminated volume assumed for this alternative is shown in Table 4-4, based on the volume with contamination greater than 1 mg/L (1000 µg/L). With this constraint, the preliminary layout for this alternative suggests that all the extraction wells can be located on the north side of Sea Cliff Avenue.

The following is a description of the remedial actions included in Alternative No. 2:

- Aquifer tests would be performed on-site (downgradient) in order to provide information to efficiently design the groundwater extraction system. The aquifer pump tests should be performed at various depth intervals. Results of the pump tests will be used to assess optimum pump rates and well layouts for the pumping wells as well as provide preliminary information on contaminant loading to the treatment system.

- Conceptually the extraction system would consist of three extraction wells and would be operated for long-term groundwater control (i.e., at least 30 years).
- A groundwater treatment system would be installed in a new treatment building. Alternatively, existing structures on the Pall Corporation site could be evaluated for use if appropriate.
- The groundwater treatment system is expected to consist of an equalization tank, bag filters, an air stripper (a presumptive remedy [DER-15], NYSDEC, 2007), a granular activated carbon system (for polishing), and an effluent holding tank. A vapor phase carbon adsorption system would be used for removal of organic air emissions from the air stripper; however, the carbon systems could eventually be removed when contaminant concentration levels are below applicable NYSDEC criteria. Conceptually, treated water would be discharged to the stormwater sewer system located along Sea Cliff Avenue (see section 6.2.5.2 for a discussion of the groundwater discharge options).
- Groundwater monitoring would be performed to evaluate the extent to which the remedial action objectives are being met at the northern property boundary (between Pall/August Thomsen Site and City of Glen Cove property).
- Operation and maintenance activities are necessary for the extraction and treatment systems (e.g., equipment maintenance, monitoring effluent air and water, vapor and liquid-phase carbon replacement). This work is necessary to maintain treatment performance and life span. This work should be performed weekly.
- Groundwater samples would be collected from select monitoring wells on an annual basis for analysis of VOCs. The results will be summarized in annual Periodic Review reports.

7.1.4 Alternative No. 4 – In Situ Chemical Oxidation

Figure 7-3 presents the conceptual layout for Alternative No. 4. A component of this alternative is *in situ* chemical oxidation to address the contaminated groundwater with total VOC concentrations greater than 1,000 µg/L. Injection of a chemical oxidant (provides an aggressive approach to treatment of impacted OU-2 groundwater. The targeted approach will allow for aggressive treatment for areas of higher concentrations while allowing the lesser contamination to diminish by natural attenuation.

ISCO injection wells would be installed with an equal spacing between wells though spacing may be affected by on site structures. For the purpose of this FS, the injection well spacing is estimated to be 50 ft. The injections would be performed in the areas of higher VOC concentrations which are located on the Pall Corporation Site. This remedy is compatible with the OU-1 remedy for the Pall Corporation Site as specified in the ROD (NYSDEC, 2004).

One chemical oxidation technology is selected for detailed analysis. Although several chemical oxidants (permanganate and Fenton's) are considered to be effective at reducing VOC concentrations at the source area, sodium permanganate is considered and evaluated herein for *in situ* groundwater treatment for a number of reasons, including the following:

- A pilot study has been conducted in OU-1 which has demonstrated the effectiveness of permanganate at remediating contaminated groundwater at the Site.

- Sodium permanganate ($NaMnO_4$) has a longer half-life in the subsurface relative to Fenton's Reagent (i.e., months compared to hours).

- Sodium permanganate is safer than Fenton's Reagent in that no significant heat and off-gas will be generated.

- The overall costs of a full-scale application of Fenton's Reagent and sodium permanganate would be comparable, relative to the costs of other available innovative *in situ* treatment technologies (e.g., *in situ* thermal treatment via steam stripping).

- Sodium permanganate would be injected to reduce the volume of highly contaminated groundwater associated with the source area. The reagent would be applied through deep injection wells screened with in OU-2 groundwater to target groundwater with VOC concentrations greater than 1,000 µg/L.

- It is assumed that up to three injections of approximately 250,000 pounds of sodium permanganate in a 10 percent solution will be required to treat an estimated 11,100,000 gallons of impacted groundwater above 1mg/L in OU-2.

Prior to full-scale implementation, a pilot study would be performed to assess the feasibility of the process at the site and to design the injection volumes of permanganate. The pilot study would include first a laboratory treatability study to further evaluate the efficiency of permanganate with site groundwater samples. If the results of the pilot study are favorable, a full-scale/phased application of the technology would be implemented.

For the purposes of this FS, *in situ* chemical oxidation via sodium permanganate would reduce the mass of subsurface chlorinated VOCs in deep groundwater (OU-2), such that long term groundwater monitoring would be reduced to approximately 12 years of monitoring after the three years of injections.

Groundwater monitoring would be performed as described for Alternative No. 1; however samples will be collected on a quarterly basis for the first three years in order to monitor the effectiveness of the permanganate.

7.1.5 Alternative No. 5 - ISCO Injection and Pump and Treat

This alternative is a combination of Alternatives 2 and 3 and would include the injection of permanganate, groundwater extraction at the northern edge of the Pall Corporation Site and upgradient reinjection of treated water. The conceptual layout for Alternative No. 5 is included as Figure 7-4.

- Aquifer testing would be performed on-site in order to provide information to design the groundwater extraction and reinjection system. Due to the variability in the lithology at the site tests should be performed at various depth intervals near the proposed extraction and reinjection wells. Results of the study will be used to assess optimum pump rates, injection rates and well layouts as well as provide preliminary information on contaminant loading to the treatment system. Groundwater modeling would be used to determine if mounding will be an issue with reinjection of groundwater.

- The extraction system would consist of several pumping wells and would be operated for long-term groundwater control.

- A groundwater treatment system would be installed in a new treatment building. Alternatively, existing structures on the Pall Corporation Site could be evaluated for use if appropriate.
- The groundwater treatment system is expected to consist of an equalization tank, bag filters, an air stripper, a granular activated carbon system (for polishing), and an effluent holding tank. A vapor phase carbon adsorption system would be used for removal of organic air emissions from the air stripper; however, the carbon systems could eventually be removed when contaminant concentration levels are below applicable NYSDEC criteria.
- Conceptually, treated groundwater would be injected through a gallery of six infiltration wells screened in OU-2 near the upgradient edge of the plume on the Pall Corporation Site.
- It is assumed that up to the initial oxidant injection will be the same as in Alternative 4; i.e., 250,000 pounds of sodium permanganate in a 10 percent solution will be injected into several injection wells screened in OU-2 groundwater. Due to the additional contaminant mass reduction achieved through the pump and treat system, it is assumed that the second and third oxidant injection volumes will be reduced; specifically, to 200,000 pounds in the second event and 150,000 pounds in the third event.
- Groundwater monitoring would be performed to evaluate the extent to which the remedial action objectives are being met at the northern property boundary (between Pall/August Thomsen and City of Glen Cove property).
- Operation and maintenance activities are necessary for the extraction and treatment systems (e.g., equipment maintenance, monitoring effluent air and water, vapor and liquid-phase carbon replacement). This work is necessary to maintain treatment performance and life span. This work should be performed weekly.

7.1.6 Alternative No. 6 - ISCO Injection and Groundwater Extraction (Recirculation) without Ex Situ Treatment

This alternative is a combination of Alternatives 2, 3, and 4 and would include the injection of permanganate, groundwater extraction at the northern edge of the Pall Corporation Site and upgradient reinjection of untreated water. The conceptual layout for Alternative No. 6 is included as Figure 7-5.

- Aquifer testing would be performed on-site in order to provide information to design the groundwater extraction and reinjection system. Due to the variability in the lithology at the site tests should be performed at various depth intervals near the proposed extraction and reinjection wells. Results of the study will be used to assess optimum pump rates, injection rates and well layouts. Groundwater modeling would be used to determine if mounding will be an issue with reinjection of groundwater.
- The extraction system would consist of several pumping wells and would be operated for long-term groundwater control.
- Conceptually, untreated (i.e., no *ex situ* treatment) extracted groundwater would be re-injected through a gallery of six infiltration wells screened in OU-2 near the upgradient edge of the plume on the Pall Corporation Site.

- Sodium permanganate would be injected to reduce the volume of highly contaminated groundwater associated with the source area. The reagent would be applied through deep injection wells screened with in OU-2 groundwater to target groundwater with VOC concentrations greater than 1,000 µg/L.
- It is assumed that up to three injections of approximately 250,000 pounds of sodium permanganate in a 10 percent solution will be required to treat an estimated 11,100,000 gallons of impacted groundwater above 1 mg/L in OU-2.
- Groundwater monitoring would be performed to evaluate the extent to which the remedial action objectives are being met at the northern property boundary (between Pall/August Thomsen and City of Glen Cove property).
- Operation and maintenance activities are necessary for the extraction and reinjection systems (e.g., equipment maintenance, monitoring effluent water). This work is necessary to maintain treatment performance and life span. This work should be performed weekly.

Prior to full-scale implementation, a pilot study would be performed to assess the feasibility of the process at the site and to design the injection volumes of permanganate. The pilot study would include first a laboratory treatability study to further evaluate the efficiency of permanganate with site groundwater samples. If the results of the pilot study are favorable, a full-scale/phased application of the technology would be implemented.

For the purposes of this FS, *in situ* chemical oxidation via sodium permanganate would reduce the mass of subsurface chlorinated VOCs in deep groundwater (OU-2), such that long-term groundwater monitoring would be reduced to approximately 12 years of monitoring after the three years of injections.

Groundwater monitoring would be performed as described for Alternative No. 1; however samples will be collected on a quarterly basis for the first three years in order to monitor the effectiveness of the permanganate.

7.2 Detailed Analysis of Alternatives - General

7.2.1 Introduction

The purpose of the detailed analysis of remedial action alternatives is to present the relevant information to select an on-Site remedy. During the detailed analysis, the alternatives established in Section 6.1 are compared on the basis of environmental benefits and costs using criteria established by NYSDEC in DER-10 (NYSDEC, 2010). This approach is intended to provide needed information to compare the merits of each alternative and select an appropriate remedy that satisfies the remedial action objectives for the Site.

This section first presents a summary of the seven evaluation criteria (six environmental criteria and cost effectiveness) in DER-10 to be used to compare the alternatives. As discussed below, the eighth criterion, land use, is not applicable to the OU-2 remedy selection process. The final criterion, Community Acceptance, is evaluated after the public comment period.

7.2.2 Description of Evaluation Criteria

1. <u>Overall Protection of Human Health and the Environment:</u> This criterion provides an overall assessment of protection of human health and the environment, based on a composite of factors assessed under the evaluation

criteria, especially short-term effectiveness, long-term effectiveness and performance, and compliance with cleanup goals.

2. Compliance with Applicable or Relevant and Appropriate SCGs and Remediation Goals: This criterion is used to evaluate the extent to which each alternative may achieve the proposed cleanup goals. The cleanup goals were developed based on SCGs developed in Section 2.0.

3. Long-Term Effectiveness and Permanence: This criterion addresses the long-term protection of human health and the environment after completion of the remedial action. An assessment is made of the effectiveness of the remedial action in managing the risk posed by untreated wastes and/or the residual contamination remaining after treatment, and the long-term reliability of the remedial action.

4. Reduction of Toxicity, Mobility, and Volume through Treatment: This criterion addresses NYSDEC's preference for selecting "remedial technologies that permanently and significantly reduce the toxicity, mobility and volume" of the contaminants of concern at the Site. This evaluation consists of assessing the extent that the treatment technology destroys toxic contaminants, reduces mobility of the contaminants using irreversible treatment processes, and/or reduces the total volume of contaminated media.

5. Short-Term Impacts and Effectiveness: This criterion addresses the impacts of the alternative during the construction and implementation phase until the remedial action objectives are met. Factors to be evaluated include protection of the community during the remedial actions; protection of workers during the remedial actions; and the time required to achieve the remedial action objectives. Several alternatives described within the following sections may not be effective in meeting remedial action objectives in less than 30 years. Therefore, references to short-term impacts and effectiveness may include discussions of impacts/ effectiveness over a period of 30 years.

6. Implementability: This criterion addresses the technical and administrative feasibility of implementing an alternative and the availability of services and materials required during implementation. Technical feasibility refers to the ability to construct and operate a remedial action for the specific conditions at the Site and the availability of necessary equipment and technical specialists. Technical feasibility also considers construction and operation and maintenance difficulties, reliability, ease of undertaking additional remedial action (if required), and the ability to monitor effectiveness. Administrative feasibility refers to compliance with applicable rules, regulations, statutes and the ability to obtain permits or approvals from other government agencies or offices.

7. Cost Effectiveness: The estimated capital costs, long-term operation and maintenance costs, and environmental monitoring costs are evaluated. The estimates included herein assume engineering costs equal 15% of the capital costs; and, contingency/administrative costs equal 20% of the capital costs. A net present worth (also referred to as net present value, or NPV) analysis is made to compare the remedial alternatives on the basis of a single dollar amount for the base year. For the net present worth analysis, the interest rate applicable to borrowed funds and the average inflation rate is assumed to be 5%. [NPV

calculations were performed as described in USEPA (2007b), with Year 1 discounted in accordance with NYSDEC policy.] It is also assumed that a maximum 30-year operational period would be necessary for groundwater control systems and Site monitoring. The comparative cost estimates are intended to reflect actual costs with an accuracy of +50 percent to –30 percent.

8. Land Use: This criterion is an evaluation of the current, intended, and reasonably foreseeable future use of the site and its surroundings, as it relates to an alternative or remedy. The "Site," as it applies to this RI/FS, is defined as OU-2 (deep groundwater) and does not include a land use component. Land use for the Pall Corporation and Photocircuits Corporation was addressed in the previously-issued RODs for the two sites (see Appendix A), and is therefore not addressed in this FS report.

9. Community Acceptance: This criterion is evaluated after the public review of the remedy selection process as part of the final selection/approval of a remedy for the site. As such, this criterion is not evaluated as part of this FS report.

7.3 Detailed Analysis of Site Alternatives

Alternatives No. 1 through 6 are evaluated individually in terms of the seven environmental and cost criteria described above. Descriptions of the alternatives are provided in Section 7.1. Table 7-9 presents a summary of the Detailed Analysis.

7.3.1 Alternative No. 1 – No Action

1. Overall Protection of Human Health and the Environment: This alternative is not protective of human health and the environment, since the Site would remain in its present condition. As identified as part of the qualitative risk assessment, groundwater can migrate further off site, to impact downgradient receptors and continue to harm the aquifer, although there are no current known exposed receptors. High concentrations of chlorinated VOCs in deep groundwater (OU-2) will also adversely impact any remedial activities undertaken for shallow groundwater (OU-1) under existing RODs (NYSDEC, 2004; and NYSDEC, 2008a).

2. Compliance with Applicable or Relevant and Appropriate SCGs and Remediation Goals: This alternative will not comply with the chemical-specific SCGs for the Site. The contaminant levels in the groundwater are not expected to decrease appreciably over time, as neither natural attenuation nor volatilization is expected to significantly reduce the levels of contamination.

No location-specific SCGs were identified. Action-specific SCGs (e.g., OSHA regulations) will be met during sampling activities.

3. Long-Term Effectiveness and Permanence: Because this alternative does not involve removal or treatment of the contaminated groundwater, the risks involved with the migration of contaminants and direct contact with contaminants would remain essentially the same. Collection of groundwater samples would be performed to assess the natural attenuation of the contamination. Given the mass of on-Site contaminants, reduction in risk associated with natural attenuation is not expected in a reasonable or predictable timeframe. Therefore, this alternative is not expected to provide long-term protection to human health and the environment.

4. Reduction of Toxicity, Mobility, and Volume through Treatment: This alternative does not involve the removal or treatment of the source of on-Site contamination. Therefore, neither the toxicity, nor mobility, nor volume of contamination is expected to be reduced significantly.

Natural attenuation of contaminants may reduce the concentrations in groundwater over time. However, this reduction is not expected to be significant within a reasonable amount of time (i.e., 30 years), given the high concentrations of chlorinated solvents detected at the site, long after the assumed cessation of further contaminant inputs to the system. There may be some reduction in toxicity as PCE and TCE degrade to cis-1,2-DCE, a less toxic compound. Vinyl chloride, a Class A carcinogen (USEPA-IRIS), is normally generated as the next step in the PCE/DCE sequence; however, the existing data do not show a buildup of vinyl chloride.

5. Short-Term Impacts and Effectiveness: No short-term impacts (other than those existing) are anticipated during the implementation of this alternative since there are no remedial actions involved.

This alternative does not include source removal or treatment, and will not meet the on-Site remedial action objectives in a reasonable or predictable timeframe. Human health and the environment would not be protected under this alternative. The duration of natural cleanup would depend on the natural attenuation of VOCs in groundwater. There are uncertainties in the rate and interaction of the various natural attenuation processes. The length of time required for natural cleanup or attenuation of deep groundwater contamination is unknown, however the time to reach remedial action objectives is expected to be greater than 30 years. Consequently, in accordance with USEPA FS guidance, a duration of 30 years (the maximum time period specified for evaluation) is assumed for this alternative.

6. Implementability: This alternative includes no action at the Site.

7. Cost Effectiveness: There is no cost associated with this alternative as it does not include a remedial action.

7.3.2 Alternative No. 2 – No Action with Groundwater Monitoring

1. Overall Protection of Human Health and the Environment: This alternative is not protective of human health and the environment, since the Site would remain in its present condition. As identified as part of the qualitative risk assessment, groundwater can migrate further off site, to impact downgradient receptors and continue to harm the aquifer, although there are no current known exposed receptors. High concentrations of chlorinated VOCs in deep groundwater (OU-2) will also adversely impact any remedial activities undertaken for shallow groundwater (OU-1) under existing RODs (NYSDEC, 2004; and NYSDEC, 2008a).

2. Compliance with Applicable or Relevant and Appropriate SCGs and Remediation Goals: This alternative will not comply with the chemical-specific SCGs for the Site. The contaminant levels in the groundwater are not expected to decrease appreciably over time, as neither natural attenuation nor volatilization is expected to significantly reduce the levels of contamination.

No location-specific SCGs were identified. Action-specific SCGs (e.g., OSHA regulations) will be met during sampling activities.

3. Long-Term Effectiveness and Permanence: Because this alternative does not involve removal or treatment of the contaminated groundwater, the risks involved with the migration of contaminants and direct contact with contaminants would remain essentially the same. Collection of groundwater samples would be performed to assess the natural attenuation of the contamination. Given the mass of on-Site contaminants, reduction in risk associated with natural attenuation is not expected in a reasonable or predictable timeframe. Therefore, this alternative is not expected to provide long-term protection to human health and the environment.

4. Reduction of Toxicity, Mobility, and Volume through Treatment: This alternative does not involve the removal or treatment of the source of on-Site contamination. Therefore, neither the toxicity, nor mobility, nor volume of contamination is expected to be reduced significantly. Natural attenuation of contaminants may reduce the concentrations in groundwater over time. However, this reduction is not expected to be significant within a reasonable amount of time (i.e., 30 years), given the high concentrations of chlorinated solvents detected at the site, long after the assumed cessation of further contaminant inputs to the system. There may be some reduction in toxicity as PCE and TCE degrade to cis-1,2-DCE, a less toxic compound. Vinyl chloride, a Class A carcinogen (USEPA-IRIS), is normally generated as the next step in the PCE/DCE sequence; however, the existing data do not show a buildup of vinyl chloride.

5. Short-Term Impacts and Effectiveness: No short-term impacts (other than those existing) are anticipated during the implementation of this alternative since there are no construction activities involved, only sampling. Field personnel would wear appropriate personal protective equipment during groundwater sampling in order to limit health risks due to exposure to contaminants and physical hazards. In addition, equipment used for sampling purposes would be decontaminated prior to leaving the Site, as necessary, in order to avoid the transport of contaminants.

This alternative does not include source removal or treatment, and will not meet the on-Site remedial action objectives in a reasonable or predictable timeframe. Human health and the environment would not be protected under this alternative. The duration of natural cleanup would depend on the natural attenuation of VOCs in groundwater. There are uncertainties in the rate and interaction of the various natural attenuation processes. The length of time required for natural cleanup or attenuation of deep groundwater contamination is unknown, however the time to reach remedial action objectives is expected to be greater than 30 years. Consequently, in accordance with USEPA FS guidance, a duration of 30 years (the maximum time period specified for evaluation) is assumed for this alternative.

6. Implementability: This alternative is readily implementable on a technical basis, and involves no actions other than annual groundwater monitoring. Groundwater sampling can be performed without sophisticated equipment, and the necessary services and equipment are readily available. There may, however, be administrative difficulties associated with implementing this alternative as a result of community acceptance to No Action based on the nature and extent of groundwater and soil contamination. Also, institutional controls (e.g., deed or access restrictions) would be required for the on-Site property to preclude contact with contaminated media (i.e., groundwater withdrawal or use restrictions).

7. Cost Effectiveness: The quantities, unit costs, and subtotal costs and associated assumptions for this Alternative, estimated for comparative purposes, are presented in Table 7-3. The NPV of the capital cost for this alternative is estimated to total approximately $28,600, with annual monitoring costs about $38,500, with a 30-year net present value of $592,000.

The total net present worth of capital plus operation and maintenance (O&M) and monitoring costs is estimated to be approximately $620,000 over a 30-year period.

7.3.3 Alternative No. 3 – Groundwater Extraction and Treatment by Air Stripping

1. Overall Protection of Human Health and the Environment: This alternative is considered to be protective of human health and the environment. Implementation of this alternative would result in remediation of groundwater, except for possible highly contaminated areas. Although the alternative will not meet the SCGs throughout the Site within the 30-year evaluation period,

this alternative for groundwater remediation is considered to be protective of human health since groundwater will be contained on Site.

2. Compliance with Applicable or Relevant and Appropriate SCGs and Remediation Goals: It is expected that this alternative will meet the chemical-specific SCGs for on-site groundwater between the source area and the downgradient property line within a 30-year timeframe for the majority of the Site areas. However, heterogeneities may limit the effectiveness of achieving the SCGs in some areas (associated with the source area). As such, SCGs are not expected to be met at the source area in a reasonable and predictable timeframe; i.e., within 30 years.

No location-specific SCGs were identified. Action-specific SCGs (e.g., OSHA regulations) will be met during construction activities.

3. Long-Term Effectiveness and Permanence: Long-term groundwater extraction would be required. Therefore, this alternative is considered an adequate and reliable remedy for mitigating human health and environmental impacts (in terms of affecting ecological receptors) due to groundwater. The aquifer proximate to the source area will remain impacted for an indefinite period of time (i.e., this alternative is not expected to meet RAOs within the 30-year evaluation period).

4. Reduction of Toxicity, Mobility, and Volume through Treatment: The toxicity, mobility and volume of on-Site groundwater contamination are expected to be reduced significantly through the use of extraction wells and subsequent treatment. This alternative provides some degree of hydraulic control, reducing contaminant mobility. However, it is only partially effective in reducing contaminant toxicity in that PCE and TCE concentrations are expected to remain at concentrations exceeding SCGs at the end of the 30-year evaluation period.

5. Short-Term Impacts and Effectiveness: There are minimal short-term effects related to the installation and construction of this type of treatment system. The potential exists for worker exposure to contaminated groundwater during the installation of the extraction wells and during the startup of the system.

6. Implementability: This alternative is readily implementable on a technical basis. Construction and installation of the groundwater extraction/treatment systems would involve standard construction methods and equipment; and materials and services necessary for construction are readily available. With regard to operation and maintenance, the materials and services required for the systems are also readily available. Also, the instrumentation and control systems will be automated with remote access capabilities, such that the effect of possible system shut-downs would be minimized. Confirmatory groundwater sampling would be performed to monitor the effectiveness of remedial systems.

In terms of administrative concerns, this alternative is also considered to be implementable. Implementation of this alternative would require coordination with and approval by Nassau County, and Glen Cove agencies (e.g., Department of Public Works, Building Department, etc.), as well as coordination with the owners/occupants of the Site buildings and adjacent properties (e.g., August Thomsen). However, no specific problems are anticipated in obtaining permits or approvals from the various agencies and other concerns. Disruption of current Site operations is not expected to be a major concern as neither Pall nor Photocircuits is currently active (as of May 2010), although work on the Glen Cove and August Thomsen properties would have to consider minimizing disruptions to those operations. A thorough survey of utilities and piping traversing the property would need to be conducted prior to the installation of the injection/extraction wells and the associated infrastructure.

Institutional controls (e.g., deed or access restrictions) would be required for the Site property to preclude contact with remaining contaminated media.

7. Cost Effectiveness: The quantities, unit costs, and subtotal costs and associated assumptions for this Alternative, estimated for comparative purposes, are presented in Table 7-4. The NPV of the capital cost for this alternative is estimated to total approximately $645,000.

The annual O&M cost (excluding groundwater monitoring) is estimated to be approximately $196,000, with a net present value of about $3,006,000 over the 30-year life of the alternative. It should be noted that the O&M costs for this alternative are sensitive to the cost of off-site treatment (i.e., the POTW costs). If actual discharge costs are significantly higher than estimated, an alternate discharge option may need to be evaluated.

As with Alternative 2, the total net present worth of the groundwater monitoring over the 30-year life of the alternative is $592,000.

The total net present worth for this alternative is approximately $4,243,000.

7.3.4 Alternative No. 4 – In Situ Chemical Oxidation

1. Overall Protection of Human Health and the Environment: This alternative is considered to be protective of human health and the environment. Implementation of this alternative would result in remediation of groundwater. Although the alternative will not meet the SCGs throughout the Site because the fringe of the plume is not being treated it is expected that these concentrations will attenuate with the treatment of the higher VOC contaminated groundwater.

2. Compliance with Applicable or Relevant and Appropriate SCGs and Remediation Goals: This alternative is expected to meet the chemical-specific SCGs for on-site groundwater between the source area and the plume limits within a 15-year timeframe for the majority of the Site areas. This remedy targets the areas of the plume with concentrations of VOCs concentrations greater than 1,000 µg/L, allowing the fringe of the plume and residual contamination to attenuate naturally.

3. Long-Term Effectiveness and Permanence: Several injections of the oxidant would be required to effectively treat the OU-2 groundwater. This alternative is considered an adequate and reliable remedy for mitigating human health and environmental impacts (in terms of affecting habitat or vegetation) due to groundwater. The injection of an oxidant has a potential to eliminate source area impacts allowing the lower concentrations of VOCs to dissipate through natural attenuation.

4. Reduction of Toxicity, Mobility, and Volume through Treatment: The injection of a chemical oxidant would reduce the concentration of VOCs within the injected area. The injections will target groundwater impacts greater than 1,000 µg/L. As the contaminant load is reduced in the injection areas, the lower impacts on the fringe of the plume should attenuate naturally. This alternative does not control the short term expansion of the VOC plume or reduce the plume's mobility.

5. Short-Term Impacts and Effectiveness: Short-term impacts associated with *in situ* chemical oxidation utilizing sodium permanganate include risks to workers mixing and handling the solution during injection.

6. Implementability: This alternative is readily implementable on a technical basis. Construction and installation of the injection systems would involve standard construction methods and equipment; and materials and services necessary for construction are readily available. Several vendors supply and have readily available the necessary oxidants. Confirmatory groundwater sampling would be performed to monitor the effectiveness of injections. A pilot scale injection would be required prior to full scale implementation.

In terms of administrative concerns, this alternative is also considered to be implementable. Disruption of current Site operations is not expected to be a major concern as neither Pall nor Photocircuits is currently active, although work on the Glen Cove and August Thomsen properties would have to consider minimizing disruptions to those operations.

Institutional controls (e.g., deed or access restrictions) would be required for the Site property to preclude contact with remaining contaminated media. No location-specific SCGs were identified. Action-specific SCGs (e.g., OSHA regulations) will be met during construction activities.

7. Cost Effectiveness: The quantities, unit costs, and subtotal costs and associated assumptions for this Alternative, estimated for comparative purposes, are presented in Table 7-5. The net present value of the capital cost for this alternative (over the three-year expenditure period) is estimated to total approximately $3,578,000.

The annual groundwater monitoring costs for this the first three years of this alternative included more frequent monitoring (quarterly) and includes more parameters, for an annual cost in years 1 through 3 of about $94,000. Annual monitoring costs for years 4 through 15 are the same as for alternatives 2 and 3; i.e., $38,500. Over the 15-year life of the alternative, the net present value of monitoring costs is estimated to be approximately $551,000.

The total assumed net present worth for this alternative is approximately $4,130,000.

7.3.5 Alternative No. 5 – In Situ Chemical Oxidant Injection and Pump and Treat with Reinjection

1. Overall Protection of Human Health and the Environment: This alternative is considered to be protective of human health and the environment. Implementation of this alternative would result in the reduction of groundwater contamination within OU-2 groundwater.

2. Compliance with Applicable or Relevant and Appropriate SCGs and Remediation Goals: This alternative is expected to meet the chemical-specific SCGs for on-site groundwater between the source area and the downgradient property line within a10-year timeframe for the majority of the Site areas. This remedy targets source area with ISCO and allows for hydraulic control of the plume with the use of a pump and treat system. No location-specific SCGs were identified. Action-specific SCGs (e.g., OSHA regulations) will be met during construction activities.

3. Long-Term Effectiveness and Permanence: This alternative is considered an adequate and reliable remedy for mitigating human health and environmental impacts due to groundwater. The aquifer proximate to the source area may remain impacted for an indefinite period.

4. Reduction of Toxicity, Mobility, and Volume through Treatment: The injection of a chemical oxidant would reduce the concentration of VOCs within the injection area(s) and the extracted groundwater would be treated by the air stripper. The use of an extraction well(s) on the downgradient edge of the Pall Corporation Site to control the plume would limit the mobility of contaminated groundwater. The sodium permanganate injections will target the higher areas of contamination allowing for the natural attenuation of the remaining plume. The combination

of these two remedies would further reduce the time required for remediation of the plume. The quantity of permanganate required over time will be reduced because of the contaminant mass removed by the pump and treat system.

5. Short-Term Impacts and Effectiveness: There are few short-term effects associated with installation of the treatment system and the associated infrastructure. The potential exists for worker contact with impacted groundwater during the installation of the wells. There is also a short-term risk relative to workers handling the sodium permanganate.

6. Implementability: This alternative is readily implementable on a technical basis. Construction and installation of the groundwater extraction/treatment systems would involve standard construction methods and equipment; and materials and services necessary for construction are readily available. With regard to operation and maintenance, the materials and services required for the systems are also readily available. Also, the instrumentation and control systems will be automated with remote access capabilities, such that the effect of possible system shut-downs would be minimized. Confirmatory groundwater sampling would be performed to monitor the effectiveness of remedial systems.

In terms of administrative concerns, this alternative is also considered to be implementable. Implementation of this alternative would require coordination with and approval by Nassau County, and Glen Cove agencies (e.g., Department of Public Works, Building Department, etc.), as well as coordination with the owners/occupants of the Site buildings and adjacent properties (e.g., August Thomsen). However, there are no anticipated, specific problems associated with obtaining permits or approvals from the various agencies and other concerns. Disruption of current Site operations is not expected to be a major concern as neither Pall nor Photocircuits is currently active, although work on the Glen Cove and August Thomsen properties would have to consider minimizing disruptions to those operations. A thorough survey of utilities and piping traversing the property would need to be conducted prior to the installation of the injection/extraction wells and the associated infrastructure. Mounding of groundwater may be a concern pertaining to the reinjection of groundwater. A pre-design investigation of aquifer characteristics and groundwater modeling will be used to properly place the reinjection wells to avoid mounding. Automated controls will monitor for mounding and would shut down the system should this condition occur.

Institutional controls (e.g., deed or access restrictions) would be required for the Site property to preclude contact with remaining contaminated media.

7. Cost Effectiveness: The quantities, unit costs, and subtotal costs and associated assumptions for this alternative, estimated for comparative purposes, are presented in Table 7-6. The net present value of the capital cost for this alternative (over a three-year period) is estimated to total approximately $3,866,000.

The total net present value of the O&M costs over a 10-year duration is estimated to be approximately $729,000. The net present value of the total groundwater monitoring costs over the same 10-year period is approximately $462,000

The total assumed net present worth for this alternative is approximately $5,057,000.

7.3.6 Alternative No. 6 – In Situ Chemical Oxidant Injection and Groundwater Extraction and Reinjection

1. Overall Protection of Human Health and the Environment: This alternative is considered to be protective of human health and the environment. Implementation of this alternative would result in the reduction of groundwater contamination within OU-2 groundwater.

2. Compliance with Applicable or Relevant and Appropriate SCGs and Remediation Goals: This alternative is expected to meet the chemical-specific SCGs for on-site groundwater between the source area and the downgradient property line within a 12-year timeframe for the majority of the Site areas. This remedy targets source area with ISCO and allows for hydraulic control of the plume with the use of a pump and treat system. No location-specific SCGs were identified. Action-specific SCGs (e.g., OSHA regulations) will be met during construction activities.

3. Long-Term Effectiveness and Permanence: This alternative is considered an adequate and reliable remedy for mitigating human health and environmental impacts due to groundwater. The aquifer proximate to the source area may remain impacted for an indefinite period.

4. Reduction of Toxicity, Mobility, and Volume through Treatment: The injection of a chemical oxidant would reduce the concentration of VOCs within the injection area(s) and the extracted groundwater would be reinjected without *ex situ* treatment. The use of an extraction well(s) on the downgradient edge of the Pall Corp. property to control the plume would limit the mobility of contaminated groundwater. The sodium permanganate injections will target the higher areas of contamination allowing for the natural attenuation of the remaining plume.

5. Short-Term Impacts and Effectiveness: There are few short-term effects associated with installation of the treatment system and the associated infrastructure. The potential exists for worker contact with impacted groundwater during the installation of the wells. There is also a short-term risk relative to workers handling the sodium permanganate.

6. Implementability: This alternative is readily implementable on a technical basis. Construction and installation of the groundwater extraction system would involve standard construction methods and equipment; and materials and services necessary for construction are readily available. With regard to operation and maintenance, the materials and services required for the systems are also readily available. Also, the instrumentation and control systems will be automated with remote access capabilities, such that the effect of possible system shut-downs would be minimized. Confirmatory groundwater sampling would be performed to monitor the effectiveness of remediation.

In terms of administrative concerns, this alternative is also considered to be implementable. Implementation of this alternative would require coordination with and approval by Nassau County, and Glen Cove agencies (e.g., Department of Public Works, Building Department, etc.), as well as coordination with the owners/occupants of the Site buildings and adjacent properties (e.g., August Thomsen). However, there are no anticipated, specific problems associated with obtaining permits or approvals from the various agencies and other concerns. Disruption of current Site operations is not expected to be a major concern as neither Pall nor Photocircuits is currently active, although work on the Glen Cove and August Thomsen properties would have to consider minimizing disruptions to those operations. A thorough survey of utilities and piping traversing the property would need to be conducted prior to the installation of the injection/extraction wells and the associated infrastructure. Mounding of groundwater may be a concern pertaining to the reinjection of groundwater. A pre-design investigation of aquifer characteristics and groundwater modeling will be used to properly place the reinjection wells to avoid mounding. Automated controls will monitor for mounding and would shut down the system should this condition occur.

Institutional controls (e.g., deed or access restrictions) would be required for the Site property to preclude contact with remaining contaminated media.

7. Cost Effectiveness: The quantities, unit costs, and subtotal costs and associated assumptions for this alternative, estimated for comparative purposes, are presented in Table 7-7. The net present value of the capital cost for this alternative (over a three-year period) is estimated to total approximately $4,024,000.

The total net present value of the O&M costs over a 12-year duration is estimated to be approximately $386,000. The net present value of the total groundwater monitoring costs over the same 12-year period is approximately $492,000

The total assumed net present worth for this alternative is approximately $4,901,000.

7.4 Comparative Analysis of Alternatives

This section presents the comparative analysis of remedial alternatives. The alternatives are compared below on the basis of the six environmental and one cost criteria. The comparative analysis is based on the descriptions provided in Section 4.0. The cost comparison is summarized on Table 7-8, and the overall comparative analysis is summarized on Table 7-9.

7.4.1 Overall Protection of Human Health and the Environment

Alternative Nos. 3, 4, 5, and 6 will be protective of human health and the environment. Alternatives No. 1 and 2 do not provide for adequate protection of human health and the environment with regard to contaminated environmental media.

7.4.2 Compliance with Applicable or Relevant and Appropriate SCGs and Remediation Goals

Alternatives No. 3, 4, 5, and 6 are expected to achieve substantial compliance with the chemical-specific SCGs/remediation action objectives for groundwater; Alternatives No. 1 and 2 are not expected to achieve such compliance. Complete achievement of SCGs in source areas will require concurrent effective remediation of the Pall Corporation Site shallow groundwater (OU-1) and Photocircuits Site shallow groundwater (OU-1). However, Alternative 3 is not expected to meet contaminant-specific SCGs within the 30-year evaluation period.

Each of the alternatives evaluated is considered to be in compliance with action-specific SCGs; permits and approvals necessary for implementing these alternatives will be obtained prior to initiating the remedial action. No location-specific SCGs were identified.

7.4.3 Long-Term Effectiveness and Permanence

Alternatives Nos. 3, 4, 5, and 6 are considered to be adequate, reliable and permanent remedies for the remediation of groundwater. Alternatives Nos. 3 and 5 exert hydraulic control through the use of extraction wells to prevent further off-site migration of the OU-2 plume. However, Alternative 3 will approach RAOs but is not expected to achieve all SCGs within the 30-year evaluation period.

Alternatives No. 1 and 2 are not considered adequate, reliable, or permanent long-term remedies for groundwater.

7.4.4 Reduction of Toxicity, Mobility and Volume through Treatment

Alternatives Nos. 3, 4, 5, and 6 provide for the reduction of mobility and volume of impacted OU-2 groundwater. Alternatives Nos. 3, 5, and 6 exert hydraulic control of the plume.

Based on the effectiveness of the chemical oxidant approach, Alternative Nos. 4 and 5 could provide a significant reduction in contaminant levels in the highly contaminated groundwater. This FS assumes that Alternatives Nos. 4, 5, and 6 provide for a significant reduction of the subsurface PCE mass, such that a greater reduction of toxicity, mobility and volume is achieved in a shorter timeframe (approximately 10 to 15 years) than in Alternatives Nos. 1, 2 or 3. By flushing the groundwater through extraction and reinjection, Alternative No. 5 may further reduce the time required for remediation of the plume. Alternative 3 will reduce the mobility of the contaminants but will not achieve as great a reduction in toxicity (contaminant concentrations) as Alternatives 4 and 5. Alternative 6 may not achieve as great a reduction of toxicity as Alternative 5.

Alternatives No. 1 and 2 will not reduce the toxicity, mobility and volume of Site contaminants, except as occurs through natural attenuation.

7.4.5 Short-Term Impacts and Effectiveness

Alternatives Nos. 3, 4, 5, and 6 involve intrusive work, which could cause releases of contamination during installation of the remedial systems. Alternatives Nos. 4 and 5 involve the handling of sodium permanganate which can be harmful if contacted directly by workers. The implementation of a HASP and CAMP at the site will limit the potential for exposure through monitoring, PPE, and engineering controls. These alternatives may also pose disruptions to current site operations, although the disruptions are limited due the fact that neither the Pall Corporation nor Photocircuits Sites are currently in use. Alternatives No. 1 and 2 are not expected to cause releases of contamination or disruption to Site operations.

Alternatives Nos. 1, 2, and 3 are not expected to achieve the RAOs for OU-2 groundwater in a 30-year timeframe. Alternatives Nos. 4, 5, and 6 are more aggressive treatments and would allow for achieving remedial action objectives in approximately 10 to 15 years.

Alternatives No. 1 and 2 are not expected to be effective in meeting the remedial action objectives. Alternative 3 will approach RAOs but is not expected to achieve all SCGs within the 30-year evaluation period.

7.4.6 Implementability

Alternatives Nos. 1, 2, 3, 4, 5, and 6 are technically implementable with readily available methods, equipment, materials and services. Alternatives Nos. 1, 2, 3, 4, 5, and 6 are also administratively implementable. Alternative 4 requires the least amount of intrusive work and has minimal impact on site use and operation. Alternatives Nos. 3 and 5 require the installation underground piping and above-ground treatment units. For Alternatives 3, 4, 5, and 6, there are potential administrative issues for off-site disposal options; and possible technical issues (to be addressed by pilot tests or modeling) for on-site reinjection.

7.4.7 Cost

The estimated costs associated with the implementation of each alternative are presented on Tables 7-2 through 7-7, and are summarized on Table 7-8.

Alternative 1 is a no-action, no-cost alternative. Alternative No. 2 does not include remedial actions for groundwater; rather, this alternative only includes long-term groundwater monitoring. The total net present value of this alternative is approximately $620,000.

The estimated net present value of the costs for Alternatives 3, 4, 5, and 6 are in the range of $4.13 to $5.06 million.

Alternative No. 3, groundwater extraction and treatment by air stripping, is estimated to cost approximately $4.243 million. The total includes operating the system and groundwater sampling for 30 years; however, the cost is sensitive to the discharge fee paid to the POTW. Alternative No. 4, *in situ* chemical oxidation, is estimated to have a NPV cost of approximately $4.13 million. This cost assumes three injections over a three-year period with 12 additional years of groundwater monitoring.

Alternative No. 5, *in situ* chemical oxidation combined with groundwater extraction and *ex situ* treatment and reinjection has an estimated NPV cost of $5.06 million. This cost assumes three injections over a three-year period, with system operation for 10 years, and 10 years of groundwater monitoring.

Alternative No. 6, *in situ* chemical oxidation and reinjection (without *ex situ* treatment) has an estimated NPB cost of $4.90 million. This cost assumes three injections over a three-year period, with groundwater extraction, reinjection, and groundwater monitoring for 12 years.

7.8 Summary of Detailed Evaluation of Alternatives

The detailed evaluation of the alternatives is summarized on Table 7-9. All of the groundwater alternatives presented with the exception of Alternatives No. 1 and 2 would likely meet the RAOs established for the Site within the 30-year evaluation period. There are currently no significant risks to human health or the environment associated with the OU-2 groundwater and shallow groundwater will be remediated as part of the various OU-1 remedies. The concentrations of COCs in the OU-2 can be expected to decline over time through attenuation. The OU-1 remedies are likely to enhance the remediation of OU-2 because there is no physical barrier between OU-1 and OU-2; conversely, effective and complete remediation of OU-2 is to contingent upon remediation of OU-1. The data presented in the RI indicates that limited natural biodegradation of the COCs was occurring, but the data is insufficient at this time to indicate if the plume is at steady state and no longer migrating. The full areal extent of the plume is unknown due to the lack of monitoring points the east and west of the Sites. The primary concern regarding groundwater is, therefore, the potential (prior to reaching steady state) for additional migration of COCs to adjacent, less-impacted, areas. It is unknown if there are other sources of groundwater contamination cross-gradient which may be contributing to the plume. Long-term groundwater monitoring will be administratively required by the NYSDEC regardless of the alternative selected. A Site Management Plan and Site environmental easement would further address groundwater usage.

Extraction and treatment of groundwater, with discharge to the POTW, has a risk of generating added liabilities and permit issues, but would effectively reduce mass and provide a degree of control over mobility. Downgradient hydraulic control of the plume may be achieved through the use of pumping wells preventing further contamination of groundwater below the Glen Cove property to the north of the Pall Corporation Site.

In situ chemical oxidation would both enhance the potential for additional, long-term natural attenuation by reducing the concentration of COCs in the most impacted areas of OU-2. A pilot study has been conducted at the Pall Corporation Site OU-1 which demonstrated that permanganate is effective at treating the COCs at the Site. *In situ* chemical oxidation could also be cost effectively utilized in conjunction with a groundwater extraction and treatment system to reduce the duration of required treatment system operations and to provide hydraulic control of the plume.

None of the alternatives developed and evaluated in this FS achieves the goal of restoring the site to pre-release conditions, to the extent practical, with ‘pre-release’ conditions defined as no detectable contamination. Based on the extent and depth of contamination at this site, restoration to pre-release conditions was not considered practical or cost effective. However, implementation of Alternatives 3, 4, 5, or 6 will eventually achieve SCGs, which is assumed to be the pre-release condition of the aquifer at the site. Continued operation of any of the active alternatives (3, 4, 5, and 6) beyond the point where SCGs are achieved may more closely approach pre-release conditions by further reducing contaminant concentrations below SCG concentration levels.

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8.0 RECOMMENDED ALTERNATIVE

The recommended alternative will be identified after NYSDEC completes its review and evaluation of the alternatives presented in Section 7 of this report.

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SOURCE: IMAGERY USDA FARM SERVICE AGENCY; PROVIDED BY GOOGLE EARTH 2010

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FIGURE 1-1
GENERAL SITE LOCATION

PHOTOCIRCUITS AND PALL CORPORATION
GLEN COVE, NEW YORK
NYSDEC SITES 1-30-009 & 1-30-053B

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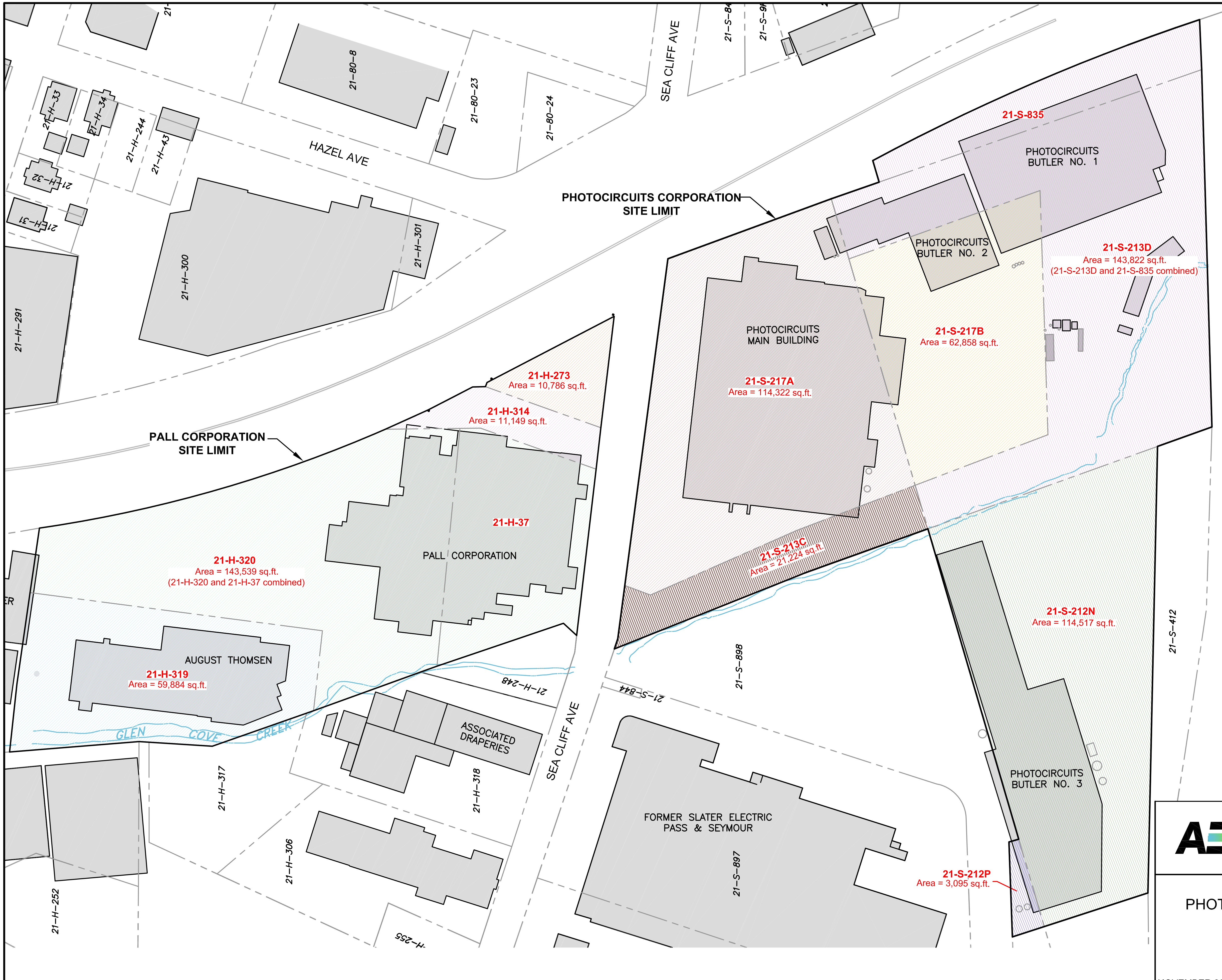

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FIGURE 1-2
PHOTOCIRCUITS AND PALL CORPORATION SITE AREAS AND LIMITS

PHOTOCIRCUITS AND PALL CORPORATION
GLEN COVE, NEW YORK
NYSDEC SITES 1-30-009 & 1-30-053B

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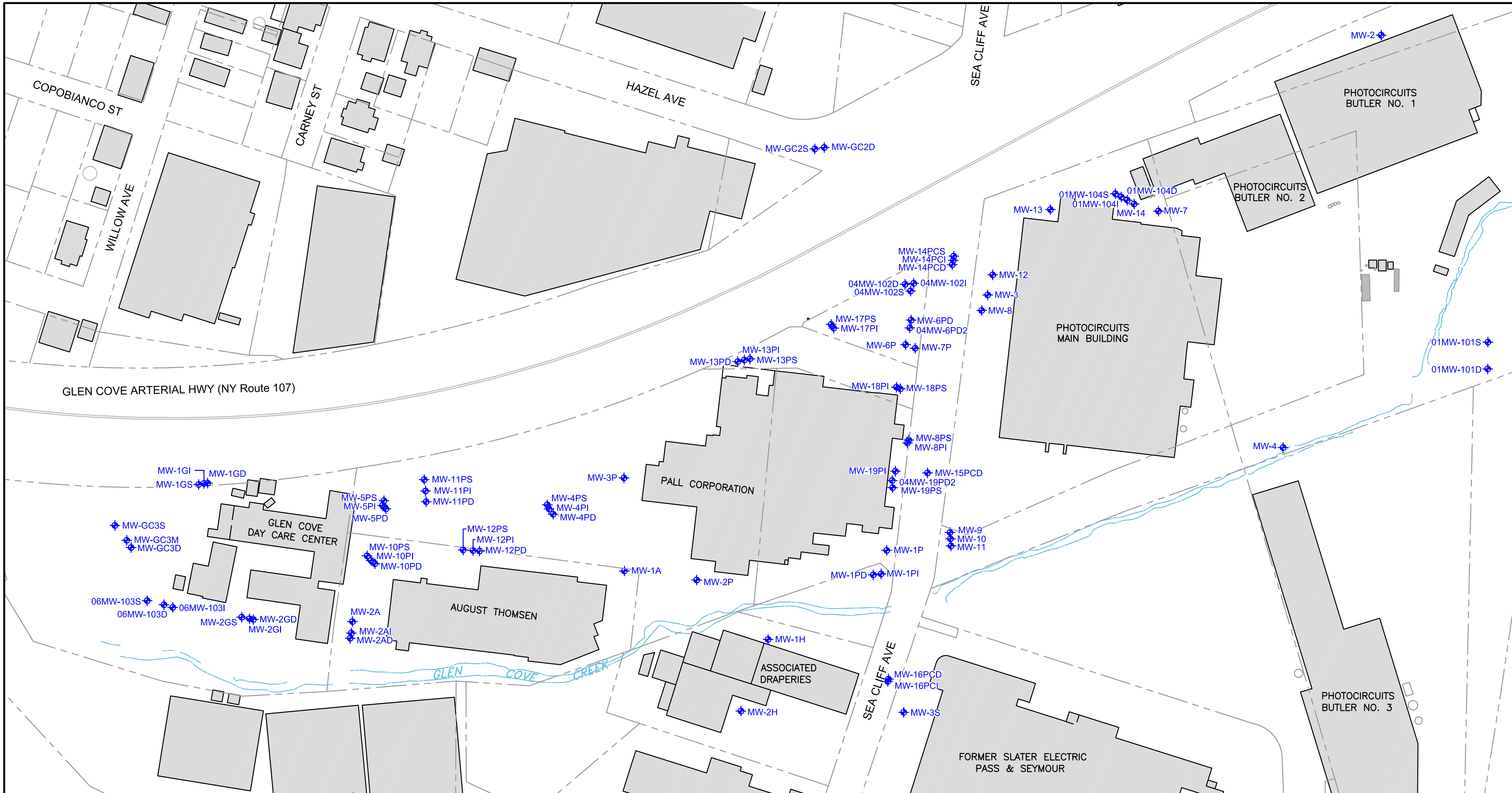

LEGEND:

MW-2GD ⌖ MONITORING WELL LOCATION

BUILDING

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FIGURE 1-3
SITE FEATURES

PHOTOCIRCUITS AND PALL CORPORATION
GLEN COVE, NEW YORK
NYSDEC SITES 1-30-009 & 1-30-053B

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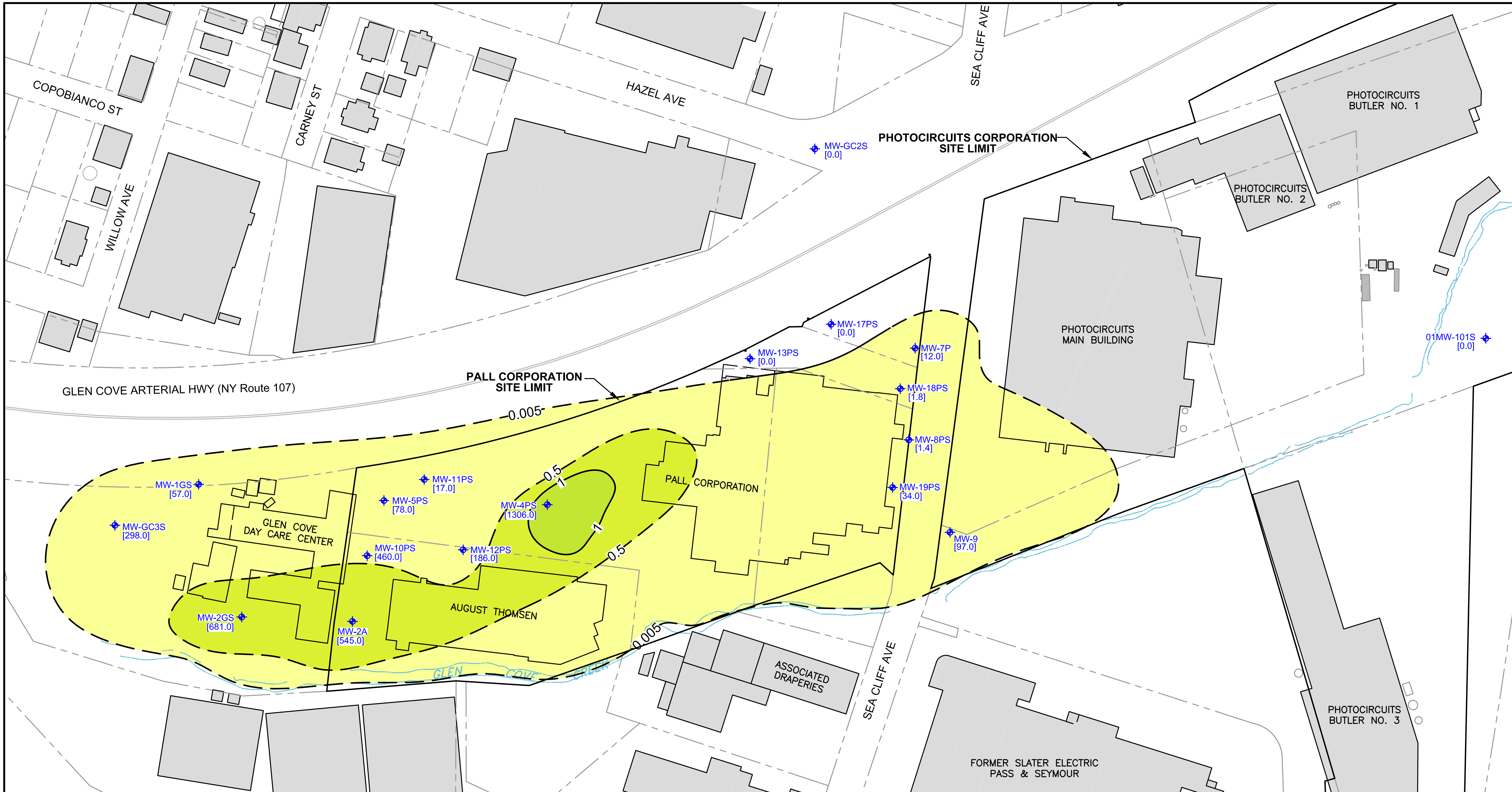

LEGEND:

MW-GC3S	MONITORING WELL LOCATION
[298.0]	TOTAL CHLORINATED ALIPHATIC CONCENTRATION IN µg/L
(line)	ISOCONCENTRATION CONTOUR LINE (DASHED WHERE INFERRED)
(grey box)	BUILDING
(light yellow)	TOTAL CHLORINATED ALIPHATICS 0.005 TO 0.5 mg/L
(yellow-green)	TOTAL CHLORINATED ALIPHATICS 0.5 TO 1 mg/L
(green)	TOTAL CHLORINATED ALIPHATICS >1 mg/L

NOTE:

1. CONTOURS ARE APPROXIMATE BASED ON THE AVAILABLE LABORATORY DATA.

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FIGURE 3-1.1
EXTENT OF CONTAMINATION APRIL 2008
SHALLOW DEPTH INTERVAL

PHOTOCIRCUITS AND PALL CORPORATION
GLEN COVE, NEW YORK
NYSDEC SITES 1-30-009 & 1-30-053B

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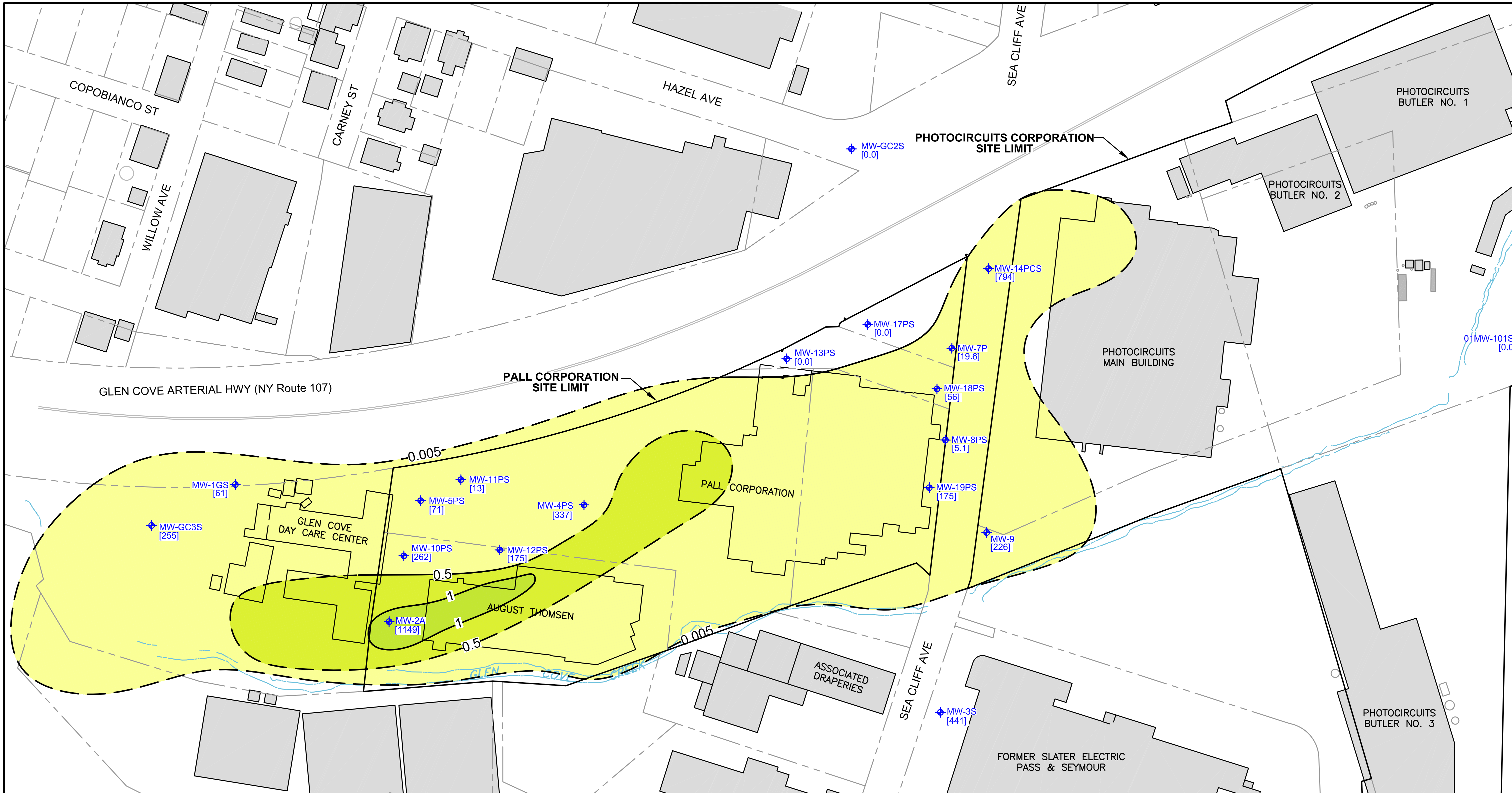

LEGEND:

- MW-GC3S — MONITORING WELL LOCATION
- [255] — TOTAL CHLORINATED ALIPHATIC CONCENTRATION IN µg/L
- ISOCONCENTRATION CONTOUR LINE (DASHED WHERE INFERRED)
- BUILDING
- TOTAL CHLORINATED ALIPHATICS 0.005 TO 0.5 mg/L
- TOTAL CHLORINATED ALIPHATICS 0.5 TO 1 mg/L
- TOTAL CHLORINATED ALIPHATICS >1 mg/L

NOTE:

1. CONTOURS ARE APPROXIMATE BASED ON THE AVAILABLE LABORATORY DATA.

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FIGURE 3-1.2
EXTENT OF CONTAMINATION OCTOBER 2008
SHALLOW DEPTH INTERVAL

PHOTOCIRCUITS AND PALL CORPORATION
GLEN COVE, NEW YORK
NYSDEC SITES 1-30-009 & 1-30-053B

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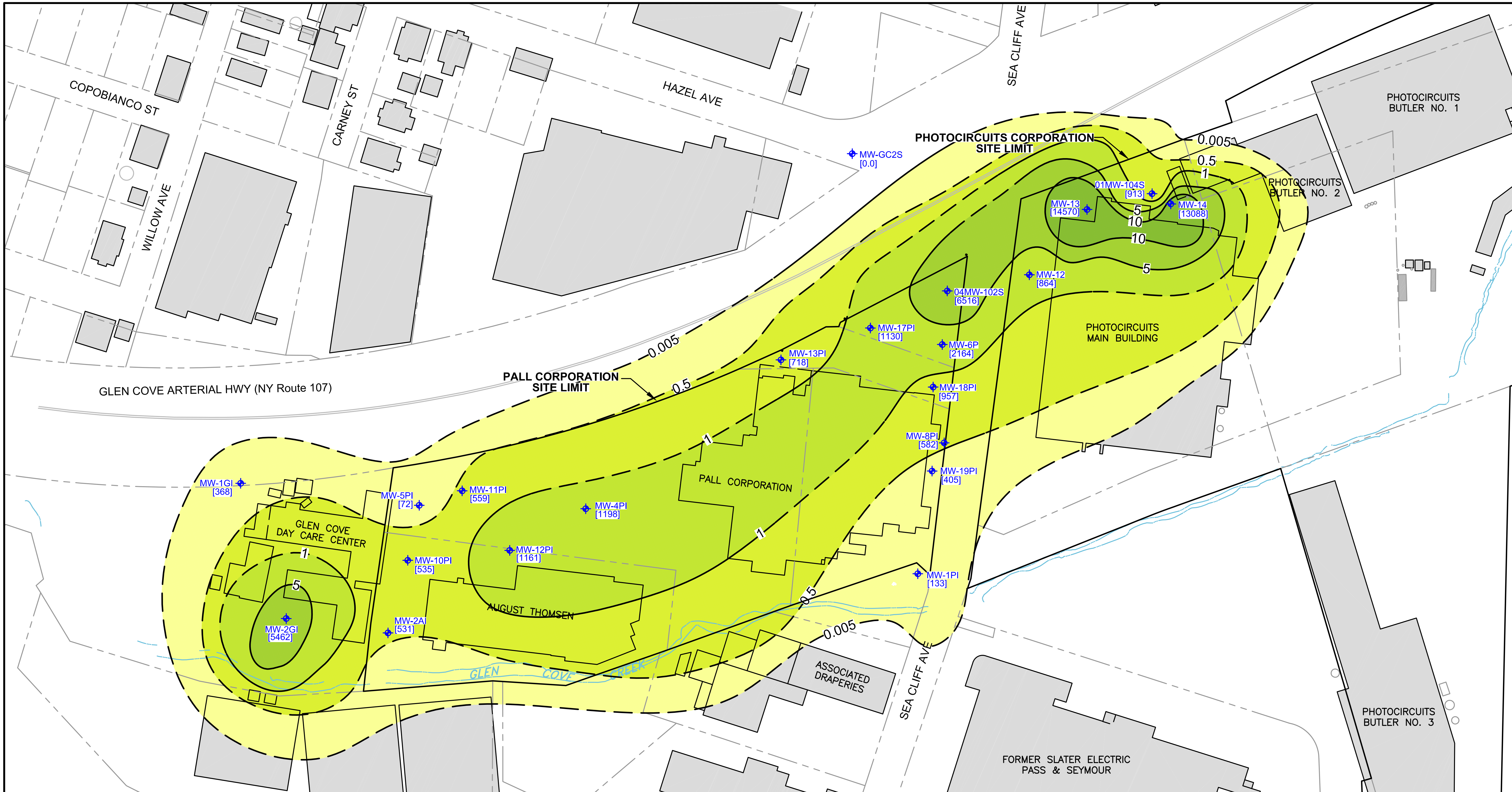

LEGEND:

MW-1GI	MONITORING WELL LOCATION		TOTAL CHLORINATED ALIPHATICS 0.005 TO 0.5 mg/L
[368]	TOTAL CHLORINATED ALIPHATIC CONCENTRATION IN µg/L		TOTAL CHLORINATED ALIPHATICS 0.5 TO 1 mg/L
			TOTAL CHLORINATED ALIPHATICS 1 TO 5 mg/L
	ISOCONCENTRATION CONTOUR LINE (DASHED WHERE INFERRED)		TOTAL CHLORINATED ALIPHATICS 5 TO 10 mg/L
	BUILDING		TOTAL CHLORINATED ALIPHATICS >10 mg/L

NOTE:

1. CONTOURS ARE APPROXIMATE BASED ON THE AVAILABLE LABORATORY DATA.

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FIGURE 3-2.1
EXTENT OF CONTAMINATION APRIL 2008
INTERMEDIATE DEPTH INTERVAL

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GLEN COVE, NEW YORK
NYSDEC SITES 1-30-009 & 1-30-053B

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FIGURE 3-2.2
EXTENT OF CONTAMINATION OCTOBER 2008
INTERMEDIATE DEPTH INTERVAL

PHOTOCIRCUITS AND PALL CORPORATION
GLEN COVE, NEW YORK
NYSDEC SITES 1-30-009 & 1-30-053B

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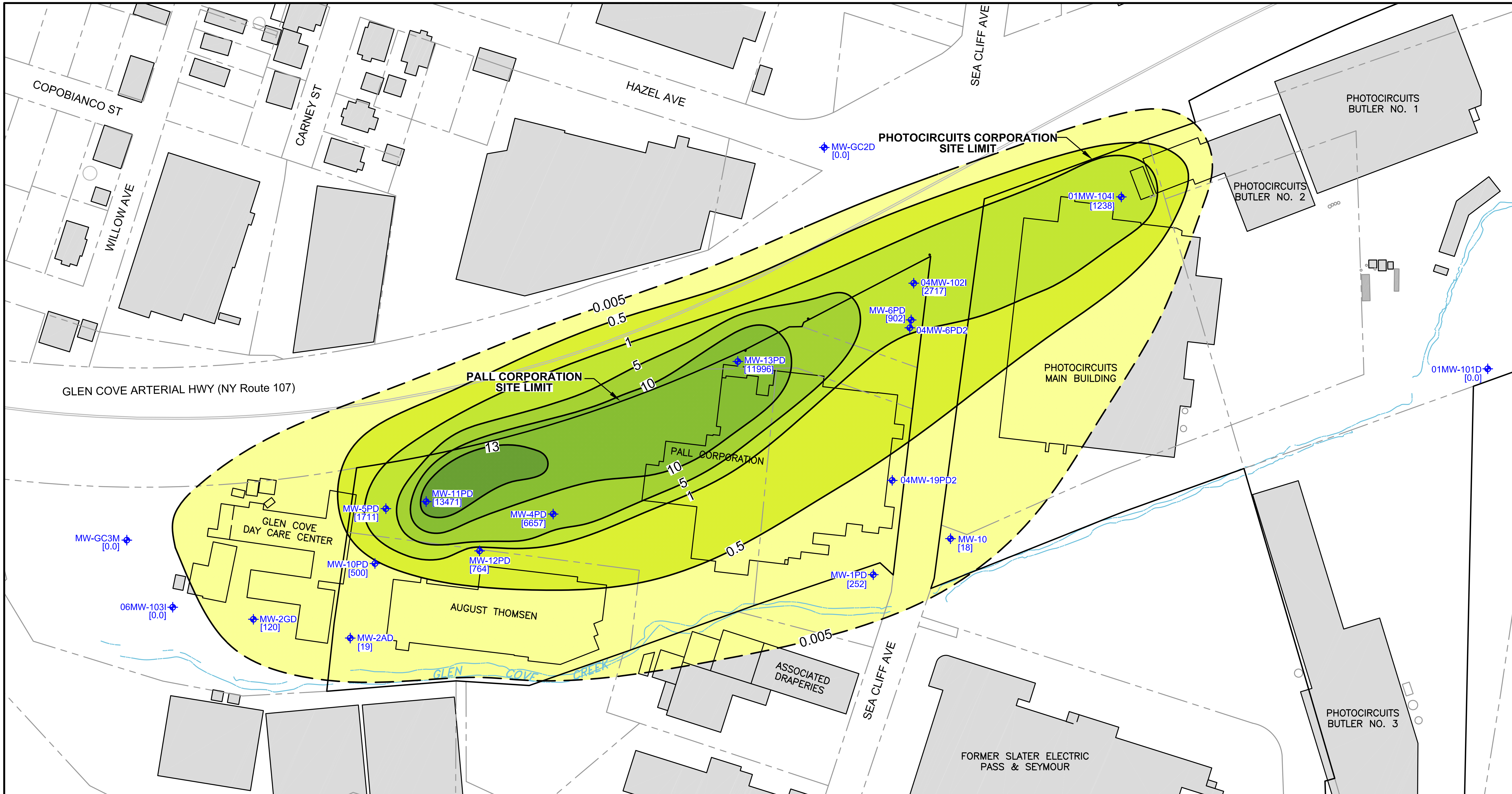

LEGEND:

- MW-2GD — MONITORING WELL LOCATION
- [120] — TOTAL CHLORINATED ALIPHATIC CONCENTRATION IN µg/L
- ISOCONCENTRATION CONTOUR LINE (DASHED WHERE INFERRED)
- BUILDING
- TOTAL CHLORINATED ALIPHATICS 0.005 TO 0.5 mg/L
- TOTAL CHLORINATED ALIPHATICS 0.5 TO 1 mg/L
- TOTAL CHLORINATED ALIPHATICS 1 TO 5 mg/L
- TOTAL CHLORINATED ALIPHATICS 5 TO 10 mg/L
- TOTAL CHLORINATED ALIPHATICS 10 TO 13 mg/L
- TOTAL CHLORINATED ALIPHATICS >13 mg/L

NOTES:

1. CONTOURS ARE APPROXIMATE BASED ON THE AVAILABLE LABORATORY DATA.
2. 04MW-18PD2 AND 04MW-6PD2 NOT CONSIDERED FOR ISOCONCENTRATION CONTOURS.

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FIGURE 3-3.1
EXTENT OF CONTAMINATION APRIL 2008
DEEP INTERVAL

PHOTOCIRCUITS AND PALL CORPORATION
GLEN COVE, NEW YORK
NYSDEC SITES 1-30-009 & 1-30-053B

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LEGEND:

- MW-2GD — MONITORING WELL LOCATION
- [120] — TOTAL CHLORINATED ALIPHATIC CONCENTRATION IN µg/L
- ISOCONCENTRATION CONTOUR LINE (DASHED WHERE INFERRED)
- BUILDING
- TOTAL CHLORINATED ALIPHATICS 0.005 TO 0.5 mg/L
- TOTAL CHLORINATED ALIPHATICS 0.5 TO 1 mg/L
- TOTAL CHLORINATED ALIPHATICS 1 TO 5 mg/L
- TOTAL CHLORINATED ALIPHATICS 5 TO 10 mg/L
- TOTAL CHLORINATED ALIPHATICS 10 TO 13 mg/L
- TOTAL CHLORINATED ALIPHATICS >13 mg/L

NOTES:

1. CONTOURS ARE APPROXIMATE BASED ON THE AVAILABLE LABORATORY DATA.
2. 04MW-19PD2 AND 04MW-6PD2 NOT CONSIDERED FOR ISOCONCENTRATION CONTOURS.

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FIGURE 3-3.2
EXTENT OF CONTAMINATION OCTOBER 2008
DEEP INTERVAL

PHOTOCIRCUITS AND PALL CORPORATION
GLEN COVE, NEW YORK
NYSDEC SITES 1-30-009 & 1-30-053B

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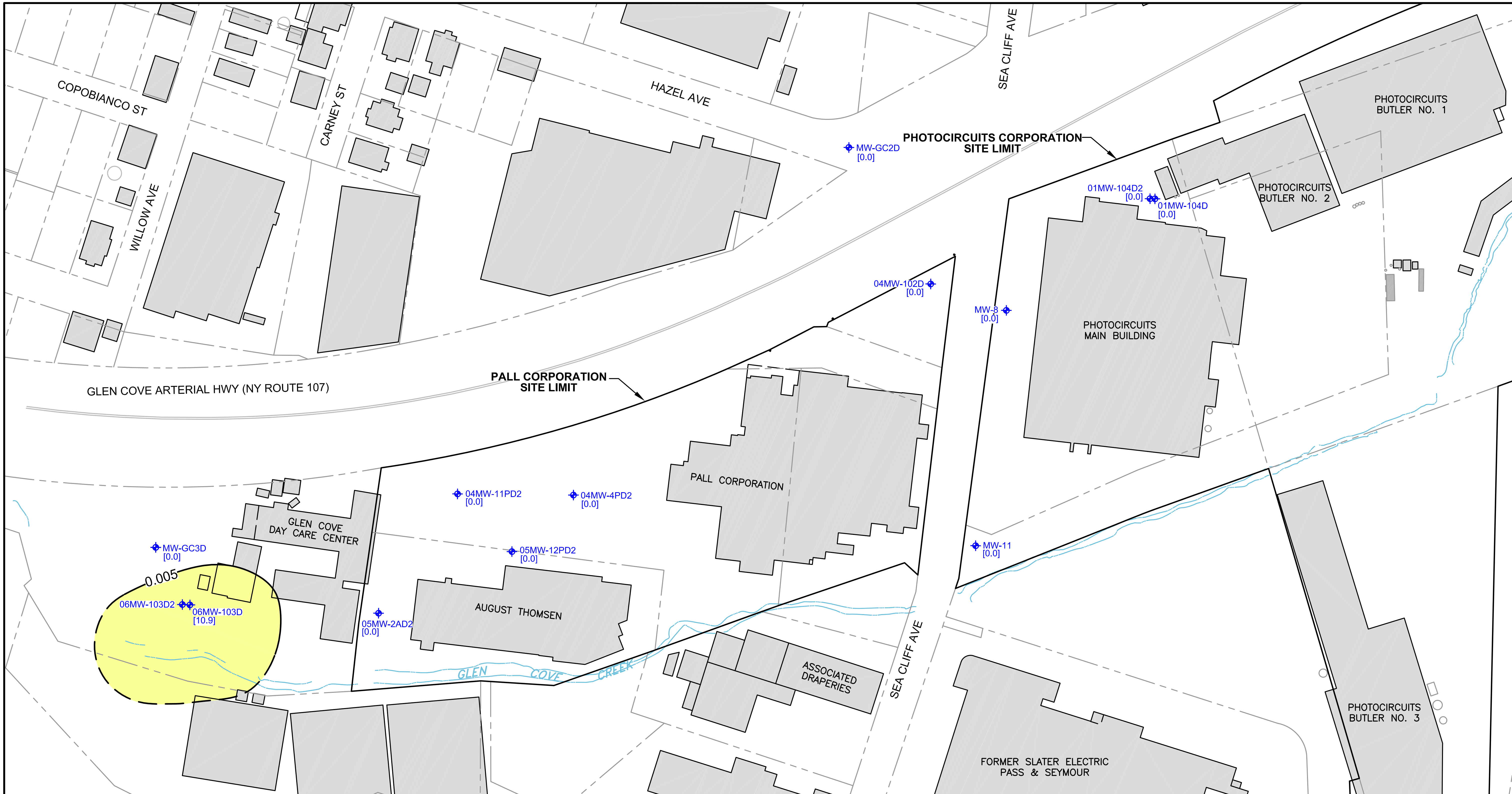

LEGEND:

- 06MW-103D MONITORING WELL LOCATION
- [10.9] TOTAL CHLORINATED ALIPHATIC CONCENTRATION IN µg/L
- ISOCONCENTRATION CONTOUR LINE (DASHED WHERE INFERRED)
- BUILDING
- TOTAL CHLORINATED ALIPHATICS >0.005

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FIGURE 3-4
EXTENT OF CONTAMINATION APRIL 2008
VERY DEEP INTERVAL

PHOTOCIRCUITS AND PALL CORPORATION
GLEN COVE, NEW YORK
NYSDEC SITES 1-30-009 & 1-30-053B

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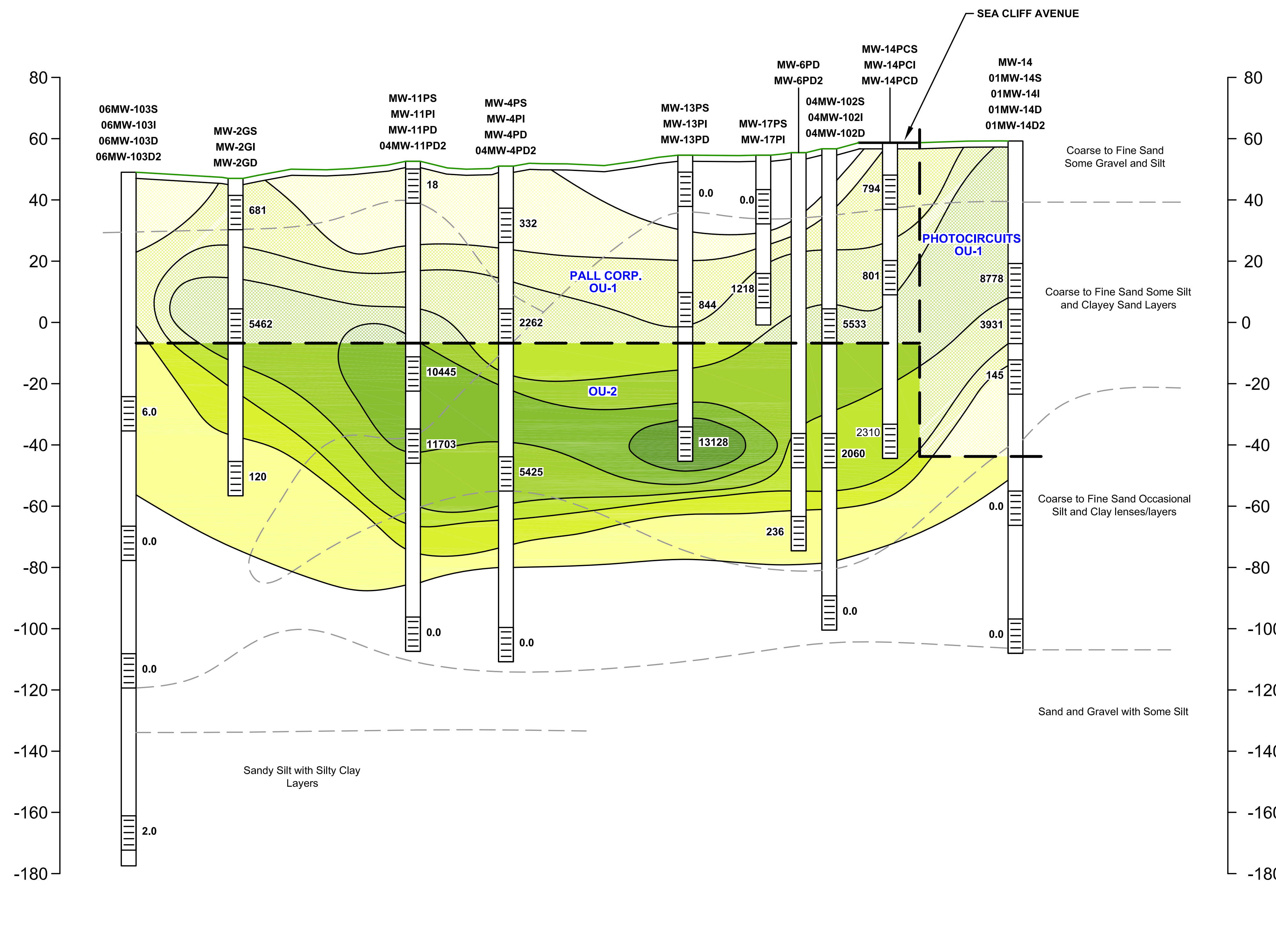

LEGEND:

- TOTAL CHLORINATED ALIPHATICS 0.005 TO 0.5 mg/L
- TOTAL CHLORINATED ALIPHATICS 0.5 TO 1 mg/L
- TOTAL CHLORINATED ALIPHATICS 1 TO 5 mg/L
- TOTAL CHLORINATED ALIPHATICS 5 TO 10 mg/L
- TOTAL CHLORINATED ALIPHATICS 10 TO 13 mg/L
- TOTAL CHLORINATED ALIPHATICS >13 mg/L

145 TOTAL CHLORINATED ALIPHATICS CONCENTRATION (µg/L) DATA COLLECTED OCTOBER 2008

BOUNDARY BETWEEN OU-1 AND OU-2

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FIGURE 3-5
EXTENT OF CONTAMINATION CROSS-SECTION

PHOTOCIRCUITS AND PALL CORPORATION
GLEN COVE, NEW YORK
NYSDEC SITES 1-30-009 & 1-30-053B

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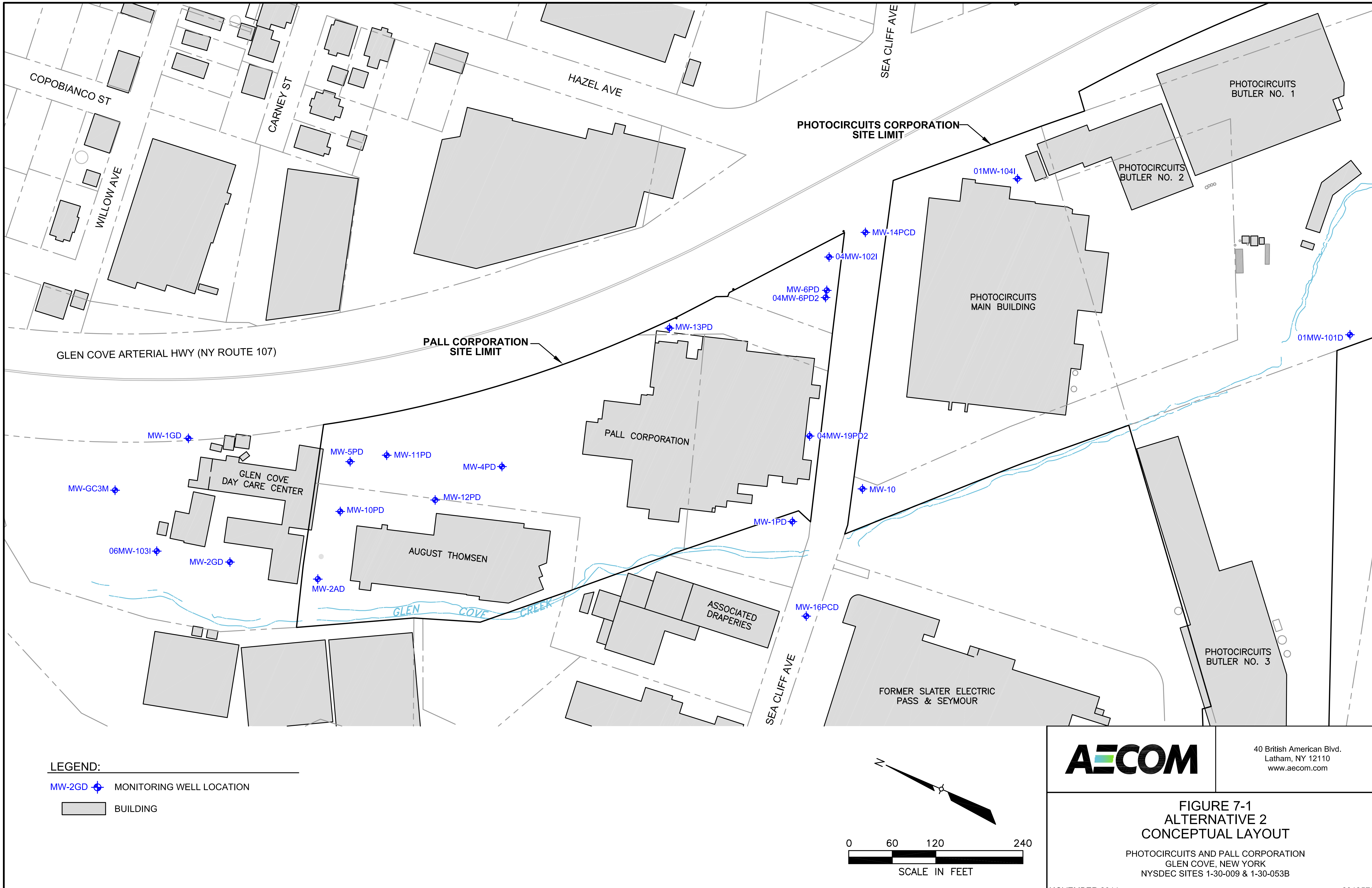

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FIGURE 7-1
ALTERNATIVE 2
CONCEPTUAL LAYOUT

PHOTOCIRCUITS AND PALL CORPORATION
GLEN COVE, NEW YORK
NYSDEC SITES 1-30-009 & 1-30-053B

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LEGEND:

- PROPOSED EXTRACTION WELL LOCATION
- MW-2GD — MONITORING WELL LOCATION
- [120] — TOTAL CHLORINATED ALIPHATIC CONCENTRATION IN µg/L
- ISOCONCENTRATION CONTOUR LINE (DASHED WHERE INFERRED)
- BUILDING
- TOTAL CHLORINATED ALIPHATICS 0.005 TO 0.5 mg/L
- TOTAL CHLORINATED ALIPHATICS 0.5 TO 1 mg/L
- TOTAL CHLORINATED ALIPHATICS 1 TO 5 mg/L
- TOTAL CHLORINATED ALIPHATICS 5 TO 10 mg/L
- TOTAL CHLORINATED ALIPHATICS 10 TO 13 mg/L
- TOTAL CHLORINATED ALIPHATICS >13 mg/L

NOTES:

1. CONTOURS ARE APPROXIMATE BASED ON THE AVAILABLE LABORATORY DATA.
2. 04MW-19PD2 AND 04MW-6PD2 NOT CONSIDERED FOR ISOCONCENTRATION CONTOURS.

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FIGURE 7-2
ALTERNATIVE 3
CONCEPTUAL LAYOUT

GLEN COVE, NEW YORK
NYSDEC SITES 1-30-009 & 1-30-053B

NOVEMBER 2011 60135725

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LEGEND:

- PROPOSED ISCO INJECTION WELL LOCATION
- MW-2GD MONITORING WELL LOCATION
- [120] TOTAL CHLORINATED ALIPHATIC CONCENTRATION IN µg/L
- ISOCONCENTRATION CONTOUR LINE (DASHED WHERE INFERRED)
- BUILDING
- TOTAL CHLORINATED ALIPHATICS 0.005 TO 0.5 mg/L
- TOTAL CHLORINATED ALIPHATICS 0.5 TO 1 mg/L
- TOTAL CHLORINATED ALIPHATICS 1 TO 5 mg/L
- TOTAL CHLORINATED ALIPHATICS 5 TO 10 mg/L
- TOTAL CHLORINATED ALIPHATICS 10 TO 13 mg/L
- TOTAL CHLORINATED ALIPHATICS >13 mg/L

NOTES:

1. CONTOURS ARE APPROXIMATE BASED ON THE AVAILABLE LABORATORY DATA.
2. 04MW-19PD2 AND 04MW-6PD2 NOT CONSIDERED FOR ISOCONCENTRATION CONTOURS.

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FIGURE 7-3
ALTERNATIVE 4
CONCEPTUAL LAYOUT

GLEN COVE, NEW YORK
NYSDEC SITES 1-30-009 & 1-30-053B

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LEGEND:

- ▲ PROPOSED INJECTION WELL LOCATION
- ■ PROPOSED EXTRACTION WELL LOCATION
- ● PROPOSED ISCO INJECTION WELL LOCATION
- MW-2GD ⌖ MONITORING WELL LOCATION
- [120] ⌖ TOTAL CHLORINATED ALIPHATIC CONCENTRATION IN µg/L
- ISOCONCENTRATION CONTOUR LINE (DASHED WHERE INFERRED)
- TOTAL CHLORINATED ALIPHATICS 0.005 TO 0.5 mg/L
- TOTAL CHLORINATED ALIPHATICS 0.5 TO 1 mg/L
- TOTAL CHLORINATED ALIPHATICS 1 TO 5 mg/L
- TOTAL CHLORINATED ALIPHATICS 5 TO 10 mg/L
- TOTAL CHLORINATED ALIPHATICS 10 TO 13 mg/L
- TOTAL CHLORINATED ALIPHATICS >13 mg/L
- BUILDING

NOTES:

1. CONTOURS ARE APPROXIMATE BASED ON THE AVAILABLE LABORATORY DATA.
2. 04MW-19PD2 AND 04MW-6PD2 NOT CONSIDERED FOR ISOCONCENTRATION CONTOURS.

0 60 120 240
SCALE IN FEET

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FIGURE 7-4
ALTERNATIVE 5
CONCEPTUAL LAYOUT

GLEN COVE, NEW YORK
NYSDEC SITES 1-30-009 & 1-30-053B

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LEGEND:

- PROPOSED INJECTION WELL LOCATION
- PROPOSED EXTRACTION WELL LOCATION
- PROPOSED ISCO INJECTION WELL LOCATION
- MW-2GD — MONITORING WELL LOCATION
- [120] — TOTAL CHLORINATED ALIPHATIC CONCENTRATION IN µg/L
- ISOCONCENTRATION CONTOUR LINE (DASHED WHERE INFERRED)
- TOTAL CHLORINATED ALIPHATICS 0.005 TO 0.5 mg/L
- TOTAL CHLORINATED ALIPHATICS 0.5 TO 1 mg/L
- TOTAL CHLORINATED ALIPHATICS 1 TO 5 mg/L
- TOTAL CHLORINATED ALIPHATICS 5 TO 10 mg/L
- TOTAL CHLORINATED ALIPHATICS 10 TO 13 mg/L
- TOTAL CHLORINATED ALIPHATICS >13 mg/L
- BUILDING

NOTES:

1. CONTOURS ARE APPROXIMATE BASED ON THE AVAILABLE LABORATORY DATA.
2. 04MW-19PD2 AND 04MW-6PD2 NOT CONSIDERED FOR ISOCONCENTRATION CONTOURS.

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SCALE IN FEET

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FIGURE 7-5
ALTERNATIVE 6
ISCO INJECTION AND GROUNDWATER EXTRACTION (RECIRCULATION) WITHOUT EX SITU TREATMENT
GLEN COVE, NEW YORK
NYSDEC SITES 1-30-009 & 1-30-053B

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Table 1-1

Block and Lot Information and Area Calculation for Photocircuits and Pall Corporation Sites

Pall Corporation Site

Section/ Block (1)	Lot(s) (1)	Address (1)	Area (AECOM calculated) (3)		Tax Map Area (acres) (1)	Owner (2)
			Square ft	Acres		
21 H	37, 320	30 Sea Cliff Avenue	143538.58	3.295	3.290	Pall Corporation
21 H	319	36 Sea Cliff Avenue	59883.99	1.375	1.370	August Thomsen
21 H	273	30 Sea Cliff Avenue	10785.50	0.248	NC	Pall Corporation
21 H	314	30 Sea Cliff Avenue	11149.25	0.256	NC	Pall Corporation
Pall Corp total			225357.32	5.173	4.660	

Photocircuits Corporation Site

Section/ Block (1)	Lot(s) (1)	Address (1)	Area (AECOM calculated) (3)		Tax Map Area (acres) (1)	Owner (2)
			Square ft	Acres		
21 S	217A	31 Sea Cliff Avenue, Glen Cove	114231.94	2.622	2.610	Photocircuits
21 S	217B	31 Sea Cliff Avenue, Oyster Bay	62858.45	1.443	1.390	PC Acquisition Corp
21 S	213C	31 Sea Cliff Avenue, Glen Cove	21223.68	0.487	NC	Photocircuits
21 S	213D/835	31 Sea Cliff Avenue, Oyster Bay	143821.55	3.302	3.350	PC Acquisition Corp
21 S	212N	31 Sea Cliff Avenue, Oyster Bay	114517.03	2.629	2.620	PC Acquisition Corp
21 S	212P	31 Sea Cliff Avenue, Oyster Bay	3094.74	0.071	NC	Photocircuits
Photocircuits total			459747.39	10.554	9.970	

(1) Nassau County Tax records; accessed 10.12/2011 at Nassau County Assessor's office http://www.nassaucountyny.gov/mynassauproperty/main.jsp

(2) Parcel owners are from NYS GIS clearinghouse database of 2004 Nassau County Tax Parcels released by NYSDEC to YEC in June 2007.

(3) Areas calculated by AECOM using CAD/GIS from YEC surveyed maps. For areas shown as multiple lots in the Nassau County records, AECOM calculated the areas of the individual lots and then summed the areas to verify the areas.

Table 3-1
Summary of Contaminants Detected in Groundwater - Round 1 Data (April 2008)

Contaminant	Screening Concentration (Class GA Criterion) (µg/L)	Number of Data Points	Number of Detections	Number Exceeding Class GA Criteria	Maximum Detected Value	Maximum Detection Sample
Chlorinated Aliphatics						
Chloroethane	5	63	9	6	6700	MW-14
Chloroform	7	70	4	0	1.3	MW-19PS
1,1-Dichloroethane	5	70	46	39	5700	MW-14
1,2-Dichloroethane	0.6	70	9	9	53	04MW-102S
1,1-Dichloroethene	5	70	37	32	780	MW-11PD
cis-1,2-Dichloroethene	5	70	53	44	5600	MW-13PD
trans-1,2-Dichloroethene	5	70	20	9	23	MW-13PD
1,2-Dichloropropane	1	70	1	1	4.1	MW-1GS
Methylene chloride	5	70	4	2	51	MW-11PD
Tetrachloroethene	5	70	46	37	1500	MW-13
1,1,1-Trichloroethane	5	70	27	15	760	MW-11PD
1,1,2-Trichloroethane	1	70	10	7	3	MW-13PD
Trichloroethene	5	70	49	42	10000	MW-13
Vinyl chloride	2	70	25	25	360	MW-11PD
Chlorofluorocarbons						
Dichlorodifluoromethane	5	53	3	3	160	MW-2GS
Chlorinated Aromatics						
2-Chlorotoluene	5	70	10	4	2000	MW-12
4-Chlorotoluene	5	70	1	1	30	MW-12
Chlorobenzene	5	70	1	0	0.69	MW-102I
1,2-Dichlorobenzene	3	70	1	0	0.68	04MW-102I
1,2,3-Trichlorobenzene	5	70	1	0	1.1	MW-12PS
1,2,4-Trimethylbenzene	5	70	1	0	2.7	MW-14
Aromatics						
Benzene	1	70	10	7	15	MW-13
Isopropylbenzene	5	70	1	0	1.2	MW-7P
n-Propylbenzene	5	70	1	0	0.6	MW-7P
Toluene	5	70	3	1	99	MW-14
Xylene (Total)	5	70	2	0	2.3	MW-14
Ketones						
Acetone	50	1	1	0	19	MW-18PS
2-Butanone	50	1	1	1	99	MW-14
Other/Miscellaneous						
Methyl tert-butyl ether	10	70	24	6	210	MW-18PS
Carbon disulfide	60	70	1	0	0.7	MW-102I

USEPA MCL for Carbon Disulfide is 50 µg/L.
All other Class GA criteria are equal to or more stringent than USEPA MCLs.

Table 3-2
Summary of Contaminants Detected in Groundwater - Round 2 Data (October 2008)

Contaminant	Screening Concentration (Class GA Criterion) (µg/L)	Number of Data Points	Number of Detections	Number Exceeding Class GA Criteria	Maximum Detected Value	Maximum Detection Sample
Chlorinated Aliphatics						
Chloroethane	5	73	8	7	3300	MW-14
Chloroform	7	73	1	0	1.1	MW-5PD
1,1-Dichloroethane	5	73	49	40	3200	MW-14
1,2-Dichloroethane	0.6	73	11	11	57	MW-102S
1,1-Dichloroethene	5	73	42	36	560	MW-104S
cis-1,2-Dichloroethene	5	73	55	45	5900	MW-13PD
trans-1,2-Dichloroethene	5	73	21	14	20	MW-13PD
Methylene chloride	5	73	8	4	35	MW-11PD
Tetrachloroethene	5	73	51	40	2000	MS-4PI
1,1,1-Trichloroethane	5	73	30	13	2000	MW-14
1,1,2-Trichloroethane	1	73	9	9	3.1	MW-11PD
Trichloroethene	5	73	56	44	9300	MW-13
Vinyl chloride	2	73	33	32	1200	MW-14PCI
Chlorofluorocarbons						
Dichlorodifluoromethane	5	73	5	3	55	MW-12PI
1,1,2-Trichlorotrifluoroethane	5	73	7	6	240	MW-12PS
Chlorinated Aromatics						
2-Chlorotoluene	5	73	15	9	2100	MW-12
4-Chlorotoluene	5	73	3	1	32	MW-14
1,2-Dichlorobenzene	3	73	2	0	1.2	MW-14PCI
Aromatics						
Benzene	1	73	13	13	13	MW-13
Isopropylbenzene	5	73	1	0	1.1	MW-7P
Toluene	5	73	3	2	67	MW-14
1,2,4-Trimethylbenzene	5	73	1	0	2.6	MW-14
Xylene (Total)	5	73	3	1	9.9	MW-14PCI
Ketones						
Acetone	50	6	6	0	49	MW-6P
2-Butanone	50	1	1	1	100	MW-14
2-Hexanone	50	73	1	0	6.5	MW-14
Other/Miscellaneous						
Methyl tert-butyl ether	10	73	25	6	180	MW-18PS
Naphthalene	10	73	1	0	1.7	MW-14

Class GA criteria are equal to or more stringent than USEPA MCLs.

Table 3-3
Monitoring Well Depth Interval Assignmenta and Groundwater Elevation Data Used in Groundwater Contour Maps
July 2007, April 2008, and October 2008 Measurements

Well Designation	Site	Ground Elev	PVC Elev	DT Top Screen	Top Elev Screen	TWD (ft)	Diam (inches)	July 2007		April 2008			October 2008		
								DTW	GW ELEV	DTW	GW ELEV	Head	DTW	GW ELEV	Head
Shallow Wells															
MW-2S	Pass & Seymour	61.07	60.96	6.00	55.07	20.8	4	5.80	55.16	5.72	55.24		Not measured	NA	
MW-3S	Pass & Seymour	58.64	58.31	5.00	53.64	19.3	4	6.19	52.12	5.93	52.38		Not measured	NA	
MW-7P	Pall Corp	56.28	55.66	3.00	53.28	17.6	4	2.81	52.85	2.05	53.61		2.77	52.89	
MW-GC2S	Public - Offsite	71.21	70.96	19.00	52.21	39	4	15.65	55.31	15.09	55.87		16.35	54.61	
MW-2	Photocircuits	61.07	60.96	10.00	51.07	24.6	2	4.33	56.63	3.54	57.42		4.41	56.55	
MW-8PS	Pall Corp	55.74	55.38	5.00	50.74	14.1	2	3.58	51.80	3.52	51.86		4.19	51.19	
MW-1A	August Thomsen	53.39	52.75	3.00	50.39	12.5	4	2.05	50.70	2.08	50.67		2.49	50.26	
MW-1P	Pall Corp	55.24	54.98	5.00	50.24	NR	4	3.71	51.27	3.23	51.75		3.75	51.23	
MW-3P	Pall Corp	53.15	52.86	3.00	50.15	15.3	4	2.18	50.68	1.62	51.24		2.24	50.62	
MW-2P	Pall Corp	53.78	53.43	4.00	49.78	14.2	4	2.60	50.83	2.52	50.91		2.87	50.56	
MW-13-PS	Pall Corp	54.73	54.43	5.00	49.73	14.7	2	2.48	51.95	1.70	52.73		2.25	52.18	
GC-3S	Public - Offsite	53.22	52.99	4.00	49.22	23.5	4	3.85	49.14	3.51	49.48		3.72	49.27	
MW-5P	Pall Corp	50.88	50.39	3.00	47.88	12.6	4	0.00	50.39	Slight artesian	50.40		0.43	49.96	
MW-7	Photocircuits	58.74	58.42	11.00	47.74	NR	4	1.20	57.22	1.45	56.97		0.89	57.53	
MW-14PCS	Sea Cliff Ave	57.64	57.27	10.00	47.64	23.5	4	3.07	54.20	Not measured	NA		3.42	53.85	
MW-3	Photocircuits	57.48	56.84	10.00	47.48	Not measured	4	2.43	54.41	Not measured	NA		3.13	53.71	
MW-2A	August Thomsen	50.14	49.24	3.00	47.14	13.1	4	0.70	48.54	0.17	49.07		0.55	48.69	
MW-4	Photocircuits	56.55	56.04	10.00	46.55	23.7	2	1.00	55.04	0.70	55.34		0.83	55.21	
MW-12PS	Pall Corp	51.50	51.06	5.00	46.50	14.5	2	1.00	50.06	1.00	50.06		1.15	49.91	
MW-11PS	Pall Corp	51.35	50.78	5.00	46.35	14.2	2	0.72	50.06	0.04	50.74		0.68	50.10	
MW-1GS	Carney St WF	50.92	50.47	5.00	45.92	15	2	1.02	49.45	0.41	50.06		0.93	49.54	
MW-10PS	Pall Corp	50.66	50.32	5.00	45.66	14.4	2	1.55	48.77	0.99	49.33		1.51	48.81	
MW-9	Photocircuits	55.46	57.03	10.00	45.46	27.8	4	5.40	51.63	4.95	52.08		5.52	51.51	
MW-2GS	Carney St WF	48.16	47.73	5.00	43.16	13.4	2	0.60	47.13	0.32	47.41		0.65	47.08	
MW-17PS	Pall Corp	56.27	55.97	15.00	41.27	27.8	4	2.65	53.32	2.16	53.81		3.19	52.78	
MW-18PS	Pall Corp	56.20	55.5	15.00	41.20	26.2	4	2.97	52.53	2.68	52.82		3.40	52.10	
MW-19PS	Pall Corp	55.69	55.07	15.00	40.69	26.2	4	3.47	51.60	3.33	51.74		3.85	51.22	
MW-4P (4PS)	Pall Corp	52.31	51.81	13.00	39.31	23.8	4	1.38	50.43	0.85	50.96		1.41	50.40	

Table 3-3
Monitoring Well Depth Interval Assignmenta and Groundwater Elevation Data Used in Groundwater Contour Maps
July 2007, April 2008, and October 2008 Measurements

Well		Ground	PVC	DT Top	Top Elev	TWD	Diam	July 2007		April 2008			October 2008		
Designation	**Site**	**Elev**	**Elev**	**Screen**	**Screen**	**(ft)**	**(inches)**	**DTW**	**GW ELEV**	**DTW**	**GW ELEV**	**Head**	**DTW**	**GW ELEV**	**Head**
Intermediate Wells															
MW-14	Photocircuits	59.16	58.8	35.00	24.16	45	4	2.50	56.30	2.13	56.67		3.25	55.55	
MW-14PCI	Sea Cliff Ave	57.77	57.38	37.00	20.77	55.9	2	2.70	54.68	Not measured	NA		3.16	54.22	
MW-13	Photocircuits	59.59	58.8	40.00	19.59	50	4	3.97	54.83	3.44	55.36		4.24	54.56	
MW-18PI	Pall Corp	56.05	55.61	37.00	19.05	55.8	4	2.30	53.31	1.84	53.77		2.60	53.01	
MW-17PI	Pall Corp	55.92	55.54	37.00	18.92	54.8	4	1.60	53.94	1.46	54.08		1.72	53.82	
MW-19PI	Pall Corp	55.68	55.21	37.00	18.68	55.9	4	2.68	52.53	2.61	52.60		3.02	52.19	
MW-12	Photocircuits	58.16	58.76	40.00	18.16	50.3	4	4.62	54.14	3.55	55.21		4.52	54.24	
MW-16PCI	Sea Cliff Ave	57.34	57.04	40.00	17.34	49.5	2	4.57	52.47	Not measured	NA		5.07	51.97	
MW-8PI	Pall Corp	55.96	55.67	40.00	15.96	49.6	2	2.62	53.05	2.30	53.37		2.93	52.74	
MW-1PI	Pall Corp	55.25	55.04	40.00	15.25	48.4	2	3.07	51.97	2.62	52.42		3.18	51.86	
MW-13PI	Pall Corp	54.61	54.3	40.00	14.61	50.2	2	1.65	52.65	0.72	53.58		1.78	52.52	
MW-12-PI	Pall Corp	51.63	51.33	40.00	11.63	47.6	2	1.68	49.65	1.32	50.01		1.74	49.59	
MW-11PI	Pall Corp	51.38	50.72	40.00	11.38	50	2	1.12	49.60	0.65	50.07		+0.92	51.64	0.26
MW-1GI	Carney St WF	50.97	50.56	40.00	10.97	50.1	2	0.55	50.01	0.24	50.32		0.85	49.71	
MW-10PI	Pall Corp	50.92	50.65	40.00	10.92	48.9	2	1.20	49.45	0.85	49.80		1.26	49.39	
MW-5PI	Pall Corp	50.89	50.5	40.00	10.89	48.4	2	0.30	50.20	+0.13	50.63		0.45	50.05	
01MW-101S	Photocircuits	60.33	59.94	49.50	10.83	60	2	NA	NA	3.13	56.81		3.30	56.64	
MW-2AI	August Thomsen	50.18	49.91	40.00	10.18	49.65	2	Artesian	NM	+0.74	50.65	0.47	+0.25	50.16	-0.02
01MW-104S	Photocircuits	59.60	59.18	49.50	10.10	58.5	2	NA	NA	3.52	55.66		3.91	55.27	
MW-2GI	Carney St WF	48.21	47.93	40.00	8.21	NR (49.6)	2	Artesian	NM	+2.58	50.51	2.30	+3.07	51.00	2.79
04MW-102S	Pall Corp	57.36	57.37	50.00	7.36	60	2	NA	NA	2.93	54.44		2.79	54.58	
MW-4PI	Pall Corp	52.31	51.85	45.00	7.31	48.5	2	1.72	50.13	1.23	50.62		1.71	50.14	
MW-6P	Pall Corp	56.23	55.87	50.00	6.23	59.6	4	2.05	53.82	1.34	54.53		2.11	53.76	
Deep Wells															
01MW-104I	Photocircuits	59.49	59.18	69.50	-10.01	80.15	2	NA	NA	3.40	55.78		3.93	55.25	
06MW-103S	Carney St WF	49.11	51.97	70.00	-20.89	83.1	2	NA	NA	1.07	50.90	1.79	1.67	50.30	
MW-14PCD	Sea Cliff Ave	57.87	57.44	85.00	-27.13	92	2	2.70	54.74	Not measured	NA		2.98	54.46	
MW-16PCD	Sea Cliff Ave	57.24	57.04	85.00	-27.76	95.7	2	4.12	52.92	Not measured	NA		4.55	52.49	
01MW-101D	Photocircuits	60.09	59.54	90.00	-29.91	100	2	NA	NA	3.21	56.33		3.56	55.98	
MW-2AD	August Thomsen	50.09	49.74	80.00	-29.91	104.5	2	Artesian	NM	+1.72	51.46	1.37	+1.18	50.92	0.83
MW-13PD	Pall Corp	54.55	54.33	85.00	-30.45	94.2	2	1.52	52.81	0.89	53.44		1.59	52.74	
04MW-102I	Pall Corp	57.81	57.49	89.00	-31.19	100	2	NA	NA	2.50	54.99		2.85	54.64	
MW-6PD	Pall Corp	56.95	56.67	90.00	-33.05	100.2	2	2.40	54.27	1.76	54.91		2.49	54.18	
MW-12PD	Pall Corp	51.73	51.51	85.00	-33.27	100.2	2	Artesian	NM	+0.46	51.97	0.24	0.06	51.45	
MW-5	Photocircuits	56.55	NS	90.00	-33.45	100.1	2	3.62	Not Surveyed	1.80	NA		1.72	NA	
MW-11PD	Pall Corp	51.45	51.51	85.00	-33.55	93.2	2	Artesian	NM	+1.24	52.75	1.30	+0.64	52.15	0.70
MW-1GD	Carney St WF	51.01	50.69	85.00	-33.99	94	2	at the cap		Slight artesian	50.70	-0.31	0.10	50.59	
MW-15PCD	Off Site	55.48	55.22	90.00	-34.52	85	2	1.65	53.57	Not measured	NA		Not measured	NA	
MW-1PD	Pall Corp	55.05	54.79	90.00	-34.95	97.6	2	2.01	52.78	1.49	53.30		2.07	52.72	
MW-10PD	Pall Corp	51.58	51.17	90.00	-38.42	99.2	2	top of PVC	51.17	+0.41	51.58	0.00	+0.01	51.18	-0.40
MW-4PD	Pall Corp	52.32	52.16	91.00	-38.68	101.4	2	0.42	51.74	0.02	52.14		0.55	51.61	
MW-5PD	Pall Corp	50.96	50.73	90.00	-39.04	98.38	2	Artesian	NM	+1.43	52.16	1.20	+0.81	51.54	0.58
MW-2GD	Carney St WF	48.22	47.93	90.00	-41.78	NR	2	Artesian	NM	+3.28	51.21	2.99	+3.86	51.79	3.57
GC-3M	Public - Offsite	51.73	51.53	94.00	-42.27	114	4	2.53	49.00	2.04	49.49		2.51	49.02	
01MW-104D	Photocircuits	59.34	59.08	110.00	-50.66	132.5	2	NA	NA	3.24	55.84		3.86	55.22	
04MW-6PD2	Pall Corp	56.71	56.42	116.00	-59.29	126	2	NA	NA	1.29	55.13		1.99	54.43	
MW-10	Photocircuits	55.57	56.96	115.00	-59.43	132	4	3.36	53.60	2.85	54.11		3.41	53.55	

Table 3-3
Monitoring Well Depth Interval Assignmenta and Groundwater Elevation Data Used in Groundwater Contour Maps
July 2007, April 2008, and October 2008 Measurements

Well Designation	Site	Ground Elev	PVC Elev	DT Top Screen	Top Elev Screen	TWD (ft)	Diam (inches)	July 2007		April 2008			October 2008		
								DTW	GW ELEV	DTW	GW ELEV	Head	DTW	GW ELEV	Head
Deep Transitional Wells (see text)															
06MW-103I	Carney St WF	48.52	51.38	110.00	-61.48	122.0	2	NA	NA	0.26	51.12	2.60	0.86	50.52	
04MW-19PD2	Pall Corp	55.39	55.11	120.00	-64.61	130	2	NA	NA	1.02	54.09		1.62	53.49	
Very Deep (D2) Wells															
04MW-102D	Pall Corp	57.90	57.56	140.00	-82.10	150	2	NA	NA	2.42	55.14		3.55	54.01	
01MW-104D2	Photocircuits	59.49	59.21	150.00	-90.51	162.9	2	NA	NA	3.50	55.71		4.10	55.11	
04MW-4PD2	Pall Corp	52.38	52.06	145.00	-92.62	155	2	NA	NA	+0.62	52.68	0.30	0.00	52.06	
05MW-12PD2	August Thomsen	51.89	51.66	145.00	-93.11	155	2	NA	NA	+0.72	52.38	0.49	+0.07	51.73	-0.16
04MW-11PD2	Pall Corp	51.53	51.18	145.00	-93.47	152.6	2	NA	NA	+1.41	52.59	1.06	+1.46	52.64	1.11
05MW-2AD2	August Thomsen	50.25	50.05	145.00	-94.75	155	2	NA	NA	+1.71	51.76	1.51	+1.01	51.06	0.81
MW-8	Photocircuits	57.19	57.56	155.00	-97.81	NR	4	3.48	54.08	2.61	54.95		2.18	55.38	
06MW-103D	Carney St WF	48.59	51.34	150.00	-101.41	161.3	2	NA	NA	0.14	51.20	2.61	0.74	50.60	
MW-11	Photocircuits	55.78	57.00	160.00	-104.22	174	NR	3.51	53.49	3.05	53.95		3.58	53.42	
MW-GC2D	Public - Offsite	70.48	70.63	188.00	-117.52	211	4	16.35	54.28	15.67	54.96		16.62	54.01	
GC-3D	Public - Offsite	51.31	50.99	180.00	-128.69	203	4	0.75	50.24	0.22	50.77		0.72	50.27	
06MW-103D2	Carney St WF	48.66	51.2	202.00	-153.34	212	2	NA	NA	>+2.0	53.74		0.55	50.65	

Elevations in ft NGVD; as surveyed by YEC (2007).
October 2008 Depth to water for Sea Cliff Avenue Wells (MW-14PC and MW-16PC series) measurements taken at time of sample collection.
See RI text (chapter 5) for discussion of depth interval assignment. Deep Transitional Wells not used in contaminant concentration contour maps.
DT Top Screen = Depth to top of screen (ft bgs)
DTW = Depth to Water (ft bgs)
TWD = Total Well Depth (ft)
Public - Offsite = Public Wellfield Monitoring Wells (installed by NCDOH and NCDPW)
Head = Artesian head

Table 4-1

Chemical-Specific Standards, Criteria, and Guidance

Title	Citation	Description/applicability
Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations	6 NYCRR 700-706 Water Quality Regulations; especially Part 703.5; summarized in TOGS 1.1.1.	Groundwater (Class GA) standards and guidance values; applicable. Establishes long-term remediation goals.
New York Public Water Supplies	10 NYCRR 5-1.52 (Tables); 10 NYCRR 170.4 (Standards for Raw Water)	Drinking Water standards; relevant. May be used where groundwater standard may not be protective of aquifer use for potable water supply.
Primary Drinking Water Regulations – Maximum Contaminant Levels	40 CFR 141.61	Establishes federal maximum contaminant levels for organic contaminants in drinking water; relevant where it addresses contaminants not included in state standards, or has more stringent criteria.
Ambient (Surface Water) standards and guidance values	NYCRR 700-706; especially Part 701 (establishes water classes); 6 NYCRR 885.6 Table I (designates Glen Cove Creek as Class C)	Surface Water Standards (Class C); potentially applicable to discharge to Glen Cove Creek.

Table 4-2

Action-Specific Standards, Criteria, and Guidance

Title	Citation	Description/applicability
Hazardous Waste Regulations	6 NYCRR Part 370	Potentially applicable for off-site disposal of contaminated groundwater classified as hazardous waste
Solid Waste Regulations	6 NYCRR Part 360	Potentially applicable for off-site disposal of contaminated groundwater classified as hazardous waste
Selection of remedial actions at hazardous waste disposal sites	NYSDEC TAGM 4030	This TAGM provides guidelines to select an appropriate remedy at State Superfund sites, and sets forth a hierarchy of remedial technology treatments consistent with SARA and RCRA land disposal restrictions.
Guidelines for the Control of Toxic Ambient Air Contaminants	Air Guide 1	Potentially applicable for alternatives with discharges to air (e.g., air stripping)
Underground Injection/ Recirculation at Groundwater Remediation Sites	NYSDEC T.O.G.S. 2.1.2	Potentially applicable for alternatives involving re-injection of groundwater
Surface water standards	6 NYCRR 701.8 (best uses for Class C); 6 NYCRR 703.5; TOGS 1.1.1.	Potentially applicable for alternatives with discharges to surface water
Glen Cove Municipal Code Title VII, Discharge Restrictions	Glen Cove Municipal Code §225 especially §225-45, -46, and -47.	Potentially Applicable for alternatives with discharges to sanitary sewer system
Stormwater discharge general permit	Nassau county general permit GP-02	Potentially applicable for discharges to stormwater sewer system

The following local (county) ordinance was reviewed but did not appear to be relevant (i.e., did not add any further requirements):

Article XI – Nassau County Public Health Ordinance – Toxic and Hazardous Materials Storage, Handling and Control Regulations.
[Revision Date: 12/02/2005]

Table 4-3

Location-Specific Standards, Criteria, and Guidance

Title	Citation	Description/applicability
None	NA	No Location-Specific SCGs identified

Table 4-4
Photocircuits/Pall Corp OU-2 FS
Contaminated Area and Volume Estimates

Total OU-2 Plume Area and Volume with Total Chlorinated VOC Concentrations Greater than 5 µg/L (0.005 mg/L)

Site Area	**Area**		**Water Column**	**Volume**	**Effective**	**Pore Volume**
(Property Name)	Sq Ft	Acres	(OU2; ft thick)	Cu ft	**Porosity**	MG
Photocircuits	76,881	1.8	10	768,810	0.3	1.7
Sea Cliff Ave (Street ROW)	38,439	0.9	65	2,498,535	0.3	5.6
Pall Corp	176,107	4.0	60	10,566,420	0.3	23.7
August Thomsen	59,863	1.4	70	4,190,410	0.3	9.4
Glen Cove (Carney St Wellfield/Day Care Ctr))	46,176	1.1	60	2,770,560	0.3	6.2
Off-Site (not included above)	155,164	3.6	60	9,309,840	0.3	20.9
Total	552,630	12.7				**67.6**

Total OU-2 Plume Area and Volume with Total Chlorinated VOC Concentrations Greater than 1.0 mg/L (FS Target Area)

Site Area	**Area**		**Water Column**	**Volume**	**Effective**	**Pore Volume**
(Property Name)	Sq Ft	Acres	(OU2; ft thick)	Cu ft	**Porosity**	MG
Photocircuits	0	0.0	0	0	0.3	0.0
Sea Cliff Ave (Street ROW)	4,916	0.1	10	49,160	0.3	0.1
Pall Corp	100,859	2.3	40	4,034,360	0.3	9.1
August Thomsen	0	0.0	0	0	0.3	0.0
Glen Cove (Carney St Wellfield/Day Care Ctr))	0	0.0	0	0	0.3	0.0
Off-Site (not included above)	43,321	1.0	20	866,420	0.3	1.9
Total	149,096	3.4				**11.1**

Contaminated areas derived by AutoCadd based on extent of contamination, deep interval, October 2008 data (Figure 3-3.2).
Off-site area includes portion of plume beneath Glen Cove Arterial Highway (NY Route 107) and areas east of Glen Cove Creek.
OU2 contaminated water column thickness scaled from cross-section Figure 3-5.

Table 7-1
Monitoring Wells Included In Bi-Annual Monitoring Program
(No Action Alternative and Other Alternatives)

Well ID	Location	Depth		OU	Rationale
		Screen (bgs)	Elev (NGVD)		
01MW-101S	Photocircuits	49.5	10.83	OU-1	Monitor upgradient groundwater
01MW-101D	Photocircuits	90	−29.91	OU-1	Monitor upgradient groundwater
01MW-104S	Photocircuits	49.5	10.1	OU-1	Monitor concentrations near Photocircuits source area
01MW-104I	Photocircuits	69.5	−10.01	OU-1	Monitor concentrations near Photocircuits source area
01MW-104D	Photocircuits	110	−50.66	OU-2	Monitor concentrations near Photocircuits source area
01MW-104D2	Photocircuits	150	−90.51	OU-2	Monitor concentrations near Photocircuits source area
MW-9	Photocircuits	10	45.56	OU-1	Westernmost on-site monitoring wells
MW-10	Photocircuits	115	−59.43	OU-2	Westernmost on-site monitoring wells
MW-11	Photocircuits	160	−104.22	OU-2	Westernmost on-site monitoring wells
MW-GC2S	Off-Site	19	52.21	NA	Sentinel well, east of known extent of plume (shallow)
MW-GC2D	Off-Site	188	−117.52	NA	Sentinel well, east of known extent of plume (deep)
MW-13PS	Pall Corp	5	49.73	OU-1	Monitor concentrations near high-contamination area
MW-13PI	Pall Corp	40	14.61	OU-1	Monitor concentrations near high-contamination area
MW-13PD	Pall Corp	85	−30.45	OU-2	Monitor concentrations near high-contamination area
MW-11PS	Pall Corp	5	46.35	OU-1	Monitor concentrations at center of Pall Corp
MW-11PI	Pall Corp	40	11.38	OU-1	Monitor concentrations at center of Pall Corp
MW-11PD	Pall Corp	85	−33.55	OU-2	Monitor concentrations at center of Pall Corp
04MW-11PD2	Pall Corp	145	−94.75	OU-2	Monitor concentrations at center of Pall Corp
06MW-103S	Glen Cove	70	−20.89	NA	Monitor northern extent of plume and migration
06MW-103I	Glen Cove	110	−61.48	NA	Monitor northern extent of plume and migration
06MW-103D	Glen Cove	150	−101.41	NA	Monitor northern extent of plume and migration
06MW-103D2	Glen Cove	202	−153.34	NA	Monitor northern extent of plume and migration

Screen (bgs) = depth to top of screen in ft bgs.
Elev = top of screen, elevation in ft NGVD.
OU = Operable unit. OU1 is ≤60 ft bgs on Pall Corp and ≤100 ft bgs on Photocircuits site.
NA = Not applicable (Off-site wells MW-GC2 series and 06MW-103 series are not within the boundaries of the OU for any site.)

Note:
Some shallow and intermediate depth wells (OU-1) and off-site wells may be included in monitoring program conducted as part of Pall Corp or Photocircuits remedial program; separate samples / analysis may not be necessary for OU2 monitoring.

Table 7-2
Alternative 1 Cost Estimate Summary
No Action
Photocircuits/Pall Corporation OU-2 Feasibility Study

Item	Item Description	Quantity	Unit Cost	Unit	Extension
CAPITAL COSTS					
	None				$0
ANNUAL O&M COSTS					
	None				$0
PRESENT WORTH CALCULATIONS					
	Total Capital Costs				$0
	Annual GW Monitoring Costs (30 year duration)				$0
	TOTAL PRESENT WORTH				**$0**
	COST TO IMPLEMENT NO ACTION REMEDIAL ALTERNATIVE			**Assume:**	**$0**

Table 7-3
Alternative 2 Cost Estimate Summary
No Action with Groundwater Monitoring
Photocircuits/Pall Corporation OU-2 Feasibility Study

Item	Item Description	Quantity	Unit Cost	Unit	Extension
CAPITAL COSTS					
	Deed Restriction, Environmental Easement	1	$ 30,000	LS	$ 30,000
	TOTAL CAPITAL COSTS				**$ 30,000**
ANNUAL O&M COSTS					
	Annual Groundwater Monitoring (21 Wells)				
	Project Planning and Organizing	1	$ 1,000	event	$ 1,000
	Field Sampling Labor	120	$ 75	hr	$ 9,000
	Sampling Equipment, Shipping, Consumable Supplies	1	$ 3,500	event	$ 3,500
	Sample Analysis(25 VOCs/MNAs)	25	$ 200	Sample	$ 5,000
	Data Evaluation and Reporting (Annual PRR Report)	1	$ 20,000	Year	$ 20,000
	Total Annual Groundwater Monitoring Cost				**$ 38,500**
PRESENT WORTH CALCULATIONS (5% Discount Rate)					
	Total Capital Costs				$ 28,571
	Annual GW Monitoring Costs (30 year duration)				$ 591,839
	TOTAL PRESENT WORTH				**$ 620,410**
	COST TO IMPLEMENT REMEDIAL ACTION ALTERNATIVE			**Assume:**	**$ 620,000**

Table 7-4
Alternative 3 Cost Estimate Summary
Groundwater Extraction and *Ex Situ* Treatment by Air Stripping
Photocircuits/Pall Corporation OU-2 Feasibility Study

Item	Item Description	Quantity	Unit Cost	Unit	Extension
CAPITAL COSTS					
Subcontractor Costs- System Construction					
	System Contractor Mobilization	1	$ 20,000	LS	$ 20,000
	Driller Mobilization	1	$ 15,000	LS	$ 15,000
	Recovery Well Installation (three 6" Wells to 90')	270	$ 105	ft	$ 28,350
	Well heads HDPE Transistions	9	$ 800	EA	$ 7,200
	Well Development	9	$ 500	Well	$ 4,500
	Pumps	3	$ 1,500	pump	$ 4,500
	Instrumentation and Controls	1	$ 25,000	LS	$ 25,000
	Air Stripper	1	$ 15,000	LS	$ 15,000
	Vapor Phase Carbon Adsorbers	2	$ 2,000	EA	$ 4,000
	Electric Hookup	1	$ 20,000	LS	$ 20,000
	Liquid Phase Carbon Adsorbers	2	$ 8,000	EA	$ 16,000
	Trenching	400	$ 75	LF	$ 30,000
	2 inch HDPE Piping	200	$ 6	LF	$ 1,200
	Treatment Building	1	$ 125,000	LS	$ 125,000
	Liquid Phase Carbon Adsorbers	2	$ 8,000	EA	$ 16,000
	Holding Tank	1	$ 3,000	EA	$ 3,000
	Waste Disposal/Analytical	18	$ 600	Each	$ 10,800
	System Assembly (Labor, travel)	1	$ 21,750	LS	$ 21,750
	System Startup	4	$ 7,500	LS	$ 30,000
	Subtotal Subcontractor Costs				**$ 397,300**
	General Contractor (15% subcontractor)				$ 59,595
	Subtotal Construction Costs (Subcontractor + Gen. Contr.)				**$ 456,895**
	Design Engineering (15% construction)				$ 68,534
	Contingency (20%)				$ 91,379
	Pre Design Pump Test/GW Modeling	1	$ 60,000	LS	**$ 60,000**
	TOTAL CAPITAL COSTS (Year 1)				**$ 677,000**
ANNUAL O&M COSTS					
	Annual Groundwater Monitoring (21 Wells)				
	Project Planning and Organizing	1	$ 1,000	event	$ 1,000
	Field Sampling Labor	120	$ 75	hr	$ 9,000
	Sampling Equipment, Shipping, Consumable Supplies	1	$ 3,500	event	$ 3,500
	Sample Analysis (25 VOCs/MNAs)	25	$ 200	Sample	$ 5,000
	Data Evaluation and Reporting (Annual PRR)	1	$ 20,000	Year	$ 20,000
	Total Annual Groundwater Monitoring Cost				**$ 38,500**
	System Operations and Maintenance				
	O&M Labor (16 hours per week)	832	$ 65	hr	$ 54,080
	O&M Analytical (Influent and Effluent GW)	12	$ 250	Sample	$ 3,000
	O&M Analytical (Vapor, TO-15)	12	$ 200	Sample	$ 2,400
	Vapor Phase Carbon	2	$ 1,000	EA	$ 2,000
	Liquid Phase Carbon	2	$ 4,000	EA	$ 8,000
	Parts	1	$ 5,000	Year	$ 5,000
	Electric	133000	$ 0.12	kwh	$ 15,960
	Discharge Fee for POTW (250 gpm @ 80% efficiency)	1.1E+08	$ 0.0010	Gallon	$ 105,120
	Total Annual System O&M				**$ 195,560**
PRESENT WORTH CALCULATIONS (5% Discount Rate)					
	Total Capital Costs				$ 644,762
	Annual GW Monitoring Costs (30 year duration)				$ 591,839
	Annual System O&M Cost (30 year duration)				$ 3,006,237
	TOTAL PRESENT WORTH				**$ 4,242,838**
	COST TO IMPLEMENT REMEDIAL ACTION ALTERNATIVE			**Assume:**	**$ 4,243,000**

Table 7-5
Alternative 4 Cost Estimate Summary
In Situ Chemical Oxidation (ISCO) Injection
Photocircuits/Pall Corporation OU-2 Feasibility Study

Item	Item Description	Quantity	Unit Cost	Unit	Extension
CAPITAL COSTS					
Subcontractor Costs- Sodium Permanganate Injection					
	Driller Mobilization	1	$ 15,000	LS	$ 15,000
	Injection Well Installation (ten 4" wells to 90)	900	$ 85	ft	$ 76,500
	Sodium Permanganate (250K-lbs/injection inc. delivery)	750,000	$ 2.80	lb	$ 2,100,000
	Injection Labor and per diem (4 weeks)	3	$ 93,000	Event	$ 279,000
	Injection Equipment (rental tanks/pumps/mixers etc.)	3	$ 10,000	Event	$ 30,000
	Subtotal Subcontractor Costs				**$ 2,500,500**
	General Contractor (15% subcontractor)				$ 375,075
	Subtotal Construction Costs (Subcontractor + Gen. Contr.)				**$ 2,875,575**
	Design Engineering (15% construction)				$ 431,336
	Contingency (20%)				$ 575,115
	Pre Design ISCO Bench Test/GW Modeling	1	$ 50,000	LS	**$ 50,000**
	TOTAL CAPITAL COSTS (Years 1 to 3)				**$ 3,933,000**
ANNUAL O&M COSTS					
	QuarterlyAnnual Groundwater Monitoring (21 Wells)				
	Project Planning and Organizing	4	$ 1,000	event	$ 4,000
	Field Sampling Labor	480	$ 75	hr	$ 36,000
	Sampling Equipment, Shipping, Consumable Supplies	4	$ 3,500	event	$ 14,000
	Sample Analysis (25 VOCs/MNAs)	100	$ 200	Sample	$ 20,000
	Data Evaluation and Reporting (Annual PRR)	1	$ 20,000	Year	$ 20,000
	Total GW Monitoring Annual Costs (Years 1-3)				**$ 94,000**
	Annual Groundwater Monitoring (21 Wells)				
	Project Planning and Organizing	1	$ 1,000	event	$ 1,000
	Field Sampling Labor	120	$ 75	hr	$ 9,000
	Sampling Equipment, Shipping, Consumable Supplies	1	$ 3,500	event	$ 3,500
	Sample Analysis (25 VOCs/MNAs)	25	$ 200	Sample	$ 5,000
	Data Evaluation and Reporting (Annual PRR)	1	$ 20,000	Year	$ 20,000
	Total GW Monitoring Annual Costs (Years 4-15)				**$ 38,500**
PRESENT WORTH CALCULATIONS (5% Discount Rate)					
	Total Capital Costs (NPV Years 1-3)				$ 3,578,747
	Annual GW Monitoring Costs (Years 1-15)				$ 550,757
	TOTAL PRESENT WORTH				**$ 4,129,504**
	COST TO IMPLEMENT REMEDIAL ACTION ALTERNATIVE			**Assume:**	**$ 4,130,000**

Table 7-6
Alternative 5 Cost Estimate Summary
ISCO, Groundwater Extraction and *Ex Situ* Treatment by Air Stripping and Groundwater Reinjection
Photocircuits/Pall Corporation OU-2 Feasibility Study

Item	Item Description	Quantity	Unit Cost	Unit	Extension
CAPITAL COSTS					
Subcontractor Costs- System Construction					
	Driller Mobilization	1	$ 15,000	LS	$ 15,000
	System Contractor Mobilization	1	$ 20,000	LS	$ 20,000
	Recovery/Injection Well Installation (nine 6" wells to 90')	810	$ 105	ft	$ 85,050
	Well heads HDPE Transistions	9	$ 800	EA	$ 7,200
	Well Development	9	$ 500	Well	$ 4,500
	Pumps	3	$ 1,500	EA	$ 4,500
	Instrumentation and Controls	1	$ 30,000	LS	$ 30,000
	Air Stripper	1	$ 15,000	LS	$ 15,000
	Vapor Phase Carbon Adsorbers	2	$ 2,000	EA	$ 4,000
	Electric Hookup	1	$ 25,000	LS	$ 25,000
	Liquid Phase Carbon Adsorbers	2	$ 8,000	EA	$ 16,000
	Holding Tank	1	$ 3,000	EA	$ 3,000
	Reinjection Manifold	2	$ 2,500	EA	$ 5,000
	Reinjection Pumps	2	$ 1,500	EA	$ 3,000
	Trenching	1500	$ 75	LF	$ 112,500
	2 inch HDPE Piping	1500	$ 6	LF	$ 9,000
	Treatment Building	1	$ 125,000	LS	$ 125,000
	Waste Disposal/Analytical	18	$ 600	Sample	$ 10,800
	System Assembly (Labor, travel)	1	$ 25,000	LS	$ 25,000
	System Startup	4	$ 7,500	Week	$ 30,000
Subcontractor Costs- Sodium Permanganate Injection					
	Driller Mobilization	1	$ 15,000	LS	$ 15,000
	Injection Well Installation (ten 4" wells to 90')	900	$ 85	ft	$ 76,500
	Sodium Permanganate (250/200/150 K-lbs/event inc. delivery)	600,000	$ 2.80	lb	$ 1,680,000
	Injection Labor and per diem (4 weeks)	3	$ 93,000	Event	$ 279,000
	Injection Equipment (rental tanks/pumps/mixers etc.)	3	$ 10,000	Event	$ 30,000
	Subtotal Subcontractor Costs				**$ 2,630,050**
	General Contractor (15% subcontractor)				$ 394,508
	Subtotal Construction Costs (Subcontractor + Gen. Contr.)				**$ 3,024,558**
	Design Engineering (15% construction)				$ 453,684
	Contingency (20%)				$ 604,912
	Pre Design Pump Test/ISCO Bench Test/GW Modeling	1	$ 100,000	LS	**$ 100,000**
	TOTAL CAPITAL COSTS (Year 1 to 3)				**$ 4,184,000**
ANNUAL O&M COSTS					
	Quarterly Groundwater Monitoring (21 Wells)				
	Project Planning and Organizing	4	$ 1,000	event	$ 4,000
	Field Sampling Labor	480	$ 75	hr	$ 36,000
	Sampling Equipment, Shipping, Consumable Supplies	4	$ 3,500	event	$ 14,000
	Sample Analysis(25 VOCs/MNAs)	100	$ 200	Sample	$ 20,000
	Data Evaluation and Reporting (Annual PRR)	1	$ 20,000	Year	$ 20,000
	Total GW Monitoring Annual Costs (Years 1-3)				**$ 94,000**
	Annual Groundwater Monitoring (21 Wells)				
	Project Planning and Organizing	1	$ 1,000	event	$ 1,000
	Field Sampling Labor	120	$ 75	hr	$ 9,000
	Sampling Equipment, Shipping, Consumable Supplies	1	$ 3,500	event	$ 3,500
	Sample Analysis (25 VOCs/MNAs)	25	$ 200	Sample	$ 5,000
	Data Evaluation and Reporting (Annual PRR)	1	$ 20,000	Year	$ 20,000
	Total GW Monitoring Annual Costs (Years 4-10)				**$ 38,500**
	System Operations and Maintenance				
	O&M Labor (16 hours per week)	832	$ 65	hr	$ 54,080
	O&M Analytical (Influent and Effluent GW)	12	$ 250	Sample	$ 3,000
	O&M Analytical (Vapor, TO-15)	12	$ 200	Sample	$ 2,400
	Vapor Phase Carbon	2	$ 1,000	EA	$ 2,000
	Liquid Phase Carbon	2	$ 4,000	EA	$ 8,000
	Parts	1	$ 5,000	Year	$ 5,000
	Electric	166000	$ 0.12	kwh	$ 19,920
	Total System O&M Annual Costs (Years 1-10)				**$ 94,400**
PRESENT WORTH CALCULATIONS (5% Discount Rate)					
	Total Capital Costs (NPV Years 1-3)				$ 3,866,153
	Annual GW Monitoring Costs (Years 1-10)				$ 462,043
	Annual System O&M Costs (10 year duration)				$ 728,932
	TOTAL PRESENT WORTH				**$ 5,057,128**
	COST TO IMPLEMENT REMEDIAL ACTION ALTERNATIVE			**Assume:**	**$ 5,057,000**

Table 7-7
Alternative 6 Cost Estimate Summary
ISCO, Groundwater Extraction and Reinjection
Photocircuits/Pall Corporation OU-2 Feasibility Study

Item Item Description	Quantity	Unit Cost	Unit	Extension
CAPITAL COSTS				
Subcontractor Costs- System Construction				
Driller Mobilization	1	$ 15,000	LS	$ 15,000
Extraction/Reinjection System Contractor Mobilization	1	$ 10,000	LS	$ 10,000
Recovery/Injection Well Installation (nine 6" wells to 90')	810	$ 105	ft	$ 85,050
Well heads HDPE Transistions	9	$ 800	EA	$ 7,200
Well Development	9	$ 500	Well	$ 4,500
Pumps	3	$ 1,500	EA	$ 4,500
Instrumentation and Controls	1	$ 7,500	LS	$ 7,500
Air Stripper	0	$ 15,000	LS	$ -
Vapor Phase Carbon Adsorbers	0	$ 2,000	EA	$ -
Electric Hookup	1	$ 12,500	LS	$ 12,500
Liquid Phase Carbon Adsorbers	0	$ 8,000	EA	$ -
Holding Tank	0	$ 3,000	EA	$ -
Reinjection Manifold	2	$ 2,500	EA	$ 5,000
Reinjection Pumps	0	$ 1,500	EA	$ -
Trenching	1125	$ 75	LF	$ 84,375
2 inch HDPE Piping	1125	$ 6	LF	$ 6,750
Treatment Building	0	$ 125,000	LS	$ -
Waste Disposal/Analytical	18	$ 600	Sample	$ 10,800
System Assembly (Labor, travel)	1	$ 5,000	LS	$ 5,000
System Startup	1	$ 7,500	Week	$ 7,500
Subcontractor Costs- Sodium Permanganate Injection				
Driller Mobilization	1	$ 15,000	LS	$ 15,000
Injection Well Installation (ten 4" wells to 90')	900	$ 85	ft	$ 76,500
Sodium Permanganate (250 K-lbs/event inc. delivery)	750,000	$ 2.80	lb	$ 2,100,000
Injection Labor and per diem (4 weeks)	3	$ 93,000	Event	$ 279,000
Injection Equipment (rental tanks/pumps/mixers etc.)	3	$ 10,000	Event	$ 30,000
Subtotal Subcontractor Costs				**$ 2,766,175**
General Contractor (15% subcontractor)				$ 414,926
Subtotal Construction Costs (Subcontractor + Gen. Contr.)				**$ 3,181,101**
Design Engineering (15% construction)				$ 477,165
Contingency (20%)				$ 636,220
Pre Design Pump Test/ISCO Bench Test/GW Modeling	1	$ 100,000	LS	**$ 100,000**
TOTAL CAPITAL COSTS (Year 1 to 3)				**$ 4,395,000**
ANNUAL O&M COSTS				
Quarterly Groundwater Monitoring (21 Wells)				
Project Planning and Organizing	4	$ 1,000	event	$ 4,000
Field Sampling Labor	480	$ 75	hr	$ 36,000
Sampling Equipment, Shipping, Consumable Supplies	4	$ 3,500	event	$ 14,000
Sample Analysis(25 VOCs/MNAs)	100	$ 200	Sample	$ 20,000
Data Evaluation and Reporting (Annual PRR)	1	$ 20,000	Year	$ 20,000
Total O&M Annual Costs (Years 1-3)				**$ 94,000**
Annual Groundwater Monitoring (21 Wells)				
Project Planning and Organizing	1	$ 1,000	event	$ 1,000
Field Sampling Labor	120	$ 75	hr	$ 9,000
Sampling Equipment, Shipping, Consumable Supplies	1	$ 3,500	event	$ 3,500
Sample Analysis (25 VOCs/MNAs)	25	$ 200	Sample	$ 5,000
Data Evaluation and Reporting (Annual PRR)	1	$ 20,000	Year	$ 20,000
Total Groundwater Monitoring Annual Costs (Years 1-12)				**$ 38,500**
System Operations and Maintenance				
O&M Labor (8 hours per week)	416	$ 65	hr	$ 27,040
O&M Analytical (Extracted GW 1 composite/month)	12	$ 125	Sample	$ 1,500
Parts	1	$ 5,000	Year	$ 5,000
Electric	83000	$ 0.12	kwh	$ 9,960
Total System O&M Annual Costs (Years 1-12)				**$ 43,500**
PRESENT WORTH CALCULATIONS (5% Discount Rate)				
Total Capital Costs (Years 1-3)				$ 4,023,509
Annual GW Monitoring Costs (Years 1-12)				$ 492,375
Annual Extraction System O&M Costs (12 year duration)				$ 385,551
TOTAL PRESENT WORTH				**$ 4,901,435**
COST TO IMPLEMENT REMEDIAL ACTION ALTERNATIVE			**Assume:**	**$ 4,901,000**

Table 7-8
Remedial Action Alternatives - Comparison of Cost Estimate Summaries
Photocircuits/Pall Corporation OU-2 Feasibility Study

Item	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6
CAPITAL COSTS						
TOTAL CAPITAL COSTS (Net Present Value)	$ -	$ 28,571	$ 644,762	$ 3,578,747	$ 3,866,153	$ 4,023,509
ANNUAL O&M COSTS (Long term)						
Treatment System O&M (Net Present Value)	$ -	$ -	$ 3,006,237	$ -	$ 728,932	$ 385,551
Monitoring Program (Net Present Value)	$ -	$ 591,839	$ 591,839	$ 550,757	$ 462,043	$ 492,375
COST TO IMPLEMENT REMEDIAL ACTION ALTERNATIVE	**$ -**	**$ 620,000**	**$ 4,243,000**	**$ 4,130,000**	**$ 5,057,000**	**$ 4,901,000**

Alt 1 No Action
Alt 2 No Action with Groundwater Monitoring
Alt 3 Photocircuits/Pall Corporation OU-2 Feasibility Study
Alt 4 In Situ Chemical Oxidation (ISCO) Injection
Alt 5 ISCO, Groundwater Extraction and *Ex Situ* Treatment by Air Stripping and Groundwater Reinjection
Alt 6 ISCO, Groundwater Extraction and Reinjection

Table 7-9

Detailed Evaluation of Alternatives Summary

Alternative	Compliance with SCGs	Protection of Human Health and Environment	Reduction of Toxicity, Mobility, or Volume	Short-Term Effectiveness	Long-Term Effectiveness	Implementability	Cost
Alternative 1 – No Action	Non-compliant.	None; contamination remains in OU-2 groundwater, a potential drinking water source. Off-site migration may continue.	Little or none; some natural attenuation may occur.	Not effective, no short term impacts.	Not effective; on- and off-site CVOC concentrations remain high even more than 30 years after release.	Readily implementable.	No cost alternative.
Alternative 2 – No Action with Groundwater Monitoring	Non-compliant.	None; contamination remains in OU-2 groundwater, a potential drinking water source. Off-site migration may continue.	Little or none; some natural attenuation may occur.	Not effective, no short term impacts.	Not effective; on- and off-site CVOC concentrations remain high even more than 30 years after release.	Readily implementable.	Bi-annual monitoring at 22 MW and 5-year report, 30 year duration; approx net present value (NPV) $620,000.
Alternative 3 – Groundwater Extraction with Treatment by Air Stripping and off-site discharge to POTW.	Expected to meet SCGs throughout most of site but some areas of non-compliance likely to persist.	Limited effectiveness in short-term; source area remains impacted indefinitely. Considered adequate for long-term protection of human health. No ecological or environmental impacts expected.	Expected to achieve significant reductions in contaminant concentrations and toxicity. May also reduce off-site migration (to north) based on positioning of extraction wells.	No short term environmental impacts. Requires coordination with site occupants (August Thomsen) to minimize disruptions of current operations.	Expected to be effective but likely to take more than 30 years. With proper extraction well location may also provide contaminant reduction to the north (Glen Cove property).	Implementable. Bench/pilot test needed for air stripper design. Aquifer tests required to establish extraction well layout and design.	Capital cost NPV about $645,000. Total net present value of annual O&M + monitoring cost about $3,598,000. Total net present cost about $4.243 million. Sensitive to POTW costs.
Alternative 4 – *In Situ* Chemical Oxidation	Expected to meet SCGs throughout most of site but some areas of non-compliance likely to persist after active remediation is terminated.	Limited effectiveness in short-term; three injections may be required. Fringe areas expected to attenuate as source area is remediated. Considered adequate for long-term protection of human health. No ecological or environmental impacts expected.	Expected to achieve significant reductions in contaminant concentrations and toxicity; will not treat groundwater at edges of plume. Fringe areas expected to attenuate as source area is remediated.	Short term hazards to the injection team associated with the handling of permanganate. Less intrusive (to current operations) than Alternative 3.	Expected to achieve substantial completion in 15 years. Long-term effectiveness relies on natural attenuation after treatment is discontinued. May not control off-site migration (to Glen Cove property).	Implementable. Pilot tests required to establish injection well location and design, mitigate potential mounding, and permanganate dosing.	Capital cost NPV about $3,579,000. Total net present value of annual O&M + monitoring cost about $551,000. Total net present cost about $4.13 million.

Table 7-9

Detailed Evaluation of Alternatives Summary

Alternative	Compliance with SCGs	Protection of Human Health and Environment	Reduction of Toxicity, Mobility, or Volume	Short-Term Effectiveness	Long-Term Effectiveness	Implementability	Cost
Alternative 5 – *In Situ* Chemical Oxidant Injection and Pump & Treat with Reinjection	Expected to meet SCGs throughout most of site but some areas of non-compliance likely to persist after active remediation is terminated.	Combined treatment approach achieves greatest short-term effectiveness of alternatives evaluated. Considered to be adequate for long-term protection of human health and the environment. Fringe areas expected to attenuate as source area is remediated. No ecological or environmental impacts expected.	Expected to achieve significant reductions in contaminant concentrations and toxicity; will not treat groundwater at edges of plume. Fringe areas expected to attenuate as source area is remediated.	Short term hazards to the injection team associated with the handling of permanganate. Requires coordination with site occupants (August Thomsen) to minimize disruptions of current operations.	Expected to achieve substantial completion in about 10 years, shortest of alternatives evaluated. Long-term effectiveness contingent upon natural attenuation after treatment is discontinued. Offers some hydraulic control reducing off-site migration to Glen Cove property.	Implementable. Bench/pilot test needed for air stripper design. Pilot tests required to establish extraction well layout and design, injection well location and design, mitigate potential mounding, and permanganate dosing.	Capital cost NPV about $3,866,000. Total net present value of annual O&M + monitoring cost about $1,191,000. Total net present cost about $5.06 million, most expensive of alternatives evaluated.
Alternative 6 – *In Situ* Chemical Oxidant Injection and Groundwater Extraction and Reinjection	Expected to meet SCGs throughout most of site but some areas of non-compliance likely to persist after active remediation is terminated.	Considered to be adequate for long-term protection of human health and the environment. Fringe areas expected to attenuate as source area is remediated. No ecological or environmental impacts expected. May not be as protective in short term as Alternative 5.	Expected to achieve significant reductions in contaminant concentrations and toxicity; will not treat groundwater at edges of plume. Fringe areas expected to attenuate as source area is remediated.	Short term hazards to the injection team associated with the handling of permanganate. Requires coordination with site occupants (August Thomsen) to minimize disruptions of current operations.	Expected to achieve substantial completion in about 12 years. Long-term effectiveness contingent upon natural attenuation after treatment is discontinued. Offers some hydraulic control reducing off-site migration to Glen Cove property.	Implementable. Pilot tests required to establish extraction well layout and design, injection well location and design, mitigate potential mounding, and permanganate dosing.	Capital cost NPV about $4,024,000. Total net present value of annual O&M + monitoring cost about $878,000. Total net present cost about $4.9 million.