nationalgrid

Thomas J. Campbell
Project Manager

November 14, 2008

Mr. Amen M. Omorogbe, P.E.
Project Manager, MGP Remedial Section
New York State Department of Environmental Conservation
Division of Environmental Remediation
Bureau of Western Remedial Action, 11th Floor
625 Broadway
Albany, New York 12233-7010

Re: Glen Cove Former Manufactured Gas Plant Site
Final Remedial Investigation Report
Glen Cove, New York
Site # 1-30-089P

Dear Mr. Omorogbe:

Enclosed please find one hard copy and one electronic copy of the following report:

Final Remedial Investigation Report
Glen Cove Former Manufactured Gas Plant (MGP) Site
Glen Cove, New York

If you have any questions, or require any additional information, feel free to contact me at (516)-545-2555.

Sincerely,

Thomas J. Campbell

Thomas J. Campbell
Project Manager

tjc/las

Enclosures (1 copy, 1 CD)

cc: R. Ockerby, NYSDOH (1 Copy, CD)
W. Parish, NYSDEC Region 1 (1 Copy)
R. Weitzman, NCDH (1 Copy)
C. Willard, National Grid (1 CD)
F. Murphy, National Grid (1 CD)

Environmental Department, 175 East Old Country Road, Hicksville, New York 11801
T: (516) 545-2555 ■ F: (516) 545-2582 ■ thomas.campbell@us.ngrid.com ■ www.nationalgrid.com

P:_Administrative\N_FinalDocuments\Job#\C2522\J012-024\NOVEMBER 2008 Final RI Report\JMPLCL.doc

GLEN COVE
FORMER MANUFACTURED GAS PLANT SITE

FINAL REMEDIAL INVESTIGATION REPORT

Prepared for:

KEYSPAN CORPORATION
175 East Old Country Road
Hicksville, New York

NOVEMBER 2008

Prepared by:

PS&S engineering

Paulus, Sokolowski and Sartor Engineering, PC
67A Mountain Boulevard Extension
P.O. Box 4039
Warren (Somerset County), New Jersey 07059

TABLE OF CONTENTS

List of Appendices

List of Drawings

List of Figures

List of Tables

EXECUTIVE SUMMARY

This Final Remedial Investigation Report (RIR) addresses the former Manufactured Gas Plant (MGP) site located adjacent to the intersection of Grove and Stanco Streets in Glen Cove, Long Island, New York. This RIR presents the results of a Remedial Investigation (RI) program undertaken by Paulus, Sokolowski and Sartor, Engineering, PC (PS&S) on behalf of KeySpan Corporation (KeySpan) at the former MGP site along with previously conducted site investigation activities. This RIR presents the findings, conclusions and recommendations of all the RI activities performed. This RIR is submitted in accordance with the Order on Consent (D1-0001-98-11) with the New York State Department of Environmental Conservation (NYSDEC). As required by the Consent Order, the RI activities were completed in accordance with the NYSDEC approved work plans.

This RIR has been prepared in accordance with NYSDEC's Section 3.14 of the "Draft DER-10 Technical Guidance for Site Investigation and Remediation" (DER-10), December 2002. NYSDEC Technical and Administrative Guidance Memorandum #4046 (TAGM 4046) Recommended Soil Cleanup Objectives (RSCO) were used in evaluating soil chemistry and NYSDEC Technical and Operational Guidance Series 1.1.1 (TOGS) Ambient Water Quality Standards, Guidance Values, and Groundwater Effluent Limitations (AWQS) were used in evaluating groundwater chemistry.

Reason for Investigation

The former Glen Cove MGP operations produced coal gas by-products (wastes/residuals) such as coal tar that are known to present hazards to human health and the environment. The purpose of the RI is to determine the nature and extent of the MGP-related residuals and residual constituents on the site, to determine if constituents are migrating from the site, and to identify whether exposure pathways to potential human and environment receptors exist for MGP-related residuals and/or residual constituents. KeySpan is responsible for the investigation because a predecessor company owned the site at the time residuals associated with the former Glen Cove MGP operations were produced on the site. The RI scope of work has included the completion of soil borings, the installation of groundwater probes, the installation of groundwater monitoring wells, installation of soil vapor probes and the sampling and chemical analysis of site soils and groundwater, creek sediment, creek surface water and soil vapor at adjoining residential properties.

Site Location and Description

The former MGP site is located in Glen Cove, Nassau County, New York. The former MGP property is an L-shaped parcel covering 1.91-acres in an area of commercial and residential land use. The site is bordered by the Long Island Railroad (LIRR) track and station to the north, mixed commercial/residential properties to the south and east; and Glen Cove Arterial Highway (Route 107) right-of-way (ROW) to the west. The site is currently owned by the Long Island Power Authority (LIPA) and operated by KeySpan under contract to LIPA as a major electrical substation. Topographically, the site resides in a depression bounded by 20 feet high embankments, leading up to the LIRR tracks to the north and residential properties to the south and east. The site proper is flat in the eastern half, and in the western half slopes steeply in a westerly direction to Glen Cove Creek. Total relief between the eastern portion (flat) and Glen Cove Creek is about 17 feet.

Glen Cove Creek flows through a box culvert from beneath Route 107 southwest of the site into an open channel with concrete-lined sidewalls adjacent to and along the western site property boundary. The creek flows in a south to north direction to where it leaves the property boundary at the northwest corner of the site and enters a box culvert that directs flow beneath the LIRR tracks. The majority of flow in Glen Cove Creek is generated by surface runoff; however, the presence of water in the stream channel during dry weather conditions is evidence of a groundwater derived baseflow component. Glen Cove Creek directs storm water away from the site area to the northwest and eventually discharges to Mosquito Cove (Hempstead Bay).

Site History

The former Glen Cove MGP began operations in 1905 under the ownership of the Sea Cliff and Glen Cove Gas Company. The MGP footprint was relatively small and remained unchanged through its operational period, which ended in 1929. The MGP consisted of a 60,000 cubic foot gas holder located in the west-central portion of the site; boilers, purifiers, retorts, coal shed, engine room, tar and oil tanks located in the eastern portion of the site; and approximately eight gas tanks located in the northwestern portion of the site. In 1923, Sea Cliff and Glen Cove Gas Company was purchased or merged with the Long Island Lighting Company (LILCO). A 40,000 cubic foot high pressure Hortonsphere gas holder was added to the MGP in the southwestern portion of the site in 1925 for gas distribution purposes.

In 1929, LILCO terminated MGP operations and demolished the MGP manufacturing structures to the surface level sometime thereafter. Site activities following 1929 consisted solely of natural gas storage in the Hortonsphere gas holder through the 1950's. The Hortonsphere was decommissioned and demolished between 1959 and 1966. In 1998, Brooklyn Union Gas and LILCO merged to form the KeySpan Corporation, at which time the ownership was transferred to the Long Island Power Authority (LIPA). Currently, the site is owned by the Long Island Power Authority (LIPA) and operated by KeySpan under contract to LIPA as a major electrical substation, which was constructed in the mid-1960s.

Previous Investigation Activities

In addition to the RI activities performed by PS&S in 2004 and 2005, two previous investigations were performed at the site, a Phase I Site Investigation in 1995 that was summarized in a 1997 report and submitted to the NYSDEC and a Due Diligence Investigation in 1999, which was summarized in a February 2000 report. The results of these investigations were used in conducting this Remedial Investigation to establish existing site conditions, the relationship between the historical site operations and the observed impacts to soil and groundwater and to prepare this RIR.

Key Findings

The following presents the Key Findings of the information obtained during all investigations at the site regarding existing surface and subsurface conditions, the nature and extent of the MGP-related residuals and residual constituents, and potential exposure pathways for human and environment receptors.

1. The RI results define the existing site conditions, nature and extent of chemical constituents at the site and in the surrounding environmental media and potential human health and environmental risk, sufficient to fulfill the remedial investigation requirements of DER-10 and in the determination of a significant threat under 6 NYCRR Part 375.

2. The shallow geology beneath the site consists of heterogeneous fill soil underlain by glacial outwash deposits. The fill soils extend from the surface to depths of 10 feet beneath the site proper, and to depths of 30 feet under the elevated area north of the site. The fill soils consist of sand and gravel with varying percentages of silt, clay and coal fragments. The underlying glacial outwash extends to the greatest depth investigated (82 feet). The outwash soils consist of highly permeable sands and gravelly sands interbedded with lower permeability silty sands. Groundwater occurring under water table conditions was generally first encountered near the base of the fill soils at a depth of 8 feet below the site surface and is part of the regional Upper Glacial Aquifer. The groundwater flows generally from east to west across the site toward Glen Cove Creek.

3. MGP-related residuals have been visually observed in the subsurface soils in the form of solid tar, dense non-aqueous phase liquid (DNAPL), blebs (individual droplets), or as coatings, sheens; and stains on the soil particles which are residuals expectable of a former MGP. MGP-related residuals contain chemical constituents of concern including benzene, toluene, ethylbenzene and xylenes (BTEX) and polycyclic aromatic hydrocarbons (PAHs) several of which are carcinogenic. DNAPL residual impacts occur over a relatively compact area beneath and just downgradient of the former MGP operations and extend just beyond the northern site limits. The DNAPL impacts generally begin at or just above the water table and decrease with depth to approximately 45 feet below the site. The absence of DNAPL impacts in the surface fill suggests the fill was placed after the removal of the former MGP.

4. Measurable DNAPL occurred in only one site well, in the area of the former gas holder. No measurable DNAPL was observed in the other site monitoring wells or piezometers.

5. The limited extent of DNAPL visual impacts is a key factor in understanding the distribution of the dissolved BTEX and PAH constituents in soils and groundwater. Elevated BTEX and PAH constituents generally coincide with or are downgradient of the MGP residuals and DNAPL observed in the subsurface soil. In groundwater the estimated extent of the dissolved phase contaminant plume (BTEX and PAH at 10 parts per billion (ppb)) occupies a relatively compact area and appears limited to the same areas/depths of soil exhibiting MGP-related DNAPL. The dissolved phase BTEX and PAH concentrations in groundwater decrease in both the horizontal and vertical direction

from levels in the range of 1,000 parts per billion (ppb) beneath the former MGP operations area to negligible and non-detectable concentrations immediately downgradient of the former MGP operations, the site perimeter at Glen Cove Creek and just beyond the site limits to the north.

6. As a result of the relative absence of MGP-related DNAPL visual impacts in soil above the water table, BTEX constituents are not constituents of concern in the upper 10 feet of site soil. Comparison of the background surface soil study results to PAHs detected on-site in surface soils suggest a potential contribution of PAH constituents from activities conducted on the former MGP site after or as part of placement of the surface fill soils. The background surface soil study indicated certain metals detected on-site are consistent with local conditions surrounding the site and are not likely attributable to the activities on the former MGP site.

7. The RI and Qualitative Human Health Exposure Assessment (QHHEA) indicate that there are potential pathways through which individuals (receptors) on and near the site could be exposed to potentially hazardous materials related to former MGP activities. The existing institutional and engineering controls, including the existing gravel or other surface cover restrict direct contact with surface soils; the fencing and gating restrict public access; and continued employee awareness training of the site soil and groundwater conditions mitigate these pathways and should be maintained. The greatest risk of potential exposure is associated with subsurface construction activities in near-surface soils and groundwater, if undertaken without appropriate precautions.

   Another potential pathway is through public supply/domestic wells. A domestic and/or an expanded public supply well search will be conducted upon guidance from the NYSDEC. However, domestic or public supply wells located within the potential search radius are not anticipated to be impacted, due to their significant distance (greater than ½ mile) from the former Glen Cove MGP site and the horizontal and vertical limits of the estimated extent of the dissolved phase plume.

   Overall, there are no significant imminent threats to human health that warrant an interim remedial action.

8. Fish and wildlife potential impacted media were identified as Glen Cove Creek surface water and sediments since groundwater flowing beneath the site discharges to the creek. However, no surface water impacts were observed in samples from Glen Cove Creek. Supplemental sediment samples collected from Glen Cove Creek, recommended by the initial Fish and Wildlife Resources Impact Analysis (FWRIA), indicate that concentrations of PAHs, are representative of generally background PAH sources and are not related to the site. Overall, there are minimal potential risks of wildlife exposure, given the industrial use of the property and highly transient nature of the wildlife.

<u>Summary of Report</u>:

Section 1.0 - Introduction: Presents the project objectives, a discussion of site background and available historical information, figures depicting the site location, a summary of previous site investigations and a description of the site setting and surroundings, including land use demographics, climate, topography, regional geology and hydrogeology and potable water supplies in the surrounding area.

Section 2.0 – Remedial Investigation Program: Provides an overview of the field activities associated with the Remedial and Supplemental Remedial Investigation Field Programs performed by PS&S with a figure depicting the sampling locations and monitoring wells. The investigation programs completed previously by others are presented in their respective reports as identified in **Section 1.0**. Additionally, this section discusses data management, chemical data validation/usability and any deviations from the NYSDEC approved work plan.

Section 3.0 - Regional and Site Geology and Hydrogeology: Summarizes the regional geology and hydrogeology based on review of published literature. The site specific geology is discussed based on the subsurface conditions encountered during the installation of GeoProbe and monitoring wells with an interpretation of the geology on the site. Figures presented in this section depict cross sections of the encountered site geology. Additionally, this section discusses the site hydrogeology based on the obtained water level measurements and hydraulic conductivity testing conducted to determine groundwater flow across the site and the hydraulic gradient and conductivity.

Section 4.0 - Nature and Extent of Chemical Constituents: Provides a description of the encountered MGP-related visual impacts observed during the implementation of the RI and Supplemental RI programs and their location and depth on-site. Additionally, this section summarizes the presence/absence of MGP-related chemical constituents and their concentrations in relation to the NYSDEC Recommended Soil Cleanup Objectives (RSCOs) and Ambient Water Quality Standards (AWQS), identified through laboratory chemical analysis, their location and depth on-site for samples collected in soil, creek sediment, groundwater and surface water. Figures included in this section depict the nature and extent of the encountered visual observations and analytical results. This section also provides a discussion of exposure pathways as identified in a QHHEA and a FWRIA.

Section 5.0 - Fate and Transport of DNAPL and Chemical Constituents: Discusses the fate and transport of MGP-related DNAPL and its chemical constituents in soils, creek sediment, groundwater and surface water. This section also provides an explanation of those physical, chemical and biological processes that have affected the identified DNAPL and its associated chemical constituents within the former MGP site.

Section 6.0 – Site Conceptual Model: Describes the relationship between the former MGP operations, the findings of the RI and potential migration and exposure pathways for the identified impacts. In addition, this Section discusses what has happened, and what will happen, to the MGP-related impacts that entered the subsurface during the operation of the former MGP. A figure presented in this section depicts the migration of MGP-related impacts.

Section 7.0 – Conclusions: Presents a summary of site environmental conditions based on the findings of the investigations conducted at the former MGP site.

Section 8.0 – Recommendations: Based upon the investigation findings and resulting conclusions, this section provides recommendations for future work to be completed at the former MGP site.

Section 9.0 - References: Lists all documents and other sources of information utilized in the preparation of this report.

1.0 INTRODUCTION

On behalf of KeySpan Corporation (KeySpan), Paulus, Sokolowski and Sartor, Engineering, PC (PS&S) completed a Remedial Investigation (RI) to address environmental impacts at the former manufactured gas plant (MGP) site located at Glen Cove, Nassau County, New York (site). This Final Remedial Investigation Report (RIR) is submitted in accordance with the Order on Consent (D1-0001-98-11) with the New York State Department of Environmental Conservation (NYSDEC). As required by the Order on Consent, the Remedial Investigation was completed in accordance with the scope of work presented in the Glen Cove Former MGP Remedial Investigation Work Plan, dated October 2003 (RIWP); the Background Surface Soil Investigation Work Plan, dated July 2004; the Supplemental Remedial Investigation Work Plan (SRIWP), dated January 2005; the Surface Water, Seep Water and Background Sediment Sampling Work Plan, dated September 2005; and the Letter Work Plan to Implement Supplemental Remedial Investigation Activities, dated March 2007. This Final RIR has been prepared in accordance with NYSDEC's Section 3.14 of the "Draft DER-10 Technical Guidance for Site Investigation and Remediation", December 2002.

The RI included the installation of soil borings, groundwater probes, monitoring wells and the sampling and analysis of soil, sediment, groundwater, soil vapor, and surface water. The results of the RI delineate the nature and extent of soil, creek sediment, soil vapor, groundwater and surface water impacts associated with the former MGP operations. This Final RIR presents a compilation of the remedial and supplemental remedial investigations completed by PS&S and GEI Consultants, Inc. and the findings of the following previously conducted site investigations:

- *Phase I Site Investigation Report For The Glen Cove Former Manufactured Gas Plant Site*, GEI Consultants, Inc./Atlantic Environmental Division, dated April 21, 1997;
- *Due Diligence Investigation*, Dvirka and Bartilucci, dated February 16, 2000; and
- *Remedial Investigation – Preliminary Data Submittal and Proposed Additional Work Scope*, Paulus, Sokolowski and Sartor Engineering, PC, October 2004.

1.1 Overview of Report Organization

This report is organized into the following sections:

- **Executive Summary:** Summarizes and provides an overview of the site-related investigation activities and the findings of the Final RIR.

- **Section 1.0 - Introduction:** Presents the project objectives, a discussion of site background and available historical information, a summary of previous site investigations and a description of the physical setting of the site and its surroundings.

- **Section 2.0 – Remedial Investigation Program:** Provides an overview of the field activities associated with the Remedial and Supplemental Remedial Investigation Field Programs performed by PS&S. The investigation programs completed previously by others are presented in their respective reports as identified in **Section 1.0**. Additionally, it discusses data management and chemical data validation/usability.

- **Section 3.0 - Regional and Site Geology and Hydrogeology:** Summarizes the regional and site specific geology and hydrogeology.

- **Section 4.0 - Nature and Extent of Chemical Constituents:** Summarizes the presence/absence of MGP-related Dense Non-Aqueous Phase Liquid (DNAPL) and concentrations of chemical constituents detected in the soil, creek sediment, groundwater and surface water.

- **Section 5.0 - Fate and Transport of DNAPL and Chemical Constituents:** Discusses the fate and transport of MGP-related DNAPL and its chemical constituents in soils, creek sediment, groundwater and surface water.

- **Section 6.0 – Site Conceptual Model**: Describes the relationship between the former MGP operations, the findings of the Remedial Investigations and potential migration and exposure pathways for the identified impacts.

- **Section 7.0 – Conclusions**: Presents a summary of site environmental conditions based on the findings of the investigations conducted at the subject site.

- **Section 8.0 – Recommendations**: Based upon the investigation findings and resulting conclusions, this section contains recommendations for future work to be completed at the subject site.

- **Section 9.0 - References:** Lists all documents and other sources of information utilized in the preparation of this report.

- **Appendix A - Database Search Report/Sanborn Maps**

- **Appendix B – Hydraulic Conductivity Calculations**
- **Appendix C – Analytical Results – Data Summary Tables**

- **Appendix D - Boring Logs and Well Construction Logs**

- **Appendix E – Low Flow Sampling Forms**

- **Appendix F - Qualitative Human Exposure Assessment and Fish and Wildlife Resources Impact Analysis which includes the Background Surface Soil Sampling Report**

1.2 Project Objectives

The objective of the RI is to identify, characterize and delineate the nature and extent of environmental (MGP- and non-MGP-related) impacts at the site and its surroundings; identify potential exposure pathways; identify potentially impacted receptors; evaluate fate and transport mechanisms; and present a site conceptual model. The RI objectives were achieved through visual observation of site soil conditions and impacts, and the collection and chemical analysis of on-site and off-site soil, soil vapor, creek sediment, groundwater and surface water samples.

1.3 Site Location and Description

The former MGP site is located in Glen Cove, Nassau County, New York (**Figure 1-1**). The site is an L-shaped parcel covering 1.91-acres. The site is bordered by the Long Island Railroad (LIRR) track and station to the north, mixed commercial/residential properties to the south and east; and Glen Cove Arterial Highway (Route 107) right-of-way (ROW) to the west. The site is currently owned by the Long Island Power Authority (LIPA) and operated by KeySpan under contract to LIPA as a major electrical substation. Topographically, the site resides in a depression bounded by embankments, leading up to the LIRR tracks to the north and residential properties to the south and east. The site proper is flat in the eastern half and in the western half, slopes steeply in a westerly direction to Glen Cove Creek. Total relief between the eastern portion (flat) and Glen Cove Creek is about 17 feet.

Glen Cove Creek flows from the west via a box culvert beneath Route 107 where it is immediately adjacent to the western site boundary and flows in a northwesterly direction within an open channel with concrete-lined sidewalls. The Creek leaves the property boundary at the northwest corner of the site through a box culvert that directs flow beneath the LIRR tracks. The majority of flow in Glen Cove Creek is generated by surface runoff; however, the presence of water in the stream channel during dry weather conditions is evidence of a baseflow component. Glen Cove Creek directs storm water from the area to the northwest and eventually discharges to Mosquito Cove (Hempstead Bay).

Vehicle access to the site is possible by a steeply-graded access road from Grove Street. The substation portion of the site is fenced, as is access to the wooded western portion of the site, and access from Grove Street. **Figure 1-2** provides the site layout with the locations of the former MGP structures and topographic contours.

1.4 Site History

Based upon the review of the previously conducted site investigation reports, the former Glen Cove MGP began operation in 1905 under the ownership of the Sea Cliff and Glen Cove Gas Company. Sea Cliff and Glen Cove Gas Company owned and operated the MGP until 1923 with the exception of the year 1912, and served the local communities of Sea Cliff, Glen Cove and Oyster Bay. In 1912 the property was leased to Nassau Gas Construction Company (NGCC) of Newark, New Jersey. NGCC's use or activities conducted on the property during this lease period is not known. In 1923, Sea Cliff and

Glen Cove Gas Company was purchased or merged with the Long Island Lighting Company (LILCO). In 1929, LILCO terminated MGP operations and demolished the

MGP surface manufacturing structures sometime thereafter. Site activities following 1929 consisted solely of gas storage in the Hortonsphere gas holder and continued through the 1950's. The Hortonsphere was decommissioned and demolished between 1959 and 1966. In 1998, Brooklyn Union and LILCO merged to form the KeySpan Corporation. Currently, the site is occupied by a LIPA substation.

Record of Ownership*
Former Glen Cove Manufactured Gas Plant

Directory Years	**Ownership**
1887 to 1904	No Record
1905 to 1911	Sea Cliff and Glen Cove Gas Company
1912	Leased to Nassau Gas Construction Company, Newark, NJ although still owned by Sea Cliff and Glen Cove Gas Company
1913 to 1923	Sea Cliff and Glen Cove Gas Company
1923 to 1929	Long Island Lighting Company
1929	Termination of MGP Operations by Long Island Lighting Company
1929 – 1950's	Storage of gas in Hortonsphere by Long Island Lighting Company
1998	Long Island Power Authority

* Source: "Brown's Directory of American Gas Companies" and April 1997, Phase I Site Investigation Report.

The MGP footprint was relatively small and remained relatively unchanged through its operational period. The MGP consisted of a 60,000 cubic foot gasholder located in the west-central portion of the site; boilers, purifiers, retorts, coal shed, engine room, tar and oil tanks in the eastern portion at the site; approximately eight gas tanks in the northwestern portion of the site; and a 40,000 cubic foot high pressure Hortonsphere gas holder added to the MGP in 1925 for gas distribution purposes. These former structures were identified in the 1908 Sanborn Fire Insurance Map. The MGP footprint is depicted on **Figure 1-2**. Although operations ceased in 1929, gas storage continued through the 1950's until the arrival of pipeline natural gas. Based on the available historic records and aerial photographs, the existing electrical substation was constructed in the mid-1960's as some of the substation structures appear on the 1966 aerial photograph. **Appendix A** contains copies of the Sanborn Maps that illustrate the historic plant layout.

1.5 Project Background

1.5.1 Land Use and Demographics

The former Glen Cove MGP site is zoned industrial. The area surrounding the site includes commercial, residential and recreational/entertainment land uses. Properties immediately to the north of the site are designated as a community service land use, as well as a right-of-way for the LIRR. Properties immediately to the east are designated as residential. The properties to the west are right-ofways for the Glen Cove Creek and Route 107 and beyond which are described as community services land use. The properties to the south are described as residential and commercial land use.

The most recent population estimates prepared by the United States Census Bureau for the City of Glen Cove reports a population of 26,622 as of 2000. This is relatively consistent with the April 1, 1990, census which reported a population of 24,226.

1.5.2 Climate

The climate of Long Island is typically identified as humid continental with a significant maritime influence (Soil Survey of Nassau County, 1975). Monthly and yearly precipitation totals and temperature data were obtained from the Weather Underground website which utilizes data obtained from the National Weather Service and the National Climatic Data Center of the National Oceanic and Atmospheric Administration (NOAA). Measurements were collected from the LaGuardia Airport weather station located in Queens, New York, approximately 14 miles west - southwest of the Former Glen Cove MGP site. **Table 1-1** shows the monthly average temperatures, wind speed and precipitation data for years 2004 and 2005, a time period consistent with the remedial investigation activities.

The average annual temperature for the years 2004 and 2005 was 56 degrees Fahrenheit (°F), with average monthly temperatures ranging from a low of 26°F in January 2004 to a high of 81°F in August 2005 (**Table 1-1**). The average monthly temperatures for 2004 and 2005 were typical as compared to the 30-year monthly averages. The annual precipitation rate was 50.69 inches in 2004 and 48.12 inches in 2005. These annual precipitation rates are typical for the region when compared to the 30-year average.

1.5.3 Topography

The topography at the Glen Cove Former MGP site varies from relatively flat in the area of the former operations surrounded by steep rising embankments to the north, south and east; and a steep downward slope to the west towards Glen Cove Creek. Site elevations in the existing substation area are approximately 58 feet above mean sea level (msl). The elevations at the top of the north, east and south embankments are at approximately 80 feet msl. The elevation of the Glen Cove Creek channel is approximately 41 feet msl.

1.5.4 Storm Water

The majority of the site consists of a permeable soil cover with vegetation or crushed stone. Surface water infiltration on site is generally good. Storm water

TABLE 1-1
FORMER GLEN COVE MGP SITE
KEYSPAN CORPORATION
CLIMATOLOGICAL DATA

TIME PERIOD (months)		JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE
2004	Average Temperature (^{o}F)	26	36	43	54	65	73
	Average Maximum Temperature (^{o}F)	32	42	50	62	74	80
	Average Minimum Temperature (^{o}F)	19	29	37	45	56	65
	Average Wind Speed (mph)	14	12	12	12	9	10
	Total Precipitation (inches)	1.97	2.54	2.95	4.80	4.45	2.46
2005	Average Temperature (^{o}F)	31	36	39	55	59	75
	Average Maximum Temperature (^{o}F)	37	42	45	63	66	83
	Average Minimum Temperature (^{o}F)	25	30	33	45	51	66
	Average Wind Speed (mph)	12	11	12	11	12	9
	Total Precipitation (inches)	3.71	3.09	4.26	4.59	0.92	2.46

Notes:

The data utilized in this summary table was obtained from Weather Underground (www.wunderground.com).
Readings were obtained from the weather station at the New York LaGuardia Airport.

TABLE 1-1 (cont.)
FORMER GLEN COVE MGP SITE
KEYSPAN CORPORATION
CLIMATOLOGICAL DATA

TIME PERIOD (months)		JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL PRECIPITATION
2004	Average Temperature (^{o}F)	76	76	71	58	49	38	
	Average Maximum Temperature (^{o}F)	82	81	77	63	55	44	
	Average Minimum Temperature (^{o}F)	70	69	64	52	43	32	
	Average Wind Speed (mph)	10	9	10	10	11	13	
	Total Precipitation (inches)	8.63	4.42	10.28	1.09	3.77	3.33	**50.69**
2005	Average Temperature (^{o}F)	79	81	75	60	51	37	
	Average Maximum Temperature (^{o}F)	86	88	83	76	65	41	
	Average Minimum Temperature (^{o}F)	71	74	60	46	29	31	
	Average Wind Speed (mph)	9	9	10	12	12	12	
	Total Precipitation (inches)	2.33	3.87	0.39	14.71	3.57	4.22	**48.12**

Notes:

The data utilized in this summary table was obtained from Weather Underground (www.wunderground.com).
Readings were obtained from the weather station at the New York LaGuardia Airport.

runoff from the north, south, and east embankments, and from the western downslope, drain via sheet flow to the west to Glen Cove Creek.

1.5.5 Surface Water

The closest surface water body is the Glen Cove Creek located immediately adjacent to the site's western property boundary. The creek flows in a northerly direction eventually discharging to Mosquito Cove (Hempstead Bay), located approximately 1.3 miles west of the site. The creek flows continuously and during heavy rainfall events a flash flow is evident, draining storm water runoff from upstream areas to the southwest of the site.

1.5.6 Regional Soil Classification

According to the United States Department of Agriculture Soil Survey for Nassau County, the site soils consist of Urban Land-Montauk Complex. This unit consists of urbanized areas and very deep well-drained Montauk soils located on the sides of strongly sloping small hills and ridges. The soils sequence consists of a surface layer of dark grayish-brown, fine sandy loam underlain by a subsoil of strong brown, fine sandy loam; yellowish-brown, fine sandy loam and light yellowish brown sandy loam. The substratum of this sequence consists of firm pale brown sandy loam and firm light yellowish-brown, gravelly loamy sand. The permeability of the Montauk soils are listed as moderate and the substratum is listed as restricting downward movement of water.

1.5.7 Regional Geology

The site vicinity is underlain by unconsolidated glacial deposits of Pleistocene age which are underlain by unconsolidated coastal plain deposits of Cretaceous age which overlie igneous and metamorphic Ordovician/Cambrian bedrock approximately 350 feet beneath the surface. The unconsolidated deposits are composed of interbedded layers and lenses of gravel, sand, silt and clay. Two ice advances, during the Wisconsin Glaciations, account for the glacial deposits consisting of till and outwash that are present throughout the area. **Section 3.1** provides a detailed description of the regional and site specific geology.

1.5.8 Regional Hydrogeology

The regional aquifer underlying the general site area occurs in the unconsolidated glacial and coastal plain deposits of Pleistocene Age and Cretaceous Age. The aquifer is subdivided into six hydrogeologic units consisting of, from oldest to youngest, the Lloyd Aquifer, the Raritan Clay, the Magothy and Port Washington Aquifers, the Port Washington Clay, and the Upper Glacial Aquifer. Precipitation filtering downward to the water table is the principal source of groundwater recharge. Typically, the Upper Glacial Aquifer transmits all recharge to the underlying aquifers. However, the Long Island Regional Planning Board 208

Study, dated 1979, places the Former Glen Cove MGP site within regional Hydrogeologic Zone VIII. This is a zone of regional discharge and any infiltrating fluid are not likely to recharge the underlying sole source Magothy Aquifer but more likely to discharge to shallow surface water bodies. **Section 3.2** provides a detailed description of the regional and site specific hydrogeology.

1.5.9 Potable Water Supply

A search of NYSDEC well records was conducted to identify the presence of public supply wells in the area of the site. Based on the findings of this well search, seven public supply wells were identified within 7,500 feet upgradient and sidegradient of the site. The wells are utilized for public or municipal supply and are screened from 202 to 465 feet below ground surface (feet bgs). **Table 1-2** provides a summary of those wells identified in the search of NYSDEC records. **Figure 1-3** depicts the approximate location of Public Supply Wells.

1.6 Environmental Database Search

As presented in the October 2003 RIWP, an environmental records review of the site and surrounding properties was obtained through Environmental Data Resources (EDR) to evaluate potential upgradient sources of contamination. EDR searched available environmental government database records and provided a report that met the requirements of American Society of Testing and Materials (ASTM) Standard Practice for Environmental Site Assessments, E527-00. The area searched was that stipulated by ASTM search distances. A copy of the EDR report, presented in the October 2003 RIWP is included in **Appendix A**.

The EDR report revealed no listing of the former MGP site. The current electrical substation (Orchard Substation) was listed as a large quantity generator. Numerous off-site, upgradient properties in the vicinity of the former MGP site were identified as having environmental records. Reported sites that have conditions that could potentially impact groundwater at the former MGP site were considered. Based on review of the records, the following types of sites were found in the vicinity of the Former MGP site:

- Resource Conservation and Recovery Information System (RCRIS)-Small Quantity Generators (SQG) [includes sites that generate, store, treat or dispose of hazardous waste]: 4 listed sites;
- Leaking storage tank incident report (LTANK) [includes sites with aboveground or below ground storage tanks that failed tank tests, tank failures, overfilled tanks]: 1 listed site;
- Underground Storage Tank (UST) [USTs that are listed in the NYSDEC petroleum bulk storage tank program]: 3 listed sites; and
- New York Spill Incident: 1 listed site.

Many of these sites had multiple listings. Summary information for these sites is presented below:

TABLE 1-2
FORMER GLEN COVE MGP SITE
KEYSPAN CORPORATION
SUMMARY OF PUBLIC SUPPLY WELLS

Well Number	Owner	Location to Site	Depth of Well (ft. bgs)	Screened Interval		Use	Capacity (gpm)	Status
				Top (ft. bgs)	Bottom (ft. bgs)			
N-9334	City of Glen Cove	2400 East	298	242.66	293	Public Supply	1200	In Service
N-5762	*Not Legible*	4700 East	283	220	278	Public Supply	1400	*Not Legible*
N-9211	City of Glen Cove	6200 Northeast	269	202	262	Public Supply	1400	*Not Legible*
N-9210	City of Glen Cove	6200 Northeast	275	209	269	Public Supply	1400	*Not Legible*
N-7857	Sea Cliff Water Company	6000 Southwest	614	236	290	Municipal Supply	1300	In Service
N-5792	Sea Cliff Water Company	6400 South	300	255	295	Public Supply	*Not Legible*	In Service
N-6151	Locust Valley Water District	7500 Northeast	465	385	465	Public Supply	1550	In Service

Notes:

Ft. Bgs - Indicates feet below ground surface.
Gpm - Indicates gallons per minute
Data collected from a well search conducted of NYSDEC records.

- Rallye Motors, Incorporated (20 Cedar Swamp Road) was listed as a RCRIS-SQG (Environmental Protection Agency (EPA) Identification Number 1000293623); LTANK listing (failed tank test due to mechanical equipment), UST listing (two 2,500-gallon waste oil USTs, one 4,000-gallon gasoline UST indicated as empty, and three empty USTs with 13,000 gallons total capacity);
- Porta Systems Corporation (1 Alexander Place) was listed as a RCRIS-SQG (EPA Identification Number 1000405968) with historic violations and manifest information in Connecticut and New York;
- Micronics Technology (7 Alexander Place) was listed as a RCRIS-SQG (EPA Identification Number 1000556204);
- S&G Cleaners (10 Cedar Swamp Road) was listed as a RCRIS-SQG (EPA Identification Number 1000107347);
- Glen Cove High School/Schools (Cedar Swamp Road/Desoris Avenue) were listed for LTANK incidents (failed tank tests that occurred because of mechanical equipment failures. Both tanks were reportedly removed); and,
- Transformer leak (Grove Street and Hazel Street) was listed for leaking approximately four gallons of transformer oil that was subsequently washed into the storm sewer.

These sites are located upgradient of the former Glen Cove MGP site.

As presented in the October 2003 RIWP, Sanborn Fire Insurance maps were reviewed for selected years from the early 1900s through the 1970s. A review of historic Sanborn maps was completed for surrounding land use activities that were located topographically upgradient of the site and could potentially impact groundwater beneath the site. Available Sanborn maps from 1908, 1915, 1925, 1931, 1947 and 1972 are located in **Appendix A**. These maps summarize the adjacent land-use for the area surrounding the former Glen Cove MGP site. Three operations located upgradient from the site were identified that stored and/or handled petroleum (gasoline and fuel oil) or have had historic operations that could potentially impact site groundwater.

- Standard Oil Company (22 Cedar Swamp Road [formerly 1222-1224 Cedar Swamp Road]) previously stored bulk petroleum in aboveground storage tanks from approximately 1908 through 1925. Gasoline underground storage tanks (USTs) were depicted at the parcel from circa 1931 through 1947. This site was subsequently developed as an automobile sales and service facility circa 1972. The activities and waste activities of these historic facilities are unknown at this time;

- Residential gasoline UST is depicted at 28 Cedar Swamp Road from circa 1931 through 1945. The status and disposition of this tank is unknown; and

- Residential gasoline UST is depicted at 20 Grove Street from circa 1925 through 1931. The status and disposition of this tank is unknown.

1.7 Previous Site/Remedial Investigations

This section provides an overview of investigations conducted prior to the Order on Consent for the former Glen Cove MGP site. Historical sample locations are shown on **Drawing 2A** which is provided in a map pocket at the end of **Section 2.0** of this report.

November 1995 Phase I Site Investigation

Performed By: GEI Consultants, Inc./Atlantic Environmental Division

In November 1995, Atlantic Environmental Division (Atlantic) conducted a Phase I Site Investigation, for LILCO, at the former Glen Cove MGP site. A report presenting the results was prepared by Atlantic entitled, "Phase I Site Investigation for the Former Glen Cove Manufactured Gas Plant Site," dated April 21, 1997. The objectives of Atlantic's investigation were designed to provide data to:

- Determine the shallow geology at the site;
- Determine the environmental conditions at eight former tank locations;
- Determine the nature/character of any on-site soil and groundwater contamination;
- Determine the generalized groundwater flow/movement at the site;
- Evaluate the potential for contamination to migrate beyond the site boundaries; and
- Evaluate the potential application of an interim remedial measure (IRM) to be conducted at the site, if necessary.

The Phase I field investigation consisted of surface soil sampling, shallow subsurface-soil sampling using hand tools, test borings with subsurface soil sampling, monitoring well installations and groundwater sampling. The Phase I report concluded the following:

- Non-Aqueous Phase Liquids (NAPL) was observed in soils on the northwestern portion of the site in the vicinity of the former 60,000 cubic foot gas holder. Fill material below 7 feet was stained and contained concentrations of polycyclic aromatic hydrocarbons (PAHs). Isolated tar seams and odors were found in native soil between 15 and 21 feet bgs until a denser sand and gravel layer was encountered that appeared to inhibit downward migration of contaminant. Elevated benzene, toluene, ethylbenzene and xylenes (total) [BTEX] and PAH concentrations and sheens in groundwater co-existed with the presence of observed tar in soils.

- No visible evidence of MGP residues was encountered during an inspection of Glen Cove Creek.

- No former MGP structures were encountered. Borings in the vicinity of the former oil tanks and tar tank did not encounter impacts.

- No imminent risk to on-site workers or the public was identified by the Phase I Site Investigation.

February 2000 Due Diligence Investigation

Performed By: Dvirka and Bartilucci (D&B).

A Due Diligence Investigation was completed by D&B for KeySpan and submitted to the NYSDEC on February 16, 2000. This investigation focused on the area of steep embankments directly to the north and south of the substation. Three borings (GCSB-25 through GCSB-27) with subsurface samples, three surface samples (GCSS-16 through GCSS-18) and three "ash" samples (GCAS-01 through GCAS-03) were collected, off-site, adjacent to the retaining wall on the south side of the substation. Four borings (GCSB-28 through GCSB-31) were completed on the top of the steep embankment along the northern property line adjacent to the ROW for the LIRR.

Analytical results of soil borings completed in the substation area (GCSB-25 through GCSB-27) revealed trace BTEX and total cyanide concentrations. Total PAH concentrations ranged from non-detectable (ND) to 45.3 milligrams per kilogram (mg/kg). Polychlorinated biphenyls (PCBs) were not detected in any of the analytical samples collected. Metals concentrations were consistent with those found in historic fill material at the site. Analytical results of surface soil samples collected in this area (GCSS-16 through GCSS-18) contained total PAH concentrations ranging from 12.2 to 22.9 mg/kg.

Soil borings GCSB-28 through GCSB-31 were completed to a total depth of 36 to 47 feet below ground surface (bgs) on the top of the embankment on the northern side of the substation. Fill material (black soils with coal fragments, wood fragments, and clinkers with odors) was encountered within each of the borings from the ground surface to approximately 32 feet bgs and was characterized by trace detections of BTEX and total cyanide and PAH concentrations. Oily soils with odors were noted within GCSB-29 and soils with sheen and odor within GCSB-30. Total PAH concentrations ranged from ND to 1,595 mg/kg with the highest concentrations observed in soil boring GCSB-29 at a depth of 34 to36 feet bgs. Total BTEX concentrations from these samples were all below 1 mg/kg. Metals concentrations were consistent with background concentrations and no PCBs were detected.

2.0 REMEDIAL INVESTIGATION PROGRAM

2.1 Organization and Overview of Field Program Activities

A RI was conducted between January and April 2004. The RI was performed in accordance with the October 29, 2003 RIWP approved by NYSDEC. In October 2004 the "Preliminary Data Submittal Report, was submitted to the NYSDEC and recommended supplemental soil and groundwater investigations needed to delineate the horizontal and vertical extent of identified MGP impacts.

To provide the environmental information needed to complete characterization and delineation of the site conditions, work plans were prepared and submitted to the NYSDEC: in July 2004 for background surface soil sampling; in January 2005 for supplemental soil and groundwater sampling; in September 2005 for surface water, seep water and background sediment sampling; and in March 2007 for surface water, seep water, background sediment sampling, soil vapor sampling and private well and basement survey. These supplemental work plans were approved by NYSDEC and the supplemental remedial investigation field programs were conducted between April and October 2005 and between December 2007 and April 2008. The program targeted data gaps needed to complete the horizontal and vertical delineation of constituents in soils and groundwater, and evaluate potential impacts to Glen Cove Creek, the potential receptor.

The RI program (sampling events undertaken in 2004, 2005, 2007 and 2008) addressed on-site and adjacent-site conditions and included the following activities:

- Surface soil sampling;
- Subsurface soil sampling;
- Groundwater probe installation and sampling;
- Groundwater monitoring well installation and sampling;
- Aquifer permeability testing;
- Perimeter air monitoring;
- Sediment sampling;
- Surface water sampling;
- Seep sampling;
- Soil Vapor sampling;

- Private Well and Basement Survey; and
- Surveying and mapping.

2.2 Field Investigation Program

The field procedures and analytical methodologies presented in the October 2003 RIWP were used to complete the RI program. The sampling techniques and analytical methodologies utilized in the 1995 and 1999 site investigations are discussed in their respective summary reports and are not summarized in this report. A brief summary including deviations from the sampling and analysis methodologies, drilling and well installation protocols conducted during the RI program are provided below. The analytical methodologies are summarized in **Table 2-1**. Also, a matrix including media sampled, sample location/number, depth and analytical parameters is presented as **Table 2-2**. The sample locations are shown on **Drawing 2A**.

2.2.1 Surface Soil Sampling

Surface soil samples were collected from a depth of 0 to 2 inches below any encountered ground surface cover utilizing a dedicated polyethylene scoop and placed into laboratory-supplied sample containers. All samples were screened utilizing a photoionization detector (PID) for the presence of volatile organic vapors. A total of 28 surface soil samples were collected at the site. These samples were collected to determine on-site surface soil quality. The analytical results of the surface soil samples collected on-site are presented and discussed in **Section 4.1.2**. The surface soil sample locations are shown on **Drawing 2A**. **Table 2-3** identifies the location of the surface soil samples relative to on-site and off-site locations.

2.2.2 Subsurface Soil Sampling

Subsurface soil samples were collected using either the direct push (GeoProbe) sampling technique with a decontaminated probe sampler or a decontaminated split spoon sampler in conjunction with a conventional hollow stem auger drill rig. The samples were screened for volatile organic vapors utilizing a PID; inspected for the presence of staining, discoloration, NAPL, ash, tar and other MGP-residuals; checked for odors; and logged by a geologist using the Unified Soil Classification System (USCS).

A total of 29 soil probes were advanced as part of this RI Program. Soil probes were advanced to a depth of 60 feet below the water table (approximately 82 feet bgs) or until at least 10 feet of visibly “non-impacted” soil had been encountered. Samples were collected continuously throughout each borehole and selected for chemical analysis based on visual observations and PID readings. Soil samples were collected to achieve three purposes: (1) for subsurface soil characterization soil samples were biased to depth intervals exhibiting impacts and/or elevated

TABLE 2-1
FORMER GLEN COVE MGP SITE
KEYSPAN CORPORATION
ANALYTICAL MEDIA AND METHODOLOGY SUMMARY

ANALYSIS	SAMPLE MEDIA AND ANALYTICAL METHOD				
	Soil	**Groundwater**	**Sediment**	**Surface Water**	**Seep**
BTEX	8021	8021	8021	8021	8021
PAHs	8270	8270	8270	8270	8270
TCL VOCs	8260	8260	8260	8260	8260
TCL SVOCs	8270	8270	8270	8270	8270
TAL Metals	6010/7471	6010/7471	6010/7471	6010/7471	6010/7471
RCRA Metals	6010/7471	6010/7471	6010/7471	6010/7471	6010/7471
Total Cyanide	9012	9012	9012	9012	9012
PCBs	8082	8082	8082	8082	8082
TOC	9060	9060	9060	9060	9060
Grain Size	D-422	D-422	D-422	D-422	D-422
Bulk Density	D2937-94	D2937-94	D2937-94	D2937-94	D2937-94
Moisture Content	D2937-94	D2937-94	D2937-94	D2937-94	D2937-94

Notes:

All test methods specified are Environmental Protection Agency (EPA) SW-846, with the exception of soil physical characteristic parameters.

The methods utilized for soil physical characteristic parameters are from the American Society for Testing and Materials (ASTM).

TABLE 2-2
FORMER GLEN COVE MGP SITE
KEYSPAN CORPORATION
ANALYTICAL SAMPLING SUMMARY

SAMPLE LOCATION NUMBER	ANALYTICAL SAMPLE DEPTH	SAMPLING LOCATION	SAMPLE TYPE					ANALYSIS									SAMPLING RATIONALE
			Soil	Ground Water	Surface Water	Sediment	Seep	BTEX	PAH	TCL VOC	TCL SVOC	RCRA Metals	Total Cyanide	TAL Metals	PCBs	TOC	
GCSB-32	10-12	South of the current electrical substation control room	*					*	*			*	*				To evaluate potential discharges downgradient of the active cesspool that receives sanitary waste from the LIPA electrical substation and evaluate for the presence/absence of the clay/sandy-clay confining layer.
	18-20		*					*	*			*	*				
	50-52		*					*	*			*	*				
GCSB-33	12-14 (MS/MSD)	Western boundary of the current electrical substation within the footprint of the former 60,000 cubic foot Gas Holder.	*							*	*		*	*			To evaluate the presence of the bottom of the former 60,000 cubic foot gas holder structure and the presence/absence of the clay/sandy clay confining layer.
	21-23		*							*	*		*	*			
	30-32		*							*	*		*	*			
	50-52		*							*	*		*	*			
GCSB-34	13-15	Western boundary of the current electrical substation.	*					*	*			*	*				To evaluate the potential impacts from the former 60,000 cubic foot gas holder structure and the presence/absence of the clay/sandy clay confining layer.
	20-22		*					*	*			*	*				
	46-48		*					*	*			*	*				
GCSB-35	9-11	Northern boundary of the current electrical substation.	*					*	*			*	*				To evaluate the lateral extent of tar impacts at the site and the presence/absence of the clay/sandy clay confining layer.
	14-16		*					*	*			*	*				
	24-26		*					*	*			*	*				
	50-52		*					*	*			*	*				
GCSB-36	12-14	In the northern parcel that borders the site within the asphalt parking area.	*							*	*		*	*			To evaluate the lateral extent of tar impacts adjacent to the site and the presence/absence of the clay/sandy clay confining layer.
	14-16		*							*	*		*	*			
	22-24 (MS/MSD)		*							*	*		*	*			
	30-32		*							*	*		*	*			
	34-36		*							*	*		*	*			
	66-68		*							*	*		*	*			
GCSB-37	9-11	On the northern parcel that borders the site within the asphalt parking area.	*							*	*		*	*			To evaluate the lateral extent of tar impacts adjacent to the site and the presence/absence of the clay/sandy clay confining layer adjacent to the site.
	22-24 (MS/MSD)		*							*	*		*	*			
	36-38		*							*	*		*	*			
	46-48		*							*	*		*	*			
	68-70		*							*	*		*	*			
GCSB-38	6-8	In the northwestern corner of the site adjacent to the existing retaining wall.	*					*	*			*	*				To evaluate the lateral extent of tar impacts and evaluate the presence/absence of the clay/sandy clay confining layer.
	14-16		*					*	*			*	*				
	50-52		*					*	*			*	*				
GCSB-39	18-20	In the northern parcel that borders the site within the asphalt parking area.	*							*	*		*	*		*	To evaluate the lateral extent of tar impacts adjacent to the site and the presence/absence of the clay/sandy clay confining layer adjacent to the site.
	26-28		*							*	*		*	*		*	
	34-36		*							*	*		*	*		*	
	68-70		*							*	*		*	*		*	
	70-72		*							*	*		*	*		*	

TABLE 2-2 (cont.)
FORMER GLEN COVE MGP SITE
KEYSPAN CORPORATION
ANALYTICAL SAMPLING SUMMARY

SAMPLE LOCATION NUMBER	ANALYTICAL SAMPLE DEPTH	SAMPLING LOCATION	SAMPLE TYPE					ANALYSIS									SAMPLING RATIONALE
			Soil	Ground Water	Surface Water	Sediment	Seep	BTEX	PAH	TCL VOC	TCL SVOC	RCRA Metals	Total Cyanide	TAL Metals	PCBs	TOC	
GCSB-40	5-7	Within the access road adjacent to PZ-01.	*							*	*		*	*		*	To evaluate the lateral extent of tar impacts adjacent to the site and the presence/absence of the clay/sandy clay confining layer.
	17-19 (MS/MSD)		*							*	*		*	*		*	
	68-69		*							*	*		*	*		*	
GCSB-41	18-20	On the western boundary of the site adjacent to the culverted Glen Cove creek in the area of the former Hortonsphere.	*							*	*		*	*		*	To evaluate the soils for tar impacts and the presence/absence of the clay/sandy clay confining layer.
	26-28 (MS/MSD)		*							*	*		*	*		*	
	58-60		*							*	*		*	*		*	
	74-76		*							*	*		*	*		*	
	80-82		*							*	*		*	*		*	
GCSB-42	13-15	On the northern boundary of the current electrical substation.	*							*	*		*	*		*	To evaluate the vertical extent of tar impacts and to evaluate the thickness of the clay/sandy clay confining layer.
	24-26 (MS/MSD)		*							*	*		*	*		*	
	58-60		*							*	*		*	*		*	
GCSB-43	17-19	At the eastern side of the substation at the bottom of the site boundary slope.	*					*	*			*	*			*	To evaluate the soils for potential impacts from current and historic sources of contamination.
	22-24 (MS/MSD)		*					*	*			*	*			*	
	50-52		*					*	*			*	*			*	
GCSB-44	8-10	On the northern side of the substation at the bottom of the site boundary slope.	*					*	*			*	*				To evaluate and delineate the extent of impacts north of soil borings GCSB-34 and GCSB-38.
	15-17		*					*	*			*	*				
	32-34		*					*	*			*	*				
	38-40		*					*	*			*	*				
	48-50		*					*	*			*	*				
	58-60		*					*	*			*	*				
GCSB-45	14-16	In the southern corner of the substation, south of the former 60,000 cubic foot gas holder.	*							*	*		*	*			To evaluate and delineate the extent of impacts south of soil boring GCSB-33 and the former 60,00 cubic foot gas holder.
	20-22		*							*	*		*	*			
	30-32		*							*	*		*	*			
	32-34		*							*	*		*	*			
	40-42		*							*	*		*	*			
GCSB-46	10-12	In the access road west of the former 60,000 cubic foot gas holder.	*							*	*		*	*			To evaluate and delineate the extent of impacts west of soil boring GCSB-33 and the former 60,00 cubic foot gas holder.
	44-46		*							*	*		*	*			
	48-50		*							*	*		*	*			
	58-60		*							*	*		*	*			
GCSB-47	14-16	On the western boundary of the site adjacent to the culverted Glen Cove creek in the area of the former Gas Tanks.	*							*	*		*	*			To evaluate and delineate the extent of impacts west of soil boring GCSB-33 and the former 60,00 cubic foot gas holder and gas tanks.
	24-26		*							*	*		*	*			
	58-60		*							*	*		*	*			
GCSB-48	10-12	In the access road southwest of the former 60,000 cubic foot gas holder.	*							*	*		*	*			To evaluate and delineate the extent of impacts south west of soil boring GCSB-33 and the former 60,00 cubic foot gas holder.
	22-24		*							*	*		*	*			
	58-60		*							*	*		*	*			
GCSB-49	13-15	In the substation on the eastern edge of the former 60,000 cubic foot gas holder.	*							*	*		*	*			To evaluate and delineate the extent of impacts east of soil boring GCSB-33 and the former 60,00 cubic foot gas holder.
	20-22		*							*	*		*	*			
	54-56		*							*	*		*	*			

TABLE 2-2 (cont.)
FORMER GLEN COVE MGP SITE
KEYSPAN CORPORATION
ANALYTICAL SAMPLING SUMMARY

SAMPLE LOCATION NUMBER	ANALYTICAL SAMPLE DEPTH	SAMPLING LOCATION	SAMPLE TYPE					ANALYSIS									SAMPLING RATIONALE
			Soil	Ground Water	Surface Water	Sediment	Seep	BTEX	PAH	TCL VOC	TCL SVOC	RCRA Metals	Total Cyanide	TAL Metals	PCBs	TOC	
GCSB50	21.5 - 22	Located west of the substation control building.	*					*	*			*	*				The boring was used to evaluate potential discharges downgradient of the former boilers and to evaluate the presence/absence of the clay/sandy-clay layer beneath the footprint of the former MGP.
	37 - 37.5		*					*	*			*	*				
	37 - 37.5 (BD)		*					*	*			*	*				
	51 - 52		*					*	*			*	*				
GCSB51	9.5 - 10.5	Located to the southeast of the former 60,000 cubic foot gas holder.	*					*	*			*	*				The boring was used to evaluate and delineate the presence of previously identified impacts in the footprint of the former gas holder structure and to evaluate the presence/absence of the clay/sandy-clay layer beneath the footprint of the former MGP.
	18 - 19		*							*	*		*	*			
	33.5 - 34.5 (MS/MSD)		*							*	*		*	*			
	50 - 51.5		*					*	*			*	*				
GCSB52	10 - 10.5	Located to the north of the former 60,000 cubic foot gas holder at the entrance to the substation.	*					*	*			*	*				The boring was used to evaluate and delineate previously identified impacts from the former 60,000 cubic foot gas holder structure and to evaluate the presence/absence of the clay/sandy-clay layer beneath the footprint of the former MGP.
	11 - 11.5		*					*	*			*	*				
	14.5 - 15		*					*	*			*	*				
	34 - 34.5		*					*	*			*	*				
	48 - 50 (MS/MSD)		*					*	*			*	*				
GCSB53	14 - 14.5	Located along the western boundary of the site at the top of the slope west of the current electrical substation fence.	*					*	*			*	*				The boring was used to evaluate the vertical and horizontal extent of previously identified site impacts and to evaluate the presence/absence of the clay/sandy-clay layer.
	34 - 35		*					*	*			*	*				
	34 - 35 (BD)		*					*	*			*	*				
	51 - 52 (MS/MSD)		*					*	*			*	*				
	61 - 62		*					*	*			*	*				
	61 - 62 (BD)		*					*	*			*	*				
	62 - 64 (MS/MSD)		*					*	*			*	*				
GCSB54	9 - 10	Located in the western side of the former 40,000 cubic foot gas holder footprint (Hortonsphere).	*					*	*			*	*				The boring was used to evaluate the vertical and horizontal extent of previously identified impacts adjacent to the Hortonsphere and to evaluate the presence/absence of the clay/sandy-clay layer adjacent to the site.
	12.5 - 13		*					*	*			*	*				
	31.5 - 32		*					*	*			*	*				
	51 - 52		*					*	*			*	*				
GCSB55	7.5 - 8	Located on the west side of Glen Cove Creek in the shoulder of the Glen Cove Arterial Highway.	*					*	*			*	*				The boring was used to evaluate the lateral extent of tar impacts adjacent to the site and to evaluate the presence/absence of the clay/sandy-clay layer adjacent to the site.
	18 - 19		*					*	*			*	*				
	34 - 35		*					*	*			*	*				
	34 - 35 (BD)		*					*	*			*	*				
	51 - 52		*					*	*			*	*				
GCSB56	11 - 11.5	Located on the west side of Glen Cove Creek in the shoulder of the Glen Cove Arterial Highway.	*							*	*		*	*			The boring was used to evaluate the lateral extent of tar impacts adjacent to the site and the presence/absence of the clay/sandy-clay layer adjacent to the site.
	17 - 18		*					*	*			*	*				
	34 - 35 (MS/MSD)		*							*	*		*	*			
	49 - 50		*					*	*			*	*				
GSSB57	17 - 18	Located on the northern side of the LIRR right-of-way north of the site.	*					*	*			*	*				The boring was used to evaluate the lateral extent of previously identified impacts adjacent to the site and to evaluate the presence/absence of the clay/sandy-clay layer on the site.
	33 - 33.5		*					*	*			*	*				
	35 - 36		*					*	*			*	*				
	50 - 52 (MS/MSD)		*					*	*			*	*				

TABLE 2-2 (cont.)
FORMER GLEN COVE MGP SITE
KEYSPAN CORPORATION
ANALYTICAL SAMPLING SUMMARY

SAMPLE LOCATION NUMBER	ANALYTICAL SAMPLE DEPTH	SAMPLING LOCATION	SAMPLE TYPE					ANALYSIS									SAMPLING RATIONALE
			Soil	Ground Water	Surface Water	Sediment	Seep	BTEX	PAH	TCL VOC	TCL SVOC	RCRA Metals	Total Cyanide	TAL Metals	PCBs	TOC	
GCSB58	18 - 19	Located on the northern side of the LIRR right-of-way north of the site.	*					*	*			*	*				The boring was used to evaluate the lateral extent of previously identified impacts adjacent to the site and to evaluate the presence/absence of the clay/sandy-clay layer on the site.
	33 - 34		*					*	*			*	*				
	49 - 50		*					*	*			*	*				
GCSB59	19 - 20	Located on the northern side of the LIRR right-of-way north of the site.	*					*	*			*	*				The boring was used to evaluate the lateral extent of previously identified impacts adjacent to the site and to evaluate the presence/absence of the clay/sandy-clay layer on the site.
	24 - 24.5		*					*	*			*	*				
	33 - 34		*					*	*			*	*				
	51 - 52 (BD)		*					*	*			*	*				
	51 - 52		*					*	*			*	*				
GCSB60	34 - 35	Located on the northern parcel that borders the site within the asphalt parking area between soil borings GCSB-37 and GCSB-39.	*					*	*			*	*				The boring was used to evaluate the lateral extent of identified impacts adjacent to the site and the presence/absence of the clay/sandy-clay layer adjacent to the site.
	38 - 40 (MS/MSD)		*					*	*			*	*				
	50 - 51.5		*					*	*			*	*				
	50 - 51.5 (BD)		*					*	*			*	*				
	62 - 64		*					*	*			*	*				

TABLE 2-2 (cont.)
FORMER GLEN COVE MGP SITE
KEYSPAN CORPORATION
ANALYTICAL SAMPLING SUMMARY

SAMPLE LOCATION NUMBER	ANALYTICAL SAMPLE DEPTH	SAMPLING LOCATION	SAMPLE TYPE					ANALYSIS									SAMPLING RATIONALE
			Soil	Ground Water	Surface Water	Sediment	Seep	BTEX	PAH	TCL VOC	TCL SVOC	RCRA Metals	Total Cyanide	TAL Metals	PCBs	TOC	
GCSS-19	0-0.25'	Southwest portion of the site.	*					*	*							*	To evaluate surface soil conditions within the first two inches of mineral soil.
GCSS-20	0-0.25'	Western portion of the site.	*					*	*							*	To evaluate surface soil conditions within the footprint of the former 40,000 cubic foot gas holder (Hortonsphere).
GCSS-21	0-0.25'	Western portion of the site.	*					*	*							*	To evaluate surface soil conditions between the footprint of the fromer Hortonsphere and the former gas tanks.
GCSS-22	0-0.25'	Central portion of the site in the substation.	*							*	*		*	*			To evaluate surface soil conditions east of the footprint of the former 60,000 cubic foot gas holder.
GCSS-23	0-0.25'	Eastern portion of the site, in the substation.	*					*	*							*	To evaluate surface soil conditions within the active transformer substation.
GCSS-24	0-0.25'	In the northwestern corner of the site.	*					*	*							*	To evaluate surface soil conditions within the footprint of the potential impact zone.
GCSS-25	0-0.25'	In the northwestern portion of the site in the substation adjacent to the former 60,000 cubic foot gas holder.	*					*	*							*	To evaluate surface soil conditions adjacent to the former 60,000 cubic foot gas holder within the active transformer substation..
GCSS-26	0-0.25'	In the northern portion of the site in the substation.	*					*	*						*	*	To evaluate surface soil conditions within the active transformer substation.
GCSS-27	0-0.25'	In the eastern portion of the site.	*					*	*							*	To evaluate surface soil conditions at the former SS-4 sampling location.
GCSS-28	0-0.25' (BD)	Western portion of the site.	*					*	*							*	Blind Duplicate of sample GCSS-21
GCSS30	0 - 2"	In the eastern portion of the substation.	*						*			*					Located thought the substation and immediately west of the substation to delineate and evaluate the surficial soil conditions identified in the initial RI field program. Surficial soil samples will be collected within the first two inches of mineral soils.
GCSS31	0 - 2"	In the eastern portion of the substation.	*						*			*					
GCSS32	0 - 2"	In the eastern central portion of the substation.	*						*			*					
GCSS33	0 - 2"	In the eastern central portion of the substation.	*						*			*					
GCSS34	0 - 2"	In the eastern central portion of the substation.	*						*			*					
GCSS35	0 - 2"	In the eastern portion of the substation.	*						*			*					
GCSS36	0 - 2"	In the eastern portion of the substation.	*						*			*					
GCSS37	0 - 2"	In the eastern central portion of the substation.	*						*			*					
GCSS38	0 - 2"	In the southern portion of the substation.	*						*			*					
GCSS39	0 - 2"	In the northern portion of the substation.	*						*			*					
GCSS40	0 - 2"	In the northern portion of the substation.	*						*			*					
GCSS41	0 - 2"	In the northern central portion of the substation.	*						*			*					
GCSS42	0 - 2"	In the central portion of the substation.	*						*			*					
GCSS43	0 - 2" (MS/MSD)	In the central portion of the substation.	*							*	*	*					
GCSS44	0 - 2"	In the southern central portion of the substation.	*						*			*					
GCSS45	0 - 2"	In the southern portion of the substation.	*						*			*					
GCSS46	0 - 2"	In the southern portion of the substation.	*						*			*					
GCSS47	0 - 2"	In the northern portion of the substation.	*						*			*					
GCSS48	0 - 2"	In the northwestern corner of the site.	*							*	*	*					
GCSS50	0 - 2" (BD)	In the southern central portion of the substation.	*						*			*					Blind Duplicate of sample GCSS-44

TABLE 2-2 (cont.)
FORMER GLEN COVE MGP SITE
KEYSPAN CORPORATION
ANALYTICAL SAMPLING SUMMARY

SAMPLE LOCATION NUMBER	ANALYTICAL SAMPLE DEPTH	SAMPLING LOCATION	SAMPLE TYPE					ANALYSIS									SAMPLING RATIONALE
			Soil	Ground Water	Surface Water	Sediment	Seep	BTEX	PAH	TCL VOC	TCL SVOC	RCRA Metals	Total Cyanide	TAL Metals	PCBs	TOC	
GCBSS01	0 - 2"	Various off-site locations surrounding the site.	*						*			*					To define the nature of polycyclic aromatic hydrocarbons and metal concentrations in surface soils surrounding the Glen Cove former MGP site and to complete a statistical comparison with obtained on-site surface soil data, to determine if on-site soils are similar to background concentrations in the surrounding community.
GCBSS05	0 - 2"		*						*			*					
GCBSS06	0 - 2"		*						*			*					
GCBSS07	0 - 2"		*						*			*					
GCBSS08	0 - 2"		*						*			*					
GCBSS09	0 - 2"		*						*			*					
GCBSS10	0 - 2" (MS/MSD)		*						*			*					
GCBSS11	0 - 2"		*						*			*					
GCBSS12	0 - 2"		*						*			*					
GCBSS13	0 - 2"		*						*			*					
GCBSS14	0 - 2"		*						*			*					
GCBSS15	0 - 2"		*						*			*					
GCBSS16	0 - 2"		*						*			*					
GCBSS17	0 - 2"		*						*			*					
GCBSS18	0 - 2" (MS/MSD)		*						*			*					
GCBSS19	0 - 2"		*						*			*					
GCBSS20	0 - 2"		*						*			*					
GCBSS21	0 - 2" (BD)		*						*			*					Blind Duplicate of GCBSS-01

TABLE 2-2 (cont.)
FORMER GLEN COVE MGP SITE
KEYSPAN CORPORATION
ANALYTICAL SAMPLING SUMMARY

SAMPLE LOCATION NUMBER	ANALYTICAL SAMPLE DEPTH	SAMPLING LOCATION	SAMPLE TYPE					ANALYSIS									SAMPLING RATIONALE
			Soil	Ground Water	Surface Water	Sediment	Seep	BTEX	PAH	TCL VOC	TCL SVOC	RCRA Metals	Total Cyanide	TAL Metals	PCBs	TOC	
GCGWP-01	16-20	On the western boundary of the site adjacent to the culverted Glen Cove creek in the area of the former Hortonsphere.		*				*	*								To evaluate potential migration of MGP constituents along the former Glen Cove Creek Channel.
	32-36			*				*	*								
	48-52			*				*	*								
GCGWP-02	16-20	On the western boundary of the site adjacent to the culverted Glen Cove creek in the area of the former gas tanks.		*				*	*								To evaluate potential migration of MGP constituents along the former Glen Cove Creek Channel.
	32-36			*				*	*								
	48-52			*				*	*								
GCGWP-03	16-20	In the northwestern corner of the site adjacent to the existing retaining wall.		*				*	*								To evaluate potential migration of MGP constituents along the former Glen Cove Creek Channel.
	32-36			*				*	*								
	48-52			*				*	*								
GCGWP-04	16-20	On the northwestern side of the site at the bottom of the site boundary slope.		*				*	*								To evaluate potential migration of MGP constituents along the former Glen Cove Creek Channel.
	32-36			*				*	*								
	48-52			*				*	*								
	60-64			*				*	*								
	68-72			*				*	*								
GCGWP-05	16-20	On the northern side of the substation at the bottom of the site boundary slope.		*				*	*								To evaluate potential migration of MGP constituents along the former Glen Cove Creek Channel.
	32-36			*				*	*								
	48-52			*				*	*								
GCGWP-06	16-20	Northern boundary of the current electrical substation.		*				*	*								To evaluate potential migration of MGP constituents along the former Glen Cove Creek Channel.
	32-36			*				*	*								
	48-52			*				*	*								
GCGWP-37	36-40	On the northern parcel that borders the site within the asphalt parking lot.		*						*	*		*	*			To evaluate the tar impacts on the groundwater in this area of the site.
	62-66			*						*	*		*	*			
	70-74			*						*	*		*	*			
GCGWP08	18 - 22	Located west of the substation control building.		*				*	*			*					Located in the northwestern corner of the site. The temporary groundwater probe will be installed into the groundwater table to evaluate potential migration of MGP constituents along the former Glen Cove Creek channel.
	18 - 22 (BD)			*				*	*			*					
	36 - 40			*				*	*			*					
	46 - 50 (MS/MSD)			*				*	*			*					
GCGWP09	12 - 16	Located to the southeast of the former 60,000 cubic foot gas holder.		*				*	*			*					Located to the southeast of the former gas holder. The proposed groundwater probe will be used to evaluate and delineate the presence of previously identified groundwater impacts and to aid in selecting the location(s) for the installation of new groundwater monitoring wells.
	32 - 36			*				*	*			*					
	48 - 52			*				*	*			*					

TABLE 2-2 (cont.)
FORMER GLEN COVE MGP SITE
KEYSPAN CORPORATION
ANALYTICAL SAMPLING SUMMARY

SAMPLE LOCATION NUMBER	ANALYTICAL SAMPLE DEPTH	SAMPLING LOCATION	SAMPLE TYPE					ANALYSIS									SAMPLING RATIONALE
			Soil	Ground Water	Surface Water	Sediment	Seep	BTEX	PAH	TCL VOC	TCL SVOC	RCRA Metals	Total Cyanide	TAL Metals	PCBs	TOC	
GCGWP10	12 - 16	Located to the north of the 60,000 cubic foot gas holder at the entrance of the substation.		*				*	*			*					Located to the north of the former gas holder. The proposed groundwater probe will be used to evaluate and delineate previously identified groundwater impacts from the former 60,000 cubic foot gas holder structure and aid to in selecting the location(s) for new groundwater monitoring wells.
	32 - 36 (MS/MSD)			*				*	*			*					
	43 - 47			*				*	*			*					
	43 - 47 (BD)			*				*	*			*					
GCGWP11	64 - 68	Located along the western boundary of the site at the top of the slope west of the current electrical substation fence.		*				*	*			*					Located along the western boundary of the site at the top of the slope outside of the current electrical substation fence. The proposed groundwater probe will be used to evaluate the vertical and horizontal extent of previously identified groundwater impacts at the site.
	48 - 52			*				*	*			*					
	48 - 52 (BD)			*				*	*			*					
	14 - 18			*				*	*			*					
	32 - 36			*				*	*			*					
GCGWP12	14 - 18	Located along the western boundary of the site at the top of the slope west of the current electrical substation fence.		*				*	*			*					Located along the western boundary of the site at the top of the slope outside of the current electrical substation fence. The proposed groundwater probe will be used to evaluate the vertical and horizontal extent of previously identified groundwater impacts at the site.
	32 - 36			*				*	*			*					
	48 - 52 (MS/MSD)			*				*	*			*					
	64 - 68			*				*	*			*					
GCGWP13	14 - 18	Located within the footprint of the former 40,000 cubic foot gas holder (Hortonsphere).		*				*	*			*					Located to the west of the former Hortonsphere. The proposed groundwater probe will be used to evaluate the vertical and horizontal extent of previously identified groundwater impacts adjacent to the Hortonsphere and to aid in selecting the location(s) for new groundwater monitoring wells.
	14 - 18 (BD)			*				*	*			*					
	28 - 32 (MS/MSD)			*				*	*			*					
	46 - 50			*				*	*			*					
GCGWP14	15-19	Located on the northern side of the LIRR right-of-way north of the site.		*				*	*			*					Located on the northern side of the LIRR right-of-way north of the site. The proposed groundwater probe will be used to evaluate the vertical and horizontal extent of previously identified groundwater impacts at the site and, if necessary, aid in selecting the location(s) for new groundwater monitoring wells.
	33-37			*				*	*			*					
	49-53			*				*	*			*					
	49-53 (BD)			*				*	*			*					
GCGWP15	15-19	Located on the northern side of the LIRR right-of-way north of the site.		*				*	*			*					Located on the northern side of the LIRR right-of-way north of the site. The proposed groundwater probe will be used to evaluate the vertical and horizontal extent of previously identified groundwater impacts at the site and if necessary, aid in selecting the location(s) for new groundwater monitoring wells.
	31-35			*				*	*			*					
	46-50 (MS/MSD)			*				*	*			*					
GCGWP16	20-24	Located on the northern side of the LIRR right-of-way north of the site.		*				*	*			*					Located on the northern side of the LIRR right-of-way north of the site. The proposed groundwater probe will used to evaluate the vertical and horizontal extent of previously identified groundwater impacts at the site and, if necessary, aid in selecting the location(s) for new groundwater monitoring wells.
	31-35			*				*	*			*					
	48-52			*				*	*			*					
GCGWP17	31-35	On the northern parcel that borders the site within the asphalt parking lot.		*				*	*			*					Located on the northern parcel that borders the site within a gravel parking area between soil borings GCSB-37 and GCSB-39. The proposed groundwater probe will be used to evaluate the horizontal and vertical extent of identified groundwater impacts adjacent to the site and, if necessary, aid in selecting the location(s) for new groundwater monitoring wells.
	48-52			*				*	*			*					
	48-52 (BD)			*				*	*			*					
	64-68 (MS/MSD)			*				*	*			*					

TABLE 2-2 (cont.)
FORMER GLEN COVE MGP SITE
KEYSPAN CORPORATION
ANALYTICAL SAMPLING SUMMARY

SAMPLE LOCATION NUMBER	ANALYTICAL SAMPLE DEPTH	SAMPLING LOCATION	SAMPLE TYPE					ANALYSIS									SAMPLING RATIONALE
			Soil	Ground Water	Surface Water	Sediment	Seep	BTEX	PAH	TCL VOC	TCL SVOC	RCRA Metals	Total Cyanide	TAL Metals	PCBs	TOC	
PZ-01A	29.5	Located in the northwestern portion of the site.		*				*	*			*	*				To obtain shallow groundwater chemical and hydrologic information.
PZ-02A	20.5	Located in the southwestern portion of the site north of the former Hortonsphere.		*				*	*			*	*				To obtain shallow groundwater chemical and hydrologic information.
PZ-03	15.5	Located in the northern central portion of the substation.		*				*	*			*	*				To obtain shallow groundwater chemical and hydrologic information.
PZ-04	16.5 (MS/MSD)	Located in the southern portion of the substation south of the former 60,000 cubic foot gas holder.		*					*	*		*	*				To obtain shallow groundwater chemical and hydrologic information.
PZ-05	15	Located in the eastern portion of the substation.		*					*	*		*	*				To obtain shallow groundwater chemical and hydrologic information.
PZ-06	12	Located in the northeastern portion of the substation.		*				*	*			*	*				To obtain shallow groundwater chemical and hydrologic information.
PZ-07	8.5	Located in the southernmost portion of the site south of the Hortonsphere.		*				*	*			*	*				To obtain shallow groundwater chemical and hydrologic information.
GCMW-08S	27	On the northern parcel that borders the site within the asphalt parking lot.		*				*	*			*	*				To screen the groundwater table aquifer for potential impacts and provide hydrologic information.
GCMW-08D	65 (MS/MSD)			*				*	*			*	*				To screen the groundwater table aquifer above the clay/sandy clay layer for potential impacts and provide hydrologic information.
GCMW-09S	14	In the northwestern portion of the site within the access road.		*						*	*		*	*			To screen the groundwater table aquifer for potential impacts and provide hydrologic information.
GCMW-09I	31			*						*	*		*	*			To screen the groundwater table aquifer above the clay/sandy clay layer for potential impacts and provide hydrologic information.
GCMW-10S	14.5 (MS/MSD)	In the southwestern portion of the site within the area of the former 40,000 cubic foot gas holder (Hortonsphere).		*						*	*		*	*			To screen the groundwater table aquifer for potential impacts and provide hydrologic information.
GCMW-10I	23.5			*						*	*		*	*			To screen the groundwater table aquifer above the clay/sandy clay layer for potential impacts and provide hydrologic information.
GCMW-11S	15	In the northern boundary of the substation.		*				*	*			*	*				To screen the groundwater table aquifer for potential impacts and provide hydrologic information.
GCMW-11I	25.5			*				*	*			*	*				To screen the groundwater table aquifer above the clay/sandy clay layer for potential impacts and provide hydrologic information.
GCMW-12S	0.5	In the eastern portion of the substation.		*						*	*		*	*			To screen the groundwater table aquifer for potential impacts and provide hydrologic information.
GCMW-13S		In the substation within the area of the former 60,000 cubic foot gas holder.		*				*	*			*	*				To screen the groundwater table aquifer for potential impacts and provide hydrologic information.
GCMW-13I	27			*				*	*			*	*				To screen the groundwater table aquifer above the clay/sandy clay layer for potential impacts and provide hydrologic information.
GCMW-14S	15	On the western boundary of the site adjacent to the culverted Glen Cove creek in the area of the former gas tanks.		*				*	*			*	*				To screen the groundwater table aquifer for potential impacts and provide hydrologic information.
GCMW-14I	30			*				*	*			*	*				To screen the groundwater table aquifer above the clay/sandy clay layer for potential impacts and provide hydrologic information.
PZ-08	8.5	Blind Duplicate of PZ-07		*				*	*			*	*				
PZ-09	16.5	Blind Duplicate of PZ-04		*					*	*		*	*				
GCMW-08	27	Blind Duplicate of GCMW-08S		*				*	*			*	*				

TABLE 2-2 (cont.)
FORMER GLEN COVE MGP SITE
KEYSPAN CORPORATION
ANALYTICAL SAMPLING SUMMARY

SAMPLE LOCATION NUMBER	ANALYTICAL SAMPLE DEPTH	SAMPLING LOCATION	SAMPLE TYPE					ANALYSIS									SAMPLING RATIONALE
			Soil	Ground Water	Surface Water	Sediment	Seep	BTEX	PAH	TCL VOC	TCL SVOC	RCRA Metals	Total Cyanide	TAL Metals	PCBs	TOC	
PZ-01A	29.5	Located in the northwestern portion of the site.		*				*	*			*	*				To obtain shallow groundwater chemical and hydrologic information.
PZ-02A	20.5	Located in the southwestern portion of the site.		*				*	*			*	*				To obtain shallow groundwater chemical and hydrologic information.
PZ-03	15.5 (MS/MSD)	Located in the northern central portion of the substation.		*						*	*		*	*			To obtain shallow groundwater chemical and hydrologic information.
PZ-04	16.5	Located in the southern portion of the substation south of the former 60,000 cubic foot gas holder.		*				*	*			*	*				To obtain shallow groundwater chemical and hydrologic information.
PZ-04A	16.5 (BD)			*						*	*		*	*			
PZ-05	15	Located in the eastern portion of the substation.		*				*	*			*	*				To obtain shallow groundwater chemical and hydrologic information.
PZ-06	12	Located in the northeastern portion of the substation.		*				*	*			*	*				To obtain shallow groundwater chemical and hydrologic information.
PZ-07	8.5	Located in the southernmost portion of the site.		*				*	*			*	*				To obtain shallow groundwater chemical and hydrologic information.
GCMW08S	27	On the northern parcel that borders the site within the asphalt parking lot.		*				*	*			*	*				To screen the groundwater table aquifer for potential impacts and provide hydrologic information.
GCMW08D	65 (MS/MSD)			*				*	*			*	*				To screen the groundwater table aquifer above the clay/sandy clay layer for potential impacts and provide hydrologic information.
GCMW08	65 (BD)			*				*	*			*	*				
GCMW-09S	14	In the northwestern portion of the site within the access road.		*				*	*			*	*				To screen the groundwater table aquifer for potential impacts and provide hydrologic information.
GCMW-09I	31 (MS/MSD)			*						*	*		*	*			To screen the groundwater table aquifer above the clay/sandy clay layer for potential impacts and provide hydrologic information.
GCMW-10S	14.5	In the southwestern portion of the site within the are of the former 40,000 cubic foot gas holder (Hortonsphere).		*				*	*			*	*				To screen the groundwater table aquifer for potential impacts and provide hydrologic information.
GCMW-10I	23.5			*				*	*			*	*				To screen the groundwater table aquifer above the clay/sandy clay layer for potential impacts and provide hydrologic information.
GCMW-11S	15	In the northern boundary of the substation.		*				*	*			*	*				To screen the groundwater table aquifer for potential impacts and provide hydrologic information.
GCMW-11I	25.5			*				*	*			*	*				To screen the groundwater table aquifer above the clay/sandy clay layer for potential impacts and provide hydrologic information.
GCMW-11A	25 (BD)			*						*	*		*	*			
GCMW-12S	0.5	In the eastern portion of the substation.		*				*	*			*	*				To screen the groundwater table aquifer for potential impacts and provide hydrologic information.
GCMW-13I	27	In the substation within the area of the former 60,000 cubic foot gas holder.		*				*	*			*	*				To screen the groundwater table aquifer above the clay/sandy clay layer for potential impacts and provide hydrologic information.
GCMW-14S	15	On the western boundary of the site adjacent to the culverted Glen Cove creek in the area of the former Hortonsphere.		*				*	*			*	*				To screen the groundwater table aquifer for potential impacts and provide hydrologic information.
GCMW-14I	30			*				*	*			*	*				To screen the groundwater table aquifer above the clay/sandy clay layer for potential impacts and provide hydrologic information.
GCMW-15	12	Located on the west side of the culverted Glen Cove creek in the shoulder of the Glen Cove arterial highway.		*				*	*			*	*				Located on the west side of Glen Cove Creek in the shoulder of the Glen Cove Arterial Highway. The well will be used to evaluate the vertical and horizontal extent of tar impacts adjacent to the site.
GCMW-16	10	Located on the west side of the culverted Glen Cove creek in the shoulder of the Glen Cove arterial highway.		*				*	*			*	*				Located on the west side of the Glen Cove Creek in the shoulder of the Glen Cove Arterial Highway. The well will be used to evaluate the vertical and horizontal extent of tar impacts in groundwater adjacent to the site.

TABLE 2-2 (cont.)
FORMER GLEN COVE MGP SITE
KEYSPAN CORPORATION
ANALYTICAL SAMPLING SUMMARY

SAMPLE LOCATION NUMBER	ANALYTICAL SAMPLE DEPTH	SAMPLING LOCATION	SAMPLE TYPE					ANALYSIS										SAMPLING RATIONALE
			Soil	Ground Water	Surface Water	Sediment	Seep	BTEX	PAH	TCL VOC	TCL SVOC	RCRA Metals	Total Cyanide	TAL Metals	PCBs	TOC	
GCSED01	1' below creek bottom	Upstream side of Glen Cove Creek, adjacent to the site, where the box culvert under Route 107 empties into the channel.				*		*	*				*				To determine the potential for upstream impacts to the creek.
GCSED02	1' below creek bottom	Midway in the Glen Cove Creek, adjacent to the site, in the area of the Hortonsphere.				*		*	*				*				To determine the potential for impacts on the creek from site related sources.
GCSED03	1' below creek bottom	Downstream side of Glen Cove Creek, adjacent to the site, where the box culvert below the LIRR begins.				*		*	*				*				To determine the potential for impacts on the creek from site related sources.
GCSED04	1' below creek bottom	Upstream side of Glen Cove Creek, adjacent to the site, where the box culvert under Route 107 empties into the channel.				*		*	*				*				Blind Duplicate of sample GCSED-01
GCSED04	1' below creek bottom	Upstream side of Glen Cove Creek beyond the box culvert on the west side of Route 107.				*			*								To determine the potential for upstream impacts to the creek.
GCSED05	1' below creek bottom (MS/MSD)	Upstream side of Glen Cove Creek beyond the box culvert on the west side of Route 107.				*			*								To determine the potential for upstream impacts to the creek.
GCSED06	1' below creek bottom	Upstream side of Glen Cove Creek beyond the box culvert on the west side of Route 107.				*			*								To determine the potential for upstream impacts to the creek.
GCSED07	1' below creek bottom	Upstream side of Glen Cove Creek beyond the box culvert on the west side of Route 107.				*			*								Blind Duplicate of sample GCSED-06
GCSW01	0.5' below water surface	Downstream side of the Glen Cove Creek within the culvert below the LIRR.			*			*	*								To determine the potential for impacts on the creek from site related sources and to aid in determining a connection between the creek and site groundwater.
GCSW02	0.5' below water surface (MS/MSD)	Midstream side of the Glen Cove Creek adjacent to the site.			*			*	*								To determine the potential for impacts on the creek from site related sources and to aid in determining a connection between the creek and site groundwater.
GCSW03	0.5' below water surface	Upstream side of the Glen Cove Creek beyond the box culvert on the west side of Route 107.			*			*	*								To determine the potential for upstream impacts to the creek.
GCSW04	0.5' below water surface	Upstream side of the Glen Cove Creek beyond the box culvert on the west side of Route 107.			*			*	*								Blind Duplicate of sample GCSW-01
GCSEEP03		On the northern side of the substation at the bottom of the site boundary slope.		*				*	*								To determine the potential for impacts on the creek from site related sources.

TABLE 2-3
FORMER GLEN COVE MGP SITE
KEYSPAN CORPORATION
LOCATION OF SURFACE SOIL SAMPLES

SAMPLE	SAMPLE	PARCEL IDENTIFICATION			SAMPLE LOCATION	
NUMBER	DEPTH	SECTION	BLOCK	LOT	ON-SITE	OFF-SITE
GCSS - 16	0 - 6"	21	H	302	X	
GCSS - 17	0 - 6"	21	H	302	X	
GCSS - 18	0 - 6"	21	H	302	X	
GCSS - 19	0 - 2"	21	H	302	X	
GCSS - 20	0 - 2"	21	H	302	X	
GCSS - 21	0 - 2"	21	H	302	X	
GCSS - 22	0 - 2"	21	H	302	X	
GCSS - 23	0 - 2"	21	H	302	X	
GCSS - 24	0 - 2"	21	H	302	X	
GCSS - 25	0 - 2"	21	H	302	X	
GCSS - 26	0 - 2"	21	H	302	X	
GCSS - 27	0 - 2"	21	H	302	X	
GCSS - 30	0 - 2.5"	21	H	302	X	
GCSS - 31	0 - 2.5"	21	H	302	X	
GCSS - 32	0 - 2.5"	21	H	302	X	
GCSS - 33	0 - 2.5"	21	H	302	X	
GCSS - 34	0 - 2.5"	21	H	302	X	
GCSS - 35	0 - 2.5"	21	H	302	X	
GCSS - 36	0 - 2.5"	21	H	302	X	
GCSS - 37	0 - 2.5"	21	H	302	X	
GCSS - 38	0 - 2.5"	21	H	302	X	
GCSS - 39	0 - 2.5"	21	H	302	X	

Notes:

The sample depth is represented as inches below ground surface.

TABLE 2-3 (cont.)
FORMER GLEN COVE MGP SITE
KEYSPAN CORPORATION
LOCATION OF SURFACE SOIL SAMPLES

SAMPLE NUMBER	SAMPLE DEPTH	PARCEL IDENTIFICATION			SAMPLE LOCATION	
		SECTION	BLOCK	LOT	ON-SITE	OFF-SITE
GCSS - 40	0 - 2.5"	21	H	302	X	
GCSS - 41	0 - 2.5"	21	H	302	X	
GCSS - 42	0 - 2.5"	21	H	302	X	
GCSS - 43	0 - 2.5"	21	H	302	X	
GCSS - 44	0 - 2.5"	21	H	302	X	
GCSS - 45	0 - 2.5"	21	H	302	X	
GCSS - 46	0 - 2.5"	21	H	302	X	
GCSS - 47	0 - 2.5"	21	H	302	X	
GCSS - 48	0 - 2.5"	21	H	302	X	
GCSB - 25	0 - 24"	21	H	302	X	
GCSB - 26	0 - 24"	21	H	302	X	
GCSB - 27	0 - 24"	21	H	302	X	
GCAS - 01	0 - 12"	21	H	19		X
GCAS - 02	0 - 12"	21	H	19		X
GCAS - 03	0 - 12"	21	H	19		X
SS - 01	0 - 3"	21	H	302	X	
SS - 02	0 - 3"	21	H	302	X	
SS - 03	0 - 3"	21	H	302	X	
SS - 04	0 - 3"	21	H	302	X	
SS - 05	0 - 3"	21	H	302	X	
SS - 06	0 - 3"	21	H	302	X	
HB - 07	0 - 3"	21	H	302	X	

Notes:

The sample depth is represented as inches below ground surface.

TABLE 2-3 (cont.)
FORMER GLEN COVE MGP SITE
KEYSPAN CORPORATION
LOCATION OF SURFACE SOIL SAMPLES

SAMPLE NUMBER	SAMPLE DEPTH	PARCEL IDENTIFICATION			SAMPLE LOCATION	
		SECTION	BLOCK	LOT	ON-SITE	OFF-SITE
GCBSS01	0 - 2"	Public area immediately south of Site				X
GCBSS05	0 - 2"	21	H	142		X
GCBSS06	0 - 2"	21	H	142		X
GCBSS07	0 - 2"	Public area immediately west of Site along Route 107				X
GCBSS08	0 - 2"	Public area immediately west of Site along Route 107				X
GCBSS09	0 - 2"	Public area immediately west of Site along Route 107				X
GCBSS10	0 - 2"	Public area immediately north of Site along LIRR				X
GCBSS11	0 - 2"	21	D	612		X
GCBSS12	0 - 2"	21	D	616		X
GCBSS13	0 - 2"	Public area immediately west of Site along Route 107				X
GCBSS14	0 - 2"	21	H	310		X
GCBSS15	0 - 2"	21	H	310		X
GCBSS16	0 - 2"	21	D	611		X
GCBSS17	0 - 2"	21	D	612		X
GCBSS18	0 - 2"	21	D	611		X
GCBSS19	0 - 2"	Public area south of Site along Willow Avenue				X
GCBSS20	0 - 2"	Public area south of Site along Willow Avenue				X

Notes:

The sample depth is represented as inches below ground surface.

PID readings; (2) for horizontal delineation soil sample depth intervals selected for chemical analysis were determined based on visual impacts and/or previous analytical results at corresponding depth intervals at adjacent soil boring locations; and (3) for vertical delineation soil samples were biased to intervals at the base of the boring which lacked visual impacts and/or no to low PID readings.

The analytical results of the subsurface soil samples collected from the soil probes are discussed in **Section 4.1.3**. The locations of the soil borings are shown on **Drawing 2A**.

Upon completion of the soil probes, recovered sample material that was not retained for laboratory analysis was placed in 55-gallon steel drums and disposed of in accordance with applicable federal, state and local regulations. Each probe hole was backfilled via pressure grouting. All probe holes were restored to grade to their original existing condition. For example, asphalt areas were restored with asphalt, concrete areas were restored with concrete and grass and soil areas were restored with grass and soil, respectively.

2.2.3 Groundwater Probes

Groundwater probe samples were collected by driving GeoProbe rods to the bottom of the designated sample depth interval and retracting 4 feet of the outer steel casing to expose a decontaminated stainless steel screen. Dedicated polyethylene tubing and a decontaminated stainless steel check valve were inserted into the rod assembly to obtain a water sample. The screen, check valve and rods were decontaminated and new tubing was used between each sampling interval. Water quality parameters including pH, conductivity, turbidity, dissolved oxygen, temperature and redox potential were monitored utilizing a calibrated Horiba U-22 multiple parameter instrument. Additionally, any evidence of odors, sheens or the presence of NAPL was noted. All observations and results were logged in project field forms. Groundwater samples were then collected from the tubing/check valve assembly and transferred into laboratory-supplied sample containers.

Upon completion, each probe hole was allowed to naturally collapse into itself. Probe holes in potential source areas were tremie grouted to grade with cement/bentonite slurry. All probe holes were restored at grade with the same material that was originally in place, as described in **Section 2.2.2**.

A total of 17 groundwater probes were installed as part of this RI Program. Groundwater probes were advanced to a depth of 60 feet below the water table (approximately 82 feet bgs) based on visibly “non-impacted” soils observed in the adjacent soil boring. Groundwater samples were collected for chemical analysis based on visual observations and PID readings to address three purposes: (1) groundwater samples were biased to depth intervals showing impacts and/or elevated PID readings for groundwater characterization; (2) groundwater sample intervals selected for chemical analysis were determined based on visual impacts and/or previous analytical results at corresponding depth intervals at adjacent soil boring locations for horizontal delineation; and (3) groundwater samples were biased to depth intervals showing the absence of visual impacts and/or no to low PID readings for vertical delineation. The analytical results of the collected groundwater probe samples are discussed in **Section 4.2**. The groundwater probe locations are shown on **Drawing 2A**.

2.2.4 Groundwater Monitoring Well and Piezometer Installation

A total of 15 monitoring wells were installed as either shallow or intermediate wells based upon their location. Two of the seven existing piezometers (PZ02 and PZ07) were replaced adjacent to their original location. The monitoring well and piezometer locations are shown on **Drawing 2A**.

Monitoring wells were installed within the shallow groundwater and in the intermediate groundwater. As recommended by the RIWP, monitoring well construction consisted of 2-inch diameter, PVC, 20-slot well screens and Schedule 40 well casings. Typically, the monitoring well screen length was 10 feet and the casing extended from the screen to grade. Below the monitoring well screen, a 2-foot sump was installed on all wells to aid in the collection of DNAPL. Monitoring wells GCMW15 and GCMW16 were installed utilizing the 1.75-inch diameter stainless steel pre-pack well screens and completed to grade with a 2-inch PVC riser, as per NYSDEC approval.

The only well construction deviations from the RIWP were the lengthening of the uppermost portion of the well screens at GCMW11S and GCMW13S by two and four feet, respectively. This increase in the well screen length was constructed based on the higher than anticipated water table. Also, it is noted that the added screen lengths at wells GCMW11S and GCMW13S were 10-slot screen, rather than the 20-slot screen.

The RIWP proposed a well integrity inspection and potential replacement of the existing piezometers. The replacement piezometers were constructed of 1.75-inch diameter stainless steel pre-pack well screens and completed to grade with a 2-inch PVC riser, as per NYSDEC approval. The piezometers were constructed in a similar manner to the PVC monitoring wells, with the exception that the filter pack was pre-installed around the well screen and no sumps were installed below the well screen interval.

Drilling equipment (i.e., augers, split spoon samplers, rods, etc.) was decontaminated using a steam cleaner/pressure washer at the decontamination pad before commencement of drilling activities and between well locations/sampling intervals, in accordance with the October 2003 RIWP and as discussed in **Section 2.3.1**.

The monitoring wells were protected and secured with either above grade ("stick-up") or flush-mount locking steel casings. Well construction details are summarized in **Table 2-4**.

A No. 2-grade sand pack was installed in the annular space from about one foot below the bottom of the monitoring well sump to approximately one to three feet above the top of the well screen. A bentonite slurry was pumped into the annulus via a tremie pipe above the gravel pack. A bentonite/grout slurry was pumped into the annulus via a tremie pipe, from the top of the bentonite seal to the surface.

Soil cuttings generated during the installation of each well were placed into 55-gallon drums and properly disposed of in accordance with applicable federal, state and local regulations.

The groundwater monitoring wells and piezometers were developed following installation. The well development process involved the well purging method using a submersible pump or air lifting. The development process continued until the turbidity readings were at or below 50 Nephelometric Turbidity Units (NTUs) or a two-hour development period, whichever occurred first. All development water was temporarily containerized on-site in a polyethylene holding tank. After waste characterization, all containerized liquids were removed from the site for proper off-site transportation and disposal.

2.2.5 Groundwater Sampling

The initial round of groundwater sampling was conducted approximately two weeks after well development (May 2004). A second round of groundwater sampling was completed in June 2005. The groundwater sampling events included sample collection from the existing piezometers, replacement piezometers and the newly-installed wells. Prior to groundwater sample collection, fluid level measurements for groundwater and NAPL were obtained from each well. An oil/water interface probe, cotton string and disposable bailers were used to determine if any NAPL was present in the wells or piezometers.

The monitoring wells and piezometers were sampled in accordance with the "Low-Flow" sampling protocol. As part of the protocol, wells and piezometers were purged at a low pumping rate using a Grundfos Rediflo® submersible pump or peristaltic pump and dedicated tubing. The dedicated 0.75-inch diameter tubing was connected to a flow-through cell. The groundwater was pumped from the well through the bottom of the flow cell and exited through a tube near the top. The probes from the Horiba-U22 were placed into the flow cell so that the parameters for pH, specific conductance, temperature, turbidity, dissolved oxygen and ORP could be monitored and recorded. Following stabilization of the field parameters, groundwater was carefully poured from the discharge tubing into laboratory-supplied sample containers. It should be noted that when the peristaltic pump was used in the well purging process, a dedicated disposable

TABLE 2-4
FORMER GLEN COVE MGP SITE
KEYSPAN CORPORATION
MONITORING WELL AND PIEZOMETER CONSTRUCTION SUMMARY

MONITORING WELL	WELL DEPTH (feet bgs)	TOTAL DEPTH (feet bgs)	GROUND SURFACE ELEVATION (feet above msl)	TOP OF CASING ELEVATION (feet above msl)	CASING DIAMETER (inches)	SCREENED INTERVAL (feet bgs)	SUMP INTERVAL (feet bgs)
PZ - 01A	35	35	57.40	57.11	1.75/2	25 - 35	NA
PZ - 02A	21	21	55.87	58.58	1.75/2	18 - 21	NA
PZ - 03	19	19	56.76	56.76	2	14 - 19	NA
PZ - 04	19	19	56.96	56.96	2	16 - 19	NA
PZ - 05	18	18	60.67	62.88	2	8 - 18	NA
PZ - 06	17	17	58.52	58.52	2	7 - 17	NA
PZ - 07	10	10	48.62	50.36	2	3 - 10	NA
GCMW - 08S	36	38	78.80	78.59	2	26 - 36	36 - 38
GCMW - 08D	70	72	78.83	78.82	2	60 - 70	70 - 72
GCMW - 09S	18	20	57.31	56.81	2	8 - 18	18 - 20
GCMW - 09I	36	38	57.29	56.88	2	26 - 36	36 - 38
GCMW - 10S	16	18	50.72	52.62	2	11 - 16	16 - 18
GCMW - 10I	26	28	51.13	53.08	2	16 - 26	26 - 28
GCMW - 11S	20	22	57.83	57.52	2	8 - 20	20 - 22
GCMW - 11I	28	30	57.84	57.45	2	23 - 28	28 - 30
GCMW - 12S	24	26	64.19	66.63	2	14 - 24	24 - 26
GCMW - 13S	22	24	57.99	57.73	2	12 - 22	22 - 24
GCMW - 13I	30	32	57.88	57.73	2	25 - 30	30 - 32
GCMW - 14S	18	20	57.03	58.74	2	8 - 18	18 - 20
GCMW - 14I	30	32	57.02	58.75	2	25 - 30	30 - 32
GCMW - 15	16	16	51.57	51.34	1.75/2	6 - 16	NA
GCMW - 16	16	16	51.03	51.29	1.75/2	6 - 16	NA

Notes:

BGS - Indicates Below Ground Surface.
MSL - Indicates Mean Sea Level.

bailer was used to collect groundwater for volatile organic analysis. The submersible pump and flow cell were decontaminated prior to each use in accordance with the October 2003 RIWP. The analytical results of groundwater samples are discussed in **Section 4.2**. The locations of the groundwater samples are shown on **Drawing 2A**.

2.2.6 Surface Water Sampling

During the implementation of the September 2005 SRIWP, a total of three surface water samples were collected; one upgradient of the site, one adjacent to the site in the open portion of the creek channel and one downgradient of the site. At the request of NYSDEC, these locations were resampled and reanalyzed for Free Cyanide during the implementation of the March 2007 SRIWP, in December 2007. The surface water samples were collected to determine surface water quality in the creek and the potential impacts to the creek from dissolved phase constituents detected in groundwater beneath the former Glen Cove MGP site. The surface water samples were collected in laboratory-supplied containers. The analytical results of surface water samples are discussed in **Section 4.3**. The locations of the surface water samples are shown on **Drawing 2A**.

2.2.7 Seep Water Sampling

During the implementation of the September 2005 SRIWP, three seep samples were proposed and only one seep sample was collected from the eastern wall of the creek culvert adjacent to the site. Only seep water sample GCSEEP03 was collected at the time of sampling as it was the only seep in which water was present. At the request of NYSDEC, this location was resampled and reanalyzed for Free Cyanide during the implementation of the March 2007 SRIWP, in December 2007. The samples were collected to determine if any MGP-related constituents were present in the seep water. The grab sample of seep water was placed into laboratory-supplied sample containers. The analytical results of the seep sample are discussed in **Section 4.3.** The location of the seep water samples collected for analysis as well as the other two proposed sampling locations are shown on **Drawing 2A**.

2.2.8 Sediment Sampling

During the implementation of the September 2005 SRIWP, sediment sampling was performed to determine the sediment quality in the creek bed at locations upgradient of and adjacent to the site. A total of six sediment samples were collected; three samples were collected from the open portion of the creek channel adjacent to the site and three samples were collected upgradient of the site. At the request of NYSDEC, three additional sediment sampling locations were sampled and analyzed during the implementation of the March 2007 SRIWP, in December 2007. The samples were collected at a depth of 0 to 24 inches into the creek sediments utilizing a stainless steel split-spoon coring device. The coring device was decontaminated prior to each use in accordance with the October 2003 RIWP. The sediment samples were transferred into laboratory-supplied containers. All samples were field screened using a PID for the presence of volatile organic vapors. The analytical results of the sediment samples collected on-site are discussed in **Section 4.4**. The locations of the sediment samples are shown on **Drawing 2A**.

2.2.9 Hydraulic Conductivity Testing

On October 20 and 21, 2005, rising head slug tests were conducted at a total of six wells (three shallow and three intermediate) at the former Glen Cove MGP Site. The rising head slug tests were completed in accordance with the standard operating procedure for rising head slug tests as presented in Appendix F of the October 2003 RIWP with the following exceptions. A bailer was used (rather than slug bar) to remove groundwater and manual measurements (rather than automatic dataloggers) were used to record the rising head for the following reasons:

- The placement of a transducer, water level meter, and slug bar in a 2-inch diameter well creates a "tight fit". Removal of the slug to begin the test often disrupts the transducer elevation as it is recording water levels resulting in erroneous data; and

- In preparing for the hydraulic testing event, purging data and general observations regarding groundwater recovery in the selected wells were discussed and it was determined that recovery of the rising head would be at a rate conducive to manual measurement.

The slug test data was evaluated using the Bouwer and Rice method and indicates hydraulic conductivities typical of the soil matrix logged during soil boring/well installation at the Glen Cove site. The publication "A Slug Test for Determining Hydraulic Conductivity of Unconfined Aquifers With Completely or Partially Penetrating Wells" by Bouwer and Rice, 1976 was used as technical guidance. **Section 3.2.3** presents a discussion of the hydraulic conductivity.

2.2.10 Background Surface Soil Sampling Program

A background surface soil sampling program was implemented, at predetermined off-site locations within a 500-foot radius of the site, in accordance with the July 26, 2004 NYSDEC approved work plan. The work plan originally proposed the collection of 20 surface soil samples at predetermined locations representative of background surface soil conditions that were not impacted by the former MGP operations. However, a total of 17 samples were collected due to access limitations at three of the sampling locations (GCBSS-02, GCBSS-03 and GCBSS-04). Figure 1 of the Background Surface Soil Sampling Report (**Appendix F**) and **Drawing 4J** depict the sampling locations. As stated in

Section 2.2.1, Table 2-3 identifies the location of the surface soil samples relative to on-site and off-site locations.

The background surface soil samples were collected from a one square-meter area from the upper two inches below any turf or vegetative layer. The surface soil samples were field screened with a PID for volatile organic vapors and collected for analysis biased to the location exhibiting the highest PID reading. If no PID reading was recorded from the sampling area, the volatile organic fraction of the sample was collected randomly from the sampling area. The remaining sample for other analytical parameters were homogenized and transferred into laboratory-supplied containers.

Soil samples were submitted for analysis to H2M Laboratories of Melville, New York (H2M), a NYSDEC-approved laboratory that meets Environmental Laboratory Approved Program (ELAP) requirements. The samples were analyzed for polycyclic aromatic hydrocarbons (PAHs) via EPA Method 8270 and for RCRA metals by EPA Method 6010/7471. Data validation was completed for the all of the data under the requirements for the New York State Analytical Services Protocol (NYSASP) Category B deliverables.

2.2.11 Soil Vapor Sampling Program

Soil vapor samples were collected on April 3 and 9, 2008 at seven locations (see Table 2.6 and Figure 1 of the QHHEA). The seven soil vapor sample probes were installed to a depth of approximately 5 feet bgs utilizing a GeoProbe® drill rig. At each location, a 6-inch stainless steel soil gas point fitted with Teflon tubing was installed and the annulus was then backfilled with clean sand and sealed with approximately 0.5 feet of bentonite and backfilled to the surface.

To ensure that each sampling point was isolated from the ambient air above ground, GEI utilized helium as a tracer gas as described in the NYSDOH Soil Vapor Intrusion Guidance document. The soil vapor samples were collected in individually certified one-liter SUMMA® canisters with 10-minute flow controllers at a rate of 0.2 Liter (L)/minute. Soil vapor samples were shipped via Federal Express to Alpha Woods Hole Laboratories for analysis. The samples were analyzed for VOCs and naphthalene by the modified EPA Method TO-15 reporting list. Helium was analyzed by American Society of Testing and Materials (ASTM) Method D-1945.

2.3 Field Operating Procedures

2.3.1 Decontamination

In accordance with the October 2003 RIWP, drilling and probing equipment, including augers, split spoon samplers and, soil and groundwater probe rods, were decontaminated using a steam cleaner/pressure washer at the decontamination pad before implementation of soil sampling, soil and groundwater probing and drilling activities and between boring locations. All non-dedicated sampling equipment were decontaminated between each use by steam cleaning and/or thoroughly washing with alconox and water, using a brush to remove particulate matter or surface film, followed by a thorough rinsing with tap water, followed by a 10% nitric acid solution rinse, followed by a distilled water rinse, followed by a methanol rinse, and a distilled water rinse and allowed to air dry. All liquids generated from the decontamination process were pumped into a polyethylene holding tank and disposed of in accordance with federal, state and local regulations.

2.3.2 Air Monitoring

A PID and dust monitor (dataRAM) was used to monitor volatile organic vapors and soil particulates, respectively, in the breathing zone during ground intrusive activities. The PID was calibrated on at least a daily basis. Equipment calibration was documented in the project field forms and instrument calibration logs.

2.3.3 Perimeter Air Monitoring

During drilling activities, calibrated air monitoring instruments were used to monitor for potential releases of volatile organic vapors and particulates from the site. Upwind and downwind air monitoring stations were established at each drilling location. Each monitoring station contained a data logging PID and particulate meter. All air monitoring instruments were calibrated on a daily basis prior to the start of field work. The calibration records are maintained in the project files. All data from the stationary air monitoring stations were electronically downloaded to the on-site computer at the conclusion of each work day. The results of the perimeter air monitoring are presented in **Section 4.7**.

2.4 Fluid Level Measurements

During the groundwater sampling events, a complete round of fluid level measurements was collected from monitoring wells and piezometers. Two additional rounds of fluid level measurements were collected in August and October 2005 that included a fluid level measuring point located just north of the LIRR ROW and a surface water gauging point in the Glen Cove Creek. The fluid level measurement events recorded the presence/absence of NAPL in groundwater and the groundwater level in each well and piezometer (**Table 2-5**). Fluid level measurements were measured utilizing a Solinst water level indicator to an accuracy of 0.01-feet, a Solinst interface meter, cotton string and disposable bailers. Groundwater level data is discussed in **Section 3.2.3**. The locations of the groundwater monitoring wells, piezometers and groundwater measuring points are shown on **Drawing 2A**.

TABLE 2-5
GLEN COVE FORMER MGP SITE
KEYSPAN CORPORATION
GROUNDWATER MEASUREMENTS AND ELEVATIONS

Well Number	Measurement Date	Elevations		Difference between: TOC Elevation and the Ground Elevation	Well Depth		Depth to Water			Product		Groundwater Elevation*
		Top of PVC Well Casing (TOC)	Ground Surface		Feet below TOC	Feet Below Ground Surface	Time	Feet Below TOC	Feet Below Ground Surface	(Y/N)	Thickness (ft.)	Feet above (+) or below (-) Mean Sea Level on:
GCMW08S	8/6/2004	78.59	78.80	-0.21	38.00	38.21	8:40	29.34	29.55	N	N/A	49.25
GCMW08D	8/6/2004	78.82	78.83	-0.01	72.00	72.01	11:50	30.43	30.44	N	N/A	48.39
GCMW09S	5/13/2004	56.81	57.31	-0.50	19.27	19.77	10:55	9.86	10.36	N	N/A	46.95
GCMW09I	5/12/2004	56.88	57.29	-0.41	38.24	38.65	2:20	9.83	10.24	N	N/A	47.05
GCMW10S	5/12/2004	52.62	50.72	1.90	20.11	18.21	8:10	7.21	5.31	N	N/A	45.41
GCMW10I	5/11/2004	53.08	51.13	1.95	30.83	28.88	2:30	5.81	3.86	N	N/A	47.27
GCMW11S	5/18/2004	57.52	57.83	-0.31	22.10	22.41	10:50	9.69	10.00	N	N/A	47.83
GCMW11I	5/18/2004	57.45	57.84	-0.39	30.71	31.10	12:35	9.91	10.30	N	N/A	47.54
GCMW12S	5/14/2004	66.63	64.19	2.44	28.29	25.85	9:10	12.99	10.55	N	N/A	53.64
GCMW13S	5/17/2004	57.73	57.99	-0.26	22.21	22.47	12:50	9.99	10.25	N	N/A	47.74
GCMW13I	5/17/2004	57.73	57.88	-0.15	32.30	32.45	2:10	9.78	9.93	N	N/A	47.95
GCMW14S	5/13/2004	58.74	57.03	1.71	21.36	19.65	2:50	11.71	10.00	N	N/A	47.03
GCMW14I	5/13/2004	58.75	57.02	1.73	33.74	32.01	1:55	11.98	10.25	N	N/A	46.77
PZ-01A	5/12/2004	57.11	57.40	-0.29	34.64	34.93	11:35	10.02	10.31	N	N/A	47.09
PZ-02A	5/12/2004	58.58	55.87	2.71	23.15	20.44	9:30	11.71	9.00	N	N/A	46.87
PZ-03	8/4/2004	56.76	56.76	0.00	18.54	18.54	10:10	10.45	10.45	N	N/A	46.31
PZ-04	5/17/2004	56.96	56.96	0.00	18.66	18.66	9:15	9.43	9.43	N	N/A	47.53
PZ-05	5/14/2004	62.88	60.67	2.21	19.63	17.42	10:55	9.22	7.01	N	N/A	53.66
PZ-06	5/14/2004	58.52	58.52	0.00	16.06	16.06	12:05	5.54	5.54	N	N/A	52.98
PZ-07	5/11/2004	50.36	48.62	1.74	12.32	10.58	12:30	4.99	3.25	N	N/A	45.37

NOTES:

1) * = Measured from Ground Surface Elevation

2) Depth to groundwater table measured using an interface probe.

3) Product thickness measured using a combination of interface probe, weighted cotton string, and tape measure.

TOC - Indicates Top of PVC Well Casing.

Ground - Indicates Top of Ground Surface Elevation.

N/A - Indicates entry was Not Applicable.

NM - Indicates Well was Not Measured.

TABLE 2-5 (cont.)
GLEN COVE FORMER MGP SITE
KEYSPAN CORPORATION
GROUNDWATER MEASUREMENTS AND ELEVATIONS

Well Number	Measurement Date	Elevations		Difference between: TOC Elevation and the Ground Elevation	Well Depth		Depth to Water			Product		Groundwater Elevation*
		Top of PVC Well Casing (TOC)	Ground Surface		Feet below TOC	Feet Below Ground Surface	Time	Feet Below TOC	Feet Below Ground Surface	(Y/N)	Thickness (ft.)	Feet above (+) or below (-) Mean Sea Level on:
GCMW08S	Not Measured	78.59	78.80	-0.21	38.00	38.21	NM	NM	NM	N	N/A	NM
GCMW08D	Not Measured	78.82	78.83	-0.01	72.00	72.01	NM	NM	NM	N	N/A	NM
GCMW09S	6/14/2005	56.81	57.31	-0.50	19.27	19.77	11:21	10.04	10.54	N	N/A	46.77
GCMW09I	6/14/2005	56.88	57.29	-0.41	38.24	38.65	11:05	9.82	10.23	N	N/A	47.06
GCMW10S	6/14/2005	52.62	50.72	1.90	20.11	18.21	9:36	7.08	5.18	N	N/A	45.54
GCMW10I	6/14/2005	53.08	51.13	1.95	30.83	28.88	9:43	5.63	3.68	N	N/A	47.45
GCMW11S	6/16/2005	57.52	57.83	-0.31	22.10	22.41	10:09	9.76	10.07	N	N/A	47.76
GCMW11I	6/16/2005	57.45	57.84	-0.39	30.71	31.10	10:25	9.74	10.13	N	N/A	47.71
GCMW12S	6/16/2005	66.63	64.19	2.44	28.29	25.85	10:43	13.29	10.85	N	N/A	53.34
GCMW13S	6/16/2005	57.73	57.99	-0.26	22.21	22.47	8:54	10.26	10.52	**Y**	**0.74**	47.47
GCMW13I	6/16/2005	57.73	57.88	-0.15	32.30	32.45	9:37	10.00	10.15	N	N/A	47.73
GCMW14S	6/14/2005	58.74	57.03	1.71	21.36	19.65	10:04	11.90	10.19	N	N/A	46.84
GCMW14I	6/14/2005	58.75	57.02	1.73	33.74	32.01	10:16	11.52	9.79	N	N/A	47.23
GCMW15	6/14/2005	51.34	51.57	-0.23	16.35	16.58	9:13	6.07	6.30	N	N/A	45.27
GCMW16	6/14/2005	51.29	51.03	0.26	16.21	15.95	8:57	5.58	5.32	N	N/A	45.71
PZ-01A	6/14/2005	57.11	57.40	-0.29	34.64	34.93	11:34	9.85	10.14	N	N/A	47.26
PZ-02A	6/14/2005	58.58	55.87	2.71	23.15	20.44	9:50	11.75	9.04	N	N/A	46.83
PZ-03	6/16/2005	56.76	56.76	0.00	18.54	18.54	11:45	9.97	9.97	N	N/A	46.79
PZ-04	6/16/2005	56.96	56.96	0.00	18.66	18.66	11:25	9.61	9.61	N	N/A	47.35
PZ-05	6/16/2005	62.88	60.67	2.21	19.63	17.42	10:45	9.55	7.34	N	N/A	53.33
PZ-06	6/16/2005	58.52	58.52	0.00	16.06	16.06	10:59	5.83	5.83	N	N/A	52.69
PZ-07	6/14/2005	50.36	48.62	1.74	12.32	10.58	9:25	4.86	3.12	N	N/A	45.50
GCGWMP14	NM	45.57	42.49	3.08	19.00	15.92	NM	NM	NM	NM	**NM**	NM
GCCSWMP01 (up stream)	NM	45.62	44.45	1.17	5.00	3.83	NM	NM	NM	NM	**NM**	NM
GCCSWMP02 (down stream)	NM	45.35	44.17	1.18	5.00	3.82	NM	NM	NM	NM	**NM**	NM

NOTES:

1) * = Measured from Ground Surface Elevation
2) Depth to groundwater table measured using an interface probe.
3) Product thickness measured using a combination of interface probe, weighted cotton string, and tape measure.
TOC - Indicates Top of PVC Well Casing.
Ground - Indicates Top of Ground Surface Elevation.
N/A - Indicates entry was Not Applicable.
NM - Indicates Well was Not Measured.

TABLE 2-5 (cont.)
GLEN COVE FORMER MGP SITE
KEYSPAN CORPORATION
GROUNDWATER MEASUREMENTS AND ELEVATIONS

Well Number	Measurement Date	Elevations		Difference between: TOC Elevation and the Ground Elevation	Well Depth		Depth to Water			Product		Groundwater Elevation*
		Top of PVC Well Casing (TOC)	Ground Surface		Feet below TOC	Feet Below Ground Surface	Time	Feet Below TOC	Feet Below Ground Surface	(Y/N)	Thickness (ft.)	Feet above (+) or below (-) Mean Sea Level on:
GCMW08S	8/17/2005	78.59	78.80	-0.21	38.00	38.21	11:00	29.76	29.97	N	N/A	48.83
GCMW08D	8/17/2005	78.82	78.83	-0.01	72.00	72.01	10:57	30.23	30.24	N	N/A	48.59
GCMW09S	8/17/2005	56.81	57.31	-0.50	19.27	19.77	9:42	10.38	10.88	N	N/A	46.43
GCMW09I	8/17/2005	56.88	57.29	-0.41	38.24	38.65	9:44	10.29	10.70	N	N/A	46.59
GCMW10S	8/17/2005	52.62	50.72	1.90	20.11	18.21	9:25	7.30	5.40	N	N/A	45.32
GCMW10I	8/17/2005	53.08	51.13	1.95	30.83	28.88	9:27	6.11	4.16	N	N/A	46.97
GCMW11S	8/17/2005	57.52	57.83	-0.31	22.10	22.41	11:31	10.24	10.55	N	N/A	47.28
GCMW11I	8/17/2005	57.45	57.84	-0.39	30.71	31.10	11:29	10.37	10.76	N	N/A	47.08
GCMW12S	8/17/2005	66.63	64.19	2.44	28.29	25.85	11:40	14.49	12.05	N	N/A	52.14
GCMW13S	8/17/2005	57.73	57.99	-0.26	22.21	22.47	12:05	10.47	10.73	**Y**	**0.54**	47.26
GCMW13I	8/17/2005	57.73	57.88	-0.15	32.30	32.45	11:56	11.52	11.67	N	N/A	46.21
GCMW14S	8/17/2005	58.74	57.03	1.71	21.36	19.65	9:31	12.33	10.62	N	N/A	46.41
GCMW14I	8/17/2005	58.75	57.02	1.73	33.74	32.01	9:33	12.01	10.28	N	N/A	46.74
GCMW15	8/17/2005	51.34	51.57	-0.23	16.35	16.58	10:16	6.36	6.59	N	N/A	44.98
GCMW16	8/17/2005	51.29	51.03	0.26	16.21	15.95	10:08	5.84	5.58	N	N/A	45.45
PZ-01A	8/17/2005	57.11	57.40	-0.29	34.64	34.93	9:35	10.41	10.70	N	N/A	46.70
PZ-02A	8/17/2005	58.58	55.87	2.71	23.15	20.44	9:29	12.17	9.46	N	N/A	46.41
PZ-03	8/17/2005	56.76	56.76	0.00	18.54	18.54	13:16	9.97	9.97	N	N/A	46.79
PZ-04	8/17/2005	56.96	56.96	0.00	18.66	18.66	11:18	10.20	10.20	N	N/A	46.76
PZ-05	8/17/2005	62.88	60.67	2.21	19.63	17.42	11:37	10.75	8.54	N	N/A	52.13
PZ-06	8/17/2005	58.52	58.52	0.00	16.06	16.06	11:44	7.02	7.02	N	N/A	51.50
PZ-07	8/17/2005	50.36	48.62	1.74	12.32	10.58	9:22	4.82	3.08	N	N/A	45.54
GCGWMP14	8/17/2005	45.57	42.49	3.08	19.00	15.92	10:35	0.27	-2.81	N	N/A	45.30
GCCSWMP01(up stream)	8/17/2005	45.62	44.45	1.17	5.00	3.83	10:19	4.01	2.84	N	N/A	41.61
GCCSWMP02 (down stream)	8/17/2005	45.35	44.17	1.18	5.00	3.82	NM	NM	NM	N	N/A	NM

NOTES:

1) * = Measured from Ground Surface Elevation
2) Depth to groundwater table measured using an interface probe.
3) Product thickness measured using a combination of interface probe, weighted cotton string, and tape measure.
TOC - Indicates Top of PVC Well Casing.
Ground - Indicates Top of Ground Surface Elevation.
N/A - Indicates entry was Not Applicable.
NM - Indicates Well was Not Measured.

TABLE 2-5 (cont.)
GLEN COVE FORMER MGP SITE
KEYSPAN CORPORATION
GROUNDWATER MEASUREMENTS AND ELEVATIONS

Well Number	Measurement Date	Elevations		Difference between: TOC Elevation and the Ground Elevation	Well Depth		Depth to Water			Product		Groundwater Elevation*
		Top of PVC Well Casing (TOC)	Ground Surface		Feet below TOC	Feet Below Ground Surface	Time	Feet Below TOC	Feet Below Ground Surface	(Y/N)	Thickness (ft.)	Feet above (+) or below (-) Mean Sea Level on:
GCMW08S	10/26/2005	78.59	78.80	-0.21	38.00	38.21	13:45	28.52	28.73	N	N/A	50.07
GCMW08D	10/26/2005	78.82	78.83	-0.01	72.00	72.01	13:38	28.62	28.63	N	N/A	50.20
GCMW09S	10/26/2005	56.81	57.31	-0.50	19.27	19.77	11:06	8.96	9.46	N	N/A	47.85
GCMW09I	10/26/2005	56.88	57.29	-0.41	38.24	38.65	11:11	9.08	9.49	N	N/A	47.80
GCMW10S	10/26/2005	52.62	50.72	1.90	20.11	18.21	10:44	6.47	4.57	N	N/A	46.15
GCMW10I	10/26/2005	53.08	51.13	1.95	30.83	28.88	10:46	5.09	3.14	N	N/A	47.99
GCMW11S	10/26/2005	57.52	57.83	-0.31	22.10	22.41	11:30	8.68	8.99	N	N/A	48.84
GCMW11I	10/26/2005	57.45	57.84	-0.39	30.71	31.10	11:34	8.91	9.30	N	N/A	48.54
GCMW12S	10/26/2005	66.63	64.19	2.44	28.29	25.85	11:53	12.44	10.00	N	N/A	54.19
GCMW13S	10/26/2005	57.73	57.99	-0.26	22.21	22.47	11:40	9.09	9.35	**Y**	**0.34**	48.64
GCMW13I	10/26/2005	57.73	57.88	-0.15	32.30	32.45	11:47	10.42	10.57	N	N/A	47.31
GCMW14S	10/26/2005	58.74	57.03	1.71	21.36	19.65	10:50	11.12	9.41	N	N/A	47.62
GCMW14I	10/26/2005	58.75	57.02	1.73	33.74	32.01	10:51	10.87	9.14	N	N/A	47.88
GCMW15	10/26/2005	51.34	51.57	-0.23	16.35	16.58	12:50	5.37	5.60	N	N/A	45.97
GCMW16	10/26/2005	51.29	51.03	0.26	16.21	15.95	12:45	4.92	4.66	N	N/A	46.37
PZ-01A	10/26/2005	57.11	57.40	-0.29	34.64	34.93	10:58	9.03	9.32	N	N/A	48.08
PZ-02A	10/26/2005	58.58	55.87	2.71	23.15	20.44	10:48	10.99	8.28	N	N/A	47.59
PZ-03	10/26/2005	56.76	56.76	0.00	18.54	18.54	11:24	8.31	8.31	N	N/A	48.45
PZ-04	10/26/2005	56.96	56.96	0.00	18.66	18.66	14:15	8.79	8.79	N	N/A	48.17
PZ-05	10/26/2005	62.88	60.67	2.21	19.63	17.42	11:53	8.68	6.47	N	N/A	54.20
PZ-06	10/26/2005	58.52	58.52	0.00	16.06	16.06	12:00	4.96	4.96	N	N/A	53.56
PZ-07	10/26/2005	50.36	48.62	1.74	12.32	10.58	10:40	4.31	2.57	N	N/A	46.05
GCGWMP14	10/26/2005	45.57	42.49	3.08	19.00	15.92	13:24	0.00	-3.08	N	N/A	45.57
GCCSWMP01(up stream)	10/26/2005	45.62	44.45	1.17	5.00	3.83	12:54	3.72	2.55	N	N/A	41.90
GCCSWMP02 (down stream)	10/26/2005	45.35	44.17	1.18	5.00	3.82	12:56	2.92	1.74	N	N/A	42.43

NOTES:

1) * = Measured from Ground Surface Elevation

2) Depth to groundwater table measured using an interface probe.

3) Product thickness measured using a combination of interface probe, weighted cotton string, and tape measure.

TOC - Indicates Top of PVC Well Casing.
Ground - Indicates Top of Ground Surface Elevation.
N/A - Indicates entry was Not Applicable.
NM - Indicates Well was Not Measured.

2.5 Private Well and Basement Survey

As part of the Supplemental Remedial Investigation, a private well and basement survey was conducted. The purpose of the survey was to identify any residences and/or businesses in the study area that might be utilizing private wells and/or have basements, and request other pertinent information necessary to identify whether further study would be needed to determine whether these properties were being affected by the site. As part of initiating the program, questionnaires were mailed out to property owners/occupants within the survey area during February 2008. The survey area included the properties located adjacent to and approximately 1000 feet downgradient of the Glen Cove site.

A limited number of responses to the February 2008 survey have been received all of which indicate that those respondents do not have a private wells. To improve on the number of responses a second survey was initiated in September 2008 along with a follow up phone call to each recipient of the survey form to confirm their receipt of the form and answer any questions.

2.6 Surveying and Mapping

The locations, measuring point and surface elevations of new and existing monitoring wells, soil probes/borings, groundwater probes, surface soil sampling points, sediment sampling points, surface water sampling points, and the seep sampling point were surveyed by a licensed surveyor and placed on a georeferenced base map. Top of casing measurements for monitoring wells and piezometers were utilized in determining groundwater elevations. Surveyed locations for sample points are shown on **Drawing 2A**.

2.8 Laboratory Analysis and Data Management

The analytical data was transmitted by the laboratory, H2M Labs, in both hard copy and electronic disk deliverable (EDD) format. Once the data was tabulated it was checked against the hard copy data packages to ensure data integrity and completeness.

2.9 Data Validation/Data Usability

Analytical data packages submitted by H2M Labs were validated in accordance with NYSDEC 10/95 Analytical Services Protocol (ASP) Quality Assurance/Quality Control (QA/QC) requirements. Data validation of the initial and supplemental RI was performed by a QA/QC officer, meeting the qualifications required by NYSDEC to perform data validation.

The data packages were reviewed for transcription errors, as well as compliance with analytical methods and QA/QC requirements.

2.9.1 Sample Collection and Analysis

The field program consisted of sample collection from various environmental media including surface soil, subsurface soil, sediment, groundwater, surface water and seep water. Sample collection was performed in accordance with the procedures set forth in the October 2003 RIWP for the former Glen Cove MGP site. The water and soil samples were analyzed by H2M Labs in accordance with the USEPA SW-846 methods stipulated in the RIWP, as well as NYSDEC ASP QA/QC requirements. H2M Labs participate in the NYSDOH Environmental Laboratory Approval Program (ELAP) for all analyses performed as part of this project and also complies with the NYSDOH Contract Laboratory Program (CLP). A summary of the analytical sampling program is presented in **Tables 2-1** and **2-2**.

2.9.2 Data Quality Objectives

The data quality objective was to obtain valid defensible data to be used to determine the nature, extent and sources of chemical constituents at the site, as well as the preparation of a human health exposure assessment. The data was also utilized during the remedial investigation to monitor for the health and safety of workers at the site and potential receptors off-site.

To ensure data quality, several types of quality control (QC) measures were implemented. QC samples were collected (field blanks, matrix spikes and matrix spike duplicates) at a rate of 1 per 20 environmental samples. Trip blanks accompanied all shipments of water samples that required volatile organic or BTEX analysis. All samples for organic analyses were spiked with surrogate and/or internal standard compounds in order to determine the integrity/reliability of the sample results.

Due to an oversight during the 2004 part of the field investigation, field duplicates were not collected during the GeoProbe subsurface soil sampling and Groundwater probe sampling program as required by the work plan. The required Field Blanks and Matrix Spike/Matrix Spike duplicates required for these samples were collected and analyzed. Based on the data validation, the QA/QC sampling that has been performed for these samples was sufficient to validate the analytical results and provide an acceptable data set. Subsequent soil, sediment and water sampling at the site included collection of field duplicates and other QA/QC samples as required by the work plan.

To determine the comparability of the sample results, matrix spikes and matrix spike duplicates were analyzed for the organic parameters. In addition, the analytical methods also require that specific laboratory QA/QC measures be taken during analysis (i.e., calibrations, blanks, control samples, spiked blanks, etc.).

2.9.3 Data Quality and Usability

Twenty percent of the environmental samples results, as well as all QA/QC results were reviewed for data validation purposes. Data validation was performed in accordance with NYSDEC 10/95 ASP QA/QC requirements. A validation report/summary sheet was prepared for each sample delivery group (SDG) or data package.

Overall, the quality of the data was good and the results were determined to be usable for environmental assessment purposes. The findings of the validation process are summarized below.

General Findings

All laboratory packages were complete and the established analytical protocols were utilized. All holding times were met with the exceptions as noted below. All Quality Assurance data were acceptable, except as noted below. Correct qualifiers were utilized by the laboratory and additional qualifiers were added by the reviewer based on review of the Quality Control data. All calibrations were run in accordance with the specified methods.

Several samples had surrogate recoveries outside QC limits. The samples were reanalyzed, as required by the NYSDEC ASP. The data summary tables contain the “best set” of data that were deemed to be most contractually compliant and are flagged with the appropriate qualifiers.

BTEX and PAH compound concentrations were calculated using the response factors from the initial calibrations which are acceptable with USEPA SW-846 methodologies.

Additionally, there were several soil and groundwater samples which required dilution following the initial run of the samples for both the BTEX and PAH analysis. Therefore, the diluted result was reported for those compounds which required dilution. However, in the event that it was determined that a compound was diluted out during the dilution analysis run, the initial undiluted result was reported.

Soil samples collected from soil boring GCSB-43 at depths of 17-19, 22-24 and 50-52 feet bgs are qualified as unusable for Lead due to a spike recovery of less than 10%. Lead concentrations in these samples were reported as 5.8 milligrams per kilogram (mg/kg), 4.1 mg/kg and 2.5 mg/kg respectively.

Soil samples collected from soil boring GCSB-41 at depths of 18-20, 26-28, 58-60 and 74-76 feet bgs, and two soil samples from soil boring GCSB-47 at depths of 14-16 and 24-26 feet bgs were qualified as unusable for Lead due to a spike recovery of less than 10%. The lead results for soil boring GCSB-41 were 2.2

mg/kg, 7.3 mg/kg, 1.1 mg/kg and 2.3 mg/kg, respectively. The lead results for soil boring GCSB-47 were 4.5 mg/kg, and 1.7 mg/kg, respectively.

The Cyanide fraction of samples GCSB-35 at depths of 9-11, 14-16, 24-26 and 50-52 feet bgs were analyzed out of their technical holding time. The reported Cyanide concentrations for each of these samples were non-detect.

The semivolatile analysis of FB021704 was estimated as it was extracted out of its technical holding time.

Di-n-octylphthalate in soil sample GCSB-48 (10-12) was qualified by the validator as unusable due to low internal response of the associated internal standard.

Magnesium in soil sample GCSB-56 (34-34) was qualified by the validator as unusable because the spike recovery exceeded 150%.

The volatile organic compound (VOC) fraction of GCFB072605 was analyzed outside of its holding time. All results have been qualified as estimated possibly biased low.

Tentatively identified compounds were qualified as unusable in some of the volatile and semivolatile analysis because they are common laboratory contaminants.

No other problems were identified. All results have been deemed valid and usable for environmental assessment, as qualified above.

3.0 REGIONAL AND SITE GEOLOGY AND HYDROGEOLOGY

3.1 Geology

The regional geology is described based on the published references listed in **Section 9.0**. The site geology is based on the stratigraphy encountered during soil boring and groundwater well installations completed by PS&S and others. **Drawings 3A** through **3C** present cross sections of the site geology.

3.1.1 Regional

The geology of Long Island consists of wedge-shaped unconsolidated sediments overlying a crystalline bedrock surface sloping to the southeast. The bedrock is the Hartland Formation that consists of metamorphic schist and gneiss of Middle Ordovician to Lower Cambrian age. The depth to bedrock in this area of Long Island is approximately 350 feet bgs.

The unconsolidated sediments consist of a series of Pleistocene glacial deposits overlying Cretaceous coastal plain deposits composed of interbedded sand, gravel, silt, and clay. The following is the sequence of geologic units likely present beneath the former Glen Cove MGP site:

Geologic Period	Geologic Unit	Formation/Member
Pleistocene	Upper Pleistocene	Upper Pleistocene
		Gardiners Clay
		Jameco Gravel
Cretaceous	Matawan Group	Magothy
		Raritan
		Lloyd Sand
Ordovician/Cambrian	Bedrock	Hartland

Pleistocene till and outwash deposits include the Upper Pleistocene, Gardiners Clay and Jameco gravel. The Upper Pleistocene deposits along the north shore are composed mostly of clay, sand, gravel and boulders. The Gardiners Clay unit is a clay and silt with few layers of sand and gravel; and occurs in buried valleys near the north shore. The Jameco gravel is composed of fine to very coarse sand and gravel with few layers of clay and silt from crystalline and sedimentary sources. The Jameco gravel occurs typically in buried valleys near the north shore, when present.

The Cretaceous deposits were eroded by streams and glaciers. The pleistocene glacial sediments were deposited on the irregular, erosional Cretaceous surface, filling valleys cut by preglacial and glacial streams. In all but a few small areas, the Pleistocene deposits cover the Cretaceous deposits throughout Long Island forming the exposed land surface.

The upper surface of the Cretaceous deposits begins above sea level in the northern part of Nassau County. The average and approximate maximum thickness of the Cretaceous deposits are 800 and 2,000 feet, respectively; divided equally between the Magothy and Raritan Formations.

The Magothy Formation consists of fine micaceous sand, silt and interbedded clay sediments; in some areas it contains lignite and iron-oxide concretions. The unit thickness ranges from zero at its limits to more than 200 feet. The unit commonly has a very fine to coarse quartzose sand and in many places a gravel basal zone 25 to 50 feet thick.

The Raritan Formation includes the Raritan Clay and Lloyd Sand Members. The Raritan clay consists of an impermeable clay that ranges in thickness from 20 to more than 150 feet.

The Lloyd Sand Member consists mainly of deltaic deposits of fine to coarse quartzose sand interbedded with small to large pebble quartzose gravel. Also, interbeds of silt and clay, and silty and clayey sand are common throughout the unit. The thickness of the Lloyd ranges from zero at its northern extent to 300 feet. The Lloyd Sand Member's surface elevation is as shallow as 90 feet to over 800 feet below sea level.

3.1.2 Site Geology

The shallow stratigraphy beneath the site is considered heterogeneous fill and Upper Pleistocene deposits based on soil samples examined during the soil boring and monitoring well installations by PS&S and others. The stratigraphic sequence consists of outwash deposits overlain by heterogeneous fill. A general description of the two stratigraphic units is presented below.

Heterogeneous Fill

Surficial soils are composed of heterogeneous fill across most of the site and ranges in thickness from approximately 10 feet throughout most of the former site area to 30 feet in the off-site area just north of the site boundary. The fill composition is primarily poorly sorted and high permeability sand and gravel with varying percentages of gravel, silt, clay, and coal fragments. Soil boring logs indicate loosely-compacted fill is present in the eastern portion of the site from the surface to the native material. In the western portion, a well-compacted layer of fill was found extending from the surface to about 10 feet bgs. Fill in the southwestern portion of the site consists of coarse soils with intervals of clay from three to five feet bgs. The railroad embankment located to the north of the site consists of fill with a thickness along its centerline of about 25 to 30 feet.

Outwash Deposits

The glacial outwash deposits encountered on-site consist mainly of interbedded layers of permeable sand/gravel and lower permeability silty sand as shown on the cross-sections (**Drawings 3A through 3C**). The top of the glacial unit was encountered from approximately 10 feet bgs on the central portion of the former MGP site to approximately 32 feet bgs below the top of the railroad embankment. The ground surface elevation of the site is significantly lower than the top of the railroad embankment and when factoring in the ground surface elevation difference, the glacial deposits are encountered at similar elevations across the site and beneath the railroad embankment.

Soil borings or monitoring wells installed at the MGP site did not encounter the base of the glacial deposits. The deepest soil boring was installed to about 75 feet bgs. Therefore, the glacial outwash deposit thickness is at least 75 feet. The glacial outwash deposits underlying the site are consistent with regional geology discussed in **Section 3.1.1**.

The historic Glen Cove Creek occupied a natural stream channel just to the west of the MGP before it was channelized with the existing concrete walls. The natural creek bed is indicated by the alluvial deposits consisting of reworked glacial outwash present along the western boundary of the site. The alluvial deposits associated with the historic stream channel consist of isolated sand and gravelly sand layers encountered in the upper five to ten feet of soils at the western site boundary.

3.2 Hydrogeology

The regional hydrogeology is described based on the published references listed in **Section 9.0**. The site hydrogeology is based on the groundwater conditions observed in the site borings and monitoring wells and the aquifer testing completed at six on-site groundwater monitoring wells.

3.2.1 Regional

The Upper Glacial aquifer on Long Island includes the Upper Pleistocene deposits consisting of a mixture of brown sand, dark yellowish-brown sand and varying amounts of reworked Cretaceous deposits. The Upper Glacial aquifer sand is poorly to moderately sorted and overlies the Magothy Aquifer. The permeability of the Upper Glacial aquifer is variable with an average horizontal hydraulic conductivity of 270 feet/day and an anisotropy (horizontal to vertical) of 10:1. The thickness of the Upper Glacial aquifer beneath the site is at least 75 feet bgs based on site-specific soil boring data. The source of groundwater for the Upper Glacial aquifer is recharge from rainfall, streams and anthropogenic features such as storm sewers.

Regionally, the Upper Glacial aquifer is used for irrigation, commercial and industrial purposes, and is restricted as a potable water supply. The Upper Glacial aquifer has historically been impacted throughout the region by multiple sources (e.g., cesspools and septic effluents, fertilizers, spills, leaking tanks and surface waste disposal).

The Magothy Aquifer is the principal aquifer underlying the site and is Long Island's main source of public water supply. The aquifer is composed of beds and lenses of light gray, fine-to-coarse sand, with some interstitial clay. The top of the Magothy Aquifer is not planar, unlike the surfaces of the underlying units, as its upper surface ranges from 100 feet above sea level to 200 feet below sea level. Its thickness ranges from 0 to 650 feet from northwest to southeast. At the site, the Magothy Aquifer exists approximately 140 feet bgs and is approximately 150 feet thick. The layer of low permeability clay residing in the upper half of the aquifer causes the groundwater to transition from unconfined to confining conditions with depth. The average horizontal hydraulic conductivity is 50 feet/day and an anisotropy (horizontal to vertical) of 100:1.

The Raritan Clay Member is a laterally extensive, low permeable confining unit. The average vertical hydraulic conductivity is about 0.001 ft/day. The Raritan Clay separates the Magothy and Lloyd Aquifers and subsequently confines water in the Lloyd Aquifer.

The Lloyd Aquifer is moderately permeable with an average horizontal hydraulic conductivity of 60 ft/day and an anisotropy of 10:1.

3.2.2 Regional Hydrogeologic Zone

The Long Island Regional Planning Board 208 Study, dated 1979 places the Former Glen Cove MGP site within regional Hydrogeologic Zone VIII. This is a zone of regional discharge and any infiltrating fluid elements are not likely to recharge the sole source Magothy Aquifer but more likely to discharge to shallow surface water bodies.

3.2.3 Site

The groundwater beneath the former Glen Cove MGP Site is considered part of the regional Upper Glacial aquifer. The Upper Glacial aquifer occurs in the glacial outwash encountered beneath the site. Outwash soils encountered during well installation were permeable sands and gravelly sands with little to no fines interbedded with lower permeability silty sands. These soil types are consistent with the Upper Glacial aquifer matrix description and the observed interbedding of permeable and lower permeability soil is consistent with the regional anisotropy (horizontal to vertical) of 10:1. The observed interbedding and resulting anisotropy significantly limits the rate of vertical flow and migration as compared to the horizontal direction.

The total number of monitoring wells/piezometers installed at the former Glen Cove MGP site is 22. Wells GCMW-12S, GCMW-15 and GCMW-16 were installed in the shallow aquifer system. A total of six groundwater well pairings were installed at two general depth intervals designated as shallow and intermediate within the same aquifer system. Well GCMW-8S/D is located along the northern portion (off-site), GCMW-11S/I and GCMW-13S/I in the central portion, and GCMW-9S/I, GCMW-10S/I and GCMW-14S/I along the western portion of the site. Also, a total of seven piezometers were installed into the aquifer system. The shallow groundwater wells provide water level measurements and water quality data for the uppermost portion of the aquifer. The shallow monitoring wells are screened at 3 to 20 feet bgs across the water table. Intermediate groundwater wells were screened 20 to 30 feet bgs and used to provide water level measurements from deeper strata and groundwater sample collection and analysis for vertical delineation of the dissolved phase plume. Groundwater level measurement events were completed in May 2004 and; June, August and October of 2005. The groundwater level measurements and well survey data were used to calculate groundwater elevations as shown in **Table 2-5**. **Drawings 3D** and **3E** show groundwater elevation contours for the shallow and intermediate groundwater for each measurement event, respectively.

Groundwater elevations were similar for the shallow and intermediate wells ranging from about 43 to 53 feet above mean sea level (ft-msl). In general, groundwater is encountered near the base of the fill layer at the site. Groundwater elevation contours indicate a consistent groundwater flow direction to the west for both the shallow and intermediate zone wells. The potentiometric surface in the shallow groundwater follows the general topography of the site sloping from east to west. The hydraulic gradient is relatively steep (0.06 feet/foot) in the eastern and western portions of the site and less steep (0.02 feet/foot) in the central portion of the site with an average gradient of 0.04 feet/foot. A uniform hydraulic gradient of about 0.01 feet/foot appears in the intermediate groundwater across the site.

The vertical hydraulic gradient at the site was assessed by comparing the shallow and intermediate groundwater elevations at the six well pairings. In the central portion of the site, well pairings GCMW-11S/I and GCMW-13S/I indicated a downward vertical gradient. An upward vertical gradient was present along the site's western boundary at Glen Cove Creek as indicated by well pairings GCMW-9S/I, GCMW-10S/I and GCMW-14S/I. Well pairing GCMW-8S/D installed off-site to the north of the site showed variable vertical gradients likely due to recharge from rainfall events.

Rising head slug testing was completed at well pairings GCMW-9S/I, GCMW-11S/I and GCMW-14S/I. The slug testing data was analyzed using the Bouwer and Rice method. The slug testing results show relative consistency between well locations and estimate the average horizontal hydraulic conductivity to be 0.22 ft/day. The estimated groundwater seepage flow velocities were determined by multiplying the hydraulic conductivity obtained from the slug testing by the observed and hydraulic gradient and dividing the resultant by an assumed effective porosity of 20%. An average hydraulic gradient of 0.04 feet/foot was used to calculate the seepage flow velocity in the shallow zone. The shallow and intermediate groundwater seepage flow velocities are 0.044 and 0.001 ft/day, respectively. **Appendix B** contains the hydraulic conductivity testing calculations.

4.0 NATURE AND EXTENT OF CHEMICAL CONSTITUENTS

4.1 Summary of Soil Quality Conditions

The characterization and delineation of soil quality at the former Glen Cove MGP site is based on the soil analytical data from four separate investigation events performed by KeySpan and its consultants in 1995, 1999 and the two most recent in 2004 and 2005. One of the objectives of the two most recent RI events was to collect soil quality samples to fill data gaps of earlier investigations and complete the horizontal and vertical delineation of soil impacts. Soil quality results from each event are included in this report. A total of 190 soil samples have been collected at the former Glen Cove MGP site. Summary tables of soil quality data are provided in **Appendix C**. Please note that results of chemical analysis from previous site investigations, incorporated in this section, are summarized in **Tables 22 and 23** contained in **Appendix C**.

The analytical soil and sediment sample results were compared to the NYSDEC Technical and Administrative Guidance Memorandum #4046 Recommended Soil Cleanup Objectives (RSCOs) and the exceedances of the RSCOs are bolded on the data summary tables contained in **Appendix C**. The Benzo(a)pyrene equivalents were calculated for each soil sample collected from the intervals stated below and are included on the data summary tables contained in **Appendix C**. In those instances where an individual carcinogenic PAH was reported as not-detected, a value of 0 was utilized in the Benzo(a)pyrene equivalent calculations.

The presentation and discussion of soil quality data has been segmented into four depth intervals. The four depth intervals were selected based on several factors including vadose vs. saturated conditions, contaminant distribution and exposure pathways. The four depth intervals are:

- (0-1 feet below ground surface (bgs)) = surface soils;
- (1-8 feet bgs) = vadose zone;
- (8-30 feet bgs) = shallow saturated zone; and
- (greater that 30 feet bgs) = intermediate saturated zone.

Soil sample collection methodologies are discussed in **Sections 2.2.1 and 2.2.2**. Analytical methodologies are summarized in **Table 2-1**. Also, **Table 2-2** correlates the sample location/number, depth, type, and analytical parameters for the two most recent soil investigation events in 2004 and 2005.

4.1.1 MGP-Related Impacts Based on Field Observations

Continuous split spoon sampling was performed which allowed for visual inspection and field screening with a PID of soils for MGP-related impacts over the full length of the soil column. The observed MGP-related impacts were characterized by degree of impact. KeySpan has developed four categories for characterizing MGP-related visual impacts to maintain consistency between multiple former MGP sites and contractors. Description of the MGP-related impacts that were utilized during this RI program are categorized as follows:

1. **Solid tar** - Used to describe product that is solid or semi-solid phase. The magnitude of the observed solid tar was described (e.g., discrete granules or a solid layer).

2. **Saturated** - The entirety of the pore space for a sample is saturated with the tar/free product. Care was taken to ensure that observations were not of water saturating the pore spaces if this term was used. Depending on viscosity, tar/free-phase saturated materials may freely drain from a soil sample.

3. **Blebs, Coating, Sheen** – Residual product in the form of discrete sphericals and/or soil grains coated with tar/free product; in either condition, there is not sufficient free-phase material present to saturate the pore spaces. Sheen refers to soil exhibiting an irridescent petroleum-like sheen. The jar shake test was used to determine the presence/absence of sheen on the surface of the water in the jar. A petroleum sheen was continuous and did not break up at angles such as the "bacterial sheen".

4. **Stained** - Used with color (i.e., black or brown stained) to indicate that the soil matrix was stained a color other than the natural (unimpacted) color of the soil.

Drawing 4A shows the horizontal and vertical extent of MGP-related visual impacts and the designated color scheme that represents the four categories.

The MGP-related visual impacts were most frequently observed in areas within or surrounding the former MGP operations; in the northwestern and western portions of the site and just beyond the site limits to the north. With respect to depth, a total of five soil boring locations exhibited MGP-related visual impacts within the surface/vadose zone soils. Staining, and at one location, solid tar, were observed within the surface/vadose zone (**Drawings 4B** and **4C**).

The majority of MGP-related visual impacts (a total of 28 soil boring locations) were observed at and below the water table. The water table on-site is approximately 8 feet bgs. MGP-related visual impacts were encountered at 21 soil boring locations within the 8 to 30 foot bgs depth interval. The distribution of observed MGP impacts included tar/NAPL saturation at most of the 21 locations from the top of the water table to about 20 feet bgs. Thin lenses (0.5 feet or less) of tar/NAPL saturation were encountered deeper (22 and 27.8 feet bgs) at soil boring GCSB-40. Blebs were often observed below the DNAPL/Tar saturation at the same locations. Solid tar and staining were less prevalent than DNAPL/Tar saturation/blebs in the 8 to 30 foot bgs depth interval (**Drawing 4D**).

A total of eight soil boring locations within the greater than 30 foot bgs depth interval exhibited MGP-related visual impacts (**Drawing 4E**). DNAPL/Tar saturation was observed as thin lenses (0.5 feet or less) at two soil boring locations, GCSB-37 and GCSB-46. In GCSB-37 the saturation was followed at depth by the presence of blebs and staining.

Overall, the general sequence of MGP-related visual impacts begins at the water table as tar/NAPL saturation and blebs. The occurrence of these impacts reduces with depth. Also, blebs were typically found in soil beneath zones of tar/NAPL saturation. MGP-related visual impacts are negligible in the surface and vadose zone relative to the frequency of impacts observed at the water table and in the saturated zone.

The observed MGP-related visual impacts and soil quality results are presented together on **Drawings 4B** through **4E**. These illustrations present the relationship between the MGP-related visual impacts and associated chemical constituent concentrations. **Table 4-1** presents typical background metals concentrations in soil. **Table 4-2** presents a summary of the highest laboratory analytical result exceedances in soil.

4.1.2 Surface Soil Quality

Surface soils are designated as soils within the upper two inches to one foot depth beneath the surficial stone, turf or vegetative layer. A total of 44 surface soil samples were collected and analyzed. Forty of the surface soil samples were collected from within the site and along the site perimeter (**Drawing 2A**). Three of the forty-four surface soil samples were collected off-site adjacent to the property boundary. These off-site surface soil samples are identified as GCAS-01 through GCAS-03 collected during the February 2000 Due Diligence Investigation, performed by Dvirka and Bartilucci (D&B). Stainless-steel sampling spoons and trowels were used to collect each surface soil sample. The soils were screened for organic vapors using a PID prior to collection. The surface soils were collected, stored and shipped to the laboratory in accordance with the RIWP including required chain of custody documentation.

Surface soil samples were analyzed for BTEX, PAHs, RCRA metals and total cyanide. Ten percent of the surface soil samples were analyzed at random for the Target Compound List (TCL) plus a thirty-peak library search and Target Analyte List (TAL) metals. PCB analysis was included at surface soil sample locations GCSS 16 through 18, SS-01 through SS-06 and GCSS-26 to screen for potential impacts associated with the electrical transformers in this area of the substation.

Surface soil samples GCSS-22, GCSS-43 and GCSS-48 were analyzed for TCL VOCs, TCL SVOCs and metals. In addition, surface soil samples GCSS-19 and

TABLE 4-1
FORMER GLEN COVE MGP SITE
KEYSPAN CORPORATION
TYPICAL BACKGROUND METALS CONCENTRATIONS IN SOIL

Metals	Background Levels - Eastern USA (mg/kg)
Aluminum	7,000 - 100,000
Antimony	< 1 - 8.8
Arsenic	< 0.1 - 73
Barium	10 - 1,500
Beryllium	< 1 - 7
Cadmium	-
Calcium	100 - 280,000
Chromium	1 - 1,000
Cobalt	< 0.3 - 70
Copper	< 1 - 700
Iron	100 - 100,000
Lead	< 10 - 300
Magnesium	50 - 50,000
Manganese	< 2 - 7,000
Mercury	0.01 - 3.4
Nickel	< 5 - 700
Potassium	50 - 37,000
Selenium	< 0.1 - 3.9
Silver	-
Sodium	500 - 50,000
Thallium	-
Vanadium	< 7 - 300
Zinc	< 5 - 2,900

NOTES:
From: H.T. Shacklette and J.G. Boerngen, USGS Professional Paper 1270, 1984
- : Not established.

TABLE 4-2
GLEN COVE FORMER MGP SITE
KEYSPAN CORPORATION
SUMMARY OF HIGHEST EXCEEDANCES IN SOIL

Sample Number	Total BTEX Concentration (mg/kg)	Total PAH Concentration (mg/kg)	Location in Relation to Former MGP Structures and/or Site	PID (ppm)	Field Visual Observation of Recovered Sample
GCSB - 29 (34-36)	0.002	1582.5	Located on the northern parcel that borders the site within a asphalt parking area at the top of the slope.		Staining
GCSB - 33 (21-23)	113.8	2002.3	Western boundary of the current electrical substation.	295	Moderate to Strong Naphthalene-like Odor, Pockets of NAPL Saturation
GCSB - 34 (13-15)	1.73	1643.4	Western boundary of the current electrical substation.	41.2	Moderate to Strong Naphthalene-like Odor, Sheen, Coating
GCSB - 35 (9-11)	ND	585.81	Northern boundary of the current electrical substation.	0	Slight Petroleum-Like Odor
GCSB - 37 (36-38)	0.62	2497.44	On the northern parcel that borders the site within the asphalt parking area.	40.9	Moderate Naphthalene-like Odor, Saturated, Blebs, Sheen and Coated
GCSB - 41 (18-20)	ND	1100.06	On the western boundary of the site adjacent to the culverted Glen Cove creek in the area of the former Hortonsphere.	0	Moderate Petroleum-Like Odor , Sheen and Blebs
GCSB - 42 (13-15)	7.6	1173.1	On the northern boundary of the current electrical substation.	89.5	Strong Naphthalene-like Odor, Bands of NAPL Saturation
GCSB - 44 (8-10)	0.091	138,700	On the northern side of the substation at the bottom to the site boundary slope.	58.1	Strong Naphthalene-like Odor, Sheen and Blebs
GCSB - 44 (15-17)	14.96	6436	On the northern side of the substation at the bottom to the site boundary slope.	14.3	Moderate Petroleum-Like Odor , Saturated
GCSB - 45 (14-16)	1.74	1376.8	In the southern corner of the substation, south of the former 60,000 cubic foot gas holder.	86.5	Strong Naphthalene-like Odor, Bands of NAPL Saturation, Sheen and Blebs
GCSB - 46 (10-12)	377.5	59380	In the access road west of the former 60,000 cubic foot gas holder.	90.5	Moderate to Strong Naphthalene-like and Petroleum-Like Odor, Pockets of NAPL Saturation
GCSB - 50 (21.5-22)	0.308	2657.2	Located west of the substation control building.	18.9	Slight Naphthalene-Like Odor
GCSB - 52 (10-10.5)	135.04	7861	Located to the north of the former 60,000 cubic foot gas holder at the entrance to the substation.	230	Moderate to Strong Naphthalene-like Odor, Pockets of NAPL Saturation
GCSB - 52 (11 - 11.5)	56.77	3969.1	Located to the north of the former 60,000 cubic foot gas holder at the entrance to the substation.	121	Moderate Petroleum-Like Odor , Staining and Sheen
GCSB - 52 (14.5 - 15)	18.37	9553	Located to the north of the former 60,000 cubic foot gas holder at the entrance to the substation.	145	Moderate to Strong Naphthalene-like Odor, Saturated, Sheen and Blebs
GCSB - 60 (34-35)	0.027	1096.13	Located on the northern parcel that borders the site within a gravel parking area between soil borings GCSB-37 and GCSB-39.	3.2	Slight Naphthalene-Like Odor, Staining and Sheen
SB - 01 (11)	0.007	5532	On the northern boundary of the current electrical substation.	4	Saturation and Moderate Naphthalene-like Odor

GCSS-27 were analyzed for grain size distribution to support the qualitative human exposure assessment.

The BTEX analysis was performed on samples collected from 21 of the 44 surface soil sampling locations. The results indicate non-detectable concentrations at 17 of the 21 locations (**Drawing 4B**). The total BTEX concentrations were negligible ranging from 0.002 to 0.015 mg/kg at the remaining four locations. A comparison of the individual BTEX compound concentrations to the NYSDEC Technical and Administrative Guidance Memorandum #4046 Recommended Soil Cleanup Objectives (TAGM RSCO) indicates no exceedances. A summary of BTEX compounds in surface soils is provided in **Appendix C (Tables 1, 22 and 23)**.

The non-MGP related VOC compounds, methylene chloride and tetrachloroethene were detected in several surface soil samples at concentrations not exceeding their respective NYSDEC TAGM RSCOs. The source of these highly volatile compounds is likely a laboratory artifact as they were identified in the laboratory method blank.

The PAH analysis was performed at the 44 surface soil sampling locations. The results indicate the presence of PAH compounds at each sample location as shown on **Drawing 4B**. Total PAH concentrations presented on **Drawing 4B** range from 2.167 to 621 mg/kg. The distribution of total PAH concentrations show 39% of the total concentrations at or below 10 mg/kg, 48% greater than 10 mg/kg and below 100 mg/kg, and 13% at 100 mg/kg or greater.

The PAH compound, benzo(a)pyrene was detected most frequently in excess of the NYSDEC TAGM RSCO of 0.061 mg/kg at each surface soil sample location. The benzo(a)pyrene exceedances ranged from 0.15 to 46 mg/kg. Benzo(a)pyrene equivalents ranged from 0.214 mg/kg in sample GCAS-03 to 30.63 mg/kg in sample GCSS-31. **Table 4-5** provides the concentration range/frequency of exceedances statistics for additional PAH compounds. A summary of PAH compounds in surface soils is provided in **Appendix C (Tables 2, 22 and 23)**.

The non-MGP related PAH compounds include bis(2-ethylhexyl) phthalate and butylbenzylphthalate that were detected in several surface soil samples at concentrations not exceeding their respective NYSDEC TAGM RSCOs. The source of these compounds is likely a laboratory artifact.

A total of 43 surface soil samples were analyzed for RCRA Metals. In addition, 12 of the 43 surface soil samples were analyzed for TAL Metals. The following metals were detected at concentrations exceeding their respective NYSDEC TAGM RSCOs; arsenic, barium, beryllium, cadmium, chromium, copper, iron, lead, mercury, nickel, selenium and zinc. The frequency of exceedances for metals in surface soils is presented in **Table 4-5**. Cyanide was not detected. A

TABLE 4-5
GLEN COVE FORMER MGP SITE
KEYSPAN CORPORATION
FREQUENCY OF EXCEEDANCES IN SURFACE SOIL

ANALYTICAL GROUP	CHEMICAL COMPOUND	NYSDEC RSCO (mg/kg)	CONCENTRATION RANGE (mg/kg)	FREQUENCY EXCEEDING RSCO	SAMPLE REPORTED WITH HIGHEST CONCENTRATION		
					SAMPLE NUMBER	DEPTH	DATE
VOC's	Acetone	0.2	ND	0 of 4			
	Benzene	0.06	ND	0 of 20			
	2-Butanone	0.3	ND	0 of 4			
	Ethylbenzene	5.5	ND to 0.002	0 of 20	GCBS - 27	0 - 2	11/22/1999
	Methylene Chloride	0.1	ND to 0.008	0 of 4	GCSS - 22	0.16	3/15/2004
	Styrene		ND				
	Tetrachloroethene	1.4	ND to 0.003	0 of 4	GCSS - 22	0.16	3/15/2004
	Toluene	1.5	ND to 0.005	0 of 20	GCSB - 27	0 - 2	11/22/1999
	1,1,1-Trichloroethane	0.8	ND	0 of 4			
	Xylenes	1.2	ND to 0.008	0 of 20	GCSB - 27	0 - 2	11/22/1999
	Total BTEX		ND to 0.015		GCSB - 27	0 - 2	11/22/1999
SVOC's	Acenaphthene	50	ND to 0.55	0 of 44	GCSS - 32	0.20	4/15/2005
	Acenaphthylene	41	ND to 48	1 of 44	SS - 04	0.25	11/7/1995
	Anthracene	50	ND to 13	0 of 44	SS - 04	0.25	11/7/1995
	Benzo[a]anthracene	0.224	0.13 to 60	39 of 44	SS - 04	0.25	11/7/1995
	Benzo[a]pyrene	0.061	0.15 to 46	44 of 44	SS - 04	0.25	11/7/1995
	Benzo[b]fluoranthene	1.1	0.22 to 61	31 of 44	SS - 04	0.25	11/7/1995
	Benzo[g,h,i]perylene	50	0.091 to 36	0 of 44	SS - 04	0.25	11/7/1995
	Benzo[k]fluoranthene	1.4	0.20 to 35	24 of 44	SS - 04	0.25	11/7/1995
	bis(2-ethylhexyl)phthalate	50	ND to 18	0 of 17	SS - 04	0.25	11/7/1995
	Butylbenzylphthalate	50	ND to 0.20	0 of 17	SS - 06	0.25	11/7/1995
	Carbazole		ND to 0.7		GCSS - 48	0.20	4/15/2005
	Chrysene	0.4	0.26 to 79	38 of 44	SS - 04	0.25	11/7/1995
	Dibenz[a,h]anthracene	0.014	ND to 3	27 of 44	GCSS - 31	0.20	4/15/2005
	Dibenzofuran	6.2	ND to 0.34	0 of 17	GCAS - 01	0 - 1	11/23/1999
	Di-n-butyl phthalate	8.1	ND to 0.072	0 of 17	SS - 06	0.25	11/7/1995
	Fluoranthene	50	0.13 to 77	1 of 44	SS - 04	0.25	11/7/1995
	Fluorene	50	ND to 0.83	0 of 44	GCSS - 23	0.16	3/15/2004
	Indeno[1,2,3-cd]pyrene	3.2	0.091 to 33	9 of 44	SS - 04	0.25	11/7/1995
	2-Methylnaphthalene	36.4	ND to 1.5	0 of 37	GCSS - 19	0.16	3/15/2004
	Naphthalene	13	ND to 3.5	0 of 44	GCSS - 19	0.16	3/15/2004
	Phenanthrene	50	0.044 to 13	0 of 44	SS - 04	0.25	11/7/1995
	Pyrene	50	0.18 to 120	4 of 44	SS - 04	0.25	11/7/1995
	Total PAH		2.167 to 621		SS - 04	0.25	11/7/1995
	Total CaPAH		1.15 to 314		SS - 04	0.25	11/7/1995
METALS	Aluminum	SB	3030 to 16,200		GCAS - 02	0 - 1	11/23/1999
	Antimony	SB	ND to 65		SS - 01	0.25	11/7/1995
	Arsenic	7.5	ND to 85.8	12 of 43	GCAS - 02	0 - 1	11/23/1999
	Barium	300	ND to 698	3 of 43	GCSS - 16	0.50	11/22/1999
	Beryllium	0.16	ND to 2.3	8 of 12	GCAS - 02	0 - 1	11/23/1999
	Cadmium	1	ND to 4.2	13 of 43	GCAS - 01	0 - 1	11/23/1999
	Calcium	SB	1420 to 14400		SS - 02	0.25	11/7/1995
	Chromium	10	ND to 28.2	23 of 43	GCAS - 01	0 - 1	11/23/1999
	Cobalt	30	2.9 to 6.9	0 of 12	GCSS - 48	0.20	4/15/2005
	Copper	25	14.6 to 60.4	8 of 12	SS - 05	0.25	11/7/1995
	Cyanide		ND to 2.9		GCSS - 27	0.16	3/15/2004
	Iron	2000	8410 to 38,700	12 of 12	GCAS - 01	0 - 1	11/23/1999
	Lead	200 - 500	0.31 to 697	1 of 43	SS - 05	0.25	11/7/1995
	Magnesium	SB	1090 to 6050		GCSS - 48	0.20	4/15/2005
	Manganese	SB	71.5 to 300		GCSS - 48	0.20	4/15/2005
	Mercury	0.1	ND to 9.2	23 of 43	GCSS - 30	0.20	4/15/2005
	Nickel	13	8 to 19.5	6 of 12	GCAS - 01	0 - 1	11/23/1999
	Potassium	SB	ND to 1,540		GCAS - 01	0 - 1	11/23/1999
	Selenium	2	ND to 4.8	5 of 43	SS - 02	0.25	11/7/1995
	Silver	SB	ND to 6.7		GCAS - 01	0 - 1	11/23/1999
	Sodium	SB	ND to 108		GCSS - 48	0.20	4/15/2005
	Thallium	SB	ND to 1.7		SS - 03	0.25	11/7/1995
	Vanadium	150	12.7 to 53.5	0 of 12	GCAS - 01	0 - 1	11/23/1999
	Zinc	20	30.9 to 620	12 of 12	SS - 05	0.25	11/7/1995

summary of metals concentrations in surface soils is provided in **Appendix C (Tables 3, 22 and 23)**.

No PCBs/pesticides were detected in surface soils above their respective NYSDEC TAGM RSCOs. A summary of PCBs/pesticides in surface soils is provided in **Appendix C (Tables 4, 22 and 23)**.

Overall, BTEX compounds do not appear to be contaminants of concern in the surface soils. However, the presence of PAH compounds above the NYSDEC TAGM RSCOs, especially benzo(a)pyrene do exist. Several metals were detected exceeding the NYSDEC TAGM RSCOs. The identified metals are consistent with local background conditions and/or related to historic fill used to re-grade the site. No PCBs/pesticides were detected above their respective NYSDEC TAGM RSCOs in surface soils. Cyanide was not detected.

4.1.3 Subsurface Soil Quality

As discussed in **Section 4.1**, the subsurface soils are segmented by depth into three depth intervals, 1 to 8 feet bgs, 8 to 30 feet bgs and greater than 30 feet bgs. The results of the soil sampling and analysis are presented with respect to these predetermined depth intervals. Multiple soil samples were collected and analyzed at soil boring locations from within each respective depth interval. Soil probe/boring logs contain the Unified Soil Classification System (USCS) soil description, sample depth intervals, visual observations and PID readings, and are provided in **Appendix D**.

4.1.3.1 Depth Interval: 1 to 8 foot bgs

The BTEX analysis was performed on 12 soil samples collected from 9 soil boring locations. The results indicate non-detectable concentrations at 7 of the 12 samples (**Drawing 4C**). At the remaining five locations, the total BTEX concentrations were negligible ranging from 0.004 to 0.027 mg/kg. A comparison of the individual BTEX compound concentrations to the NYSDEC TAGM RSCOs indicates no exceedances. A summary of BTEX compounds in subsurface soils is provided in **Appendix C (Tables 8, 22 and 23)**.

The PAH analysis was performed on 12 soil samples from 9 soil boring locations. The results indicate the presence of PAH compounds at each location (**Drawing 4C**). Total PAH concentrations ranged from 2.435 to 291.2 mg/kg. The distribution of total PAH concentrations show 50% of the total concentrations at or below 10 mg/kg, 42% greater than 10 mg/kg and below 100 mg/kg, and 8% at 100 mg/kg or greater.

The PAH compound, benzo(a)pyrene was detected in excess of the NYSDEC TAGM RSCO of 0.061 mg/kg in each of the 12 soil samples. The benzo(a)pyrene exceedances ranged from 0.19 to 18 mg/kg. Benzo(a)pyrene equivalents ranged from 0.2579 mg/kg in sample GCSB-38 (6’-8’) to 28.87 mg/kg in sample HB-05 (7’). **Table 4-6** provides the concentration range/frequency of exceedances statistics for additional PAH compounds in subsurface soils (all intervals). A summary of PAH compounds in subsurface soils is provided in **Appendix C (Tables 9, 22 and 23)**.

The following metals exceeded their respective NYSDEC TAGM RSCO; arsenic, beryllium, cadmium, chromium, iron, mercury and zinc. The frequency of these individual metals exceedances occurred in less than 5 of the 9 samples. The metal concentration exceedances were generally within the same order of magnitude as the NYSDEC TAGM RSCOs. Cyanide was not detected. A summary of metals in subsurface soils is provided in **Appendix C (Tables 10, 22 and 23)**.

One of the three soil samples, HB-05 analyzed for pesticides detected endrin (0.13 mg/kg) in exceedance of the NYSDEC TAGM RSCO of 0.10 mg/kg at the 7-foot sample depth interval. PCBs were not detected in the 1 to 8 foot bgs soils. A summary of PCBs/pesticides in subsurface soils is provided in **Appendix C (Tables 22 and 23)**.

Overall, BTEX compounds do not appear to be a contaminant of concern in the vadose zone (1 to 8 foot bgs) depth interval in soils. However, the presence of PAH compounds above the NYSDEC TAGM RSCOs, especially benzo(a)pyrene do exist. The identified metals are consistent with local background conditions and/or related to historic fill used to re-grade the site. Cyanide was not detected. The pesticide, endrin was detected in exceedance of its NYSDEC TAGM RSCO. PCBs were not detected in 1 to 8 foot bgs soils.

4.1.3.2 Depth Interval: 8 to 30 foot bgs

The BTEX analysis was performed on 73 soil samples from 41 soil boring locations. The results indicate non-detectable concentrations at 42 of the 73 samples (**Drawing 4D**). At the remaining 31 samples, the total BTEX concentrations ranged from 0.001 to 377.5 mg/kg. The distribution of total BTEX concentrations show 68% of the total concentrations at or below 1 mg/kg, 22% greater than 1 mg/kg and below 100 mg/kg, and 10% at 100 mg/kg or greater. A summary of BTEX compounds in subsurface soils is provided in **Appendix C (Tables 8, 22 and 23)**.

Non-MGP related VOC compounds include methylene chloride, 2-butanone, acetone, carbon disulfide, tetrachloroethene and styrene that were detected in several subsurface soil samples. Methylene chloride, 2-butanone and acetone exhibited varying concentrations that ranged from below to above their respective NYSDEC TAGM RSCOs. Carbon disulfide, tetrachloroethene and styrene were detected below their respective NYSDEC TAGM RSCOs. Methylene chloride and tetrachloroethene are likely laboratory artifacts as they were detected in the laboratory method blank.

TABLE 4-6
GLEN COVE FORMER MGP SITE
KEYSPAN CORPORATION
FREQUENCY OF EXCEEDANCES IN SUBSURFACE SOIL

ANALYTICAL GROUP	CHEMICAL COMPOUND	NYSDEC RSCO (mg/kg)	CONCENTRATION RANGE (mg/kg)	FREQUENCY EXCEEDING RSCO	SAMPLE REPORTED WITH HIGHEST CONCENTRATION		
					SAMPLE NUMBER	DEPTH	DATE
VOC's	Acetone	0.2	ND to 2.96	3 of 63	SB - 02	18	11/8/1995
	Benzene	0.06	ND to 1.5	5 of 153	GCSB - 46	10 - 12	2/11/2004
	2-Butanone	0.3	ND to 0.35	1 of 63	GCSB - 46	10 - 12	2/11/2004
	Carbon Disulfide	2.7	ND to 0.08	0 of 63	GCSB - 46	10 - 12	2/11/2004
	1,1-Dichloroethane	0.2	ND	0 of 163			
	1,1-Dichloroethene	0.4	ND to 0.16	0 of 63	SB - 02	18	11/8/1995
	Dichloromethane		ND to 0.002	0 of 63	GCSB - 51	18 - 19	4/18/2005
	Ethylbenzene	5.5	ND to 120	6 of 153	GCSB - 46	10 - 12	2/11/2004
	Methyl Tertiary Butyl Ether		ND	0 of 42			
	Methylene Chloride	0.1	ND to 0.23	4 of 59	GCSB - 36	12 - 14	6/23/2004
	Styrene		ND to 27	0 of 63	GCSB - 33	21 - 23	2/5/2004
	Tetrachloroethene	1.4	ND to 0.01	0 of 67	GCSB-49/SB-02	20-22/18	3/3/4 & 11/8/95
	Toluene	1.5	ND to 16	3 of 153	GCSB - 46	10 - 12	2/11/2004
	Trichloroethene	0.7	ND to 0.11	0 of 63	SB - 02	18	11/8/1995
	1,1,1-Trichloroethane	0.8	ND to 0.05	0 of 63	SB - 02	18	11/8/1995
	Xylenes	1.2	ND to 240	8 of 153	GCSB - 46	10 - 12	2/11/2004
	Total BTEX				GCSB - 46	10 - 12	2/11/2004
SVOC's	Acenaphthene	50	ND to 3,200	13 of 153	GCSB - 46	10 - 12	2/11/2004
	Acenaphthylene	41	ND to 7,200	8 of 153	GCSB - 44	8 - 10	1/21/2004
	Anthracene	50	ND to 11,000	14 of 153	GCSB - 44	8 - 10	1/21/2004
	Benzo[a]anthracene	0.224	ND to 3,700	55 of 153	GCSB - 44	8 - 10	1/21/2004
	Benzo[a]pyrene	0.061	ND to 3,400	64 of 153	GCSB - 44	8 - 10	1/21/2004
	Benzo[b]fluoranthene	1.1	ND to 430	36 of 153	SB - 01	11	11/7/1995
	Benzo[g,h,i]perylene	50	ND to 2,100	5 of 153	GCSB - 44	8 - 10	1/21/2004
	Benzo[k]fluoranthene	1.1	ND to 2,400	35 of 153	GCSB - 44	8 - 10	1/21/2004
	bis(2-ethylhexyl)phthalate	50	ND to 0.36	0 of 61	GCSB - 47	58 - 60	2/23/2004
	Butylbenzylphthalate	50	ND	0 of 61			
	Carbazole		ND to 71		GCSB - 46	10 - 12	2/11/2004
	Chrysene	0.4	ND to 6,000	51 of 153	GCSB - 44	8 - 10	1/21/2004
	Dibenz[a,h]anthracene	0.014	ND to 160	37 of 153	GCSB - 46	10 - 12	2/11/2004
	Dibenzofuran	6.2	ND to 230	4 of 61	GCSB - 46	10 - 12	2/11/2004
	Diethylphthalate	7.1	ND to 3.1	0 of 64	GCSB - 51	18 - 19	4/18/2005
	Dimethylphthalate	2	ND	0 of 64			
	Di-n-butyl phthalate	8.1	ND to 0.11	0 of 61	GCSB - 51	33.5 - 34.5	4/18/2005
	Di-n-octyl phthalate	50	ND to 0.12	0 of 64	GCSB - 41	80 - 82	2/19/2004
	Fluoranthene	50	ND to 11,000	17 of 153	GCSB - 44	8 - 10	1/21/2004
	Fluorene	50	ND to 5,300	13 of 153	GCSB - 44	8 - 10	1/21/2004
	Indeno[1,2,3-cd]pyrene	3.2	ND to 1,500	24 of 153	GCSB - 44	8 - 10	1/21/2004
	2-Methylnaphthalene	36.4	ND to 11,000	13 of 153	GCSB - 46	10 - 12	2/11/2004
	Naphthalene	13	ND to 39,000	14 of 153	GCSB - 44	8 - 10	1/21/2004
	Phenanthrene	50	ND to 24,000	17 of 153	GCSB - 44	8 - 10	1/21/2004
	Pyrene	50	ND to 12,000	28 of 153	GCSB - 44	8 - 10	1/21/2004
	Total PAH		ND to 138,700		GCSB - 44	8 - 10	1/21/2004
	Total CaPAH		ND to 17,000		GCSB - 44	8 - 10	1/21/2004
METALS	Aluminum	SB	239 to 9,870		GCSB - 36	30 - 32	6/23/2004
	Antimony	SB	ND to 27.9		GCSB - 39	18 - 20	6/25/2004
	Arsenic	7.5	ND to 40.6	6 - 140	GCSB - 44	8 - 10	1/21/2004
	Barium	300	1.1 to 393	2 - 140	GCSB - 52	14.5 - 15	4/22/2005
	Beryllium	0.16	ND to 0.53	25 - 50	GCSB - 37	9 - 11	6/30/2004
	Cadmium	1	ND to 1.7	12 - 140	GCSB - 31	10 - 14	11/17/1999
	Calcium	SB	85.8 to 6,120		GCSB - 37	9 - 11	6/30/2004
	Chromium	10	ND to 88.3	52 of 140	GCSB - 52	11 - 11.5	4/22/2005
	Cobalt	30	ND to 9.7	0 of 50	GCSB - 47	14 - 16	2/19/2004
	Copper	25	2.8 to 52.6	1 of 50	GCSB - 37	22 - 24	6/30/2004
	Cyanide		ND to 5.5		GCSB - 46	10 - 12	2/11/2004
	Iron	2000	978 to 16,900	49 - 50	GCSB - 37	9 - 11	6/30/2004
	Lead	200 - 500	0.56 to 980	1 of 140	GCSB - 53	14 - 14.5	4/12/2005
	Magnesium	SB	15 to 4,240		GCSB - 46	48 - 50	2/12/2004
	Manganese	SB	5.3 to 827		GCSB - 39	34 - 36	6/25/2004
	Mercury	0.1	ND to 0.91	23 of 140	GCSB - 46	10 - 12	2/11/2004
	Nickel	13	ND to 34.2	5 of 50	GCSB - 40	68 - 69	1/6/2004
	Potassium	SB	29.9 to 1,630		GCSB - 40	17 - 19	1/6/2004
	Selenium	2	ND to 7.7	3 of 140	GCSB - 31	10 - 14	11/17/1999
	Silver	SB	ND to 2		GCSB - 26	0 - 2	11/22/1999
	Sodium	SB	15.9 to 147		GCSB - 40	68 - 69	1/6/2004
	Thallium	SB	ND to 1.6		GCSB - 49	13 - 15	3/3/2004
	Vanadium	150	4.4 to 29.9		GCSB - 37	9 - 11	6/30/2004
	Zinc	20	0.97 to 41.4	17 of 50	GCSB - 39	18 - 20	6/25/2004

The PAH analysis was performed on 73 soil samples from 41 soil boring locations. The results indicate non-detectable concentrations at 18 of the 73 samples (**Drawing 4D**). Total PAH concentrations ranged extensively from 0.045 to 138,700 mg/kg in the remaining 55 samples. The distribution of total PAH concentrations show 51% of the total concentrations at or below 10 mg/kg, 15% greater than 10 mg/kg and below 100 mg/kg, and 34% at 100 mg/kg or greater.

The PAH compound, benzo(a)pyrene was detected in excess of the NYSDEC TAGM RSCO of 0.061 mg/kg at 41 of the 73 soil samples. The benzo(a)pyrene exceedances ranged from 0.075 to 46 mg/kg. Benzo(a)pyrene equivalents ranged from 0.0 mg/kg in several samples to 4,004 mg/kg in sample GCSB-44 (8'-10'). **Table 4-6** provides the concentration range/frequency of exceedance statistics for additional PAH compounds in subsurface soils (all intervals). A summary of PAH compounds in subsurface soils is provided in **Appendix C (Tables 9, 22 and 23)**.

The following metals exceeded their respective NYSDEC TAGM RSCOs; arsenic, barium, beryllium, cadmium, chromium, copper, iron, lead, mercury, nickel, selenium and zinc. The frequency of individual metals exceedances is as follows; less than or equal to 7 of the 73 samples for arsenic, barium, cadmium, copper, lead, nickel and selenium; and greater than 7 of the 73 samples for beryllium, chromium, iron, mercury and zinc. Cyanide was not detected. A summary of metals in subsurface soils is provided in **Appendix C (Tables 10, 22 and 23)**.

PCBs were reported as not detected in the soil samples collected in this interval. Pesticides were reported as either not detected or detected at concentrations below their respective NYSDEC TAGM RSCOs in this subsurface soil interval. A summary of PCBs/pesticides in subsurface soils is provided in **Appendix C (Tables 22 and 23)**.

Overall, BTEX compounds do not appear to be a contaminant of concern in the shallow saturated zone (8 to 30 foot bgs) depth interval in soils. However, the presence of PAH compounds above the NYSDEC TAGM RSCOs, especially benzo(a)pyrene do exist. The identified metals are consistent with local background conditions and/or related to historic fill used to re-grade the site. Cyanide was not detected. PCBs/pesticides were reported as not detected or detected below their respective NYSDEC RSCO in subsurface soils in this depth interval.

The highest impacts (both visual and chemical) were encountered just within the northern and northwestern boundaries of the substation. These areas coincide with the locations of the former boilers (northern) and the former gas holder (northwestern). See Figure 1-2 for the locations of the former MGP structures.

4.1.3.3 Depth Interval: Greater than 30 foot bgs

The BTEX analysis was performed on 66 soil samples from 34 soil boring locations. The results indicate non-detectable concentrations at 60 of the 66 samples (**Drawing 4E**). At the remaining 6 samples, the total BTEX concentrations ranged from 0.001 to 0.62 mg/kg. A comparison of the individual BTEX compound concentrations to the NYSDEC TAGM RSCOs indicates no exceedances. A summary of BTEX compounds in subsurface soils is provided in **Appendix C (Tables 8, 22 and 23)**.

Non-MGP related VOC compounds include methylene chloride, 2-butanone, acetone, carbon disulfide, tetrachloroethene and styrene that were detected in several subsurface soil samples. Methylene chloride and acetone exhibited varying concentrations that ranged from below to above their respective NYSDEC TAGM RSCO. Carbon disulfide, 2-butanone, tetrachloroethene and styrene were detected below their respective NYSDEC TAGM RSCO. Methylene chloride and tetrachloroethene are likely laboratory artifacts as they were detected in the laboratory method blank.

The PAH analysis was performed on 66 soil samples from 34 soil boring locations. The results indicate non-detectable concentrations at 34 of the 66 samples (**Drawing 4E**). Total PAH concentrations ranged extensively from 0.038 to 2,497.44 mg/kg in the remaining 32 samples. The distribution of total PAH concentrations shows 82% of the total concentrations at or below 10 mg/kg, 9% greater than 10 mg/kg and below 100 mg/kg, and 9% at 100 mg/kg or greater. The three soil boring locations exhibiting the greater than 100 mg/kg concentrations are GCSB-29 (34'-36'), GCSB-37 (36'-38') and GCSB-60 (34'-35'). It should be noted that elevated concentrations exhibited by soil borings GCSB-29, GCSB-37 and GCSB-60 were detected at the 34 to 38 depth intervals followed by samples collected at deeper intervals showing negligible PAH concentrations (except soil boring GCSB-29) [**Drawing 4E**]. A single soil sample was collected at soil boring GCSB-29.

Benzo(a)pyrene exceedances were evaluated for comparison to concentrations detected in overlying soils. Benzo(a)pyrene exceedances were detected in excess of the NYSDEC TAGM RSCO of 0.061 mg/kg at 7 of the 66 samples. The benzo(a)pyrene exceedances ranged from 0.11 to 80 mg/kg. Benzo(a)pyrene equivalents ranged from 0.0 mg/kg in several samples to 97.985 mg/kg in sample GCSB-37 (36'-38'). **Table 4-6** provides the concentration range/frequency of exceedance statistics for additional PAH compounds in subsurface soils (all intervals). A summary of PAH compounds in subsurface soils is provided in **Appendix C (Tables 9, 22 and 23)**.

The following metals exceeded their respective NYSDEC TAGM RSCOs; barium, beryllium, cadmium, chromium, iron, mercury, nickel and zinc. The frequency of individual metals exceedances is as follows; less than or equal to 6 of the 65 samples for barium, cadmium, nickel and zinc; and greater than 6 of the 65 samples for beryllium, chromium, iron and mercury. Cyanide was not detected. A summary of metals in subsurface soils is provided in **Appendix C (Tables 10, 22 and 23)**.

No PCBs/pesticides were detected in subsurface soils in this interval. A summary of PCBs/pesticides in subsurface soils is provided in **Appendix C (Tables 22 and 23)**.

Overall, BTEX compounds do not appear to be a contaminant of concern in soils within the intermediate saturated zone (greater than 30 foot bgs) depth interval. The presence of PAH compounds above the NYSDEC TAGM RSCOs do exist in the shallower portion of the "greater than 30 foot bgs" depth interval. However, PAH concentrations in the deepest soil samples exhibit non-detectable to negligible concentrations (slightly above the NYSDEC TAGM RSCOs). Based on the analytical data for BTEX and PAHs, vertical delineation has been achieved. Several metals exceeded the NYSDEC TAGM RSCOs. The identified metals are consistent with local background conditions and/or related to historic fill used to re-grade the site. Cyanide was not detected. No PCBs/pesticides were detected in subsurface soils.

The highest impacts (both visual and chemical) were encountered just within the northern and northwestern boundaries of the substation. These areas coincide with the locations of the former boilers (northern) and the former gas holder (northwestern). See Figure 1-2 for the locations of the former MGP structures.

4.2 Summary of Groundwater Quality Conditions

The groundwater quality conditions are evaluated based on the presence of NAPL, field parameter measurements and the results of laboratory analysis for dissolved phase constituents. Groundwater sample collection and analysis and NAPL/groundwater measurements have been conducted at the former Glen Cove MGP site in 1995, 2004, and 2005.

The analytical groundwater samples were compared to the NYSDEC Technical and Operational Guidance Series 1.1.1 (TOGS) Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations (AWQS) and the exceedances of the AWQS are bolded on the data summary tables contained in **Appendix C**. The groundwater quality testing results from the multiple events are presented collectively in the following subsections. **Table 4-3** presents a summary of the highest laboratory analytical result exceedances in groundwater.

4.2.1 NAPL Monitoring Results

The groundwater monitoring wells and piezometers were monitored for the presence of NAPL during the 1995, May 2004 and June, August and October

TABLE 4-3
GLEN COVE FORMER MGP SITE
KEYSPAN CORPORATION
SUMMARY OF HIGHEST EXCEEDANCES IN GROUNDWATER

Sample Number and Depth (ft.)	Sampling Date	Total BTEX Concentration (mg/kg)	Total PAH Concentration (mg/kg)	Location in Relation to Former MGP Structures and/or Site	Field Visual Observation of Recovered Sample
GCGWP - 03 (16-20)	1/19/2004	150	6798	In the northwestern corner of the site adjacent to the existing retaining wall.	Slight MGP-like Odor
GCGWP - 03 (32-36)	1/19/2004	3	1372	In the northwestern corner of the site adjacent to the existing retaining wall.	Slight Unknown Odor
GCGWP - 04 (16-20)	1/20/2004	851	7244	On the northern side of the site at the bottom of the site boundary slope.	Blebs, Sheen, Moderate Naphthalene-like Odor
GCGWP - 04 (48-52)	1/20/2004	165	2106	On the northern side of the site at the bottom of the site boundary slope.	No Physical/Visual Evidence of Impacts
GCGWP - 04 (60-64)	2/4/2004	48	2197	On the northern side of the site at the bottom of the site boundary slope.	No Physical/Visual Evidence of Impacts
GCGWP - 05 (16-20)	3/3/2004	271	335	On the northern boundary of the current electrical substation.	Band of Saturation, Strong Naphthalene-like Odor
GCGWP - 06 (16-20)	3/2/2004	2190	18469	Northern boundary of the current electrical substation.	Slight MGP-like Odor
GCGWP - 37 (36-40)	7/2/2004	74	969	On the northern parcel that borders the site within the asphalt parking lot.	Blebs, Sheen, Coated and Saturated, Moderate Naphthalene-like Odor
GCGWP - 10 (12-16)	5/2/2005	1616	11207	Located to the north of the 60,000 cubic foot gas holder at the entrance of the substation.	Stained, Blebs, Saturated, Strong Naphthalene-like Odor
GCGWP - 10 (32-36)	5/3/2005	47	956	Located to the north of the 60,000 cubic foot gas holder at the entrance of the substation.	No Physical/Visual Evidence of Impacts
GCGWP - 17 (31-35)	9/8/2005	7	615	On the northern parcel that borders the site within the asphalt parking lot.	Sheen, Stained, Slight Naphthalene-like Odor

TABLE 4-3 (cont.)
GLEN COVE FORMER MGP SITE
KEYSPAN CORPORATION
SUMMARY OF HIGHEST EXCEEDANCES IN GROUNDWATER

Sample Number and Depth (ft)	Sampling Date	Total BTEX Concentration (mg/kg)	Total PAH Concentration (mg/kg)	Location in Relation to Former MGP Structures and/or Site	Field Visual Observation of Recovered Sample
PZ - 01A (25-35)	5/12/2004	223	581	Located in the northwestern portion of the site.	Saturation and Moderate Naphthalene-like Odor
	6/21/2005	116	199	Located in the northwestern portion of the site.	
PZ - 03 (14-19)	8/4/2004	283	3321	Located in the northern central portion of the substation.	Saturation and Moderate Naphthalene-like Odor
	6/16/2005	221	1242	Located in the northern central portion of the substation.	
GCMW - 09S (8-18)	6/21/2005	133	272	In the northwestern portion of the sit within the access road.	Saturated with Tar-like Substance, Sheen, Slight to Moderate Tar-like Odor
GCMW - 09I (26-36)	5/12/2004	38	1564	In the northwestern portion of the sit within the access road.	Saturated, Coated, Blebs, Sheen, Slight to Moderate Tar-like Odor
	6/21/2005	9	633	In the northwestern portion of the sit within the access road.	
GCMW - 11S (6-20)	5/18/2004	1003	6523	In the northern boundary of the substation.	Saturated, Strong Naphthalene-like Odor
	6/17/2005	1776	4455	In the northern boundary of the substation.	
GCMW - 11I (23-28)	5/18/2004	1062	1488	In the northern boundary of the substation.	Saturated, Strong Naphthalene-like Odor
	6/17/2005	275	16	In the northern boundary of the substation.	
GCMW - 13S (8-22)	5/17/2004	456	4581	In the substation within the area of the former 60,000 cubic foot gas holder.	Moderate to Strong Naphthalene-like Odor, Pockets of NAPL Saturation
GCMW - 13I (25-30)	5/17/2004	438	3748	In the substation within the area of the former 60,000 cubic foot gas holder.	Saturated, Sheen, Moderate Naphthalene-like Odor
GCGW01 (25-35)	11/10/1995	245	7390	Located in the northwestern portion of the site.	Saturation and Moderate Naphthalene-like Odor
GCGW02 (18-21)	11/11/1995	416	6730	Located north of the Hortonsphere.	No Physical/Visual Evidence of Impacts

Notes:

GCMW01 is also known as PZ-01 and was identified with that label in the November 1995 Phase I Site Investigation.

GCMW02 is also known as PZ-02 and was identified with that label in the November 1995 Phase I Site Investigation.

2005 product/water level measurement events. An electronic product/water interface probe was used to measure LNAPL, groundwater, DNAPL and sounding of the well bottom. These measurements were compiled in summary tables with surveyed well elevations and used to calculate groundwater elevations (**Table 2-5**).

The product/water level measurement results indicate the absence of LNAPL from all of the wells monitored and the detection of DNAPL only in monitoring well GCMW-13S. At monitoring well GCMW-13S, a DNAPL thickness of 0.74 feet was measured in June 2005. The DNAPL thickness decreased steadily to 0.54 and 0.34 feet in August and October 2005, respectively.

4.2.2 Field Parameter Measurements

Field parameter measurements were collected from the monitoring wells during the 2004 and 2005 groundwater sampling events. The field parameters consisted of pH, temperature, dissolved oxygen, specific conductivity, turbidity and oxidation reduction potential (ORP). Final field parameter data and monitoring well purge (low flow) data are presented in **Appendix E** for both the 2004 and 2005 groundwater sampling events. The recorded field measurements for the shallow and intermediate groundwater intervals for both the 2004 and 2005 sampling events were as follows:

Shallow Groundwater

The final temperature measurements ranged from 12.05^{o}C (PZ-05) to 22.7^{o}C (PZ-03) over both sampling events.

The final pH measurements ranged from 5.76 standard units (SU) (PZ-02A) to 7.46 SU (GCMW-13S) over both sampling events.

The final specific conductivity measurements ranged from 0.245 (mS/cm) (PZ-06) to 2.7 mS/cm (GCMW-15) over both sampling events.

The field recorded dissolved oxygen measurements ranged from 0.0 parts per million (ppm) (PZ-03) to 13.4 ppm (GCMW-10S) over both sampling events.

The final turbidity measurements ranged from 0.0 NTUs in several wells to 78.5 NTUs (GCMW-13S) over both sampling events.

The final ORP measurements ranged from -253 millivolts (mv) (GCMW-9S) to 162 mv (GCMW-10S) over both sampling events.

Intermediate Wells

The final temperature measurements ranged from 13.2°C (GCMW-10I) to 25.1°C (GCMW-08D) over both sampling events.

The final pH measurements ranged from 5.95 SU (GCMW-8D) to 8.03 SU (GCMW-13I) over both sampling events.

The final specific conductivity measurements ranged from 0.527 mS/cm (GCMW-8D) to 0.861 mS/cm (GCMW-14I) over both sampling events.

The field recorded dissolved oxygen measurements ranged from 0.78 ppm (GCMW-11I) to 12.29 ppm (GCMW-10I) over both sampling events.

The final turbidity measurements ranged from -3.4 NTUs (GCMW-8D) to 237 NTUs (GCMW-13I) over both sampling events.

The final ORP measurements ranged from -215 mv (GCMW-13I) to 141 mv (GCMW-10I) over both sampling events.

4.2.3 Analytical Results for Dissolved Phase Compounds

The discussion of dissolved phase chemical constituent detections in groundwater is presented by the three chemical groupings, BTEX, PAH and TAL metals; and three groundwater depth intervals, Water Table (WT)-20 feet below water table (bwt), 20-30 feet bwt and greater than 30 feet bwt. The groundwater depth intervals were selected based on groundwater probe sampling depths, piezometer and permanent monitoring well screen intervals and vertical distribution of groundwater dissolved phase contamination. During the 1995 investigation, groundwater sampling was performed on the upper two groundwater intervals. Groundwater sample analysis performed during the 1995 investigation included VOCs, SVOCs, Pesticides and Polychlorinated Biphenyls (PCBs). During the 2004 and 2005 RI groundwater sampling was performed in the three groundwater intervals. Groundwater analysis performed during the RI included VOCs, SVOCs and Metals. **Drawings 4F** through **4H** show total BTEX and total PAH analytical results in groundwater. **Drawing 4I** depicts those groundwater sampling intervals that cut the water table and their associated analytical results. **Table 4-4** relates the groundwater depth interval relative to the encountered water table.

A total of three groundwater sampling events (1995, 2004 and 2005) were completed for piezometers and permanent groundwater monitoring wells. Groundwater probe sampling was conducted in 2004 and 2005. Note that groundwater monitoring wells GCMW-15 and GCMW-16 were only sampled on one occasion as they were installed in May 2005.

TABLE 4-4
FORMER GLEN COVE MGP SITE
KEYSPAN CORPORATION
SUMMARY OF GROUNDWATER SAMPLING INTERVALS

Well Number	Sample Depth (ft bgs)	Well Total Depth (ft bgs)	Depth to Water (ft bgs)	Screened Interval (ft bgs)	Depth Below Water Table Interval	Screened Across Water Table	Ground Elevation (ft amsl)	Screened Interval (ft amsl)	Groundwater Elevation (ft amsl)
PZ - 01A	25 - 35	34.96	10.31	25 - 35	Interval A Interval B	No	57.40	32.40 - 22.40	47.09
PZ - 02A	18 - 21	20.44	9.00	18 - 21	Interval A	No	55.87	37.87 - 34.87	46.87
PZ - 03	14 - 19	18.54	10.45	14 - 19	Interval A	No	56.76	42.76 - 37.76	46.31
PZ - 04	16 - 19	18.66	9.43	16 - 19	Interval A	No	56.96	40.96 - 37.96	47.53
PZ - 05	8 - 18	17.42	7.01	8 - 18	Interval A	Yes	60.67	52.67 - 42.67	53.66
PZ - 06	7 - 17	16.06	5.54	7 - 17	Interval A	Yes	58.52	51.52 - 41.52	52.98
PZ - 07	3 - 10	10.58	3.25	3 - 10	Interval A	Yes	48.62	45.62 - 38.62	45.37
GCMW - 08S		38.21	29.55	26 - 36	Interval A	Yes	78.80	52.80 - 42.80	49.25
GCMW - 08D		72.01	30.44	60 - 70	Interval B	No	78.83	18.83 - 8.83	48.39
GCMW - 09S	8 - 18	19.77	10.36	8 - 18	Interval A	Yes	57.31	49.31 - 39.31	46.95
GCMW - 09I	26 - 36	38.65	10.24	26 - 36	Interval A Interval B	No	57.29	31.29 - 21.29	47.05
GCMW - 10S	11 - 16	18.21	5.31	11 - 16	Interval A	Yes	50.72	39.72 - 34.72	45.41
GCMW - 10I	16 - 26	28.88	3.86	16 - 26	Interval A Interval B	No	51.13	35.13 - 25.13	47.27
GCMW - 11S	6 - 20	22.41	10.00	8 - 20	Interval A	Yes	57.83	49.83 - 37.83	47.83
GCMW - 11I	23 - 28	31.10	10.30	23 - 28	Interval A	No	57.84	34.84 - 29.84	47.54
GCMW - 12S	14 - 24	25.85	10.55	14 - 24	Interval A	Yes	64.19	50.19 - 40.19	53.64
GCMW - 13S	8 - 22	22.47	10.25	12 - 22	Interval A	Yes	57.99	45.99 - 35.99	47.74
GCMW - 13I	25 - 30	32.45	9.93	25 - 30	Interval A Interval B	No	57.88	32.88 - 27.88	47.95
GCMW - 14S	8 - 18	19.65	10.00	8 - 18	Interval A	Yes	57.03	49.03 - 39.03	47.03
GCMW - 14I	25 - 30	32.01	10.25	25 - 30	Interval A Interval B	No	57.02	32.02 - 27.02	46.77

NOTES:
NS - Not Sampled
NM - Not Measured
NA - Not Applicable
ft bgs - Feet below ground surface
ft amsl - Feet above mean sea level
Interval A - Water table to 20 feet below water table
Interval B - 20 to 30 feet below water table
Interval C - Greater than 30 feet below water table

TABLE 4-4 (cont.)
FORMER GLEN COVE MGP SITE
KEYSPAN CORPORATION
SUMMARY OF GROUNDWATER SAMPLING INTERVALS

Well Number	Sample Depth (ft bgs)	Well Total Depth (ft bgs)	Depth to Water (ft bgs)	Screened Interval (ft bgs)	Depth Below Water Table Interval	Screened Across Water Table	Ground Elevation (ft amsl)	Screened Interval (ft amsl)	Groundwater Elevation (ft amsl)
GCGWP-01	16 - 20	NA	15.0	NA	Interval A	NO	56.58	NA	41.58
	32 - 36				Interval B				
	48 - 52				Interval C				
GCGWP-02	16 - 20	NA	11.0	NA	Interval A	NO	56.78	NA	45.78
	32 - 36				Interval B				
	48 - 52				Interval C				
GCGWP-03	16 - 20	NA	11.5	NA	Interval A	NO	57.71	NA	46.21
	32 - 36				Interval B				
	48 - 52				Interval C				
GCGWP-04	16 - 20	NA	9.0	NA	Interval A	NO	57.56	NA	48.56
	32 - 36				Interval B				
	48 - 52				Interval C				
	60 - 64				Interval C				
	68 - 72				Interval C				
GCGWP-05	16 - 20	NA	11.0	NA	Interval A	NO	57.76	NA	46.76
	32 - 36				Interval B				
	48 - 52				Interval C				
GCGWP-06	16 - 20	NA	8.0	NA	Interval A	NO	58.02	NA	50.02
	32 - 36				Interval B				
	48 - 52				Interval C				
GCGWP-08	18 - 22	NA	4.0	NA	Interval A	NO	58.11	NA	54.11
	36 - 40				Interval C				
	46 - 50				Interval C				
GCGWP-09	12 - 16	NA	13.0	NA	Interval A	YES	57.80	NA	44.80
	32 - 36				Interval A & B	NO			
	48 - 52				Interval C	NO			
GCGWP-10	12 - 16	NA	7.0	NA	Interval A	NO	57.61	NA	50.61
	32 - 36				Interval B				
	43 - 47				Interval C				
GCGWP-11	14 - 18	NA	7.0	NA	Interval A	NO	56.00	NA	49.00
	32 - 36				Interval B				
	48 - 52				Interval C				
	64 - 68				Interval C				
GCGWP-12	14 - 18	NA	7.0	NA	Interval A	NO	55.44	NA	48.44
	32 - 36				Interval B				
	48 - 52				Interval C				
	64 - 68				Interval C				
GCGWP-13	14 - 18	NA	7.5	NA	Interval A	NO	51.33	NA	43.83
	28 - 32				Interval B				
	46 - 50				Interval C				
GCGWP-14	15 - 19	NA	8.0	NA	Interval A	NO	42.79	NA	34.79
	33 - 37				Interval B				
	49 - 53				Interval C				
GCGWP-15	15 - 19	NA	8.0	NA	Interval A	NO	46.19	NA	38.19
	31 - 35				Interval B				
	46 - 50				Interval C				
GCGWP-16	20 - 24	NA	11.0	NA	Interval A	NO	50.02	NA	39.02
	31 - 35				Interval B				
	48 - 52				Interval C				
GCGWP-17	31 - 35	NA	33.0	NA	Interval A	YES	79.11	NA	46.11
	48 - 52				Interval A	NO			
	64 - 68				Interval C	NO			
GCGWP-37	36 - 40	NA	34.0	NA	Interval A	NO		NA	
	62 - 66				Interval B				
	70 - 74				Interval C				

NOTES:
NS - Not Sampled
NM - Not Measured
NA - Not Applicable
ft bgs - Feet below ground surface
ft amsl - Feet above mean sea level
Interval A - Water table to 20 feet below water table
Interval B - 20 to 30 feet below water table
Interval C - Greater than 30 feet below water table

TABLE 4-4 (cont.)
FORMER GLEN COVE MGP SITE
KEYSPAN CORPORATION
SUMMARY OF GROUNDWATER SAMPLING INTERVALS

Well Number	Sample Depth (ft bgs)	Well Total Depth (ft bgs)	Depth to Water (ft bgs)	Screened Interval (ft bgs)	Depth Below Water Table Interval	Screened Across Water Table	Ground Elevation (ft	Screened Interval (ft amsl)	Groundwater Elevation (ft amsl)
PZ - 01A	25 - 35	35	10.14	25 - 35	Interval A	No	57.40	32.40 - 22.40	47.26
					Interval B				
PZ - 02A	18 - 21	21	9.04	18 - 21	Interval A	No	55.87	37.87 - 34.87	46.83
PZ - 03	14 - 19	19	9.97	14 - 19	Interval A	No	56.76	42.76 - 37.76	46.79
PZ - 04	16 - 19	19	9.61	16 - 19	Interval A	No	56.96	40.96 - 37.96	47.35
PZ - 05	8 - 18	18	7.34	8 - 18	Interval A	Yes	60.67	52.67 - 42.67	53.33
PZ - 06	7 - 17	17	5.83	7 - 17	Interval A	Yes	58.52	51.52 - 41.52	52.69
PZ - 07	3 - 10	10	3.12	3 - 10	Interval A	Yes	48.62	45.62 - 38.62	45.50
GCMW - 08S	NS	36	NM	26 - 36	Interval A	Yes	78.80	52.80 - 42.80	NM
GCMW - 08D	NS	70	NM	60 - 70	Interval A	No	78.83	18.83 - 8.83	NM
GCMW - 09S	8 - 18	18	10.54	8 - 18	Interval A	Yes	57.31	49.31 - 39.31	46.77
GCMW - 09I	26 - 36	36	10.23	26 - 36	Interval A	No	57.29	31.29 - 21.29	47.06
					Interval B				
GCMW - 10S	11 - 16	16	5.18	11 - 16	Interval A	Yes	50.72	39.72 - 34.72	45.54
GCMW - 10I	16 - 26	26	3.68	16 - 26	Interval A	No	51.13	35.13 - 25.13	47.45
					Interval B				
GCMW - 11S	6 - 20	20	10.07	8 - 20	Interval A	Yes	57.83	49.83 - 37.83	47.76
GCMW - 11I	23 - 28	28	10.13	23 - 28	Interval A	No	57.84	34.84 - 29.84	47.71
GCMW - 12S	14 - 24	24	10.85	14 - 24	Interval A	Yes	64.19	50.19 - 40.19	53.34
GCMW - 13S	8 - 22	22	10.52	12 - 22	Interval A	Yes	57.99	45.99 - 35.99	47.47
GCMW - 13I	25 - 30	30	10.15	25 - 30	Interval A	No	57.88	32.88 - 27.88	47.73
					Interval B				
GCMW - 14S	8 - 18	18	10.19	8 - 18	Interval A	Yes	57.03	49.03 - 39.03	46.84
GCMW - 14I	25 - 30	30	9.79	25 - 30	Interval A	No	57.02	32.02 - 27.02	47.23
					Interval B				
GCMW - 15	6 - 16	16	6.30	6 - 16	Interval A	Yes	51.57	45.57 - 35.57	45.27
GCMW - 16	6 - 16	16	5.32	6 - 16	Interval A	Yes	51.03	45.03 - 35.03	45.71

NOTES:

NS - Not Sampled
NM - Not Measured
ft bgs - Feet below ground surface
ft amsl - Feet above mean sea level
Interval A - Water table to 20 feet below water table
Interval B - 20 to 30 feet below water table

4.2.3.1 Depth Interval: Water Table to 20 feet BWT (Shallow Groundwater)

A total of 65 groundwater samples were collected from 38 sampling locations consisting of groundwater probes, piezometers and permanent monitoring wells for assessing shallow groundwater quality conditions in the WT-20 feet bwt depth interval. Non-detectable BTEX concentrations were reported for 34 samples collected at 23 groundwater sampling locations mainly situated along the perimeter of the former Glen Cove MGP site (**Drawing 4F**). The total BTEX concentrations ranged from 1.0 to 2,190 micrograms per liter (ug/l) in the remaining 31 samples. The distribution of total BTEX concentrations show 26% of the total concentrations at or below 10 ug/l, 16% greater than 10 ug/l and below 100 ug/l, 42% greater than 100 and below 1,000 ug/l and 16% at 1,000 ug/l or greater.

A comparison of individual compound concentrations to the NYSDEC TOGS AWQS indicates benzene toluene, ethylbenzene and xylenes as the volatile organic compounds of concern based on the frequency of exceedances in this interval. **Table 4-7** provides the concentration range/frequency of exceedance statistics for VOC compounds in groundwater (all intervals). A summary of BTEX compounds in this groundwater interval is provided in **Appendix C (Tables 11, 14 and 23)**.

Non-MGP related VOC compounds detected include methyl tertiary butyl ether (MTBE) tetrachloroethene and 1,1-dichloroethane at concentrations above their respective NYSDEC TOGS AWQS in 2 samples. The compounds 2-butanone, tetrachloroethene, acetone, MTBE, 1,1-dichloroethane, 1,1-dichloroethene and 1,1,1-trichloroethane were detected below their respective NYSDEC TOGS AWQS. Methylene chloride is likely a laboratory artifact as it was detected in the laboratory method blank.

PAH analysis was conducted at a total 65 groundwater samples that were collected from 38 sampling locations consisting of groundwater probes, piezometers and permanent monitoring wells for assessing shallow groundwater quality conditions in the WT-20 feet bwt depth interval. Non-detectable PAH concentrations were reported in 20 samples from the 14 locations, mainly situated along the perimeter of the Glen Cove Former MGP site (**Drawing 4F**). PAH concentrations ranged extensively from 1 to 18,469 ug/l in the remaining 45 samples. The distribution of total PAH concentrations show 44% of the total concentrations at or below 100 ug/l, 25% greater than 100 ug/l and below 1,000 ug/l and 31% at 1,000 ug/l or greater.

A comparison of individual compound concentrations to the NYSDEC TOGS AWQS indicates a frequency of exceedances for the soluble PAH compound naphthalene, in 19 of 65 samples. Benzo(a)pyrene, a less soluble PAH compound, had 9 exceedances out of the 65 samples. The frequency of

TABLE 4-7
GLEN COVE FORMER MGP SITE
KEYSPAN CORPORATION
FREQUENCY of EXCEEDANCES IN GROUNDWATER

ANALYTICAL GROUP	CHEMICAL COMPOUND	NYSDEC AWQS (ug/L)	CONCENTRATION RANGE (ug/L)	FREQUENCY EXCEEDING AWQS	SAMPLE REPORTED WITH HIGHEST CONCENTRATION		
					SAMPLE NUMBER	DEPTH	DATE
VOC's	Acetone	50	ND to 28	0 of 14	GCGW-04	16 - 19	11/11/1995
	Benzene	1	ND to 500	26 of 103	GCMW-11I	6 - 20	5/18/2004
	2-Butanone		ND to 11	0 of 7	GCMW-095	8-18	5/13/2004
	1,1-Dichloroethane	5	ND to 5	1 of 13	GCGW-02	18-21	11/11/1995
	1,1-Dichloroethene	5	ND to 1	0 of 7	GCGW07	3-10	11/11/1995
	Ethylbenzene	5	ND to 900	27 of 103	GCGWP-06	16-20	3/2/2004
	Methyl Tertiary Butyl Ether	10	ND to 89	5 of 51	GCGWP-09	48-52	4/19/2005
	Styrene		ND	0 of 14			
	Tetrachloroethene	5	ND to 14	2 of 20	GCMW-09I	26-36	6/21/2005
	Toluene	5	ND to 130	17 of 103	GCGWP-06	16-20	3/2/2004
	1,1,1-Trichloroethane	5	ND to 2	0 of 7	GCGW-02	18 - 21	11/11/1995
	Xylenes	5	ND to 1,000	32 of 103	GCGWP-06	16-20	3/2/2004
	Total BTEX		ND to 2,190	0 of 103	GCGWP-06	16 - 20	3/2/2004
SVOC's	Acenaphthene	20	ND to 1,000	33 of 103	GCGWP-06	16-20	3/2/2004
	Acenaphthylene		ND to 290	0 of 103	GCGWP-03	32-36	1/9/2004
	Anthracene	50	ND to 880	2 of 103	GCGWP-06	16-20	3/2/2004
	Benzo[a]anthracene	0.002	ND to 180	19 of 103	GCGWP-06	16-20	3/2/2004
	Benzo[a]pyrene	ND	ND to 130	15 of 103	GCGWP-06	16-20	3/2/2004
	Benzo[b]fluoranthene	0.002	ND to 14	5 of 103	GCGWP-03	16-20	1/19/2004
	Benzo[g,h,i]perylene		ND to 59	103	GCGWP-06	16-20	3/2/2004
	Benzo[k]fluoranthene	0.002	ND to 12	3 of 103	GCGWP-03	16-20	1/19/2004
	bis(2-ethylhexyl)phthalate	5	ND to 10	1 of 7	GCGW06	7 - 17	11/11/1995
	Butylbenzylphthalate	50	ND	0 of 7			
	Carbazole		ND to 6	0 of 7	GCMW-09I/PZ-03	26-36/14-19	5/12/04 & 6/16/05
	Chrysene	0.002	ND to 190	17 of 103	GCGWP-06	16-20	3/2/2004
	Dibenz[a,h]anthracene		ND to 3	0 of 103	GCGWP-03	16-20	1/19/2004
	Dibenzofuran		ND to 17	0 of 7	GCMW-09I	26-36	5/12/2004
	Di-n-butyl phthalate	50	ND	0 of 7			
	Fluoranthene	50	ND to 430	3 of 103	GCGWP-06	16-20	3/2/2004
	Fluorene	50	ND to 490	18 of 103	GCGWP-06	16-20	3/2/2004
	Indeno[1,2,3-cd]pyrene	0.002	ND to 8	7 of 103	GCGWP-03	16-20	1/19/2004
	2-Methylnaphthalene		ND to 1,900	0 of 103	GCGWP-06	16-20	3/2/2004
	Naphthalene	10	ND to 11,000	27 of 103	GCGWP-06	16-20	3/2/2004
	Phenanthrene	50	ND to 1,400	27 of 103	GCGWP-06	16-20	3/2/2004
	Pyrene	50	ND to 590	3 of 103	GCGWP-06	16-20	3/2/2004
	Total PAH		ND to 18,469	0 of 103	GCGWP-06	16 - 20	3/2/2004
	Total CaPAH		ND to 500	0 of 103	GCGWP-06	16 - 20	3/2/2004
METALS	Aluminum		20 to 20,000	0 of 10	GCGWP-37	62-66	7/2/2004
	Antimony	3	ND to 10.8	3 of 10	GCGWP-37	62-66	7/2/2004
	Arsenic	25	ND to 21.8	0 of 76	GCMW-08S	26-36	9/24/1995
	Barium	1,000	ND to 1,690	2 of 76	GCGWP-37	70 - 74	7/2/2004
	Beryllium	3	ND to 3.9	2 of 10	GCGWP-37	70 - 74	7/2/2004
	Cadmium	5	ND to 2.3	0 of 76	GCGWP-09	12-16	4/19/2005
	Calcium		46,600 to 164,000	0 of 10	GCGWP-37	36-40	7/2/2004
	Chromium	50	ND to 1,100	17 of 76	GCGWP-37	62-66	7/2/2004
	Cobalt		ND to 177	0 of 10	GCGWP-37	70-74	7/2/2004
	Copper	200	ND to 757	2 of 10	GCGWP-37	62-66	7/2/2004
	Cyanide	200	ND to 147	0 of 10	GCMW-12S	14-24	6/22/2005
	Iron	300	17.4 to 144,000	6 of 10	GCGWP-37	62-66	7/2/2004
	Lead	25	ND to 79.2	11 of 76	GCGWP-12	32-36	4/28/2005
	Magnesium	35,000	6,190 to 28,900	0 of 10	GCGWP-37	36-40	7/2/2004
	Manganese	300	11.7 to 11,900	8 of 10	GCGWP-37	36-40	7/2/2004
	Mercury	0.7	ND to 3.9	3 of 76	GCGWP-37	36-40	7/2/2004
	Nickel	100	ND to 450	2 of 10	GCGWP-37	62-66	7/2/2004
	Potassium		4,010 to 11,000	0 of 10	GCGWP-37	70-74	7/2/2004
	Selenium	10	ND to 21.3	8 of 76	GCMW-14I	8-18	5/13/2004
	Silver	50	ND to 0.71	0 of 76	PZ-04	16-19	5/17/2004
	Sodium	20,000	9,620 to 65,100	9 of 10	GCMW-10S	16-26	5/12/2004
	Thallium	0.5	ND to 3.4	1 of 10	GCGWP-37	62-66	7/2/2004
	Vanadium		ND to 45.5	0 of 10	GCGWP-37	70-74	7/2/2004
	Zinc	2,000	14.7 to 8,500	2 of 10	GCGWP-37	62-66	7/2/2004

exceedances for individual PAHs in groundwater (all depth intervals) are provided in **Table 4-7**. A summary of PAH compounds in groundwater is provided in **Appendix C (Tables 12, 15 and 23)**.

The non-MGP related PAH compound detected above its NYSDEC TOGS AWQS was bis(2-ethylhexyl)phthalate. The non-MGP related PAH compounds detected below their NYSDEC TOGS AWQS include di-n-butylphthalate, butylbenzylphthalate, and bis(2-ethylhexyl)phthalate. These compounds are likely laboratory artifacts.

The following metals had exhibited exceedances in this interval; antimony, chromium, iron, lead, manganese, mercury, selenium and sodium. With the exception of manganese and sodium, the metal exceedances occurred in four samples or less with concentrations generally within the same order of magnitude as the NYSDEC TOGS AWQS. Cyanide was not detected above the NYSDEC TOGS AWQS of 200 ug/l. A summary of metals in groundwater is provided in **Appendix C (Tables 13, 16 and 23).**

PCBs and pesticide analytical results indicate no exceedances of NYSDEC TOGS AWQS. A summary of PCBs/pesticides in groundwater is provided in **Appendix C (Table 23)**.

Overall, BTEX and PAH exceedances were detected in shallow groundwater on-site in the central, northern and western portions of the former MGP operations and and just beyond the site limits to the north. The area(s) of highest BTEX and PAH analytical results is best illustrated as shown on **Drawing 4F**. Groundwater quality around the eastern, western and southern perimeters of the site indicates non-detectable to low BTEX and PAH concentrations. Groundwater samples were collected from the piezometers and monitoring wells during at least two of the three groundwater sampling events (**Drawing 4F**). A comparison of the BTEX and PAH concentrations between the two sampling rounds was completed and the results of that comparison are indicated as increasing, stable or decreasing concentration in the table below.

Total BTEX and PAH Concentrations Comparison		
Piezometer, Well Designation	**BTEX Concentration**	**PAH Concentration**
GCMW-8S	Decreasing	Decreasing
GCMW-9S	Increasing	Decreasing
GCMW-9I	Decreasing	Decreasing
GCMW-10S	Stable	Stable
GCMW-10I	Stable	Stable
GCMW-11S	Increasing	Decreasing
GCMW-11I	Decreasing	Decreasing
GCMW-12S	Stable	Decreasing
GCMW-13S	NAPL	NAPL
GCMW-13I	Decreasing	Decreasing

GCMW-14S	Decreasing	Decreasing
GCMW-14I	Stable	Decreasing
PZ-01/01A	Decreasing	Decreasing
PZ-02/02A	Decreasing	Decreasing
PZ-03	Stable	Stable
PZ-04	Stable	Stable
PZ-05	Stable	Stable
PZ-06	Stable	Stable
PZ-07	Stable	Stable

PCBs and pesticide analytical results indicate no exceedance of NYSDEC TOGS AWQS.

4.2.3.2 <u>Depth Interval: 20 to 30 feet BWT (Intermediate Groundwater)</u>

A total of 26 groundwater samples were collected from 20 sampling locations consisting of groundwater probes, piezometers and permanent monitoring wells for assessing groundwater quality conditions in the intermediate (20-30 feet bwt) depth interval. Non-detectable BTEX concentrations were reported in 14 samples collected at 12 locations mainly situated along the perimeter of the former Glen Cove MGP site (**Drawing 4G**). The total BTEX concentrations ranged from 3 to 438 ug/l in the remaining 12 samples. The distribution of total BTEX concentrations show 25% of the total concentrations at or below 10 ug/l, 42% greater than 10 ug/l and below 100 ug/l, 33% greater than 100 and below 1,000 ug/l and 0.0% at 1,000 ug/l or greater.

A comparison of individual compound concentrations to the NYSDEC TOGS AWQS indicates ethylbenzene and xylenes as the VOCs of concern based on the frequency of exceedances in this interval. **Table 4-7** provides the concentration range/frequency of exceedance statistics for VOC compounds in groundwater (all intervals). A summary of BTEX compounds in groundwater is provided in **Appendix C (Tables 11, 14 and 23)**.

Non-MGP related VOC compounds detected include MTBE and tetrachloroethene at concentrations above their respective NYSDEC TOGS AWQS. 2-butanone, tetrachloroethene, acetone, MTBE, 1,1-Dichloroethane, 1,1-Dichloroethene and 1,1,1-Trichloroethane were detected below their respective NYSDEC TOGS AWQS. Methylene chloride is likely a laboratory artifact as it were detected in the laboratory method blank.

PAH analysis was conducted at a total of 26 groundwater samples collected from 20 sampling locations consisting of groundwater probes, piezometers and permanent monitoring wells for assessing groundwater quality conditions in the intermediate (20-30 feet bwt) depth interval. Non-detectable PAH concentrations were exhibited at 9 samples collected from 8 sampling locations, mainly situated along the perimeter of the former Glen Cove MGP site (**Drawing 4G**). PAH concentrations ranged extensively from 3 to 7,390 ug/l at the remaining 17 samples. The distribution of total PAH concentrations show 42% of the total concentrations at or below 100 ug/l, 35% greater than 100 ug/l and below 1,000 ug/l and 23% at 1,000 ug/l or greater.

A comparison of individual compound concentrations to the NYSDEC TOGS AWQS indicates a frequency of exceedances for the soluble PAH compound naphthalene, in 9 out of the 26 samples. Benzo(a)pyrene, a less soluble PAH compound, had 3 exceedances out of 26 samples. The frequency of exceedances for individual PAHs in groundwater (all depth intervals) are provided in **Table 4-7**. A summary of PAH compounds in groundwater is provided in **Appendix C (Tables 12, 15 and 23)**.

Several naturally-occurring metals exhibited exceedances of the NYSDEC TOGS AWQS. These metals included iron, manganese, sodium and selenium. Antimony, barium, beryllium, chromium, copper, lead, mercury, nickel, thallium and zinc exceeded the NYSDEC TOGS AWQS in one sample (GCGWP-37(62'-66')). Chromium was detected in four samples and lead was detected in two samples at a concentration exceeding their respective AWQS in this interval. The source of the chromium and lead is consistent with local background conditions and/or related to historic fill used to re-grade the site. Cyanide was not detected above the NYSDEC TOGS AWQS of 200 ug/l. A summary of metals in groundwater is provided in **Appendix C (Tables 13, 16 and 23).**

PCBs and pesticide analytical results indicate no exceedance of NYSDEC TOGS AWQS. A summary of PCBs/pesticides in groundwater is provided in **Appendix C (Table 23).**

Overall, BTEX and PAH exceedances were detected on-site in intermediate (20-30 feet bwt) groundwater in the northwestern corner and central portion of the former MGP operations. The area(s) of highest BTEX and PAH analytical results is best illustrated as shown on **Drawing 4G**. Groundwater quality around a majority of the perimeter of the site indicates non-detectable to low BTEX and PAH concentrations. Groundwater samples were collected from the piezometers and monitoring wells during at least two of the three groundwater sampling events (**Drawing 4G**). A comparison of the BTEX and PAH concentrations between the two sampling rounds was completed and the results of that comparison are indicated as increasing, stable or decreasing concentration in the table below.

Total BTEX and PAH Concentrations Comparison

Piezometer, Well Designation	BTEX Concentration	PAH Concentration
GCMW-9I	Decreasing	Decreasing
GCMW-10I	Stable	Stable
PZ-01A	Decreasing	Decreasing

PCBs and pesticide analytical results indicate no exceedance of NYSDEC TOGS AWQS.

4.2.3.3 Depth Interval: Greater than 30 feet BWT (Intermediate Groundwater)

A total of 25 groundwater samples were collected from 18 sampling locations consisting of groundwater probes, piezometers and permanent monitoring wells for assessing groundwater quality conditions in the intermediate (greater than 30 feet bwt) depth interval. Non-detectable BTEX concentrations were exhibited in 19 samples collected at 14 sampling locations mainly situated along the perimeter of the former Glen Cove MGP site **(Drawing 4H).** The total BTEX concentrations ranged from 4 to 165 ug/l at the remaining 6 samples. The distribution of total BTEX concentrations show 33% of the total concentrations at or below 10 ug/l, 50% greater than 10 ug/l and below 100 ug/l, and 17% at 100 ug/l or greater.

A comparison of individual compound concentrations to the NYSDEC TOGS AWQS indicates ethylbenzene and xylenes as the VOCs of concern based on the frequency of exceedances in this interval. **Table 4-7** provides the concentration range/frequency of exceedance statistics for VOC compounds in groundwater (all intervals). A summary of BTEX compounds in groundwater is provided in **Appendix C (Tables 11, 14 and 23)**.

Non-MGP related VOC compounds detected include MTBE at concentrations above its NYSDEC TOGS AWQS. The compounds tetrachloroethene, MTBE, and 1,1-Dichloroethane were detected below their respective NYSDEC TOGS AWQS. These compounds are likely laboratory artifacts.

PAH analysis was conducted at a total of 25 groundwater samples that were collected from 18 sampling locations consisting of groundwater probes, piezometers and permanent monitoring wells for assessing groundwater quality conditions in the intermediate (greater than 30 feet bwt) depth interval. Non-detectable PAH concentrations were reported in 9 samples from 9 sampling locations, mainly situated along the perimeter of the former Glen Cove MGP site (**Drawing 4H**). PAH concentrations ranged extensively from 2 to 2,197 ug/l at the remaining 16 samples. The distribution of total PAH concentrations show 69% of the total concentrations at or below 100 ug/l, 19% greater than 100 ug/l and below 1,000 ug/l and 12% at 1,000 ug/l or greater.

A comparison of individual compound concentrations to the NYSDEC TOGS AWQS indicates a frequency of exceedances for naphthalene in 4 out of the 25 samples. Benzo(a)pyrene, a less soluble PAH compound, had 4 exceedances in 25 samples. The frequency of exceedances for individual PAHs in groundwater (all depth intervals) are provided in **Table 4-7**. A summary of PAH compounds in groundwater is provided in **Appendix C (Tables 12, 15 and 23).**

The number of metals and frequency of exceedances increased in groundwater present below 30 feet bwt relative to the shallow and intermediate groundwater intervals. The following metals had exceedances; antimony, barium, beryllium, chromium, copper, iron, manganese, lead, mercury, nickel, selenium sodium, thallium and zinc. With the exception of chromium and lead, the metal exceedances occurred in two samples or less with concentrations generally within the same order of magnitude as the NYSDEC TOGS AWQS. Chromium and lead exceeded the NYSDEC TOGS AWQS in 11 and 8 samples, respectively. The source of the chromium and lead is likely naturally occurring. Cyanide was not detected above the NYSDEC TOGS AWQS of 200 ug/l. A summary of metals in groundwater is provided in **Appendix C (Tables 13, 16 and 23).**

PCBs and pesticides were not analyzed in this sampling depth interval**.**

Overall, BTEX and PAH exceedances were detected in intermediate (greater than 30 feet bgs) groundwater in the northwestern corner of the former MGP operations and off-site just beyond the site limits to the north. The area(s) of highest BTEX and PAH analytical results is best illustrated as shown on **Drawing 4H**. Groundwater quality around the perimeter of the site indicates non-detectable to low BTEX and PAH concentrations. Groundwater samples were collected from the piezometers and monitoring wells during at least two of the three groundwater sampling events (**Drawing 4H**). A comparison of the BTEX and PAH concentrations between the two sampling rounds was completed and the results of that comparison are indicated as increasing, stable or decreasing concentration in the table below.

Total BTEX and PAH Concentrations Comparison

Piezometer, Well Designation	**BTEX Concentration**	**PAH Concentration**
GCMW-8D	Stable	Stable

4.3 Summary of Surface and Seep Water Quality Conditions

A total of three surface water quality samples were collected from sampling locations in the Glen Cove Creek channel and analyzed for BTEX, PAH and total cyanide. At each location, the surface water grab sample was collected within the channel adjacent to the embankment closest to the former Glen Cove MGP site. The analytical results indicate non-detectable BTEX, PAH and total cyanide concentrations in surface water.

As stated in Section 2.2.7, at the request of NYSDEC, these surface water sampling locations were resampled and reanalyzed for Free Cyanide, in the total and dissolved phases, during the implementation of the March 2007 SRIWP, in December 2007. A total of three surface water samples were collected from similar locations to the original surface water samples. The analytical results indicated results of less than 5 ug/l in all three samples.

The samples were additionally analyzed for salinity, hardness, chloride and total suspended solids (TSS). The analytical results indicated salinity values of less than 0.001 ug/l in all three samples. Hardness ranged from 100 to 106 mg/l in all three samples. Chloride ranged from 59.8 to 61.8 mg/l in all three samples. TSS ranged from less than 10 to 14 mg/l in all three samples.

One water sample was collected from a visual seep located adjacent to the culvert wall (closest to the site) below the LIRR. The seep water sample was analyzed for BTEX, PAHs and total cyanide. The analytical results indicate non-detectable BTEX and PAH concentrations and a negligible total cyanide concentration of 43 ug/l.

As previously stated in Section 2.2.7, at the request of NYSDEC, this sampling location was resampled and reanalyzed for Free Cyanide, in the total and dissolved phases, during the implementation of the March 2007 SRIWP, in December 2007. This seep water sample was collected from the same location as the original seep water sample. The analytical results indicated results of less than 5 ug/l in this sample in both phases.

The sample was additionally analyzed for salinity, hardness, chloride and total suspended solids (TSS). The analytical results indicated a salinity concentration of less than 0.001 ug/l; a Hardness concentration of 170 mg/l; a Chloride concentration of 20.5 mg/l; and a TSS concentration of 30 mg/l.

Overall, analytical results of the surface and seep water samples indicate no adverse impacts to Glen Cove Creek. A summary of surface water and seep quality data is provided in **Appendix C (Tables 17, 18 and 19).**

4.4 Summary of Sediment Quality Conditions

A total of six sediment samples were collected from Glen Cove Creek, three locations upstream (off-site) of the site and three locations (adjacent) in the Glen Cove Creek stream channel adjacent to the site. The off-site sediment samples (GCSED-04 through GCSED-06) were collected on October 27, 2005 and analyzed for PAHs. The adjacent sediment samples (GCSED-01 through GCSED-03) were collected prior to the off-site samples (on March 16, 2004) and analyzed for the following parameters; BTEX, PAHs and total cyanide.

The off-site sediment sample locations (GCSED-04 through GCSED-06) indicated total PAH concentrations ranging from 0.359 to 8.31 mg/kg. Total PAH concentrations at sediment sampling locations adjacent to the former Glen Cove Creek ranged from 7.71 mg/kg in sample GCSED-01 (1.5 – 2 feet bgs) to 72.23 mg/kg in sample GCSED-02 (1.5-2 feet bgs). A comparison of the individual PAH compounds detected at off-site sample locations and at the sample locations adjacent to the site are similar. Benzo(a)pyrene equivalents ranged from 0.0 mg/kg in sample GCSED-04 to 4.395 mg/kg in sample GCSED-02.

As stated in Section 2.2.8, three additional sediment sample locations were performed; one sample was collected downstream and two samples were collected upstream, beyond the limits of the previously collected sediment samples. These sediment samples were analyzed for PAH, during the implementation of the March 2007 SRIWP, in December 2007. The sediment sample locations (GCSED-08 through GCSED-10) indicated total PAH concentrations ranging from 3.71 to 8.828 mg/kg. A comparison of the individual PAH compounds detected at off-site sample locations and at the sample locations adjacent to the site are similar. Benzo(a)pyrene equivalents ranged from 0.3417 mg/kg in sample GCSED-10 to 1.0905 mg/kg in sample GCSED-08. The samples were also analyzed for Total Organic Carbon (TOC and the analytical results indicated concentrations ranging from 3,300 mg/kg to 17,000 mg/kg.

The sediment sample locations (GCSED-01 through GCSED-03) indicated non-detectable total BTEX concentrations in sediments collected adjacent to the site (**Drawing 4C**). Total cyanide was not detected in sediments collected adjacent to the site**.** A summary of sediment quality data is provided in **Appendix C (Tables 5, 6 and 7).**

4.5 Background Surface Soil Sampling Results

KeySpan completed an off-site background surface soil sampling investigation to define the nature of urban soil background PAHs and Resource Conservation and Recovery Act (RCRA) metals concentrations in surface soils surrounding the Glen Cove study area for comparison to those concentrations identified in samples collected from within the former MGP site (**Drawing 4J**). The ubiquity and type of soil constituents located in samples from the Glen Cove study area suggest that there are sources of these constituents in soil background that were not associated with MGP operations, particularly for the higher molecular weight PAHs.

Several statistical approaches were used to analyze anthropogenic soil background, particularly descriptive and nonparametric statistics. Because deposition of organic compounds in the environment is generally stochastic (that is, random and from many sources), the soil background populations were compared using nonparametric methods as suggested by United States Environmental Protection Agency guidance.

For RCRA metals, 6 of the 8 metals were detected with significant frequency for the background comparison to be reliably completed. These metals (arsenic, barium, chromium, cadmium, lead and mercury) within the Glen Cove study area were found to be consistent with the metal concentrations in the site background samples, indicating that concentrations noted to be elevated (i.e., above the SCGs) are consistent with local conditions surrounding the site and are not likely attributable to former MGP operations. The remaining two metals, selenium and silver, were not detected with significant frequency for a reliable comparison to be made. Selenium and silver are not generally attributed to MGP operations.

It was determined that there may be several sources of contaminants in the soil background, from vehicular traffic to the deposition of PAHs from the nearby Long

Island Railroad (LIRR). The relative frequency of higher molecular weight PAHs suggests that one important source of contamination is from aerosol deposition of sorbed PAHs associated with cars, trucks, and train exhaust.

The background soil data set was also compared to the Glen Cove study area soil data. It was found that surface soil concentrations for PAHs detected with significant frequency in the soil background data set were generally statistically lower than the data set collected from the Glen Cove study area.

4.6 Soil Vapor Survey

A total of seven soil vapor samples were collected from temporary soil vapor points installed on properties adjacent to the Site (see Figure 1 of the QHHEA) Soil vapor sampling was conducted in April 2008, to evaluate the migration of COPCs from the Site potentially impacting these structures. Although COPCs were detected in soil vapor on these properties above the Upper Fence Values of the New York State Department of Health (NYSDOH) Background Outdoor Air Concentrations the concentrations were either too low to present a risk if associated with a structure or their presence in the soil vapor were related to activities conducted on these properties versus soil vapor migrating from the Site (see Table 2,6 of the QHHEA).

4.7 Private Well and Basement Survey

As stated in **Section 2.5**, a limited number of responses to the February 2008 survey have been received all of which indicate that those respondents do not have a private wells. To improve on the number of responses a second survey was initiated in September 2008 along with a follow up phone call to each recipient of the survey form to confirm their receipt of the form and answer any questions. The findings February and September 2008 survey and follow-up phone calls resulted in 35 responses and each of these respondents indicated that they do not have private wells.

4.8 Perimeter Air Monitoring

As previously stated in **Section 2.3.3**, perimeter air monitoring was conducted at both upwind and downwind locations during hollow stem auger drilling activities. At no time during that activity did VOC levels or PM-10 levels at the perimeter exceed the action levels in the air monitoring plan.

4.9 Qualitative Human Health Exposure Assessment

The Qualitative Human Health Exposure Assessment (QHHEA) was completed in accordance with the NYSDEC “Draft DER-10 Technical Guidance for Site Investigation and Remediation” that summarizes the approach for preparing a qualitative exposure assessment. The QHHEA addresses qualitative exposures potentially posed to human receptors by constituents of concern that are present in environmental media at concentrations in excess of the screening criteria and guidance values provided by

NYSDEC and other federal sources. There are no future plans for this site other than its current use as an electrical sub-station. .The following is a summary of the results and conclusions provided by the July QHHEA for the former Glen Cove MGP site **(Appendix F)**.

The Constituents of Potential Concern (COPCs) are identified as VOCs, semivolatile organic compounds [SVOCs (including PAHs)], metals and/or cyanide exceeding NYSDEC TAGM values in soil and/or NYSDEC AWQS concentrations in water [Standards, Criteria, and Guidance values (SCGs)]. Where NYSDEC SCGs do not exist (e.g., cyanide criteria for soil) or are recommended by NYSDEC as "SB" (site background) (e.g., aluminum), risk-based screening criteria from EPA were used for the screening comparison. Tables 2-1 through 2-4 of the QHHEA **(Appendix F)** provide the list of COPCs in surface soils, subsurface soils, soil vapor, and groundwater at the former Glen Cove MGP site.

There are several distinct human populations, both on and in the vicinity of the former Glen Cove MGP site, who have the potential for exposures to MGP and non-MGP related COCs. The on-site populations include substation workers and trespassers under current site use conditions. Relevant current off-site receptor populations include adult and child residents and adult and child receptors at neighboring commercial establishments that may be exposed to fugitive dusts from uncovered portions of the site. These pathways are currently mitigated through the placement of coarse gravel, pavement, and substation structures in portions of the site with the greatest surface contamination. However, institutional controls at the site, such as deed restrictions, are required to maintain engineered barriers, particularly those barriers that are likely to be altered from general site use, such as the displacement of coarse gravel and cracks in the pavement. Under current site use and activities, potential receptors may include construction workers, utility workers, and adjacent residents. Under future off-site use conditions, relevant human populations include construction workers and utility workers. A summary of the potential exposure pathways, by population and medium, is presented in Table 2-5 of the QHHEA **(Appendix F)**.

The QHHEA has indicated that there are pathways through which people on-site and in the vicinity of the site could be exposed to potentially hazardous materials related to former MGP activities and historic fill. However, there are no significant imminent threats to human health that warrant an interim remedial action.

4.10 Fish and Wildlife Resources Impact Analysis

The Fish and Wildlife Resources Impact Analysis (FWRIA) was completed in accordance with the NYSDEC FWRIA Appendix 3C Decision Key. The FWRIA was completed to identify actual and potential impacts to plants, fish and wildlife residing within the former Glen Cove MGP site. Specifically, the FWRIA focuses on impacts associated with potential MGP-related constituents detected in soil, groundwater, sediment and surface water. The following is a summary of the results and conclusions provided by the February 2006 FWRIA for the former Glen Cove MGP site **(Appendix F)**.

While a number of chemicals of potential ecological concern (COPECs) exceed some toxicological benchmark values, the site reconnaissance conducted as part of this analysis indicates that the site and surrounding area are not a significant source of quality environmental resources, due to the limited areas of open space and vegetation and the constant presence of human activity in the area. Wildlife species typically present at these types of sites are adapted to an urban setting and few sensitive individuals are expected to be present and only for transient periods. Because only transient species and a few individual animals would use this area, the frequency and duration of exposure is limited. Thus, the observed chemicals detected on-site do not pose a current risk, nor is any expected in the future.

The sediment samples within the culverted portion of Glen Cove Creek which is adjacent to the former Glen Cove MGP site, had PAH concentrations above the Effects Range-Low (ER-L) value and for two of the closest samples, above the Effects Range-High ER-M value. The five upgradient samples had lower to no detectable PAH concentrations. Detected concentrations in these upgradient samples were at least above the ER-L, for at least one PAH. Based on the current dataset, there may be localized ecological impacts to the benthic community at the Glen Cove Creek nearest the site caused by either background PAHs from upgradient sources or site-related PAHs. Supplemental sediment sampling at downgradient locations in Glen Cove Creek was performed in December of 2007 (GSSED-08 through GSSED-11). The concentrations of PAHs in sediments above the ER-M adjacent to the site appear to be localized. Upgradient and downgradient sediment samples demonstrate that the PAHs downgradient are similar to those upgradient, thereby indicating that they are representative of generally background PAH sources affecting the sediments of Glen Cove Creek and are not related to the Site.

The surface water within Glen Cove Creek had no detectable concentrations of BTEX and PAHs, or cyanide at four locations both adjacent to and upgradient of the former Glen Cove MGP site. However, a seep sample likely originating from the site had concentrations of cyanide above water quality benchmark concentrations and the detection limits for the surface water samples were above these values. Only one of the surface water samples (SW-01) is considered downgradient of the seep by roughly 25 feet. This is likely to provide a significant source of dilution from the seep into this portion of the creek. Although there are potential impacts from cyanide present at the creek, the culverted portion of the creek from which this sample (SW01) was collected is unlikely to support a significant fish population due to physical (man-made) changes of the creek bottom and the additional impacts from roadway runoff at the Glen Cove Highway, which runs above the creek just north of the site.

5.0 FATE AND TRANSPORT OF DNAPL AND CHEMICAL CONSTITUENTS

5.1 Introduction

This section describes the physical, chemical and biological processes that have affected the fate and transport of DNAPL and its chemical constituents within and downgradient of the former Glen Cove MGP site. The primary influences affecting the fate and transport of chemicals in the environment at the site include:

- The presence and extent of DNAPL impacts in subsurface soils;
- The physical properties of the chemicals, including state (i.e., solid, liquid, gas), density/specific gravity, solubility in water, and propensity for volatilization and adsorption to soil;
- The environmental media in which the chemicals are released (i.e., air, soil, water) and the spatial and temporal changes of the character of the media encountered by a chemical as it moves through the environment;
- The physical, chemical and biologic processes that affect the mobility of the chemicals and/or transform the chemicals into innocuous forms; and
- Hydrogeologic characteristics of the site.

Based on the results of the data presented in **Section 4.0**, soil and groundwater are the environmental media impacted at the site. Visual impacts of MGP-related DNAPL were encountered in near-surface, vadose and primarily in the saturated soils as DNAPL/Tar saturation, blebs, staining and odors. The primary DNAPL chemical constituents of concern affecting on-site environmental media are BTEX and PAH compounds. The primary DNAPL chemical constituents of concern affecting off-site, just beyond the site limits to the north, environmental media are PAH compounds. The metals are naturally-occurring, associated with background anthropogenic sources and/or associated with historic fill placed post MGP operation.

An evaluation of the environmental fate and transport of site-related contaminants is important in determining the potential for exposure to the contaminants. There are several fate and transport mechanisms by which contaminants have and continue to degrade and migrate at the former Glen Cove MGP site. The presence of MGP-related DNAPL impacts in subsurface soils is the principal remaining source of dissolved phase BTEX and PAH constituents. Its horizontal and vertical extent is a key factor in the distribution of BTEX and PAH constituents in soils and groundwater. The migration mechanisms for the chemical constituents of concern detected at the site are detailed below. The presence and estimates of the physical and chemical properties of the constituents of concern which affect contaminant migration are also presented below.

5.2 Presence of Constituents of Concern

The presence of MGP-related contamination at the site is the result of former MGP operational activities during the years 1904 to 1929. During this period, MGP-related residuals were released to the environment. The RI findings are based on sampling results of several matrices, including soil, sediment, groundwater and surface water, completed during all investigation activities at the site. These results have indicated that MGP-related DNAPL and its constituents are present in soils and groundwater beneath the site and just beyond the site limits to the north. DNAPL exists within the interstitial soil pore spaces as DNAPL/Tar saturation and blebs or as staining on the soil particles. MGP-related odors were also noted in soil and groundwater samples from beneath the former MGP. In groundwater, MGP-related DNAPL product accumulation was detected only in shallow groundwater well GCMW-13S. MGP-related dissolved phase chemical constituents were also detected at several shallow and intermediate wells at the site proper and off-site just beyond the site limits to the north. The following is a list of MGP-related DNAPL chemical constituents detected above their respective NYSDEC RSCOs in soil and groundwater:

Contaminant Group	**MGP-Related Constituents**
Volatile Organics	Benzene, Toluene, Ethylbenzene, Xylenes
Polycyclic Aromatic Hydrocarbons	Acenaphthylene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, fluoranthene, indeno(1,2,3-cd)pyrene, naphthalene, pyrene, dibenzofuran.
Metal	Cyanide

Other non-MGP related dissolved phase chemical constituents detected above the applicable NYSDEC RSCOs include:

Contaminant Group	**Non MGP-Related Constituents**
Volatile Organics (Non-MGP)	Acetone, 2-Butanone, methylene chloride, methyl tertiary butyl ether, PCE, 1,1-DCA
Semi-Volatile Organics (Non-MGP)	di-n-butylphthalate, bis(2-ethylheryl) phthalate, butylbenzylphthalate
Metals (Non-MGP)	Arsenic, antimony, barium, beryllium, cadmium, chromium, copper, iron, manganese, lead, mercury, nickel, selenium, sodium, zinc.

The analytical laboratory is the apparent source of some of the non-MGP related VOCs as evidenced by their detection in laboratory method blanks. The metals appear to be naturally occurring, associated with background anthropogenic sources and/or associated with historic fill of unknown origin as detailed in **Section 4.0**.

5.3 Physical/Chemical Properties and Persistence of Contaminants of Concern

The understanding of physical/chemical properties and persistence of individual MGP-related chemical constituents is essential for discussion of fate and transport mechanisms. The MGP-related chemical constituents have been organized by chemical group and classified qualitatively by solubility, volatility, mobility and degradation potential (**Table 5-1**).

The physical/chemical properties of BTEX compounds are highly soluble and highly volatile, making them mobile to moderately mobile in the subsurface environment. The PAHs range from insoluble to readily soluble, low to moderate volatility (except for the high volatility of indeno[1,2,3-cd]pyrene), and immobile to slightly mobile (**Table 5-1**).

Persistence is the measure of constituent longevity in the environment before it degrades to innocuous forms or transforms, either chemically or biologically, into some other chemical. Some of the factors which affect the persistence of a constituent include the physical state of the constituent (e.g., DNAPL, vapor, dissolved phase), the constituent volume, exposure to sunlight, oxygen availability, the types and quantities of microorganisms present, availability of nutrients, temperature and pH. Persistence is expressed in terms of a chemical half-life and can be on the order of days, weeks or years.

Many complex factors may affect persistence. The actual rate of constituent degradation is very difficult to predict for a given chemical at a given site. However, a qualitative evaluation of the potential for degradation of a constituent can be estimated based on documented research. Such a qualitative evaluation was conducted for the constituents of concern detected at the site, and the results are summarized in **Table 5-1**. In this table, the degradation potential for each of the constituents of concern is indicated for the three natural environments; atmospheric, aquatic and terrestrial, as summarized below.

- Atmospheric Degradation – A constituent released to the atmosphere may degrade by such processes as photolysis and/or reactions with the hydroxyl radical, ozone, or other chemicals present.
- Aquatic Degradation- A chemical released to fresh, marine, or estuarine surface waters may degrade by such processes as photolysis, hydrolysis, oxidation, and/or biodegradation.
- Terrestrial Degradation – A chemical released to soil or groundwater may degrade by such processes as hydrolysis, oxidation, and/or biodegradation.

The BTEX compounds have a high degradation potential in the three natural environments. The estimated half-life of BTEX compounds in soils and groundwater ranges from less than a day to days. The degradation potential for PAHs ranges from high under atmospheric conditions, to low/moderate in aquatic and terrestrial environments. The estimated half-life of PAHs in soils and groundwater ranges from 10’s of days to 10 years in the three natural environments (**Table 5-1**).

TABLE 5-1
GLEN COVE FORMER MGP SITE
KEYSPAN CORPORATION
PHYSICAL/CHEMICAL PROPERTIES OF ORGANIC AND INORGANIC COMPOUNDS

Chemical Compound	Specific Gravity (g/cc)	Solubility		Volatility			Mobility		Octanol-Water Partition Coefficient Kow (mL/g)	Soil-Water Partition Coefficient Kd (mL/g)	Vapor Density at 10°C (g/L at 1atm)	Water Diffusion Coefficient at 20°C (cm^2/sec)	Degradation Potential				
		Solubility at 25° C (mg/L)	Solubility Classification	Vapor Pressure (mm Hg/Torr at 20°C)	Henry's Law (atm-m^3 mol)	Volatility Classification	Organic Carbon Partition Coefficient Koc (mL/g)	Mobility Classification					Est. Half-Life (Days at 25°C)		Atmospheric Degradation Potential	Aquatic Degradation Potential	Terrestrial Degradation Potential
													Soil	GW			
BTEX																	
Benzene	0.88	1800	Highly Soluble	76	5.50E-03	High volatility	83	Mobile	140	0.11	3.4	0.0000098	5-16	10-720	High	High	High
Toluene	0.87	530	Highly Soluble	22	6.70E-03	High volatility	150	Moderately mobile	490	0.37	3.77	0.0000086	4-22	7-28	High	High	High
Ethylbenzene	0.87	161	Highly Soluble	7	8.80E-03	High volatility	260	Moderately mobile	1400	1.1	4.57	0.0000078	3-10	144-5472	High	High	Moderate
Xylenes	o-xylene, 0.88 m-xylene, 0.86 p-xylene, 0.86	o-xylene,175 p-xylene, 198	Highly Soluble	o-xylene, 6.6	o-xylene, 5.0E-03 m-xylene, 7.0E-03 p-xylene, 7.1E-03	High volatility	350	Moderately mobile	o-xylene, 589 m-xylene, 1585 p-xylene, 1413	0.95	4.57	0.0000093	7-28	14-360	High	High	High
PAHs																	
Acenaphthene	1.07	3.8	Moderately Soluble	0.0027	1.50E-04	Moderate volatility			8318	6.29	5.23	0.0000077	24.6-204	12-102			
Acenaphthylene	0.899	3.93	Moderately Soluble	0.029	1.14E-04	Moderate volatility	5000	Slightly mobile	11749	8.88		0.0000075	85-120	43-60			
Anthracene	1.25	0.065	Not Soluble	0.000196	1.80E-06	Low volatility	16000	Hardly mobile	28184	21	6.2	0.0000077	100-920	50-460			
Benzo[a]anthracene	1.274	0.014	Not Soluble	0.000000022	6.60E-07	Low volatility	1400000	Immobile	140000	110		0.000009	204-1361	102-679	High	Low/Moderate	Low/Moderate
Benzo[a]pyrene	1.351	0.0038	Not Soluble	0.0000000055 @ 25°C	2.40E-06	Low volatility	400000	Immobile	1100000	830	8.7	0.000009	114-1059	57-529	High	Low/Moderate	Low/Moderate
Benzo[b]fluoranthene		0.00055	Not Soluble	0.0000005	1.20E-05	Moderate volatility	550000	Immobile	3700000	2800		0.0000056	719.1-1219	360-610	High	Low/Moderate	Low/Moderate
Benzo[k]fluoranthene		0.00055	Not Soluble	0.0000005	1.20E-05	Moderate volatility	550000	Immobile	3700000	2800		0.0000056	1821-4271	909-2139	High	Low/Moderate	Low/Moderate
Chrysene	1.27	0.0019	Not Soluble	0.0000000063 @ 25°C	4.32E-07	Low volatility	245500	Immobile	813800	615.23		0.0000062	745-2000	372-993			
Dibenzo[a,h]anthracene	1.28	0.0005	Not Soluble	1E-10	7.30E-09	Non-volatile	1700000	Immobile	930000	700		0.00000518	723-1880	361-942	High	Low/Moderate	Low/Moderate
Dibenzofuran	1.0886	10	Readily/Moderately Soluble	0.00248 @ 25°C	9.70E-05	Moderate volatility	10000	Slightly/Hardly mobile	15000	11	5.8	0.000006	8.5-35	7-28	High	Low/Moderate	Low/Moderate
Fluoranthene	1.252	0.26	Slightly Soluble	0.00005 @ 25°C	1.61E-05	Moderate volatility	41690	Hardly mobile	165959	125.47		0.0000064	280-880	140-440			
Fluorene	1.203	1.9	Moderately Soluble	0.0006 @ 25°C	6.40E-05	Moderate volatility	5012	Slightly mobile	15136	11.44		0.00000788	64-120	32-60			
Indeno[1,2,3-cd]pyrene		0.62	Slightly Soluble	1E-10	3.00E-02	High volatility	31000000	Immobile	46000000	35000		0.0000057	1201-1460	599-730	High	Low/Moderate	Low/Moderate
2-Methylnaphthalene	1.0058	25	Readily Soluble	0.051 @ 25°C	5.20E-04	Moderate volatility	8500	Slightly mobile	1300	9.8		0.0000078	ND	ND	High	High	Moderate/High
Naphthalene	1.15	34	Readily Soluble	0.082 @ 25°C	4.80E-04	Moderate volatility	1300	Slightly mobile	2300	1.7		0.0000075	1-258	16.6-48	High	High	High
Phenanthrene	1.179	1.3	Moderately Soluble	0.00068 @ 25°C	3.90E-05	Moderate volatility	2300	Slightly mobile	2900	22		0.00000747	32-402	16-200	High	Moderate	Moderate
Pyrene	1.271	0.132	Slightly Soluble	0.000000685	1.10E-05	Moderate volatility	75860	Hardly mobile	123027	93		0.00000724	420-3796	210-1898			
Metals																	
Arsenic	5.75	NA	NA	NA	NA	NA	NA	NA	NA	200		NA	10E08		Low	Low	Low
Chromium	7.14	NA	NA	NA	NA	NA	NA	NA				NA	10E08				
Mercury	13.534	NA	NA	NA	NA	NA	NA	NA				NA	10E08				
Nickel	8.9	NA	NA	NA	NA	NA	NA	NA				NA			Low	Low	Low
Zinc	7.14	NA	NA	NA	NA	NA	NA	NA				NA					
Total Cyanide																	
Cyanide	0.697	NA	NA	NA	NA	NA	NA	NA	NA			NA			Low/Moderate	Low/Moderate	Low/Moderate

The metals have the least potential to degrade in soils and groundwater, and therefore will likely persist the longest at the site. In fact, metals, under ordinary conditions, will likely persist indefinitely (for all practicable purposes).

The relevance of understanding the physical/chemical properties and persistence of MGP-related constituents assists in explaining the presence/absence of the various physical forms of MGP-related impacts and; the distribution/concentration of MGP-related constituents detected in soils and groundwater at the site and just beyond the site limits to the north. For example, BTEX constituents in soils and groundwater are detected less frequently and typically at lower concentrations as compared to PAH constituents. This occurrence is likely due to the BTEX constituents high volatility, solubility, mobility, high degradation potential and historic time of release to the environment. Conversely, PAH constituents are less volatile, soluble, and mobile than BTEX constituents and have a low degradation potential. As a result of these physical/chemical properties, BTEX tends to be removed more readily from the environment as compared to PAH which are more persistent.

5.4 Fate (Degradation) and Transport Mechanisms of Contaminants in the Natural Environment

The presence of MGP-related DNAPL impacts in subsurface appear to be the principal if not the sole remaining source of BTEX and PAH constituents in the subsurface soil and groundwater. The horizontal and vertical extent of the DNAPL is a key factor in the distribution of BTEX and PAH constituents detected in soils and groundwater beneath the former MGP and just beyond the site limits to the north. The majority of MGP-related DNAPL impacts were observed at and below the water table as DNAPL/Tar saturation, blebs, staining and odors. Dissolution is the process by which BTEX and PAH constituents are transferred from the DNAPL to the dissolved phase state in groundwater. The key processes affecting the fate and transport of BTEX and PAH constituents within the environment are described below.

Surface and subsurface soil quality results indicate the presence of BTEX and PAH constituents at the former Glen Cove MGP site and immediately off-site just beyond the site limits to the north. This presence and persistence of BTEX and PAHs in soils indicate sorption as a process affecting the fate and transport.

- *Sorption (ab- or adsorption)* - Sorption is the process by which chemicals in either a liquid or gas phase become physically and/or chemically associated with the surface of a solid phase. This process inhibits migration of chemicals. The sorption of organic chemicals is primarily governed by the amount of naturally occurring organic carbon present in the matrix of the soil or aquifer and the chemical’s susceptibility to sorption to organic carbon. Organic carbon is typically present as coatings on the surfaces of the solid matrix (e.g., sediment grains, fractured bedrock surfaces, etc.) of the aquifer or as particulate organic matter. The organic carbon partition coefficient (K_{oc}) is used as an indicator for the affinity of an organic chemical to adsorb to naturally occurring organic carbon. The affinity of a chemical to adsorb to organic carbon, as reflected by its K_{oc}, influences the mobility and/or attenuation of the chemical. Organic chemicals with a higher K_{oc} will adsorb to organic carbon more readily than chemicals with a lower K_{oc} (**Table 5-1**).

The migration rates of organic chemicals in groundwater that adsorb onto organic matter in the aquifer (i.e., that have a higher K_{oc}) are attenuated or retarded relative to the natural groundwater flow rate. Consistent with this principle, the migration rate of an organic chemical with a relatively high K_{oc}, is more strongly retarded as a result of sorption to organic carbon in the aquifer as compared to the migration rate for a chemical with a low K_{oc}.

In general, BTEX and low molecular weight PAH compounds, such as naphthalene have a low to moderate K_{oc} value as compared to the higher molecular weight PAH compounds, such as benzo(a)pyrene. Accordingly, in soil and aquifers containing measurable organic carbon, the higher molecular weight PAHs will migrate at a slower rate than the BTEX and low molecular weight PAHs. Therefore, higher molecular weight PAHs would not be expected to migrate far from a source area in most soil environments and aquifers.

An exception to this general rule occurs when the PAH compounds are migrating as a component of a DNAPL, such as coal tar. DNAPL migration is dependent on the volume of DNAPL mass released and its physical properties such as density and viscosity somewhat irrespective of chemical constituent sorption considerations. In this case, DNAPL containing PAHs may migrate through the soil at a higher rate and to a greater extent than the individual constituents, making DNAPL migration a significant factor in the distribution of chemical constituents in soil and groundwater beneath the site.

Groundwater quality results indicate the presence of dissolved phase BTEX and several PAH compounds beneath and immediately downgradient of the former MGP operations area and immediately off-site just beyond the site limits to the north. This occurrence demonstrates that aqueous solubility is a factor in the transport of dissolved phase constituents.

- *Aqueous Solubility* - Aqueous solubility is a measure of the maximum mass of a chemical that can exist in a dissolved phase at equilibrium with the pure chemical. This chemical property is used indirectly to assign relative potentials for a chemical to leach into an aqueous phase from a source material, such as a DNAPL. Chemicals with high solubilities will tend to leach easily and to remain in aqueous solution. The opposite conditions apply to chemicals with low aqueous solubilities. In general, high solubility chemicals, including the BTEX compounds, are more mobile in the environment than chemicals with moderate solubilities, such as the low molecular weight PAH compounds, including naphthalene and acenaphthylene. The higher molecular weight PAH compounds, such as fluoranthene, pyrene and chrysene, have low to very low solubilities, are not very mobile and are not expected to migrate far from a source.

BTEX and low molecular weight PAHs are present in soils and groundwater at the former Glen Cove MGP site making volatilization a plausible migration pathway.

- *Volatilization* - Volatilization is the process by which a fraction of a chemical in a solid or liquid phase partitions into a gas phase. The extent to which this process proceeds is measured by the vapor pressure for a particular chemical. In general, chemicals with higher vapor pressures, such as BTEX, volatilize more readily than chemicals with low vapor pressures, such as PAHs. For these reasons, dissolved-phase BTEX in groundwater is more likely to migrate to soil vapor and migrate through unsaturated soil, eventually releasing to the atmosphere. Low molecular weight PAHs have low vapor pressures relative to BTEX, therefore, while volatilization of these compounds does occur, the extent of PAH volatilization is negligible compared to BTEX. High molecular weight PAHs have very low vapor pressures indicating virtually no volatilization will occur under most conditions.

Biodegradation is likely a key degradation mechanism for reducing BTEX and PAH constituents in soils and groundwater at the former Glen Cove MGP site and just beyond the site limits to the north.

- *Biodegradation* - Biodegradation is the transformation of organic chemicals to innocuous secondary compounds and ultimately to carbon dioxide and water as the result of the metabolic activity of microbes, including bacteria and fungi, that are typically present in most natural environments (S.S. Suthersan, 1997). The processes that facilitate biodegradation have been extensively investigated and well documented to be effective in reducing concentrations of a wide range of organic compounds within soil, groundwater and surface water. Biological processes which take place in the natural environment can modify and destroy organic compounds at the point of introduction or during their transport within soil, groundwater or surface water. BTEX compounds are readily degraded under aerobic (oxygen-rich) conditions in soil, groundwater and surface water. However, benzene and ethylbenzene appear to be relatively resistant to degradation under anaerobic (oxygen deprived) conditions (R.C. Borden, et al., 1995). Low molecular weight

PAHs have been shown to naturally degrade at moderate rates under aerobic conditions.

The processes described above, along with the results of the RI, historical site investigations, and the known on-site and off-site hydrogeologic conditions, are integrated into the following sections which describe the fate and transport of constituents detected in soil and groundwater at the site. The fate and transport model proposed below identifies:

- The modes of DNAPL migration away from the source area(s);
- Leaching of the more mobile constituents (e.g., BTEX compounds) present in the DNAPL source material(s);
- Migration of these contaminant constituents through vadose zone soil to groundwater;
- The migration and attenuation of the dissolved constituents in groundwater; and,
- Migration of contaminant vapors.

5.5 DNAPL and Dissolved Phase Contaminant Migration

5.5.1 Migration of Dense Non-Aqueous Phase Liquids (DNAPLs)

MGP-related DNAPL released to surface/subsurface soils will migrate vertically through the soil column under the influence of gravity once residual saturation and capillary forces of soils are exceeded. Upon release, DNAPL typically distributes quickly within the subsurface (P.V. Noort, et al., 1994). However, much of the DNAPL may remain behind, trapped in pore spaces in the vadose zone as a residual DNAPL along its migration pathway. The DNAPL residue trapped in the pore spaces may fully or partially saturate the pore spaces or occur as individual droplets or blebs.

In the near-surface/vadose zone, the MGP-related DNAPL impacts were very limited, observed only in areas within and surrounding the former MGP operations; mainly in the northwestern and western portions of the site and off-site just beyond the site limits to the north. A total of five soil boring locations exhibited MGP-related DNAPL impacts within the vadose zone soils. Staining was observed at 4 locations, and at one location, solid tar, was observed within the near-surface/vadose zone soils (**Drawings 4B** and **4C**).

This residual DNAPL in the vadose zone soils is sorbed to the soils, however, it will dissolve slowly into infiltrating precipitation and will be a long-term source for contamination. Each recharge event will result in contaminant transport to the water table. In addition, DNAPL will volatilize forming a vapor plume that will discharge to the atmosphere and sink by advection through the vadose zone to the water table and dissolve in groundwater.

DNAPLs are denser than water and will continue to migrate past the water table into the saturated soil column until either the mass of DNAPL required to overcome capillary forces and hydrophobic effects becomes depleted, thus preventing continuation of gravity-driven migration, or it encounters a less permeable lithology (e.g., silty sand or clay). When DNAPL encounters water-saturated soils, the ability of the DNAPL to displace water from the pore spaces and continue its vertical migration can be diminished. Similarly, the presence of less-permeable silty sand lenses in the migration pathway also impedes the vertical movement of DNAPL. In both cases, a local zone or pool of immobile residual DNAPL may form.

Once DNAPL encounters the water table, its migration is influenced by the permeability of the aquifer soils and the rate and direction of groundwater flow. The natural flow of groundwater can have a notable influence on the bulk migration of DNAPL, but typically will not control its migration path which can be contrary to the groundwater flow direction. The combined effect of variable permeability of the aquifer soils and the influence of groundwater flow can produce irregular-shaped and unevenly distributed “fingers” (ganglia) or “lobes” of DNAPL extending vertically or laterally away from the source area or the initial point of entry into the water table.

Soil underlying the site consists of poorly-sorted sands and gravelly sands with a relatively high permeability interbedded with silty-sand lenses of lower permeability. Due to the predominance of high-permeability gravelly sand immediately underlying the site, vertical migration of DNAPL likely occurred rapidly with “pooling” above silty-sand layers. Gravelly sand units appear to have acted as preferential pathways for the migrating DNAPL.

The majority of MGP-related DNAPL visual impacts (a total of 28 soil boring locations) were observed in soils at and below the water table. The water table is about 8 feet bgs on the site proper. MGP-related DNAPL impacts were encountered at 21 soil boring locations within the 8 to 30 foot bgs depth interval. The distribution of MGP-related DNAPL impacts included DNAPL/Tar saturation in 11 locations in this interval. Based on the visual observations, DNAPL/Tar saturation impacts have migrated into the poorly-sorted sand, gravelly sand, and vertical migration was impeded by lenses of silty sand layers causing an accumulation of DNAPL/Tar saturation above the silty sand layer (e.g., GCSB40, GCSB42 and GCSB46). The thickness of DNAPL/Tar saturation ranged from 0.10 to 4 feet with 50% of the DNAPL/Tar saturated layers less than a foot thick. The DNAPL volume (thickness of) above the silty sand layer resulted in horizontal migration along the silty sands; and vertical migration (or penetration) of DNAPL blebs and thin layers of DNAPL/Tar saturation through the silty sands to deeper intervals**.** Thin lenses (0.5 feet or less) of DNAPL/Tar saturation were encountered deeper (22 and 27.8 feet bgs) at soil boring GCSB-40. Blebs were often observed below the DNAPL/Tar saturation at the same locations. This occurrence is best evidenced by MGP-related impacts encountered in soil borings GCSB37, GCSB40 and GCSB42.

A total of eight soil boring locations within the greater than 30 foot bgs depth interval exhibited MGP-related DNAPL impacts (**Drawing 4E**). The presence of blebs was most commonly observed at this depth interval. DNAPL/Tar saturation was observed as thin lenses (0.5 feet or less) at two soil boring locations, GCSB-37 and GCSB-46. In GCSB-37 the saturation was followed at depth by the presence of blebs and staining (**Drawing 4E**).

Overall, MGP-related DNAPL impacts are negligible in the near-surface and vadose zone soils relative to the impacts present at and below the water table. It should be noted that the near-surface and vadose zone soils are predominantly composed of historic fill placed on the property after cessation of MGP operations in 1929. Based on stratigraphic data from soil borings, fill material of unknown origin exists site-wide including the former MGP operations area. This is likely the explanation for the lack of MGP-related impacts in the fill.

MGP-related DNAPL impacts begin at the water table as DNAPL/Tar saturation and blebs with their occurrences reducing with depth. Vertical migration occurred through the permeable soils, pooled and moved laterally above the less permeable layers and upon sufficient DNAPL accumulation above the less permeable layer, migrated to deeper depths as blebs and stringers and/or staining.

The observed MGP-related DNAPL impacts and soil quality results are presented together on **Drawings 4B** through **4E**. These drawings present the relationship between the MGP-related DNAPL impacts and associated chemical constituent concentrations.

5.5.2 Migration of Contaminant Constituents in Soils

Constituents present in surface and vadose zone soils may migrate to the underlying aquifer. The primary transport mechanism or migration pathway for these constituents is dissolution into infiltrating precipitation through contact with soils containing residual MGP-related DNAPL and sorbed BTEX and PAH compounds. Precipitation that infiltrates the surface and vadose zone ultimately reaches the water table and becomes incorporated into the groundwater, thus contributing dissolved constituents to groundwater. Many factors influence the rate of constituent movement through soils. These include the physical/chemical properties of the constituents (e.g., solubility, density, viscosity) as listed in **Table 5-1**, and the physical/chemical properties of the environment (e.g., rainfall, percolation rate, soil permeability, porosity, particle size distribution, organic carbon content). Because all these factors can affect the rate of constituent movement through soils, it is difficult to predict such movement. However, based on the data collected during the RI program, some gross generalizations of this movement can be made.

Sorption of the constituent to soil particles is the most significant hindrance of constituent migration in soils at the former Glen Cove MGP site. Sorption of constituents is generally described by their distribution coefficients (K_d). The distribution coefficient can be estimated by multiplying the organic carbon partition coefficient (K_{oc}) and fraction of organic carbon in the aquifer matrix (f_{oc}) or generally expressed as:

$$K_d = \frac{\text{Mass of constituent on the solid phase per mass of solid phase}}{\text{Concentration of solute in solution}}$$

If it were not for sorption, the rainfall recharge and soil permeability at the site are high enough that all the constituents of concern would readily move through the soils. This is demonstrated by the movement of the BTEX constituents and some of the PAHs (e.g., naphthalene) through the soils. Sorption of these constituents is relatively small at the site, as indicated by their low K_{oc} values, and thus they have been detected at relatively high concentrations in groundwater. Other PAHs such as benzo(a)pyrene have much higher K_{oc} values and even though they have been observed in the soils at concentrations in excess of NYSDEC RSCOs, they have not been observed as extensively in groundwater as those with lower K_{oc} values. Sorption of these constituents of concern to the soils at the site has apparently prevented significant migration into groundwater.

Except for the solid tar and tar staining detected at a total of five locations, the near surface and vadose zone soils are not considered potential sources of MGP-related contamination. This is supported by the fact that negligible concentrations of BTEX and PAHs were detected in surface and vadose zone soil samples. Negligible total BTEX concentrations were detected at seven locations and low to moderate PAH concentrations at each of the 44 sampling locations. The total BTEX concentrations in soils were negligible ranging from 0.002 to 0.027 mg/kg at the seven locations. Total PAH concentrations in soils range from 2.167 to 621 mg/kg.

Tar staining was detected at the 0-1 foot bgs depth interval at soil boring SB-04; solid tar at soil boring GCSB-44 and tar staining at soil borings SB-02, SB-03 and HB-10A are present several feet below grade at the remaining on-site locations **(Drawings 4A through 4C)**. Infiltrating precipitation in contact with these MGP-related DNAPL impacts may transport dissolved phase constituents to groundwater.

Metals also have high K_{oc} values, and thus, will also readily sorb to soil particles at the site. However, the presence of some metals in groundwater indicates metal concentrations in soil are too high for complete sorption to occur. The metal concentrations in soil are apparently high enough such that migration into groundwater is occurring, however, this is expected to occur very slowly due to their high affinity for sorption.

5.5.3 Migration of Dissolved Phase Constituents in Groundwater

Many factors influence the rate of constituent dissolution and movement in an aquifer system. These include the physical/chemical properties of the constituents (e.g., solubility, density, viscosity, etc.) as listed in **Table 5-1**, and the physical/chemical properties of the environment (e.g., soil permeability, porosity, bulk density, and particle size distribution, etc.). Because all these factors can affect the rate of constituent movement through aquifers, it is very difficult to predict such movement. However, based on the data collected in this RI, some gross approximations of this movement can be made.

The sources of groundwater at the former Glen Cove MGP site are infiltrating precipitation (recharge) and flow from upgradient sources. As discussed in **Section 3.2.3**, ground elevation contours indicate a consistent flow direction to the west for both the shallow and intermediate zone wells. The hydraulic gradient in the shallow groundwater is relatively steep ranging from 0.06 to 0.02 feet/foot with an average site gradient of 0.04 feet/foot. The hydraulic gradient in the intermediate groundwater is relatively uniform and was calculated at 0.01 feet/foot. Using the site hydraulic conductivity of 0.22 feet/day and estimated effective porosity of 20%, the shallow and intermediate groundwater seepage velocities are estimated at 0.044 to 0.011 ft/day, respectively. As groundwater water flows beneath the former Glen Cove MGP site, dissolution of chemical constituents from source materials such as DNAPL/Tar saturation, blebs and staining; and/or the de-sorption of constituents from soils results in the formation of a dissolved phase plume in groundwater. Dissolved phase plumes transport constituents in the same direction as groundwater flow. As the dissolved phase plume migrates away from the source, the constituent concentrations spread horizontally and vertically through advection, dispersion and diffusion processes and adsorb to organic carbon in the aquifer matrix. An additional factor affecting the dissolved phase plume is that no new material has been added to the existing subsurface DNAPL since the MGP operations ended. As a result, the amount of chemical dissolution has and will continue decrease with time as the soluble constituents become depleted in the existing DNAPL source material. This ageing of the source material can not be quantified, but the soluble constituents are finite and the rate of their dissolution into the dissolved phase will continue to decrease with time as the source material continues to age.

As shown on **Drawings 4F** through **4H**, BTEX and PAH groundwater concentrations are highest beneath the former MGP operation area where MGP-related DNAPL impacts such as DNAPL/Tar saturation, blebs, and staining exist. BTEX and PAH groundwater concentrations decrease from levels in the 1,000's (ug/l) beneath the former MGP operations area to negligible and non-detectable concentrations in groundwater immediately downgradient of the former MGP operations area. **Drawings 4F** through **4H** also depict the estimated extent of the MGP-related dissolved-phase total BTEX and PAH groundwater plume at 10 ppb for the three groundwater depth intervals (WT-20 feet bwt, 20-30 feet bwt, and greater than 30 feet bwt). The estimated extent of the dissolved phase plumes further illustrate the relationship between the detected groundwater impacts and the presence of MGP-related residual DNAPL impacts in soil. As shown on **Drawing 4F** (WT-20 feet bgs depth interval), the estimated extent of the plume for total BTEX and PAH concentrations occupies the area beneath the former MGP and extends just beyond the site limits to the north. As shown on **Drawing 4G,** dissolved phase concentrations in groundwater, at the 20-30 feet bwt depth, interval show a significant decrease in the plume size and is contained mainly in the northwestern one-third of the site beneath and downgradient of the former MGP. As shown on **Drawing 4H,** the greater than 30 feet bwt depth interval, the plume is beneath the northwestern and western portions of the site, immediately adjacent to and downgradient of the former MGP operations area and extends just beyond the site limits to the north.

The shape and size of the dissolved phase plumes are also controlled by attenuation and degradation processes such as bioremediation. The following sections provide the affects of attenuation and bioremediation on dissolved phase constituents.

5.5.3.1 Attenuation (Retardation) of Dissolved Phase Constituents

As described above, the migration rate of organic constituents in groundwater is controlled, in part, by its affinity to adsorb to organic carbon in the aquifer matrix and to its relative adsorption and desorption rates. The distribution of organic constituents between the aquifer matrix and a coexisting aqueous phase is represented by the organic carbon sorption coefficient, or K_{oc}, for that constituent. The K_{oc} is defined as the ratio of adsorbed chemical per unit weight of organic carbon in the aquifer matrix to the dissolved aqueous concentration of the constituent. Therefore, using the total organic carbon content of the aquifer matrix, the dissolved concentration of a constituent in groundwater, and the constituent-specific K_{oc}, the amount of chemical constituent sorbed to the aquifer can be calculated.

The sorption of organic constituents is reversible and eventually the organic constituents desorb back into the groundwater as dissolved phase concentrations in groundwater decrease. Due to the sorption and desorption processes, the migration rates of organic constituents are retarded relative to the groundwater flow. The degree to which the migration rate of a particular organic constituent is retarded depends on the groundwater flow rate, the extent to which the constituent adsorbs to organic carbon in the aquifer matrix, and the relative sorption/de-sorption rates of the constituent to the organic carbon. The degree of retardation of a particular constituent can be determined by calculating the constituent's retardation factor (R_f) using the equation below.

$$R_f = 1 + (\rho s/ne)K_d$$

Where:

K_d = constituent distribution coefficient and equals the K_{oc} multiplied by the fraction of organic carbon (f_{oc}) in the aquifer matrix; f_{oc} equals TOC (in units of mg/kg) multiplied by 10^{-6};

ρs = bulk density of the aquifer matrix; and

ne = effective porosity of the aquifer material

The retardation factor represents the number of times constituents migrate more slowly as compared to the rate of groundwater flow.

The retardation factor for benzene and benzo(a)pyrene was calculated to demonstrate the ability of organic carbon to attenuate and reduce the migration rates of BTEX and PAHs in the downgradient groundwater plume. Benzene was selected as it is the most soluble of the BTEX and PAH constituents, and therefore is the least likely to be affected by adsorption to organic carbon. The PAH, benzo(a)pyrene was selected to illustrate compounds most affected by adsorption to organic carbon. The retardation factors for benzene and benzo(a)pyrene in the Upper Glacial aquifer at the site were calculated using the equation presented above and literature values for the following variables; K_{oc} value for benzene and benzo(a)pyrene from **Table 5-1,** fraction of organic carbon (foc) of 1% (or 0.01), bulk density (ρs) of 1.8 ml/g and effective porosity of 20% (or 0.20).

Using the equation above for benzene and benzo(a)pyrene, the retardation factor for benzene and benzo(a)pyrene is estimated to be 8.5 and 36,000, respectively. As estimated in **Section 3.0,** the groundwater flow velocity for the shallow and intermediate zones is 0.044 feet/day (or 14.6 feet/year) and 0.011 feet/day (or 3.65 feet/year), respectively. Based on retardation factors (R_f), the constituent migration rate in the shallow zone for benzene and benzo(a)pyrene is estimated at 0.00518 feet/day (1.72 feet/year) and 0.000001222 feet/day (0.0001 feet/year), respectively. The constituent migration rate in the intermediate zone is essentially a quarter (multiply by 0.25) of the rate estimated for the shallow zone.

Assuming that groundwater was impacted in the first year of operation (1905) by MGP residuals and dissolution continued to the present day, the benzene and benzo(a)pyrene in the shallow groundwater zone would have traveled approximately 172 and 0.01 feet, respectively, in the 101 year time frame. Benzene and benzo(a)pyrene represent the most and least mobile constituents of concern detected at the site. Therefore, the estimated migration distance traveled by the remaining constituents of concern are somewhere between 172 and 0.01 feet.

The estimated relatively short travel distances of dissolved phase constituents of concern, due to retardation (172 feet for benzene and 0.01 feet for benzo(a)pyrene) provides an explanation for the limited horizontal and vertical extent of dissolved phase plumes delineated at the former Glen Cove MGP site. The horizontal and vertical boundary of the dissolved phase plumes are delineated at just beyond and below the former MGP operation areas where MGP-related DNAPL impacts provide the source of MGP-related dissolved phase constituents of concern.

5.5.3.2 Degradation of Dissolved Phase Constituents in Groundwater

Biodegradation of BTEX and low molecular weight PAHs in groundwater has been documented in numerous case studies (Salanitro, 1993; Benson, et al., 1995; McAllister and Chiang, 1994; Borden, et al., 1995; Novak, et al., 1993; Buschbeck, et al., 1993; Weidemier, et al., 1994a; Weidemier, et al., 1994b; Hadley and Armstrong, 1991; Davis, et al., 1994; Weidemier, et al., 1995; Testa and Colligan, 1995; Cheng, et al., 1994; Sims, et al., 1994; Gabert, 1994; and Brubaker, 1991). During aerobic biodegradation of the organic constituents, oxygen is consumed in a process that converts the chemical constituents into carbon dioxide and water.

Based on data presented on **Drawings 4F through 4H**, BTEX and/or low-molecular weight PAHs were either not detected or were present at trace levels in upgradient groundwater represented by piezometers PZ-05 and PZ-06, and monitoring well GCMW-12S. In contrast, total BTEX and PAH concentrations within the estimated extent of the plume were detected in the 1,000’s (ug/l) range. Total dissolved phase concentrations of BTEX and PAHs in groundwater decrease from levels in the 1,000’s (ug/l) beneath the former MGP operations area to negligible and non-detectable concentrations in groundwater immediately downgradient of the former MGP operations area and just beyond the site limits to the north (**Drawings 4F through 4H**). It is assumed that this rate of decrease is not solely the result of advection, dispersion, diffusion and/or attenuation (retardation). Other naturally occurring processes, such as biodegradation, are likely reducing the dissolved phase constituent concentrations.

A field parameter indicator of biological activity is dissolved oxygen that is subsequently measured during groundwater sampling events. A review of the dissolved oxygen measurements indicates, in general, higher dissolved oxygen concentrations at well sampling locations outside the dissolved phase plume when compared to dissolved oxygen levels within the total BTEX and PAH plume. Therefore, it is a reasonable assumption that dissolved oxygen migrating onto the site from infiltration precipitation and upgradient areas is being consumed by aerobic biodegradation. An inverse correlation between dissolved oxygen and hydrocarbon concentrations has been identified as a key indicator of aerobic biodegradation (P.M. McAllister, C.Y. Chang, 1994). It is concluded that this significant reduction of dissolved oxygen is the result of active biodegradation of BTEX and PAHs in the subsurface at the site.

Active bioremediation of BTEX and low molecular weight PAH constituents, results in the reduction of dissolved phase concentrations and provides a further explanation for the limited horizontal and vertical extent of dissolved phase plumes delineated at the former Glen Cove MGP site. The downgradient and vertical boundaries of the dissolved phase plume are delineated at just beyond and below the former MGP operations area where MGP-related DNAPL impacts provide the source of dissolved phase constituents of concern.

5.5.3.3 Process Controlling the Vertical Distribution of the BTEX/PAH Plume

As discussed in **Section 4.2.3.1 and 4.2.3.2**, the highest BTEX and PAH concentrations were detected in groundwater within and immediately downgradient of the former MGP operations area and vertically, in the WT-20 feet bwt and 20-30 feet bwt depth intervals. These elevated total BTEX and PAH concentrations coincide with the MGP-related DNAPL/Tar saturation, blebs and tar staining observed in the subsurface.

The vertical distribution of dissolved BTEX/PAH in groundwater presented on **Drawings 4F** through **4H** indicates that the dissolved phase plume is primarily constrained to the top 30 feet of the Upper Glacial Aquifer. The detection of BTEX and/or PAHs in the groundwater zone (greater than 30 feet in depth) is generally limited to locations downgradient of the former MGP operations area and just beyond the site limits to the north and decrease significantly in size. Based on these occurrences, it appears that the dissolved phase concentrations of BTEX and PAHs are at least partially controlled by the limited vertical extent of MGP-related DNAPL impacts.

In addition, groundwater level measurements presented in **Section 3.2.3** indicate a vertical upward hydraulic gradient along the site's western boundary that would prevent vertical migration of dissolved phase BTEX and PAH constituents.

5.5.4 Migration of Constituent Vapors

Generally, volatilization from soil and/or water into air may be an important transport mechanism for the organic constituents with Henry's Law Constants greater than 10^{-5} atm-m^3/mole and molecular weights less than 200 g/mole. All of the volatile organic and some of the PAHs found at the site meet these criteria, and thus, MGP-related DNAPL impacts detected in surface and vadose zone soils could be a source of constituent vapors. Also, DNAPL and elevated dissolved phase BTEX and low molecular weight PAHs detected in saturated soils and groundwater will volatilize and can be a source of soil vapors in the vadose zone.

In surface (0-1 foot bgs) and vadose (1-8 feet bgs) zone soils, negligible total BTEX concentrations were detected at nine locations and low to moderate PAH concentrations at each of the 53 sampling locations. The total BTEX concentrations were negligible in surface and vadose zone soils ranging from 0.002 to 0.027 mg/kg. Total PAH concentrations in surface and vadose zone soils ranged from 2.167 to 621 mg/kg.

While some volatile emissions may intermittently discharge to the atmosphere within the site, volatilization does not appear to be either a major migration or exposure pathway for BTEX and low molecular weight PAHs. This is supported by the negligible concentrations of BTEX and PAHs detected in surface and vadose zone soil samples. BTEX and PAH constituent concentrations in the soil vapor are diluted as the soil vapor migrates through the soil column; the mass of BTEX and PAHs removed from soil via evaporation is minimal.

In surface (0-1 foot bgs) and vadose (1-8 feet bgs) zone soils, negligible total BTEX concentrations were detected at nine locations and low to moderate PAH concentrations at each of the 53 sampling locations. The total BTEX concentrations were negligible in surface and vadose zone soils ranging from 0.002 to 0.027 mg/kg. Total PAH concentrations in surface and vadose zone soils ranged from 2.167 to 621 mg/kg.

To further evaluate potential soil vapor migration, as part of the QHHEA, soil vapor samples were collected on properties adjacent to the site to evaluate the potential migration of chemicals of potential concern (COPC) impacting adjacent structures. Although COPCs were detected in soil vapor on these properties above the Upper Fence Values of the New York State Department of Health (NYSDOH) Background Outdoor Air Concentrations, the concentrations were either too low to present a risk if associated with a structure or their presence in the soil vapor were related to activities conducted on these properties versus soil vapor migrating from the site. Therefore, no further investigation regarding off-site soil vapor is warranted.

6.0 SITE CONCEPTUAL MODEL

The purpose of the site conceptual model is to describe the observed site conditions in the context of what has happened, what will happen and what the resulting impacts will be at the site. Specifically, the site conceptual model identifies and describes: (1) the history of former MGP operations at the site and vicinity, (2) the distribution of physical and chemical MGP and non-MGP-related constituent impacts detected in soil and groundwater, (3) the dominant fate and transport characteristics of the site, (4) potential exposure pathways, and (5) potential impacted receptors.

The results of the RI program has delineated the MGP-related impacts horizontally and vertically; and provided information supporting the site conceptual model. The following discussion is supplemented with a geologic/hydrogeologic cross sectional view (**Drawing 6A**).

6.1 Historical MGP-Related Releases and Site Conditions

Based on historical information, the former Glen Cove MGP operated from 1905 through approximately 1929 after which the site was used for natural gas storage. During MGP operations, surface and near-surface spillage/leakage was the primary mechanism for the observed MGP-related residuals being released to the environment. This hypothesis is substantiated by the RI's identification of MGP-related DNAPL and constituent impacts in soils and groundwater beneath and adjacent to the relatively small former MGP footprint that included an operations building and gas holder (**Drawing 6A**). The quantity of MGP-related residuals released is unknown, however, the quantities and time period of releases were sufficient to penetrate the site surface, vadose and saturated soils as evidenced by MGP-related DNAPL impacts detected in soil borings to as deep as 45 feet below site grade (i.e., GCSB33, GCSB40, GCSB42, GCSB46 and GCSB47) **[Drawing 6A]**.

During the former MGP operations, it appears the site's surface was different than present day. The former MGP site surface was likely lower in elevation based on the depth of the former gas holder pad which was encountered at approximately ten feet bgs, at soil boring GCSB-33, and currently site-wide there exists 10 feet of surface fill soil of unknown origin. The fill appears to have been added to the site after cessation of MGP operations and therefore there is a lack of visually apparent MGP-related residuals present in the fill. The presence of MGP-related DNAPL/Tar impacts are first encountered approximately eight feet below the current ground surface at or near the base of the fill soil and at the water table.

Once the former MGP was decommissioned and after placement of the existing surface fill, the site was redeveloped in the mid-1960s for its current use as a substation. The significance of the fill layer and lack of MGP-related impacts is that it separates surface activities from the deeper soil impacts. This separation prevents direct contact of any surface activities with MGP-related residual DNAPL/Tar impacts present at the base of the fill and in the underlying glacial deposits.

Other changes to the former MGP site surface include the realigning of Glen Cove Creek located adjacent to the western site boundary. Glen Cove Creek has been realigned into a concrete walled channel in conjunction with the construction of Route 107. Historic topographic maps depict the natural course of Glen Cove Creek flowing northward across the western portion of the site. Further evidence of the natural creek alignment is the presence of alluvial deposits consisting of reworked glacial outwash deposits. The alluvial deposits are similar to the outwash but lack the interbedding of gravelly sands with silty sand layers observed in the outwash deposits. The alluvial deposits extend five to ten feet below the base of the fill layer. At the same depth interval, further to the east beneath the site, the interbedded sands and silty sand layers typical of the outwash are present (**Drawing 6A**). As discussed earlier, the significance of these outwash deposits is the interbedding of gravelly and silty sand resulting in an anisotropic condition of 1:100 vertical to horizontal permeability in the formation. This condition significantly inhibits the potential for vertical fluid movement (**Drawing 6A**).

6.2 Soil Impacts

The majority of MGP-related DNAPL/Tar residual impacts were observed beneath the surface fill soil at or below the water table in the glacial outwash. MGP-related DNAPL visual impacts observed in the surface and vadose zone (fill) soils are limited to the presence of solid tar at one sample location and tar staining at four other sample locations. The limited presence of DNAPL visual impacts in the surface fill and vadose zone soils is consistent with the soil analytical results from these zones which indicated BTEX constituents at non detectable and negligible concentrations (not exceeding NYSDEC TAGM RSCOs), and supports the contention that these surface soils have a negligible potential for impacts via volatilization and leaching.

In the surface and vadose zone soils, PAH and metal compounds were detected at concentrations exceeding NYSDEC TAGM RSCOs. Based on the concentrations detected and result of the background soils study (**Appendix F**), the metal compounds in surface and vadose soils appear to be associated with surrounding background anthropogenic sources and/or the historic fill. Based on the concentrations detected and the result of the background surface soil study, PAHs detected on-site in surface and vadose soils suggests a potential contribution of PAH constituents from activities conducted on the former MGP site after or as part of placement of the historic fill soils. PAH and metal compounds have a high affinity for soils, reducing the potential for migration in the dissolved phase, and they have a low to moderate degradation potential that will result in their persistence. The potential physical processes responsible for PAH and metals transport in surface and vadose zone soils includes direct contact, particulate transport by wind and surface water and to a lesser extent leaching during recharge of precipitation. Relative to the residual DNAPL/Tar impacts observed below the fill soil and water table, the PAHs and metals detected in surface soils and the subsurface vadose zone represent significantly less potential for continued migration in the subsurface as dissolved phase constituents. The fate of the PAH compounds is slow degradation through natural processes such as biodegradation. The degradation potential for metal compounds is low and as stated in **Section 5.0**, metals will likely persist indefinitely in the site soils.

DNAPL/Tar releases from the former MGP operation area (mainly gas holder area) appear to have occurred at a surface/near-surface that pre-existed the existing site cover of approximately ten feet of historic soil fill. The majority of residuals from the historic MGP-related releases are observed near or below the base of the existing 10 feet of surface fill. Soil underlying the existing near surface fill consists of poorly-sorted sands and gravelly sands of relatively high permeability interbedded with lower permeability silty-sand layers and lenses. Due to the high-permeability gravelly sand underlying the site, vertical migration of DNAPL likely occurred readily to points where it accumulated or “pooled” above silty-sand layers. As expected, gravelly sand units appear to have provided preferential pathways for the migrating DNAPL.

The DNAPL penetrated the preexisting surface/near-surface soils, migrated through the vadose zone, intercepted the water table (currently at about eight feet bgs), and penetrated into the saturated soil column. Once DNAPL encountered the water table, its migration was influenced by the permeability of the aquifer soils and the rate and direction of groundwater flow. The combined effect of variable permeability of the interbedded aquifer soils and the influence of groundwater flow produced irregular-shaped and unevenly distributed thin lenses and/or stringers of DNAPL observed during the RI. The lenses and stringers of DNAPL extend vertically and laterally (downgradient) to the west, away from the former discharge area (**Drawing 6A**). Vertical and lateral migration of DNAPL continued until the mass of DNAPL required to overcome capillary forces and hydrophobic effects became depleted as a result of removal of the former MGP operations or when lower permeability layers (silty sand) were encountered. Both depletion of the DNAPL mass and the lower permeability silty-sand layers, prevented continued and extensive gravity-driven vertical and lateral migration beyond the former MGP area. MGP-related DNAPL impacts are present at and below the water table beneath and adjacent to the former MGP operations and just beyond the site limits to the north area as previously shown on **Drawings 4A through 4E**.

Based on the visual observations, DNAPL/Tar saturation impacts have accumulated within the poorly-sorted sand, gravelly sand above layers of silty sand. Accumulations of DNAPL/Tar saturation above silty sand layers were observed in several soil borings; GCSB33, GCSB40, GCSB42, GCSB46 and GCSB47 (**Drawing 6A**). The DNAPL/Tar accumulation above the silty sand layer resulted in horizontal migration along the upper surface of the silty sands with localized penetration through to deeper intervals observed as thin lenses, stringers and blebs of DNAPL**.**

MGP-related DNAPL impacts were observed at 21 soil boring locations predominantly as DNAPL/Tar saturation and blebs, and to a lesser frequency as staining and odors within the 8 to 30 foot bgs depth interval. The thickness of DNAPL/Tar saturated soils ranged from 0.10 to 4 feet with 50% of DNAPL/Tar saturated soils less than a foot thick. Thin lenses, stringers and blebs were often observed extending through the silty sandy soils below the DNAPL/Tar saturated soils at the same locations (**Drawing 4D**). Thin lenses or stringers (0.5 feet or less) of DNAPL/Tar saturation were encountered deeper (22 and 27.8 feet bgs) at soil boring GCSB-40. These observations are consistent with the previously discussed DNAPL migration mechanisms.

A total of eight soil boring locations within the greater than 30 foot bgs depth interval exhibited MGP-related DNAPL impacts (**Drawing 4E**). When detected in this depth interval, the DNAPL impacts were observed as blebs and staining with the exception of thin layers of DNAPL/Tar saturated soils observed at soil boring GCSB-37. The DNAPL/Tar saturated layer at GCSB37 was underlain at depth by the presence of blebs and staining **(Drawing 4E)**. The observed thin lenses and blebs represent localized penetrations of DNAPL from the overlying areas of DNAPL/Tar accumulations. The observed DNAPL impacts demonstrate that the historic DNAPL releases remain predominantly beneath the former MGP operations area (mainly the former gas holder manufacturing structures). DNAPL migration has been preferentially vertical with lateral components caused by accumulation above the less permeable silty sand lenses (**Drawing 6A**).

It should be noted that the source of the DNAPL/Tar residual was the former MGP operations area and gas holder and that cessation of the operations and previous removal of the MGP facilities eliminated subsequent MGP residual releases to the environment. Removal of the DNAPL/Tar sources has eliminated the likelihood for further DNAPL product migration in the subsurface soils. The existing finite mass of DNAPL product can no longer overcome capillary forces and hydrophobic effects, thus preventing continued gravity-driven migration.

The observed DNAPL impacts such as DNAPL/Tar saturation (DNAPL), blebs and staining in the saturated zone beneath the former MGP operations area are the principal source of the BTEX and PAH dissolved phase constituents detected in groundwater samples at the site. As groundwater flows beneath the former Glen Cove MGP site, dissolution of BTEX and PAH constituents from DNAPL source materials has resulted in the formation of the observed dissolved phase plume in groundwater beneath the site (**Drawings 4F** through **4H**). The dissolved phase plume transports constituents in the same direction as groundwater flow, in a westerly direction. As the dissolved phase plume migrates away from the residual DNAPL source, the constituent concentrations spread horizontally and vertically through advection, dispersion and diffusion processes, attenuate to organic carbon in the aquifer matrix, and biodegrade. Additionally, the rate of chemical dissolution will continue to decrease with time as the existing residual DNAPL in the subsurface continues to age and is depleted of soluble constituents.

As shown on **Drawings 4F** through **4H**, BTEX and PAH groundwater concentrations are highest beneath the former MGP operation area coinciding with the observed MGP-related DNAPL impacts. BTEX and PAH groundwater concentrations decrease from levels in the 1,000’s (ug/l) beneath the former MGP operations area to negligible and non-detectable concentrations in groundwater downgradient of the former MGP operations area. This significant decrease in dissolved phase concentration is controlled by attenuation (retardation) and degradation processes such as biodegradation.

The shallow and intermediate groundwater seepage velocities are estimated at 0.044 to 0.011 ft/day, respectively. However, based on attenuation processes collectively referred to as retardation (R_f), the constituent migration rate in the shallow zone for benzene and benzo(a)pyrene is estimated at 0.00518 feet/day (1.72 feet/year) and 0.000001222 feet/day (0.0001 feet/year), respectively. Benzene and benzo(a)pyrene represent the most and least mobile compounds of the constituents of concern detected at the site. Based on measured hydraulic conductivity values, the constituent migration rate in the intermediate zone is essentially a quarter (multiply by 0.25) of the rate estimated for the shallow zone.

Assuming that groundwater was impacted in the first year of operation (1905) by MGP-related DNAPL and dissolution continued to the present day, the benzene and benzo(a)pyrene would have traveled approximately 172 and 0.01 feet in the 101 year time frame in the shallow groundwater zone and a quarter of these distances in the intermediate zone. Since retardation factors for the other MGP-related VOCs (toluene, ethylbenzene and xylenes [total]) and PAHs are somewhere between benzene and benzo(a)pyrene, the migration distance traveled by these other MGP-related constituents are somewhere between 172 and 0.01 feet.

The estimated short travel distances of MGP-related dissolved phase constituents due to retardation (172 feet for benzene and 0.01 feet for benzo(a)pyrene) provides a partial explanation for the observed limited horizontal and vertical extent of the dissolved phase plume delineated at the former Glen Cove MGP site. The RI results delineate the horizontal and vertical boundaries of the dissolved phase plume to be below and just beyond the former MGP operations areas where MGP-related DNAPL impacts provide the source of MGP-related dissolved phase constituents.

A continued reduction in the rate of chemical dissolution and other naturally occurring processes, such as biodegradation, are likely contributing to the reduction of the downgradient dissolved phase constituent concentrations. A field parameter indicator of biological activity is dissolved oxygen that was measured during groundwater sampling events. A review of the dissolved oxygen measurements indicates aerobic conditions and the potential for active biodegradation of BTEX and PAHs in the subsurface at the site and just beyond the site limits to the north.

Based on groundwater flow data, the groundwater flowing through the site eventually enters Glen Cove Creek as a non-point discharge (**Drawings 3D and 3E**). Groundwater analytical data in wells adjacent to the creek indicate negligible to non-detectable dissolved phase concentrations. Also, surface water and seep water sampling were completed to determine if contaminated groundwater was discharging and impacting surface waters of Glen Cove Creek. The surface water and seep water analytical results indicate no impacts to Glen Cove Creek. This lack of MGP-related dissolved phase constituents in the creek water is indicative of the rapid attenuation/degradation of the on-site dissolved phase plume.

6.3 Potential Exposure Pathways and Impacted Receptor(s)

Potential exposure pathways are dependent on the constituent(s) physical and chemical properties, horizontal and vertical extent of the constituent(s) and constituent exposure to the natural climatic elements. There are two potential exposure pathways for soil and groundwater (total of four). The potential exposure pathways with regard to soil are direct contact with surface and subsurface soils, and inhalation of contaminated soil particulates. The constituents of concern are PAHs and metals that have a high affinity for soils and a low to moderate degradation potential that results in their persistence.

Direct contact with surface and subsurface soils is a potential exposure pathway for the public and substation workers. Also, fugitive dust emissions from wind or mechanical disturbances may occur from an exposed fill surface. The environmental factors that influence wind erosion are wind speed, moisture content, vegetative cover, and soil composition. Because the environmental factors at the Glen Cove site are at times and places conducive to wind erosion, each of the constituents of concern detected in surface soil is susceptible to migration via fugitive dust generation if exposed at the surface.

The direct contact and inhalation (via fugitive dust) potential exposure pathways are mitigated currently at the site through the use of engineering controls. The engineering controls include a gravel cover which is restricting direct contact with surface soils and preventing fugitive dust generation. Also, fencing and gating is maintained at the site to restrict public access. Sections 2.5 and 2.6 of the QHHEA **(Appendix F)** provide additional detail regarding potential receptor/routes of exposure and assessment scenarios for surface and subsurface soils.

The Upper Glacial Aquifer is contaminated from multiple sources (e.g., cesspools and septic effluents, fertilizers, spills, leaks from buried storage tanks and surface waste disposal). Its uses include irrigation, commercial and industrial, however, it is restricted for water supply. The potential exposure pathways for groundwater are direct contact and ingestion. Groundwater analytical results indicate elevated levels of BTEX, PAHs and naturally-occurring metals (iron, manganese and sodium) at several on-site monitoring wells. The metal, lead, showed slightly elevated levels in groundwater at well GCMW-8S. It is suspected that the lead is also naturally occurring. Five to ten feet of soils overlie the water table at the site, therefore, the direct contact and ingestion exposure pathways do not exist given current site conditions. Sections 2.5 and 2.6 of the QHHEA **(Appendix F)** provide additional detail regarding potential receptor/routes of exposure and assessment scenarios for surface and subsurface soils.

Glen Cove Creek was identified as a potential impacted receptor since groundwater flowing beneath the site discharges to the creek. Therefore, surface and seep water sampling were completed to determine if contaminated groundwater was discharging and impacting surface waters of Glen Cove Creek. The surface and seep water results indicate no impacts to Glen Cove Creek. A domestic and/or expanded public supply well search will be conducted upon guidance from the NYSDEC and the results used to assess those wells as potential impacted receptors.

6.4 Future MGP-Related Impacts – (What the Resulting Impacts Will Be at the Site)

The former MGP operations area and gas holder have been removed thus eliminating releases of MGP residuals to the environment. Elimination of MGP residual releases has removed the source of the DNAPL product and significantly reduced the potential for the existing DNAPL to continue to migrate in the subsurface soils. The finite mass of DNAPL product can no longer overcome capillary forces and hydrophobic effects preventing continued gravity-driven migration.

However, the DNAPL/Tar saturation, blebs and tar staining present in the soils as a result of past releases have persisted for decades (at least since 1929) and will most likely persist for decades to come due to the sorption capacity of the soils, mass of MGP-related DNAPL/Tar present, and low solubility and low degradation potential of MGP-related constituents. The DNAPL impacts will continue to volatilize and dissolve slowly at a decreasing rate into its individual constituents before degrading (eliminated) through natural processes such as bioremediation.

Volatilization appears to be a minor process based on negligible and non-detectable concentrations of constituents found in soil samples collected in the surface and vadose zone at the site. Given the site conditions and continued reduction in DNAPL constituent concentrations, volatilization will not be a future exposure concern and will maintain its negligible role in DNAPL constituent migration.

The dissolution process is evident based on the dissolved phase concentrations detected in groundwater collected from monitoring wells within and immediately downgradient of the DNAPL visual impacts (DNAPL/Tar saturation, blebs and tar staining). The results of multiple rounds of groundwater sampling and analysis indicate a stable dissolved phase plume in the vicinity of, and immediately downgradient of, the former MGP operations area and just beyond the site limits to the north. Dissolved phase constituents in groundwater detected in monitoring wells adjacent to Glen Cove Creek indicate a significant reduction to negligible and non-detectable concentrations. This occurrence is likely to continue as concentrations emanating from the source area decline over time, and; attenuation and bioremediation processes continue to limit constituent migration and treat dissolved phase concentrations.

The Glen Cove Creek has been recognized as the potential receptor and prompted the sampling of surface and seep waters as part of the RI program. The analytical results indicate non detectable concentrations of the MGP-related constituents and thus, it is concluded that the Glen Cove Creek is not being impacted by dissolved phase concentrations emanating from MGP-related DNAPL impacts residing in the former MGP operations area. This finding of no impact is likely to continue as concentrations emanating from the aging source area decline over time, and; attenuation and bioremediation processes continue to limit constituent migration and treat dissolved phase concentrations.

In summary, the presence of MGP-related DNAPL impacts will continue to be a diminishing source of dissolved phase concentrations in groundwater. The dissolved phase plume emanating from the DNAPL impacts will persist in the near future and eventually shrink in size and decline in constituent concentration over the long term as MGP-related constituents volatilize, dissolve and are attenuated naturally. The Glen Cove Creek is not impacted by the dissolved phase plume emanating from the DNAPL visual impacts residing in the former MGP operations area and this will likely be the case in the future as dissolved phase concentrations decline over time and attenuation and bioremediation processes continue to limit constituent migration and reduce dissolved phase concentrations.

7.0 CONCLUSIONS

Based on the findings of previous site investigations and the RI program performed to characterize the site conditions and identify impacts to soil and groundwater within and beyond the site, the following conclusions are reached:

- The results of the RI program provide an understanding of the site soil and groundwater conditions including delineation of the nature and extent of MGP-related impacts and identification of potential exposure pathways, sufficient to support evaluation of whether the potential exists for a significant threat to human health and the environment.

- The shallow stratigraphy beneath the site consists of heterogeneous fill soil at the surface overlying Upper Pleistocene glacial deposits. The fill soils extend from the surface to depths of 10 feet beneath the site proper, and to depths of 30 feet under the elevated area north of the site. The fill soils are underlain by glacial outwash deposits to the greatest depth investigated (82 feet). The fill soils consist of sand and gravel with varying percentages of gravel, silt, clay and coal fragments. The outwash deposit soils consist of highly permeable sands and gravelly sands interbedded with lower-permeability silty sands. The lower permeability silty sand layers have retarded the vertical migration of DNAPL at the site. Groundwater beneath the former Glen Cove MGP Site was generally encountered near the base of the fill soils at a depth of 8 feet below ground surface on the site proper and is part of the regional Upper Glacial Aquifer. Groundwater flows in an east to west direction across the site to Glen Cove Creek and eventually enters Glen Cove Creek as a non-point discharge.

- The areal extent of the visually apparent residual MGP-related impacts (solid tar ; DNAPL/Tar saturation; blebs, coating, sheen ; and staining) is limited to areas beneath or in the immediate vicinity of the former MGP operations in the northern and western portions of the site and just beyond the site limits to the north. The vertical distribution of MGP-related visual impacts begins at the water table, at a depth of eight feet as DNAPL/Tar saturation and blebs, and their occurrence reduces with depth. The interbedded lower-permeability silty sand layers appear to have contributed to the limited vertical extent of DNAPL migration beneath the former MGP.

- The fill soils which are predominately above the water table are generally free of visually apparent MGP residuals indicating that the fill was placed after removal of the MGP operation.

- PAHs and metals are the identified constituents of concern in surface and near surface site soils. Based on the background surface soil study, the relatively elevated PAHs detected on-site in surface/near surface soils suggests a potential contribution of PAH constituents from activities conducted on the former MGP site after or as part of placement of the surface fill soils. The source of the PAHs detected in soils at depths below the water table are associated with the MGP-related visual impacts, including

DNAPL saturated and stained soil, present at the same locations and depths. The background surface soil study indicated similar conditions between on-site and off-site surface soil regarding the detected metals (arsenic, barium, cadmium, chromium, lead and mercury). This indicates that concentrations noted on-site are consistent with local conditions surrounding the site and are not likely attributable to the activities on the former MGP site.

- Based on the NAPL and water level measurements performed on all site wells, DNAPL accumulated only in one monitoring well GCMW-13S, ranging in thickness from 0.34 to 0.74 feet. The limited presence of measurable DNAPL in monitoring wells leads to the conclusion that the DNAPL observed in the subsurface soils has a low potential for continued migration as a DNAPL plume beyond its present location.

- In groundwater, BTEX and to a lesser frequency PAHs were detected above the NYSDEC TOGS AWQS in the shallow and two intermediate zones beneath, and north and west of the former MGP operations area. BTEX and PAH groundwater concentrations are highest beneath the former MGP operation area and coincide with the observed MGP-related DNAPL impacts. The analytical data suggests that the only remaining source of the dissolved phase BTEX and PAH detections in groundwater is the residual DNAPL observed in soil at and below the water table.

- The dissolved phase BTEX and PAH plume is limited in extent to the areas/depths exhibiting residual DNAPL in the soil and is not migrating at significant concentrations beyond the site. This conclusion is evident as the presence of non-detectable to low BTEX and PAH concentrations were reported at the downgradient perimeter of the site and just beyond the site limits to the north.

- The limited extent of downgradient migration of the dissolved phase BTEX/PAH plume appears to be the result of early removal of the former MGP operations and due to naturally occurring retardation and attenuation processes degrading the residual observed soil impacts. The fate and transport mechanisms apparent at the former Glen Cove MGP Site include sorption, aqueous solubility (or dissolution), volatilization and biodegradation. These natural processes in combination with the historical removal of the former MGP operations explain the observed limited extent of residual DNAPL impacts, and a relatively compact groundwater plume. These processes in combination with the ageing of the DNAPL source material and depletion of the soluble constituents will continue to prevent the observed on-site impacts from migrating beyond the existing plume limits. The dissolved phase BTEX and PAH plume emanating from the DNAPL impacts in groundwater will persist in the near future and eventually decrease in size and decline in concentration over the long term as MGP-related constituents dissolve and degrade.

- In groundwater, the metals exceeding the NYSDEC TOGS AWQS were either naturally-occurring or from infiltrating precipitation through the historic fill. PCBs and pesticides have not been released in the site soils at significant levels and have not impacted the site groundwater. The detected metals in groundwater are not migrating at significant concentrations beyond the site.

- The analytical results of the seep water, surface water and sediment samples indicate the MGP-related impacts observed and detected on the former Glen Cove MGP site have not resulted in impacts to Glen Cove Creek. This is expected to remain the case as dissolved phase concentrations decline over time as attenuation and bioremediation processes continue to limit constituent migration and reduce dissolved phase concentrations.
- There are no significant or imminent threats to human health that warrant an interim remedial action. The on-site risks are associated with potential contact with PAHs detected in the site surface soils, which are presently prevented through Institutional and Engineering Controls. The controls currently in-place include site awareness, worker training and a gravel cover which is restricting direct contact with surface soils and preventing fugitive dust generation. Also, fencing and gating is maintained at the site to restrict public access.

- A number of chemicals of potential ecological concern (COPECs) in soil, sediment and surface water exceed some toxicological benchmark values; however, there is little area for ecological communities to come in contact with contaminated media within the site. Although the COPECs pose a potential risk of impacting local wildlife species this risk is minimal due to several reasons: the industrial/commercial area provides minimal habitat, constant physical disturbance prevents wildlife population from developing; only transient species and few individual animals would utilize the area; and the frequency and duration of exposure is limited. Therefore, the observed chemicals detected on-site do not pose a current risk nor is any risk expected in the future.

- Soil vapor samples were collected on properties adjacent to the site to evaluate the potential migration of chemicals of potential concern (COPC) impacting adjacent structures. Although COPCs were detected in soil vapor on these properties above the Upper Fence Values of the New York State Department of Health (NYSDOH) Background Outdoor Air Concentrations the concentrations were either too low to present a risk if associated with a structure. They were also too low to determine whether their presence in the soil vapor was related to activities conducted on these properties versus soil vapor migrating from the site. Therefore, no further investigation regarding off-site soil vapor is warranted.

8.0 RECOMMENDATIONS

Based on the RIR findings and conclusions, the following recommendations are made to address the identified environmental impacts:

- The existing Institutional and Engineering Controls should be evaluated and modified as appropriate to assure that the potential for exposure is minimized or eliminated through the continued maintenance of the following controls:

    1. The gravel cover or other existing cover to restrict direct contact with surface soils
    2. Fencing and gating to restrict public access
    3. Employee training to maintain awareness of the site soil and groundwater conditions.

- A Remedial Action Plan is recommended to evaluate and identify the remedial action(s) appropriate to address environmental issues identified at the site.

9.0 REFERENCES

Bouwer, Herman and R.C. Rice, A Slug Test for Determining Hydraulic Conductivity of Unconfined Aquifers With Completely and Partially Penetrating Wells, 1976, Water Resources Research, Vol. 12, No.3, pages 423-428.

Brubaker, G.R., In-Situ Bioremediation of PAH-Contaminated Aquifers, 1991, Proceedings of the Petroleum Hydrocarbons and Organic Chemicals in Groundwater: Prevention, Detection and Restoration, pp. 377-391.

Cheng, Jiayang, Duidan, M.T. and Veosa, A.D., Evaluation of Anaerobic Respirometry to Quantify Intrinsic Biodegradation Kinetics of Recalcitrant Organic Compounds, 1994, EPA Research Series: Bioremediation of Hazardous Wastes, Government Institutes, Inc., pp.119.

Cohen, Robert M. and James W. Mercer, DNAPL Site Evaluation, 1993, C. K. Smoley.

Driscoll, Fletcher G., Groundwater and Wells, 1986, Johnson Filtration Systems Inc.

Fetter, C. W., Contaminant Hydrogeology, 1993, Macmillan Publishing Company.

Franke, O.L., and Cohen, P., Regional Rates of Ground-Water Movement on Long Island, New York, United States Geologic Survey, Professional Paper 800-C, pages C271-277, 1972.

Franke, O. L. and N. E. McClymonds, Summary of the Hydrologic Situation on Long Island, New York, as a Guide to Water-Management Alternatives. Geological Survey Professional Paper 627-F. 1972.

Freeze, R. Allan and John A. Cherry, Groundwater, 1979, Prentice-Hall, Inc.

GEI Consultants, Inc., Phase I Site Investigation Report for the Glen Cove Former Manufactured Gas Plant Site, April 21, 1997.

GEI Consultants, Inc., Remedial Investigation Work Plan – Glen Cove Former Manufactured Gas Plant Site – Glen Cove, New York, October 29, 2003.

KeySpan Energy, Interim – Glen Cove Former MGP Site, February 16, 2004.

KeySpan Energy, Due Diligence Investigation – Glen Cove Former MGP Site, February 16, 2000.

Long Island Regional Planning Board, Long Island Comprehensive Waste Treatment Management Plan, Volume I and II, July 1978.

National Climatic Data Center of the National Oceanic and Atmospheric Administration.

New York State Department of Environmental Conservation, Division of Water Technical and Operational Guidance Series (1.1.1), Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitation, June 1998.

New York State Department of Environmental Conservation, Technical and Administrative Guidance Memorandum (TAGM) No. 4042, revised January 24, 1994.

New York State Department of Environmental Conservation, Technical and Operational Guidance Memorandum (TAGM) No. 4046.

NUS Corporation, Final Draft-Preliminary Assessment-Glen Cove Gas Plant, Glen Cove, New York, June 7, 1989.

Perlmutter, N.M., Geraghty, J.J., Geology and Groundwater Conditions in Southern Nassau and Southeastern Queens Counties Long Island, New York, 1963, U.S. Geological Survey Water - Supply Paper 1613-A.

Stumm, Fredrick, Hydrogeology and Extent of Saltwater Intrusion of the Great Neck Peninsula, Great Neck, Long Island, New York. USGS Water-Resources Investigations Report 99-4280. 2001.

United States Department of Agriculture Natural Resources Conservation Service, 1975, Soil Survey of Nassau County.

United States Department of Agriculture Natural Resources Conservation Service, 1987, Soil Survey of Nassau County.

APPENDIX A

DATABASE SEARCH REPORT/SANBORN MAPS

APPENDIX B

HYDRAULIC CONDUCTIVITY CALCULATIONS

APPENDIX C

ANALYTICAL RESULTS-DATA SUMMARY TABLES

APPENDIX D

BORING LOGS AND MONITORING WELL CONSTRUCTION LOGS

APPENDIX E

LOW FLOW SAMPLING FORMS

APPENDIX F

QUALITATIVE HUMAN HEALTH EXPOSURE ASSESSMENT AND FISH AND WILDLIFE RESOURCES IMPACT ANALYSIS WHICH INCLUDES THE BACKGROUND SURFACE SOIL SAMPLING REPORT