REMEDIAL INVESTIGATION

WORK ASSIGNMENT C007540-2

FORMER SPIC AND SPAN CLEANERS AND DYERS SITE
GREENPOINT/EAST WILLIAMSBURG INDUSTRIAL AREA

Prepared for:
NEW YORK STATE
DEPARTMENT OF ENVIRONMENTAL CONSERVATION
625 Broadway, Albany, New York

Joseph Martens, Commissioner

DIVISION OF ENVIRONMENTAL REMEDIATION
REMEDIAL BUREAU B

URS Corporation
77 Goodell Street
Buffalo, New York 14203

September 2012
PHASE II REMEDIAL INVESTIGATION

FOR THE

FORMER SPIC AND SPAN CLEANERS & DYERS, INC. SITE

SITE ID NO. 224129

BROOKLYN, KINGS COUNTY, NEW YORK

PREPARED FOR:

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

DIVISION OF ENVIRONMENTAL REMEDIATION

REMEDIAL BUREAU B

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77 GODELL STREET

BUFFALO, NEW YORK 14203

SEPTEMBER 2012
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<td>AARCO Environmental Services, Corporation</td>
</tr>
<tr>
<td>Air Toxics</td>
<td>Air Toxics, Ltd.</td>
</tr>
<tr>
<td>ADT</td>
<td>Aquifer Drilling and Testing, Inc.</td>
</tr>
<tr>
<td>aka</td>
<td>also known as</td>
</tr>
<tr>
<td>amsl</td>
<td>above mean sea level</td>
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<td>ASP</td>
<td>Analytical Services Protocol</td>
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<tr>
<td>bgs</td>
<td>below ground surface</td>
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<tr>
<td>BETX</td>
<td>benzene, ethylbenzene, toluene and xylene</td>
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<td>BP</td>
<td>British Petroleum</td>
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<td>BQE</td>
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<td>light non-aqueous phase liquid</td>
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<td>µg/kg</td>
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<td>Off-Site System</td>
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<td>Oxidation/Reduction Potential</td>
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<td>Standards, Criteria, and Guidance values</td>
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<td>SPDES</td>
<td>Spill Discharge Elimination System</td>
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# LIST OF ACRONYMS AND ABBREVIATIONS (Continued)

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
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<tr>
<td>Spic and Span</td>
<td>Former Spic and Span Cleaners &amp; Dyers, Inc.</td>
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<td>SVOC</td>
<td>semi-volatile organic compound</td>
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<td>TAGM</td>
<td>Technical and Administrative Guidance Memorandums</td>
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<td>TAL</td>
<td>Target Analyte List</td>
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<td>TCE</td>
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<td>USEPA</td>
<td>United States Environmental Protection Agency</td>
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<td>VC</td>
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1.0 INTRODUCTION

This Remedial Investigation (RI) Report has been prepared to summarize the field activities and analytical results from the RI Phase II field investigation at the Former Spic and Span Cleaners & Dyers, Inc. (Spic and Span) Site [New York State Department of Environmental Conservation (NYSDEC) Site Number 224129] in the Greenpoint/East Williamsburg Industrial Area section of Brooklyn, New York. The work for this site was issued to URS Corporation – New York (URS) as Work Assignment No. C007540-2. This report presents data and information gathered prior to and during the RI Phase I field investigation, which was conducted from January 24 through March 25, 2011; data collected during the Meeker Avenue Plume Trackdown Site Characterization (SC) Phase VI field investigation; and data from the RI Phase II field investigation, which was conducted from November 7, 2011 through February 15, 2012.

1.1 Site Background

The Spic and Span site is located in the Greenpoint/East Williamsburg Industrial Area section of the Borough of Brooklyn, New York (Figure 1-1). The Spic and Span site is located within the Meeker Avenue Plume Trackdown Site (NYSDEC Site Number 224121) investigation area. During the five phases of investigation at the Meeker Avenue Plume Trackdown Site conducted between May 2007 and July 2009, a source of groundwater contamination was identified at the buildings housing the Former Spic and Span Cleaners and Dyers, Inc. [a.k.a. Eastern District Dye Works (1916 Sanborn) and Norman Cleaners and Dyers Inc. (1942 Sanborn)], located at 260 Norman Avenue/315-325 Kingsland Avenue (Tax District of Brooklyn, Block 02657, Lot 0009) and 307-313 Kingsland Avenue (Tax District of Brooklyn, Block 02657, Lot 0015). In January 2009, the above mentioned source of groundwater contamination was listed as NYSDEC Class 2 Inactive Hazardous Waste Disposal Site (Site Number 224129). Geographical site and background information is provided in the following sections.

1.1.1 Site Location and Description

The area is a mixture of residential and manufacturing, including both commercial and industrial facilities. The Spic and Span property is currently being used by an import business. The entire site property and the majority of the project area are covered by one-story and multi-story
buildings and/or pavement/concrete. Residential areas are generally south of the site, although residents live on the Spic and Span property. The Spic and Span site is located in a region of historic petroleum refining and storage operations that occupied a significant portion of the Greenpoint area (Figure 1-2). By 1870 over 50 refineries were located along the banks of Newtown Creek located northeast of the site. Currently, bulk oil storage terminals exist north of the site, including the British Petroleum (BP) Terminal and the ExxonMobil Brooklyn Terminal (ExxonMobil). The former Paragon Oil facility was located east of the site along Newtown Creek, north of Bridgewater Street, between Meeker Avenue and Apollo Street. Peerless Importers, Inc. is currently located on a portion of the former Paragon Oil facility along Newtown Creek.

In September 1978, the United States Coast Guard (USCG) noted the signs of an oil spill entering Newtown Creek from the northeastern end of Meeker Avenue. A subsequent investigation concluded that the area of the spill under the Greenpoint/East Williamsburg Industrial Area was in excess of 52 acres and the total spill volume, as estimated in 1979, was approximately 17 million gallons of petroleum products as documented by Roux Associates, Inc. (Roux) (Roux, October 14, 2005). The current BP property was determined to be the source of a petroleum-free product plume east of the Spic and Span site. Investigation and remediation activities were conducted by Roux on behalf of ExxonMobil from 1990 to the present, further defining the extent of the Off-Site Plume. The Off-Site Plume area consists of the area underlain by the petroleum-free product plume that is not on the BP Terminal or the Peerless Importers, Inc. properties. Currently, the extent of the Off-Site Plume area is less than what it was in 1990 due to the operation of the Off-Site Free Product Recovery System (Off-Site System). The Off-Site System has recovered over 6,000,000 gallons of free product since it became operational in 1995 (Roux, August 12, 2011).

1.1.2 Summary of Records Search

Based on the results of several investigations conducted in the area (see Section 1.2 for more details), chlorinated solvents such as tetrachloroethene (PCE) and trichloroethene (TCE) were found in soil vapor, soil, and groundwater in areas outside the historic petroleum spill. As these chemicals are not related to petroleum, the NYSDEC initiated the Meeker Avenue Plume Trackdown Site investigation in order to determine the source(s) of this contamination. Information was gathered relevant to the Spic and Span site and other nearby potential contamination sources as part of these previous investigations.
1.2 Findings of Previous Investigations and Phases of Site Investigation Fieldwork

1.2.1 Previous Investigations by Roux

Roux Associates – September 2005

In September 2005, Roux Associates, on behalf of ExxonMobil, sampled soil vapor at 23 temporary locations in and around the perimeter of the Off-Site Plume area (Roux, October 14, 2005). The soil vapor samples collected in September 2005 indicated the presence of PCE at 7,050 micrograms per cubic meter ($\mu$g/m$^3$) at the monitoring point on the western side of Morgan Avenue between Nassau and Norman Avenues. Much lower concentrations of PCE were detected throughout the remainder of and around the perimeter of the plume area. In addition, TCE was detected at 4,500 $\mu$g/m$^3$ at the monitoring point located on the western side of Apollo Street between Nassau Avenue and Meeker Avenue, and at 151,000 $\mu$g/m$^3$ at the monitoring point on the western side of Morgan Avenue between Nassau and Norman Avenues. Much lower concentrations of TCE were detected throughout the remainder of and around the perimeter of the Off-Site Plume area. It was determined that the chlorinated solvents detected (i.e., PCE and TCE) were from a different source than the petroleum-free product plume.

Roux Associates – September 2006

Between June and September 2006, Roux Associates performed an additional soil vapor investigation in and around the perimeter of the Off-Site Plume area (Roux, November 10, 2006). A total of 50 permanent soil vapor monitoring points were installed. This included 20 nested monitoring points (one shallow and one deep) in the commercial/industrial area and 10 deep monitoring points in the residential area. Elevated concentrations of PCE were detected at 1,300 $\mu$g/m$^3$ at the monitoring point located at the northwestern corner of the intersection of Morgan and Nassau Avenues. Elevated concentrations of TCE were detected at 8,200 $\mu$g/m$^3$ at the monitoring point on the eastern side of Apollo Street between Bridgewater Street and Nassau Avenue, and at 700 $\mu$g/m$^3$ at the monitoring point on the northwestern corner of the intersection of Morgan and Nassau Avenues.
1.2.2  Previous Investigations by URS

To date, URS has conducted six phases of SC fieldwork at the Meeker Avenue Plume Trackdown Site. Only data gathered during the Phase I, II, III, V, and VI field activities are relevant to the Spic and Span site. The relevant information pertaining to the Spic and Span area from each phase of SC field activities is summarized in the sections below. Sample locations and PCE/TCE results from these investigations relevant to the Spic and Span site are shown on Figure 1-3 for soil-gas, Figure 1-4 for groundwater, and Figure 1-5 for soil.

1.2.2.1  Summary of SC Phase I Findings

The SC Phase I field investigation was conducted from May 7 through July 10, 2007. The field activities of Phase I were primarily focused on locations that were identified as potential historic users of PCE and/or TCE during the historical information review. A complete description of the field investigation and results may be found in the Phase I Data Summary Report (URS, October 2007).

Based upon the results of the Phase I field investigation, the following conclusions were made:

- Soil gas samples indicated that PCE and TCE have impacted soil gas quality. Elevated soil gas concentrations appear to be identified near locations that potentially have used PCE and TCE.
- Groundwater samples indicated that groundwater has been impacted above NYSDEC TOGS 1.1.1 Class GA groundwater standards for both PCE and TCE. Elevated groundwater concentrations appear to be identified near locations that potentially have used PCE and TCE.

1.2.2.2  Summary of SC Phase II Findings

The SC Phase II field investigation was conducted from November 5 through December 27, 2007. The field activities of Phase II were primarily focused on investigating and delineating the extent of impacted soil gas, soil and/or groundwater at locations where elevated concentrations of PCE and/or TCE were encountered during the Phase I field investigation. A complete description of the field investigation and results may be found in the Phase II Data Summary Report (URS, April 2008).
Based upon the results of the Phase II field investigation, the following conclusions were made:

- There appear to be distinct areas of elevated soil gas concentrations.
- There appear to be potential source areas where dissolved phase chlorinated solvents have adversely impacted shallow groundwater.

1.2.2.3 Summary of SC Phase III Findings

The Phase III field investigation was conducted from May 5 through July 24, 2008. The purpose of the Phase III fieldwork was to fill any data gaps identified during Phase II concerning the horizontal extent of impacted soil gas at three of the areas identified; determine if impacted soils existed at one potential source area; determine the horizontal extent of impacted shallow groundwater at the potential sources; and to assess the vertical extent of impacted groundwater at each of the potential sources. Activities included submitting Freedom of Information Law (FOIL) requests to the New York City (NYC) Fire Department (FDNY), NYC Department of Buildings (DOB) and the NYC Department of Environmental Protection (DEP) for records on potential sources. A complete description of the field investigation and results may be found in the Phase III Data Summary Report (URS, October 2008).

Based upon the results of the three phases of the field investigation, the following conclusions were made:

- The areas of elevated soil gas concentrations identified during Phase II field investigation were further delineated during Phase III.
- A dense non-aqueous phase liquid (DNAPL) containing 700,000 milligrams per kilogram (mg/kg) (i.e., 70%) PCE was identified in monitoring well DEC-024D.
- The results of groundwater samples collected during Phase III allowed URS and the NYSDEC to identify four sources of dissolved phase chlorinated solvents in the shallow groundwater. In addition, there are potentially two other sources, but insufficient information was gathered to positively identify these locations as sources without additional investigation. The horizontal extent of impacted shallow groundwater was not fully determined at the two potential source areas. The potential impact of dissolved phase chlorinated solvents to deeper groundwater was investigated at all four source areas and two potential source areas. Data
indicates that deeper groundwater was impacted at all four source areas and both potential source areas. The vertical extent of impacted groundwater was not fully determined at the four source areas and the two potential source areas.

1.2.2.3.1 **SC Phase III Source Characterization**

Using data obtained during the three Phases of the investigation [i.e., historical information (e.g., Sanborn maps, EDR reports, and business directories) soil-gas data, soil data, and groundwater data], four sources and two potential sources of PCE and/or TCE contamination were identified within the study area. The description and location of the one source identified within the Spic and Span area is described below.

**Sources**

- The former Spic and Span Cleaners and Dyers, Inc. [aka Eastern District Dye Works (1916 Sanborn) and Norman Cleaners and Dyers Inc. (1942 Sanborn)], located at 315 Kingsland Avenue (Brooklyn Tax District, Block 02657, Lot 0009) was identified as a source of groundwater contamination. Based on Sanborn map data, this facility was located at the above address from the early 1900s until the mid-1960s. DNAPL containing 70% PCE was identified in monitoring well DEC-024D. DEC-024D is located on Kingsland Avenue adjacent to the southeastern corner of the former facility.

**Potential Sources**

- No additional potential sources were identified within the Spic and Span area.

1.2.2.4 **Summary of SC Phase IV Investigation Findings**

The Phase IV field investigation was conducted from November 3 through December 8, 2008. The investigation area for Phase IV was limited to the area south of Meeker Avenue, in the area located east of, but not including DEC-016/016D and DEC-040 (i.e., between Porter and Varick Avenues) to the eastern boundary of the site investigation area (i.e., Newtown Creek). In addition, the NYSDEC directed URS to obtain and review additional Sanborn maps for the area bound by Meserole Avenue to the north, Sutton Avenue to the east, Nassau Avenue to the south and Humboldt Street to the west. The purpose of the review of the additional Sanborn maps was to confirm the report of a dry
cleaner north of Norman Avenue and west of Kingsland Avenue. A complete description of the field investigation and results may be found in the Phase IV Data Summary Report (URS, May 2009).

No field activates were performed in the Spic and Span area. However, a review of additional Sanborn maps and a review of certificates of occupancy indicated the presence of seven potential sources of PCE and TCE.

1.2.2.4.1 SC Phase IV Source Characterization

Sources

No additional sources were identified within the Spic and Span area.

Potential Sources

A total of seven new additional potential source areas were identified within the Spic and Span area. A brief description of each potential source is given below.

- The facility that was and is currently occupied by a laundry, a dyer, and dry cleaners, located at 355 Kingsland Avenue (Brooklyn Tax District, Block 02608, Lot 0078), 337-353 Kingsland Avenue (Brooklyn Tax District, Block 02608, Lot 0079), 262-268 Monitor Street (Brooklyn Tax District, Block 02608, Lot 0082), and 252 Monitor Street (Brooklyn Tax District, Block 02608, Lot 0099) may be a potential source of PCE and/or TCE. The facility was utilized as a laundry, dyers and dry cleaners from approximately 1965 to present based on Sanborn Map data.

- The facility that was occupied by a laundry located at 242 Monitor Street/253A-257 Norman Avenue (Brooklyn Tax District, Block 02608, Lot 0095) may be a potential source of PCE and/or TCE. The facility was utilized as a laundry from approximately 1933 to 1951 based on Sanborn Map data and a review of certificates of occupancy.

- The facility that was occupied by the former Rose & Co. Dye Works, located at 355 Kingsland Avenue (Brooklyn Tax District, Block 02608, Lot 0078), 347-353 Kingsland Avenue (Brooklyn Tax District, Block 02608, Lot 0079), 341 Kingsland Avenue (Brooklyn Tax District, Block 02608, Lot 0084), and 337-339 Kingsland Avenue (Brooklyn Tax District, Block 02608, Lot 0085) may be a potential source of PCE and/or TCE. The facility
was utilized as a laundry and dry cleaners from approximately 1944 to 1986 based on Sanborn Map data and a review of certificates of occupancy. The Sanborn maps identified six underground tanks, listed for use as benzene tanks from 1942-1965 and then as solvent tanks from 1965-present, on Block 02608 Lots 0084 and 0085.

- The facility that is occupied by a current metal works, located at 96-102 Anthony Street/157-163 Lombardy Street (Brooklyn Tax District, Block 02820, Lot 0028) may be a potential source or a contributing source to the presence of PCE and/or TCE in the environment. The facility started metal working in 1977 based on a review of certificates of occupancy.

- The facility that is occupied by a current metal works, located at 104-110 Anthony Street/169 Lombardy Street/503-519 Varick Avenue (Brooklyn Tax District, Block 02820, Lot 0021) may be a potential source or a contributing source to the presence of PCE and/or TCE in the environment. The facility adjoins 157 Lombardy Street to the east.

- The facility that was occupied by a former soap manufacturer and lacquer storage, located at 171-179 Lombardy Street/496-508 Varick Avenue (Brooklyn Tax District, Block 02821, Lot 0001) appears to be a potential source of groundwater contamination. Based on Sanborn Map data, the facility was utilized during the 1930s for lacquer storage, and as a manufacturer of powdered soap from the early 1950s to 1989. Monitoring wells DEC-018 and DEC-018D are located on the Varick Avenue or west side of the building, near Lombardy Street. Groundwater samples from these wells indicate significant PCE and TCE contamination in shallow groundwater.

- The facility that was occupied by a former metal works, located at 122-132 Anthony Street/181-193 Lombardy Street (Brooklyn Tax District, Block 02821, Lot 0011) may be a potential source or a contributing source to the presence of PCE and/or TCE in the environment. The facility started metal working in 1953 based on a review of certificates of occupancy.

### 1.2.2.5 Summary of SC Phase V Investigation Findings

The Phase V field investigation was conducted from June 15 through July 13, 2009. The purpose of the Phase V fieldwork was to assist in determining: the horizontal extent of the dissolved phase plume originating from near the Spic and Span site and DEC-024/024D; if there are additional...
potential sources of PCE and TCE impacting shallow groundwater north of the Spic and Span site; the horizontal extent of impacted deep groundwater; and the depth and areal extent of any DNAPL and the clayey silt unit. Using data obtained during Phases I, II, III, and V, the following conclusions were provided in the Phase V Report.

- In the area north of Meeker Avenue, soil has been impacted by chlorinated solvents and petroleum related compounds. DNAPL containing 73% PCE was identified in the adjacent well DEC-024D at a depth similar to the depth of the soil sample from DEC-024DR. Because the soil sample was collected below the water table in a zone with decreasing permeability, the impacted soil in the vicinity of DEC-024DR may be the result of lateral spreading of DNAPL. The horizontal extent of PCE impacted soil was not determined since PCE was found in only one location at significant concentrations. LNAPL was found in DEC-034 and DEC-054. Petroleum related compounds had impacted soil at DEC-034, DEC-053, and DEC-054.

- Groundwater north of Meeker Avenue has been impacted by dissolved phase chlorinated solvents. The area in the immediate vicinity of DEC-024/-024D/-024DR was identified as a source of PCE and TCE in shallow groundwater based on the presence of DNAPL in DEC-024DR.

1.2.2.5.1 SC Phase V Source Characterization

Sources

- No additional sources were identified within the Spic and Span area.

Potential Sources

- No additional sources were identified within the Spic and Span area.

1.2.2.6 Summary of SC Phase VI Investigation Findings

The Phase VI field investigation was conducted from August 2, 2011 through October 28, 2011 and November 15, 2011 through January 13, 2012 as part of the overall SC at Meeker Avenue Plume Trackdown Site. The purpose of the Phase VI fieldwork was to assist in determining: if there
are additional potential sources of PCE and TCE impacting groundwater at the site; the horizontal and vertical extent of PCE and TCE impacted groundwater across the site; the depth and areal extent of any DNAPL found at the top of the clayey silt unit; and, to establish a baseline for groundwater sample results which will be used to assess the potential for natural attenuation in groundwater. Using data obtained during Phases I, II, III, V, and VI, the following conclusions were provided in the Phase VI Report for the Spic and Span area.

1.2.2.6.1 Geology

- The flow of the shallow overburden groundwater in the Spic and Span area is to the north, northeast and southeast. The flow of the deep overburden groundwater in the Spic and Span area is to the northeast.

- An inclusive sand layer containing DNAPL and high PCE concentrations was identified within the glacial till unit in the vicinity of SSB-11, which is located adjacent to the Former Spic and Span Cleaners building.

- The entire thickness of the upper glacial aquifer has been penetrated throughout most of the Meeker Avenue Plume Trackdown Site and it varies from approximately 125.0 to 138.5 feet.

- The top of the Raritan Formation (i.e., a regional aquiclude) was encountered across the site. The elevation of the Raritan Formation near the Spic and Span site varied between -103.89 to -121.19 feet above mean sea level (amsl) and has been described as gray with white banding, brown, brownish gray, greenish gray, dark gray to greenish brown, fine sand and silt, clays mixed with carbonized plant fragments and clays with varying amounts of sand, to silts with varying amounts of sand and clay. The top of the Raritan Formation slopes towards the west and northwest. The Raritan Formation is a well-defined aquiclude regionally and has significant lateral extent. Permeabilities within the unit are less than $10^{-6}$ cm/sec.

1.2.2.6.2 Soil

VOCs, including PCE and its degradation products were detected and exceeded unrestricted use criteria in SSB-11, located south of DEC-024, and at several depths (5-6 feet bgs, 15-16 feet bgs, 24-25 feet bgs, and 53-54 feet bgs). The highest concentration of PCE detected was observed in
sample SSB-11 (15-16 feet bgs). PCE was also detected above criteria in SSB-16 (14-15 feet bgs, 26-27 feet bgs) and SSB-22 (22.5-23.5 feet bgs). TCE exceeded unrestricted use criteria in SSB-13 (14-15 feet bgs, 19-20 feet bgs, 24-25 feet bgs); SSB-15 (0-5 feet bgs, 16.5-17.5 feet bgs); SSB-16 (1-2 feet bgs, 14-15 feet bgs); and SSB-18 (10-11 feet bgs).

A shallow source of PCE and DNAPL has been identified within the inclusive sand layer in the vicinity of SSB-11, which is located along the eastern side of the Former Spic and Span Cleaners building, along Kingsland Avenue. The inclusive sand has been found between approximately 12.0 and 24.0 feet bgs. The inclusive sand layer has been found to contain elevated concentrations of PCE and DNAPL. The bottom of the northern edge of the inclusive sand layer has vertical sand stringers present with DNAPL in them and represents a vertical pathway from the shallow zone through the glacial till unit into the lower units down to approximately 63 feet bgs. DNAPL was noted in sand stringers located within the top of the clayey silt unit at SSB-30 at approximately 63 feet bgs. The northern edge of the inclusive sand layer is approximately 35 feet from DEC-024D and DEC-024DR, where DNAPL has been found at the interface between the sand layer and the clayey silt unit. The north/south (horizontal) extent of the inclusive sand layer appears to have been delineated and a vertical profile has been established. The eastern and western extent of the impacted inclusive sand layer in the vicinity of SSB-11 has not been delineated.

An unrelated shallow source of PCE contamination was identified in the vicinity of DEC-025 and DEC-025D, which is located on the east side of Kingsland Avenue, southeast of the Former Spic and Span Cleaners building adjacent to 300 Kingsland Avenue. The highest concentration of PCE was found within the top 2.5 feet bgs, below the sidewalk (1,300 mg/kg) at DEC-025D. SSB-16, which is located approximately 10 feet south of DEC-025D, had the highest photoionization detector (PID) readings (336 to 1,528 ppm) in the upper 20 feet. Below 20 feet, PID readings in SSB-16 decreased until they reached 0 ppm below 26 feet bgs. The remainder of the borings around DEC-025 and DEC-025D had significantly lower PID readings. It appears that the most PCE impacted soil is within the top 20 feet, between 30 feet north and 10 feet south of DEC-025 and DEC-025D. The north/south horizontal extent of the impacted soil appears to have been delineated and a vertical profile has been established. The eastern extent of the impacted soil near DEC-025 and DEC-025D has not been delineated.
1.2.2.6.3 NAPL

- DNAPL was found in DEC-024D and DEC-024DR. Analytical results indicated:
  - PCE was detected at 110,000,000 µg/kg (11%); TCE was detected at 220,000 µg/kg; cis-1,2-dichloroethene (cis-1,2-DCE) was detected at 7,300 µg/kg; and 1,2,4-trichlorobenzene was detected at 9,400 µg/kg in DEC-024DR during Phase VI.
  - Laboratory measured parameters from the DNAPL sample from DEC-024DR include: viscosity of 1.21 centipoise, surface tension of 26.4 dynes/cm, and specific gravity of 1.2942.

- LNAPL was measured in several monitoring wells: DEC-024, DEC-034, and DEC-053 at thicknesses of 0.01, 3.74, and 0.55 feet, respectively.

1.2.2.6.4 Groundwater

PCE and its degradation products were detected in numerous groundwater monitoring wells in both the shallow and deep overburden groundwater. The impact on deep overburden groundwater at the top of the Raritan Formation was not determined as part of the SC Phase VI. No chlorinated solvents were detected in upgradient top of clay monitoring well DEC-035TC. Elevated concentrations of dissolved phase PCE were detected adjacent to the Former Spic and Span Building in DEC-057 and DEC-057D at concentrations of 4,200 and 45,000 µg/L, respectively; downgradient of the site in DEC-058 and DEC-058D, to the northeast, at concentrations of 14,000 and 40,000 µg/L, respectively; to the east in DEC-060 and DEC-060D at concentrations of 22,000 and 15,000 µg/L, respectively; and in DEC-036 and DEC-036D at concentrations of 5,000 and 2,600 µg/L, respectively; and to the southeast in DEC-061 and DEC-061D at concentrations of 1,800 and 4,600 µg/L, respectively. TCE and cis-1,2-DCE were generally detected above criteria where PCE was detected. Vinyl chloride was detected above criteria generally to the north and east of the site, as well as in DEC-024; the maximum vinyl chloride concentration (2,700 µg/L) was detected in DEC-058 immediately downgradient of the site adjacent to the ExxonMobil property. BTEX and/or fuel-related compounds were detected in DEC-053, DEC-054, DEC-058D, and DEC-037R.
Based upon the observed concentrations of VOCs from the SC Phase VI sampling event, a dissolved chlorinated solvent plume appears to originate at the Spic and Span site, and an additional unknown apparent source is present adjacent to 300 Kingsland Avenue. In the shallow groundwater, it appears that the chlorinated solvent plume has higher concentrations of PCE immediately north and east of the Spic and Span site, and is more discrete compared to the deeper groundwater. In the deeper groundwater, the complete horizontal extent of the chlorinated solvents has not been completely delineated. The dissolved chlorinated solvent plume in the deeper groundwater appears to be impacted by both sources of PCE contamination and is spreading with groundwater flow towards the northeast and east with a southerly component, and via downward migration to deeper geologic zones. The vertical extent of PCE and TCE impacted groundwater is not expected to migrate below the top of the Raritan Formation due to its vast areal extent and low permeability.

1.2.2.6.5 SC Phase VI Source Characterization

Sources

Using data obtained during the SC Phase VI of the investigation performed by URS [i.e., historical information (e.g., Sanborn maps, EDR reports, and business directories) and soil data] two sources of PCE contamination have been identified. Descriptions and locations of the two sources are discussed below.

- A shallow source of PCE and DNAPL at the Spic and Span site has been identified within the inclusive sand layer in the vicinity of SSB-11, which is located along the eastern side of the Spic and Span Site along Kingsland Avenue. The inclusive sand layer has been found to contain elevated concentrations of PCE and DNAPL. The bottom of the northern edge of the inclusive sand layer has vertical sand stringers present with DNAPL in them and represents a vertical pathway from the shallow zone through the glacial till unit into the lower units. DNAPL was noted in sand stringers located within the top of the clayey silt unit at SSB-30 at approximately 63 feet bgs. The northern edge of the inclusive sand layer is approximately 35 feet from DEC-024D and DEC-024DR, where DNAPL has been found at the top of the clayey silt unit. The north/south (horizontal) extent of the inclusive sand layer appears to have been delineated and a vertical profile has been established. The eastern and western extent of the impacted inclusive sand layer in the vicinity of SSB-11 has not been delineated.
An unrelated shallow source of PCE contamination was identified in the vicinity of DEC-025 and DEC-025D, which is located on the east side of Kingsland Avenue, south of the Former Spic and Span Cleaners building in front of 300 Kingsland Avenue. The highest concentration of PCE was found within the top 2.5 feet bgs, below the sidewalk (1,300 mg/kg) at DEC-025D. SSB-16, which is located approximately 10 feet south of DEC-025D, had the highest PID readings (336 to 1,528 ppm) in the upper 20 feet. Below 20 feet, PID readings in SSB-16 decreased to 0 ppm below 26.0 feet bgs. The remainder of the borings around DEC-025 and DEC-025D had significantly lower PID readings. It appears that the most PCE impacted soil is within the top 20 feet of soil, between 30 feet north and 10 feet south of DEC-025 and DEC-025D. The north/south horizontal extent of the impacted soil appears to have been delineated and a vertical profile has been established. The eastern extent of the impacted soil near DEC-025 and DEC-025D has not been delineated.

**Potential Sources**

No additional sources were identified within the Spic and Span area.

1.3 **Objectives of the RI**

The objective of the RI is to define the horizontal and vertical extent of contamination related to the Spic and Span site in soil, overburden groundwater, and soil vapor. The results of this investigation, together with data from previous investigations and additional investigations to be conducted as part of a future area-wide site characterization, will be used to develop remedial action objectives and support the selection of an appropriate remedial action to address contamination related to the site.

1.4 **Report Organization**

This report has eight sections. Section 1 includes background information and a synopsis of URS’ activities at this site. Section 2 includes a description of field activities that occurred during the Remedial Investigation fieldwork. Section 3 includes a description of the local and regional geology and hydrogeology. Section 4 discusses the nature and extent of the contamination. Section 5 presents a conceptual model and discusses contaminant fate and transport. The Qualitative Human Health Exposure Assessment and Fish and Wildlife Resources Impact Analysis are provided in Section 6.
Section 7.0 presents a summary and recommendations for the next phase of the project. Section 8 contains a list of references cited. Tables, Figures, and Appendices immediately follow the text.
2.0 REMEDIAL INVESTIGATION FIELD ACTIVITIES

Field activities were performed during the RI Phase I between January 24 and March 25, 2011 and field activities were performed during the RI Phase II between November 7, 2011 and February 15, 2012 are discussed below. Monitoring well and soil boring locations are shown on Plate 1; soil gas points are shown on Plate 2.

2.1 Utility Clearance

Prior to site work, each subcontractor arranged for all appropriate utility clearance mark-outs. This included (but was not limited to) contacting the NYC Departments of Environmental Protection and Transportation, the Transit Authority, Consolidated Edison Company of New York (Con Edison), Keyspan, and Verizon, in addition to using the Dig-Safely number for New York City – 811 or (800) 272-4480. In addition, URS coordinated with Con Edison for the installation of protective jackets on overhead wires near proposed monitoring well and soil boring locations. The jackets for RI Phase I field activities were installed by Con Edison between January 17 and 21, 2011. The jackets for RI Phase II field activities were installed by Con Edison on November 9, 2011. Photographs of jacketed overhead wires are included in Appendix A.

2.2 Geophysical Survey for Utility Markouts

On January 24, 2011 for RI Phase I and again on November 7, 2011 for Phase II, Radar Solutions International (RSI) mobilized a one person crew with ground penetrating radar (GPR) and electromagnetic (EM) induction equipment to the site. The purpose of the geophysical survey was to screen for and identify the presence/location of underground utilities in areas where monitoring wells, soil borings and soil-gas implant installations were proposed.

During each phase, a 10-foot square reference grid was established around each monitoring well location prior to collecting the geophysical data. A GSSI SIR-2000 digital radar system was used to perform the GPR survey. GPR data were acquired along lines spaced 1.0 to 2.5 feet apart. The EM induction equipment used to determine the location of buried utilities were a Ditch Witch 950 RT locating system and a McLaughlin’s Verifier G2 digital locator.
RSI marked utilities and anomalies by spray-painting the outline on the pavement as soon as they were located. A photograph of a completed RSI utility mark out can be found in Appendix A. A URS geologist supervised and assisted RSI. Copies of the daily field notes are provided in Appendix B. RSI’s report is provided in Appendix C.

2.3 Soil Vapor Implant Installation

Prior to any intrusive activities, the subcontractor obtained all necessary permits (i.e., NYC DOT street opening permits) for conducting intrusive activities. During RI Phase I field activities, fourteen permanent soil vapor implants (SG-064 through SG-077) were installed on February 15 and 16, 2011 by Zebra Environmental Corp. (Zebra) under the direction of a NYSDEC representative and a URS geologist. Locations of the soil vapor implants are shown on Plate 2. All locations were installed through sidewalks. Rotary concrete drill bits were used to drill through the concrete sidewalk. A track-mounted Geoprobe® 6620 DT hydraulic push unit was utilized to advance a 2-inch outside diameter (OD) by 4-foot long acetate-lined Macrocore sampler to a maximum depth of 8 feet bgs. Select locations along Kingsland Avenue were installed to a maximum depth of 2 feet bgs (i.e., SG-067, SG-070, SG-071, SG-073, and SG-074). These locations were installed at this depth above a clayey silt layer which is found along Kingsland Avenue.

During RI Phase II field activities, fourteen permanent soil vapor implants (SG-098 through SG-111) were installed on November 21 and 22, 2011 by Zebra under the direction of a URS geologist. Locations of the soil vapor implants are shown on Plate 2. All locations were installed through sidewalks. Rotary concrete drill bits were used to drill through the concrete sidewalk. A track-mounted Geoprobe® 5400 DT hydraulic push unit was utilized to advance a 2-inch OD by 4-foot long acetate-lined Macrocore sampler to a maximum depth of 2.75 feet bgs.

Each sample core was screened with a PID. Up to one soil sample was collected from each boring from the interval exhibiting odors, staining, or the highest PID reading. If no odors, staining, or elevated PID readings were encountered, then a sample from the bottom of the boring was collected.

A 6-inch long double woven stainless steel Geoprobe® vapor sampling implant was connected to an anchor and positioned above the silty clay layer (if present) or at the bottom of the probe hole. Polyethylene tubing (¾-inch OD) was connected to the implant and was cut above the ground surface.
The annular space around the implant (screen) was backfilled with #1 silica sand to 6 inches above the implant. A bentonite slurry was placed immediately above the sand for the seal, and extended to the ground surface. During the RI Phase I field activities, implants were completed with 3-inch diameter aluminum flush-mount protective casings, secured with approximately 1 foot of concrete. Each flush mount casing cover was secured with a $9/16$-inch bolt. During the RI Phase II field activities, implants were completed with 5-inch diameter aluminum flush-mount protective casings, secured with approximately 1 foot of concrete. Each flush mount casing cover was secured with $9/16$-inch bolts.

All downhole equipment was decontaminated between each soil vapor implant location with a non-phosphate detergent and potable water. A photograph of a sampling implant and a completed soil vapor implant location can be found in Appendix A. Copies of the daily field notes are provided in Appendix B. Soil-gas implant construction logs are provided in Appendix D.

For the soil samples collected during installation of the soil vapor implants, a chain-of-custody (COC) form was maintained and accompanied the soil sample containers to H2M Labs, Inc. (H2M) of Melville, NY, a New York State Department of Health (NYSDOH) Environmental Laboratory Approval Program (ELAP) accredited laboratory. The soil samples were analyzed for target compound list (TCL) volatile organic compounds (VOCs) listed in Table 2-1, plus tentatively identified compounds (TICs), following United States Environmental Protection Agency (USEPA) SW846 Method 8260B.

All investigation derived wastes (IDW) generated from the soil vapor implant installation was containerized in DOT approved 55-gallon drums and picked up by AARCO Environmental Services, Corporation (AARCO) on a daily basis for off-site disposal at a permitted facility. IDW forms are provided in Appendix K.

2.4 **Soil Vapor Sampling**

During the RI Phase I field activities, between February 23 and 24, 2011, soil vapor samples were collected from 19 existing and newly installed soil vapor implants plus quality assurance/quality control (QA/QC) samples. Soil gas samples were unable to be collected from 7 soil vapor implants (SG-024, -025, -027, -052, -053, -064, -068) due to the presence of tight cohesive soils and/or water within the implant. Sampling locations are shown on Plate 2.
During RI Phase II, between December 6 and 9, 2011, soil vapor samples were collected from 29 existing and newly installed soil vapor implants plus QA/QC samples. Soil gas samples were unable to be collected from 12 soil vapor implants (SG-004, SG-012, SG-024, SG-025, SG-027, SG-028, SG-029, SG-052, SG-053, SG-064, SG-066, and SG-068) due to the presence of tight cohesive soils and/or water within the implant. One soil gas location, SG-006, had been removed by a homeowner during sidewalk flag replacement. Sampling locations are shown on Plate 2.

The soil vapor samples were collected in accordance with the procedures outlined in the Field Activities Plan (FAP) (URS, April 2010) using laboratory evacuated 6-liter Summa® canisters with 1 hour flow regulators (i.e., calibrated at the flow rate of approximately 0.08 L per minute) provided by Air Toxics, Ltd. of Folsom, CA (Air Toxics). Per NYSDOH’s Guidance for Evaluating Soil Vapor Intrusion in the State of New York (October 2006), a helium tracer gas was utilized during the sampling of each soil vapor implant. The tracer gas was used to verify that the infiltration of outdoor (ambient) air was not occurring during sample collection. A one-quart enclosure was placed over the well head. The well tubing was run through an outlet and plumber’s putty was used to seal the interface between the tubing and the enclosure. The enclosure was then sealed at the ground surface with a polyurethane foam gasket. A tank containing ultra-high purity helium (99.999%) was connected to the side port of the enclosure and enough helium was released to displace any ambient air and to maintain a positive pressure within the enclosure. Following the application of the tracer gas, one to three volumes were purged from the soil vapor implant using a Gilian GilAir-3 air sample pump.

A Dielectric MGD-2002 helium detector was used to check for the presence of the tracer gas in the purged soil vapor; if less that 10% of the tracer gas was detected, a sample was collected. Following the collection of the soil vapor sample, the helium detector was re-connected to the tubing to check for the presence of the tracer gas in the soil vapor; if less than 10% of the tracer gas was detected, the sample was acceptable for analyses. No elevated concentrations of helium were detected prior to or following the sample collection from any of the soil gas implants.

One outdoor (ambient) air sample was collected each day from a location upwind of the sample locations. The outdoor ambient air sample was collected by opening a summa canister fitted with a one-hour flow controller and drawing in the ambient air. Field duplicate samples were
collected using stainless steel ‘T’ fittings. Copies of the completed Summa Canister Sampling Field Data Sheets from the sampling event are provided in Appendix F.

A COC form was maintained and accompanied the air and soil gas samples, which were shipped, via Federal Express, to Air Toxics, an NYSDOH ELAP accredited laboratory. The soil vapor and outdoor air samples were analyzed for the TCL VOCs listed in Table 2-1, following USEPA Method TO-15.

2.5 Direct Push Soil Borings

On February 14, 2011, Zebra mobilized to the site to hand clear 10 direct push soil boring locations in the vicinity of the monitoring well pair DEC-025/-025D. The direct push soil boring locations are shown on Plate 1. The sidewalk was cored at each location using a 4-inch diameter core bit. Each location was then hand cleared using a bucket auger. After the locations were cleared, they were backfilled with clean sand and temporarily patched with blacktop patch. Soil from each location was screened with a PID. Up to one soil sample was collected from each hand cleared location. Samples were collected from the interval exhibiting odors, staining, or the highest PID reading.

On February 17, 2011, Zebra utilized a track-mounted Geoprobe® 6620 DT hydraulic push unit to advance a 2-inch OD by 4-foot long acetate lined Macrocore sampler at the 10 previously cleared soil borings located in the vicinity of the monitoring well pair DEC-025/-025D. The soil borings were advanced to depths between 3.5 and 25.0 feet bgs. Refusal was encountered at all locations prior to reaching the water table. Upon completion, each soil boring was backfilled with clean sand and the top 4 inches was patched with concrete.

No direct push soil borings were completed during RI Phase II field activities.

Each sample core was screened with a PID. Up to two soil samples were collected from each boring; one soil sample was collected from the interval near the bottom of the boring, the second sample was collected from the interval exhibiting odors, staining, or the highest PID reading. If no odors, staining, or elevated PID readings were encountered, then only one sample from the interval near the bottom of the boring was collected. Site photographs are provided in Appendix A; copies of the daily field notes are provided in Appendix B; and soil boring logs are provided in Appendix F.
A COC form was maintained and accompanied the soil sample containers to H2M. The soil samples were analyzed for TCL VOCs as listed in Table 2-1, plus TICs following USEPA SW846 Method 8260B.

All IDW generated from the monitoring well installation was containerized in DOT approved 55-gallon drums and picked up by AARCO on a daily basis for off-site disposal at a permitted facility.

2.6  **Groundwater Monitoring Well Installation**

The following sections describe the monitoring well installation program for the RI fieldwork.

2.6.1  **Pre-Boring Clearing**

Prior to any intrusive activities, the subcontractor obtained all necessary permits (i.e., NYC DOT street opening permits) for conducting intrusive activities. During RI Phase I field activities, on January 24, 2011, ADT mobilized two Vac-Tron® units to perform location specific utility clearance at each of the proposed monitoring well locations. A total of 17 monitoring well locations were cleared between January 24 and 26, 2011. During RI Phase II field activities, on November 7, 2011, ADT mobilized one Vac-Tron® unit to perform location specific utility clearance at each of the proposed monitoring well locations. Between November 7 and 8, 2011, 8 monitoring wells locations were cleared for utilities. In addition, on November 11 and 14, 2011, an additional 9 soil boring locations were cleared for utilities. At each location, a two-foot by two-foot square area of the sidewalk was cut. An approximately one-foot diameter by five-foot deep hole was excavated using post-hole diggers, pry bars, and an air knife along with the Vac-Tron® unit. After the location was cleared for drilling, the hole was backfilled flush with the sidewalk using the excavated spoils (rocks and debris removed) and if necessary, temporarily patched with blacktop patch or concrete. Site photographs are provided in Appendix A and copies of the daily field notes are provided in Appendix B.

2.6.2  **Soil Borings**

During RI Phase I field activities, between January 28 through February 14, 2011, ADT utilized track-mounted AMS Compact Roto Sonic 17-C drill rigs for the installation of 16 monitoring wells at the locations shown on Plate 1. Of the 16 monitoring wells installed, 6 were water table
(shallow wells) and the remaining 10 were deep wells. An attempt was made to advance a top of clay well (DEC-063TC) however, the 14-inch diameter boring that was advanced to install a 12-inch inside diameter (ID) permanent steel casing caved in more than once. The boring would not stay open to facilitate the installation of the casing and it was decided to abandon the boring and fill it with cement/bentonite grout. DEC-063TC was eventually installed as part of the SC Phase VI field activities.

During RI Phase II field activities, between November 9, 2011 through January 12, 2012, ADT utilized track-mounted and truck-mount AMS Compact Roto Sonic 17-C drill rigs and track-mounted Geoprobe® 8140LC Roto Sonic drill rig for the installation of 9 soil borings (SSB-025 through SSB-033) and 8 monitoring wells (DEC-003DD, DEC-034D, DEC-083D, DEC-084D, DEC-085, DEC-086, DEC-087, and DEC-097D) as shown on Plate 1. Of the 8 monitoring wells installed during RI Phase II, 2 were shallow overburden (water table) wells, and 6 were deep overburden wells.

The soil borings at the shallow and deep well locations were advanced using a 4-inch ID inner sampler and a 6-inch ID outer casing with sonic drilling methods. The soil boring associated with the top of clay wells were advanced using a 6-inch ID inner sampler and an 8-inch ID outer casing with sonic drilling methods. Soil samples were collected continuously from the ground surface to the terminus of each boring. The procedure for the advancement of the borehole was to advance the inner sampler the appropriate interval (5 or 10 feet) and then advance the outer casing over the inner sampler to the desired depth. After the outer casing was advanced, the inner sampler was retrieved and the sample core collected was placed in a polyethylene sample tube. The process was repeated until the desired depth was reached.

Each sample core was screened with a PID. Up to five soil samples were collected from each boring; one soil sample was collected from the interval just above the water table, the second and/or additional samples were collected from the intervals exhibiting odors, staining, or elevated PID reading(s). If no odors, staining, or elevated PID readings were encountered, then only one sample from the interval just above the water table was collected.

Soil borings that were not converted to monitoring wells were backfilled with bentonite chips to approximately 5 feet bgs, with clean well sand from 0.5-5.0 feet bgs, and with concrete in the top
0.5 feet. Site photographs are provided in Appendix A, copies of the daily field notes are provided in Appendix B, and soil boring logs are provided in Appendix F.

A COC form was maintained and accompanied the soil sample containers to H2M. The soil samples were analyzed for TCL VOCs as listed in Table 2-1, plus TICs following USEPA SW846 Method 8260B. Shelby tube and grab samples were submitted to 3rd Rock, LLC (3rd Rock) of East Aurora, NY for geotechnical analysis of grain size distribution (ASTM D422), Atterberg Limits (ASTM D4318), and falling head permeability (ASTM D5084). Results of the geotechnical analyses are discussed in Section 3.5.

All IDW generated from the monitoring well installation was containerized in DOT approved 55-gallon drums and picked up by AARCO on a daily basis for off-site disposal at a permitted facility.

2.6.3 Shallow and Deep Monitoring Well Construction

All shallow and deep monitoring wells installed during the RI field activities were constructed using the following methodologies.

The 8 shallow monitoring wells were constructed with 15 feet of 2-inch ID, Schedule 40 polyvinyl chloride (PVC) 0.010-inch slot screen and riser. The screen was nominally set between 5 feet above and 10 feet below the water table at most locations. A 00 size sand pack was installed from the bottom of the well up to 2 feet above the top of the well screen. A bentonite slurry was then installed around the riser to an elevation of 2-feet below grade via tremie pipe.

The 16 deep monitoring wells were constructed with 10 feet of 2-inch ID, Type 304 stainless steel 0.010-inch slot screen with a 2-foot long sump and Type 304 stainless steel riser. Stainless steel screen and riser were used instead of PVC in case DNAPL was present in the deep well. PVC integrity degrades when in direct contact with chlorinated solvents. Each deep well was screened across the clayey silt unit encountered at all deep well locations. A 00 size sand pack was installed from the bottom of the well up to 2 feet above the top of the well screen. A bentonite slurry was then installed around the riser to an elevation of 2-feet below grade via tremie pipe.

Each monitoring well was finished with a locking well cap, a 2-foot square concrete apron, and a flush-mounted curb box. Security bolts were installed in the well covers to minimize the...
potential for unauthorized well access. The concrete apron for each well pad was approximately 6 inches thick. Monitoring well construction logs are provided in Appendix G.

2.7 Monitoring Well Development

At least 24 hours after the monitoring wells were installed the wells were developed by URS personnel with the pump and surge development method using a Waterra Inertial Hydrolift pump with dedicated/disposable high density polyethylene (HDPE) tubing and dedicated/disposable HDPE check valves. Prior to well development, a 100-foot long Solinst oil/water interface probe was used to check for the presence/thickness of any free product. During well development, water quality parameters (pH, specific conductivity, temperature, turbidity) were measured using a Hanna 991301 Multiparameter Meter and a Lamotte 2020 turbidimeter and recorded. A monitoring well was considered developed when a minimum of 100 gallons was removed, and water quality parameters had stabilized. Well development logs may be found in Appendix H. Well development water was collected in DOT approved 55-gallon drums and picked up daily by AARCO for off-site disposal at a permitted facility.

2.8 Groundwater Level Measurements

Several rounds of groundwater levels were collected and used to develop groundwater contour elevation maps during the investigation so that groundwater flow directions could be determined. Monitoring wells within the area were checked for depth to groundwater and thickness of accumulated NAPL, if any. Water levels were determined using a 100-foot long Solinst oil/water interface probe. Table 2-2 presents groundwater level measurements and the presence/absence of NAPL in monitoring wells. Groundwater elevations were adjusted if LNAPL was present, based upon the (laboratory) measured specific gravity of the product present in monitoring well(s) at the site.

2.9 Aquifer Testing

Following well development, slug testing was conducted on select monitoring wells to estimate the horizontal hydraulic conductivity within the overburden. Falling head tests were performed by recording the initial water level in the well, lowering a pressure transducer/datalogger (In-situ MiniTroll) into the well, inserting a decontaminated slug to raise the water level in the well, and recording the water level over time until it returned to the original static level. Rising-head tests
were performed immediately following completion of the falling head test. With the slug already in the water column, the static water level was recorded, the slug was then removed, and water level readings were taken as the water level gradually returned to static condition. Aquifer testing data and results are provided in Appendix I.

2.10 **Non-Aqueous Phase Liquid Gauging**

During site characterization Phases III through VI and both Phase I and II of the RI, monitoring wells were checked for the presence of NAPL. Both DNAPL and LNAPL were observed as discussed below and presented on Table 2-2.

2.10.1 **Dense Non-Aqueous Phase Liquid Gauging**

DNAPL was previously detected during site characterization Phases III, V, and VI in DEC-024D/-024DR. The gauging was performed using a $\frac{1}{8}$-inch thick cotton rope weighted with a stainless steel bolt. Once the bottom of the well was reached, the string was left in the well for approximately 5 minutes and then removed. During the Phase V investigation on June 22, 2009, approximately 1.5 feet of the string was stained dark brown with DNAPL. A DNAPL sample was collected, the results of which are discussed in Section 4.2.1. A DNAPL sample was also encountered and collected during Phase VI on November 9, 2011 the results of which are discussed in Section 4.2.1.

During RI Phase I, on February 10, 2011, DNAPL was detected on a $\frac{1}{8}$-inch thick cotton rope weighted with a stainless steel bolt in both DEC-024D and DEC-024DR. Approximately 1.0 feet of the string was stained dark brown with DNAPL in DEC-024D. A small amount was recovered from each well using dedicated/disposable HDPE bailers to verify the presence of DNAPL in the wells; however, no laboratory analysis was conducted.

During the SC Phase VI fieldwork multiple DNAPL checks were made of the deep wells in the vicinity of the Spic and Span site. The DNAPL checks were made using dedicated/disposable HDPE bailers to verify the presence of DNAPL in the wells. Small amounts were recovered only from DEC-024D and DEC-024DR, where DNAPL had previously been detected.
2.10.2 Light Non-Aqueous Phase Liquid Gauging

During the Phase V field activities on July 7, 2009, LNAPL was detected in DEC-034 and DEC-054 with a thickness of 1.34 and 1.09 feet, respectively. LNAPL sampling from monitoring wells DEC-034 and DEC-054 is discussed in Section 2.11.

During the RI Phase I field activities, between February and March 2011, the thickness of LNAPL was observed to range from absent (0.0 feet) to 3.99 feet in DEC-034; from 0.01 feet to 1.2 feet in DEC-054; and from 0.58 to 0.84 feet in DEC-053 (Table 2-2).

During the SC Phase VI field activities, on October 17, 2011, LNAPL was detected in DEC-024, DEC-034, and DEC-053 with thicknesses ranging between 0.01 feet and 3.74 feet in these monitoring wells (Table 2-2).

During the RI Phase II field activities, on November 23, 2011, LNAPL was detected in DEC-034, DEC-053, DEC-054, and DEC-058 with thicknesses ranging between 0.28 feet and 3.24 feet in these monitoring wells (Table 2-2).

2.11 Non-Aqueous Phase Liquid Sampling

During the Phase V field activities, four NAPL samples had been collected from wells including DNAPL samples from DEC-024D on May 29, 2008 and again on June 22, 2009, and LNAPL samples on July 9, 2009 from DEC-034 and DEC-054. During the RI Phase I field activities, on March 9, 2011, an LNAPL sample was collected from DEC-053. During the SC Phase VI field activities, on November 9, 2011, a DNAPL sample was collected from DEC-024DR.

2.11.1 Dense Non-Aqueous Phase Liquid Sampling

No DNAPL samples were collected during the RI Phase II field activities; however, a DNAPL sample was collected as part of the Phase VI SC as described below.

During the SC Phase VI fieldwork, on November 9, 2011, URS purged approximately 55 gallons of water from both DEC-024D and DEC-024DR (for a total of 110 gallons) using a Waterra Inertial Hydrolift pump with dedicated/disposable HDPE tubing and check valves, to facilitate the collection of a DNAPL sample. It is estimated that approximately 1 gallon of DNAPL was removed.
during the purging process. After allowing the wells to stabilize for approximately one hour, URS and NYSDEC personnel collected a DNAPL sample from DEC-024DR using a weighted dedicated/disposable HDPE bailer with nylon rope. The DNAPL sample was transported under COC via laboratory courier to Test America. The DNAPL sample was analyzed for TCL VOCs, specific gravity by American Society for Testing and Materials (ASTM) D1298, surface tension by D-971, and viscosity by D-445. A slight sheen and a few small blebs of DNAPL were observed in DEC-024D during purging, however, the amount of DNAPL was too small to sample.

When sampling was completed, the weighted dedicated/disposable HDPE bailer, nylon rope, PPE, and polyethylene sheet were placed into a DOT approved 55-gallon drum and picked up that day by AARCO for off-site disposal at a permitted hazardous waste facility.

### 2.11.2 Light Non-Aqueous Phase Liquid Sampling

During RI Phase I field activities, on March 9, 2011, URS personnel collected an LNAPL sample from DEC-053 using a dedicated/disposable HDPE bailer. A COC form was maintained by URS and accompanied the sample containers to H2M. The LNAPL sample was analyzed for TCL VOCs plus TICs, TCL SVOCs plus TICs, Petroleum Hydrocarbons by Method 8100 (modified), and specific gravity by ASTM D4052, as listed in Table 2-1. Per the Department’s direction, a portion of the sample was subsequently sent by H2M to META Environmental, Inc. of Watertown, MA (META) for forensic analysis. In order to confirm the specific gravity results provided by Summit Environmental Technologies, Inc. of Cuyahoga Falls, OH (subcontractor to H2M), META also was instructed to analyze for specific gravity by ASTM D4052.

No LNAPL samples were collected during the RI Phase II field activities.

### 2.12 Groundwater Sampling

During the RI Phase I field activities between March 2 and March 9, 2011, URS collected groundwater samples from 36 monitoring wells (16 newly installed and 20 existing NYSDEC wells) plus QA/QC samples using low-flow sampling procedures. Groundwater samples were collected from beneath the LNAPL found in DEC-034, DEC-053 and DEC-054 using the procedures outlined below. Groundwater samples were not collected from DEC-024D and DEC-024DR due to the presence of DNAPL in the wells.
During the RI Phase II field activities, between January 23 and January 31, 2012, URS collected groundwater samples from 58 monitoring wells (8 newly installed and 50 existing NYSDEC wells) plus QA/QC samples using low-flow sampling procedures. Groundwater samples were collected from beneath the LNAPL found in DEC-034, DEC-053, DEC-054, and DEC-058 using the procedures outlined below. Groundwater samples were not collected from DEC-024D and DEC-024DR due to the presence of DNAPL in the wells.

Prior to sample collection, standing water was purged from each well with a QED SamplePro Micropurge bladder pump or a Grundfos Redi-Flo2 submersible pump using dedicated/disposable bladders and HDPE tubing. At well locations where LNAPL was encountered, a groundwater sample was collected from the well by lowering a capped tremie pipe into the well to a depth at least 5 feet below the LNAPL layer. The tremie pipe was secured to limit movement and the cap was pushed out from the bottom end of the tremie pipe to allow the sample tubing to be lowered to the desired sampling depth without coming into contact with the LNAPL. The cap was attached to the tremie pipe for retrieval. A peristaltic pump was used to purge the wells containing LNAPL.

Wells were purged at a rate of 1-liter per minute or less and the purge rate was adjusted to minimize draw down. During the purging of the well, water quality parameters (pH, specific conductivity, temperature, dissolved oxygen, turbidity) were measured using a Horiba U-22 Multi-parameter Instrument with a flow-through cell and documented on a purge log. Samples were collected after the water quality parameters stabilized. Copies of the daily field notes are provided in Appendix B, and purge logs are provided in Appendix J. Purge water was collected into DOT approved 55-gallon drums, and was picked up daily by AARCO Environmental Services for proper disposal.

All samples were transported under COC via laboratory courier to H2M. During RI Phase I field activities, the groundwater samples were analyzed for TCL VOCs plus TICs. During RI Phase II field activities, the groundwater samples were analyzed for TCL VOCs plus TICs and natural attenuation parameters [i.e., alkalinity, chloride, ferrous iron (field parameter), nitrate, total kjedahl nitrogen (TKN), phosphorous, sulfate, and sulfide] as listed in Table 2-1.
2.13 **Investigation Derived Waste Disposal**

AARCO was contracted for the daily pick-up and disposal of all drummed IDW at a permitted disposal facility. Copies of the non-hazardous bills of lading and hazardous waste manifests are provided in Appendix K.

2.14 **Monitoring Well Maintenance**

During RI Phase I field activities, well maintenance was performed on all DEC wells where groundwater samples were collected. Every well cover was removed and all the bolt holes were tapped out and lubricated with an anti-seize paste. All flush-mount protective casings on DEC wells were equipped with new Penta Head tamper proof bolts.

During RI Phase II field activities, well maintenance was performed on all DEC wells where groundwater samples were collected. Every well cover was removed and all the bolt holes were tapped out and lubricated with an anti-seize paste. All flush-mount protective casings on new DEC wells were equipped with new Penta Head tamper proof bolts. The flush-mount protective casings and well pads at DEC-016 and DEC-016D were replaced. Location IDs were painted at new monitoring well and soil gas locations and URS also repainted existing locations where the IDs were no longer visible.

2.15 **Concrete Sidewalk Flag Replacement**

During RI Phase I field activities, AARCO was contracted for the replacement of sidewalk flags that had been drilled through during previous and current site activities. AARCO replaced a total of 33 sidewalk flags between March 14 and 25, 2011. The sidewalk flags ranged in size from 5-foot by 5-foot to 10-foot by 10-foot square. Prior to removal of the damaged flags, AARCO cut the perimeter of each flag to be replaced using a water-cooled pavement saw to reduce fugitive dust. The flags were demolished, removed and disposed of by AARCO. New flags were replaced in kind to the surrounding flags.

During RI Phase II field activities, AARCO was contracted for the replacement of sidewalk flags that had been drilled through during previous and current site activities. AARCO replaced a total of 16 sidewalk flags between February 1 and 15, 2012. The sidewalk flags ranged in size from 5-
foot by 5-foot to 5-foot by 12-foot square. Prior to removal of the damaged flags, AARCO cut the perimeter of each flag to be replaced using a water-cooled pavement saw to reduce fugitive dust. The flags were demolished, removed and disposed of by AARCO. New flags were replaced in kind to the surrounding flags. Copies of the daily field notes are provided in Appendix B.

2.16 Site Survey

URS surveyed the area, including all new soil borings, monitoring wells, and soil gas points installed for location and elevation. The survey provides 100-scale mapping and does not include elevated roadways and expressways (i.e., BQE). All surveying was performed under the supervision of a New York State licensed land surveyor. All vertical control points were referenced to the North American Vertical Datum 1988 (NAVD 1988). Horizontal datum was referenced to the North American Datum of 1983 (NAD83), New York State Plane Coordinate System, Long Island Zone. A site survey drawing is provided in Appendix L.
3.0 PHYSICAL CHARACTERISTICS OF THE STUDY AREA AND GEOLOGY

This section discusses the physical characteristics of the study area including: surface features, demography and land use, geology, hydrogeology, geotechnical results, utilities and SCGs.

3.1 Surface Features

The elevation of the Spic and Span property is approximately at 20 feet above mean sea level (amsl). The topography of the site investigation area slopes gently downward to the north and northwest to approximately 6 feet amsl at the bulkhead along Newtown Creek and to approximately 10 feet amsl at the intersection of Monitor Street and Norman Avenue. The elevation to the south and east of the site rises to approximately 30 feet near the intersection of Morgan and Nassau Avenues and the edge of Monsignor McGolrick Park.

The entire site property and the majority of the project area are covered by one-story and multi-story buildings and/or pavement/concrete. The site is protected from trespassers by locked doors and windows. Vehicle access is through a secured and locked overhead door on Kingsland Avenue.

Limited green space is present in the area and generally on nearby residential properties. Surface soil is present in landscape boxes adjacent to area sidewalks; however, given the nature of the urban environment the soil should not be construed as representative of clean surface soil. Monsignor McGolrick Park is a 9.13 acre park 1,200 feet southwest of the site bounded by Monitor and Russell Streets and Nassau and Driggs Avenues (Plate 1).

3.2 Demography and Land Use

The site is located in the Greenpoint/East Williamsburg Industrial Area section of the Borough of Brooklyn, Kings County, New York. The population of the Brooklyn (Kings County) is 2,504,700 according to the 2010 Census. The area is a mixture of residences and manufacturing facilities, including both commercial and industrial facilities. The Spic and Span property is currently being used by an import business; however residences are also present on the property. Petroleum refining and storage operations occupy a significant portion of the Greenpoint area, especially to the north and east. Residential areas are generally present south of the site.
Land use in New York City is regulated by the City’s Zoning Resolution, which has two parts: zoning text and zoning maps. The text establishes zoning districts and sets forth regulations governing their land use and development. The maps show the locations and boundaries of the zoning districts. The City is divided into three basic zoning districts: residential (R), commercial (C), and manufacturing (M). The three basic districts are further divided into a range of lower-, medium-, and higher-density residential, commercial, and manufacturing districts.

The project area falls within four zoning districts identified by the New York City Department of City Planning (http://www.nyc.gov/html/dcp/html/zone/zh_zmaptable.shtml). These zoning districts are: R6, R6B, M1-2, and M3-1. The current (2011) zoning and land use of individual properties was determined through the NY City Map (http://gis.nyc.gov/doitt/nycitymap).

R6 and R6B Residential Districts (medium density). Primary permitted uses in the R6 district include medium density residential. A mixture of building types are allowed and range from small apartment buildings set back on small lots to row houses to large-scale apartment towers. The “B” suffix indicates a contextual district, where supplemental regulations require a new development to maintain the scale and form of the existing neighborhood context. Residential properties along Monitor Street, and the majority of Kingsland and Nassau Avenues, are zoned R6B.

M1-2 Manufacturing District (light industrial). Permitted uses in the M1-2 district include typical light industrial, office and retail uses. M1 districts are often a buffer between M2 or M3 manufacturing districts and adjacent residential or commercial districts. Residences are generally not included within M1 districts unless as part of a Special Mixed Use District. The “2” suffix refers to supplemental parking requirements. The majority of properties south of Norman Avenue are located in the M1-2 district.

M3-1 Manufacturing District (heavy industrial). Permitted uses in the M-3 industrial district include heavy industry that generate potential nuisance effects such as noise, traffic or pollutants and include power plants and fuel supply depots. The “1” suffix refers to supplemental parking requirements. Properties north of Norman Avenue and along the east side of Morgan Avenue are zoned M3-1.
Two properties have two zoning districts listed. The property at 284 Kingsland (Lot 48) is listed as both R6 and M1-2. The property at 307 Kingsland Avenue (Lot 15) is listed as both R6B and M1-2.

### 3.3 Regional Geology

The Spic and Span site is located within the Atlantic Coastal Plain physiographic province of New York State (Broughton, et al. 1966). The Atlantic Coastal Plain is characterized by low relief with elevations ranging from sea level to almost 400 feet amsl. The lithology of Brooklyn and Queens consists of Cretaceous and Pleistocene age unconsolidated deposits underlain by Precambrian crystalline bedrock. The unconsolidated deposits pinch out in northwestern Queens where bedrock outcrops, but reach a thickness of more than 1,000 feet in southeastern Queens. The unconsolidated deposits form six distinct hydrogeologic units consisting of four aquifers and two confining layers that generally dip to the south-southeast (Figure 3-1). The units in ascending order are the Lloyd aquifer (0-300 feet thick), the Raritan confining unit (0-200 feet thick), the Magothy aquifer (0-500 feet thick), the Jameco aquifer (0-200 feet thick), the Gardiners clay (0-150 feet thick), and the upper glacial aquifer (0-300 feet thick) (USGS, 1999a and b). The units pinch out to the north-northeast and may not all be found at any one location.

Based on borings performed near the site for unrelated work, the site is underlain from the surface down by upper glacial aquifer, the Raritan Formation, and crystalline bedrock. The upper glacial aquifer is of Wisconsin age and consists of a terminal moraine, a ground moraine, and glacial outwash deposits whose area is characterized as an unsorted and unstratified mixture of clay, sand, gravel and boulders. The Raritan Formation is recognized as a confining unit which has been described as light to dark gray, brown-red, pink, red and gray-white clay, silty clay and clayey to silty fine sand. Disseminated lignite and pyrite are common and calcareous concretions may be found. Prior to the SC Phase VI fieldwork, the Raritan Formation had previously been encountered in three borings performed near the site by the USGS: one boring near Morgan Avenue and Meeker Avenue (-47 feet amsl); one boring under the BQE near the west bank of Newtown Creek (-48 feet amsl); and one boring near Meeker Avenue between Stewart Avenue and Gardner Avenue (-71 feet amsl). The boring near Morgan Avenue and Meeker Avenue penetrated the Raritan Formation into the underlying crystalline bedrock at a depth of -163 feet amsl.
During the SC Phase VI fieldwork, the Raritan Formation was positively encountered in eight top of clay well locations at depths between 108.5 and 138.0 feet bgs (elevations of -56.95 to -121.19 feet amsl) and was described as gray with white banding, brown, brownish gray, greenish gray, dark gray to greenish brown, fine sand and silt, clays with carbonized plant fragments, clays with varying amounts of sand to silts with varying amounts of sand and clay.

3.4 **Site Geology**

Figure 3-2 presents the locations of the monitoring wells and cross sections developed during the RI. Cross sections A-A’, B-B’ and C-C’ are shown on Figures 3-3, 3-4, and 3-5, respectively and represent the cross-sections that may be found in the Spic and Span area. Based upon subsurface data obtained during this and previous investigations, both the upper glacial aquifer was penetrated and the top of the Raritan Formation was encountered at the top of clay monitoring well locations (i.e., DEC-035TC, DEC-058TC, DEC-062TC, and DEC-063TC). The following textural units have been found in the upper glacial aquifer in most borings, from the surface downward: a fill unit; a glacial till unit; an inclusive sand unit within the glacial till unit; a sand unit; a lacustrine clayey silt unit; a fine sand and silt unit; a sand/ sand and gravel unit; and the Raritan Formation. Due to the heterogeneous nature of the geology, some but not all of the units were identified at each boring. The thickness of the upper glacial aquifer in the Spic and Span area is approximately 125.0 to more than 138.0 feet thick. Figure 3-6 depicts the elevation of the top of the Raritan Formation, which appears to dip towards the west-northwest.

A fill unit is present, varying in thickness from approximately 0 to 9 feet, and consists of a heterogeneous mixture of sand, silt, clay and varying amounts of construction and demolition debris (i.e., bricks, concrete, coal, slag, etc.).

A glacial till unit was noted at the surface in some borings and consists of a heterogeneous mixture of sand, silt, and clay and varying amounts of gravel, cobbles and boulders. The glacial till unit found at the surface pinches out to the north and northeast between DEC-057 and DEC-054 to the north and DEC-058 to the northeast. At these locations and the wells located to the north of these locations, the sand unit maybe found at the surface.

An inclusive sand layer was identified within the glacial till unit in the vicinity of SSB-11 (Figure 3-4), which contained elevated concentrations of PCE and DNAPL. The inclusive sand unit is
present along Kingsland Avenue, adjacent to the Former Spic and Span building and is found laterally north and south between SSB-025 and DEC-024. The east/west extent of the inclusive sand unit is unknown and is assumed to be present to the east beneath Kingsland Avenue, and to the west under the Former Spic and Span building. The inclusive sand has been found between approximately 12.0 and 24.0 feet bgs. The bottom of the northern edge of the inclusive sand layer has vertical sand stringers present with DNAPL in them and represents a vertical migration pathway for DNAPL from the shallow zone through the glacial till unit to the lower units. The northern edge of the inclusive sand layer is approximately 35 feet from DEC-024D and DEC-024DR, where DNAPL has also been identified at the top of the clayey silt unit.

A deeper sand unit is present at the majority of boring locations and is represented by stratified sands of varying textures containing some to no fines.

A lacustrine clayey silt unit has been observed as an inclusive unit within the sand unit, and was observed in most of the borings at the site. The thickness of the clayey silt unit, where present, varies from 0.5 to over 20 feet thick. The presence of the clayey silt unit (i.e., a low permeability unit) at well location DEC-024D and DEC-024DR has resulted in the accumulation of DNAPL at the interface between the sand unit and the inclusive clayey silt unit at approximately 50 feet bgs (-29.78 feet amsl). This clayey silt unit was also identified in nearby wells at depths ranging from 50 feet bgs (-29.84 feet amsl) at DEC-024DR to 65 feet bgs (-48.80 feet amsl) at DEC-023D. The clayey silt unit’s thickness is greatest at DEC-063D (approximately 28 feet thick) and thins to the north (approximately 1-foot thick at DEC-034D and DEC-058D) and east (approximately 2.5 feet thick at DEC-062D). The lacustrine clayey silt has a lower permeability which has impeded further downward migration of DNAPL and dissolved phase contaminants.

The fine sand and silt unit beneath the sand unit consists of inter-bedded very fine to fine sands, silt and fine sands and silt mixtures with inter-bedded, discontinuous beds of sands, silts and clays. This unit is laterally discontinuous and texturally variable in nature and was typically found north of Norman Avenue and east of Kingsland Avenue.

A sand/sand and gravel unit was identified overlying the Raritan Formation at the four top of clay locations (DEC-035TC, DEC-058TC, DEC-062TC and DEC-063TC) in the Spic and Span area.
The Raritan Formation consisted of green gray, green brown, brown, or white with brown banding, silt with some sand; clay with some sand; clay and silt; or fine sand and silt and was encountered between 125 and 138.5 feet bgs (-103.89 and -121.19 feet amsl). An isopleth of the top of the Raritan formation is provided on Figure 3-6. The top of the Raritan Formation dips to the north/northwest.

3.5 Geotechnical Test Results

During Phase I of the RI, two soil samples from Shelby tubes were analyzed in March 2011 by 3rd Rock, LLC of East Aurora, NY for grain size distribution (ASTM D422), Atterberg Limits (ASTM D4318), and falling head permeability (ASTM D5084). Additional soil samples from grab samples and Shelby tubes were collected between August to September 2011 and between December 2011 to January 2012 and analyzed by 3rd Rock for the same parameters. Results are presented in Appendix M, summarized on Table 3-1 and discussed below.

3.5.1 Geotechnical Samples from Overburden Aquifer

Overburden samples from SSB-013 and SSB-014 (near DEC-025/025D) with depths between 5 and 32 feet were generally poorly graded sand, silty sand, and clayey sand with an Unified Soil Classification System (USCS) classification of SP, SM, and SC-SM. Soils were identified as either non-plastic or of low plasticity. Three samples were analyzed by ASTM D5084 Method C for permeability. Results ranged from $9.4 \times 10^{-3}$ to $1.9 \times 10^{-2}$ cm/sec.

Deep overburden samples were collected from SSB-014, DEC-059D, DEC-063D, and DEC-067D with depths between 50 and 67 feet. Results confirm the classification of ML for the depth intervals in the monitoring wells DEC-059D and DEC-063D provided in the boring logs. Soils were identified as non-plastic. The measured permeability values of the silt/sandy silt layer varied between $1.2 \times 10^{-4}$ and $6.1 \times 10^{-6}$ cm/sec, which is 1 to 3 orders of magnitude less than those of the shallow overburden above.

3.5.2 Geotechnical Samples from Top of Raritan Formation

Samples were collected from the top of the Raritan Formation, and included samples from the mixture of sand and clay material from above the clay, DEC-058TC (141-142.5 feet bgs) and DEC-
035TC (140-140.9 feet bgs), and from the clay DEC-062TC (137.5-140 feet bgs and 140-140.5 feet bgs) and DEC-063TC (125-127.5 feet bgs). USCS classifications in the Raritan ranged from SM to SC-SM and CL-ML. Soils were identified as either non-plastic or of low plasticity. The measured permeability values were $1.2 \times 10^{-6}$ for the mixture of sand and clay above the clay, and varied between $1.1 \times 10^{-7}$ to $3.4 \times 10^{-8}$ cm/sec for the clay.

3.6 **Groundwater Levels and Hydrogeology**

The primary hydrogeologic unit identified beneath the investigation area is the upper glacial aquifer. Groundwater in the area is present in unconfined conditions; however, locally confined conditions are possible due to the presence of interbeds of sand, clay, and silt. The water table surface may be found between approximately 11 and 25 feet bgs depending on the well location. The water table has been influenced by the operation of the Off-Site System operated by ExxonMobil since approximately 1995. The operation of the Off-Site System has produced localized cones of depression resulting in an inward hydraulic gradient, which has prevented the expansion of the Off-Site Plume.

3.6.1 **Groundwater Levels**

During RI Phase I field activities, several rounds of synoptic groundwater levels were obtained in February and March 2011 from 22 DEC monitoring wells. These were used to develop groundwater contour elevation maps during the RI so that groundwater flow directions could be determined. Potentiometric surface maps based on the water level measurements from the shallow wells, using a 1-foot contour interval, are provided in Figures 3-7, 3-8 and 3-9 for February 24, 2011, March 2, 2011, and March 21, 2011, respectively. Potentiometric surface maps based on the water level measurements from the deep wells, using a 1-foot contour interval, are provided in Figures 3-11, 3-12 and 3-13 for February 24, 2011, March 2, 2011, and March 21, 2011, respectively. Water level measurements are included in Table 2-2. Hydraulic gradient calculations are provided on Table 3-2.

During RI Phase II field activities, an additional synoptic round of groundwater levels were obtained on January 23, 2012 from the 60 DEC monitoring wells. Potentiometric surface maps based on the water level measurements using a 1-foot contour interval are provided in Figure 3-10 for the shallow overburden wells, in Figure 3-14 for the deep overburden wells, and in Figure 3-15 for the top of clay monitoring wells. Water level measurements are included in Table 2-2. Hydraulic gradient calculations are provided on Table 3-2.
Water levels were adjusted in monitoring wells DEC-034, DEC-053 and DEC-054 where LNAPL was found to be present based on specific gravity measurements. An LNAPL sample from DEC-053 was collected and sent to META Environmental, Inc. (META) for determination of specific gravity. Specific gravity for LNAPL in DEC-034 and DEC-054 were previously determined by Roux. Analytical results for the URS and Roux LNAPL samples are provided in Appendix O.

In the immediate vicinity of the Spic and Span property, the shallow and deep groundwater flow is north to northeast. The horizontal hydraulic gradient of the shallow groundwater flow during the RI Phase I and RI Phase II field activities was approximately 0.02 to 0.01 foot per foot (ft/ft), respectively. In the immediate vicinity of the Spic and Span property, the top of clay groundwater flow is east to northeast.

The vertical hydraulic gradients in shallow and deep well pairs varied in direction across the investigation area during RI Phase I field activities. Vertical hydraulic gradients in well pairs DEC-023/023D, DEC-024/024D, DEC-055/055D, DEC-057/057D were slightly positive or downwards (generally 0.002 ft/ft) based upon the water level information. Vertical hydraulic gradients in well pairs DEC-058/058D, DEC-059/059D, and DEC-060/060D were positive or downwards to a greater extent (0.069, 0.027, 0.084 ft/ft, respectively). The vertical hydraulic gradients in well pair DEC-035/035D and DEC-063/063D were slightly negative or upwards (-0.002 and -0.001 ft/ft, respectively) based upon the water level information.

The vertical hydraulic gradients in shallow and deep well pairs varied in direction across the investigation area during RI Phase II field activities and were generally similar to those found during the RI Phase I. Vertical hydraulic gradients in well pairs DEC-023/023D, DEC-024/024D, DEC-055/055D, DEC-063/063D were slightly positive or downwards (0.001 to 0.002 ft/ft) based upon the water level information. Vertical hydraulic gradients in well pairs DEC-059/059D, DEC-060/060D, and DEC-062/DEC-062D were positive or downwards to a greater extent (0.027, 0.084, and 0.336 ft/ft, respectively). The vertical hydraulic gradients in well pair DEC-035/035D and DEC-057/057D were zero to slightly negative or upwards (0.000 and -0.002 ft/ft, respectively) based upon the water level information. A vertical hydraulic gradient could not be calculated at DEC-058/058D due the presence of LNAPL in DEC-058. At this time the water levels in monitoring wells DEC-058 could not be adjusted because the specific gravity of the LNAPL is unknown. An attempt will be made during future field activities to obtain a sample of the LNAPL for analysis.
The vertical hydraulic gradients in top of clay well triplets varied in direction across the investigation area during RI Phase I field activities. Vertical hydraulic gradients between the shallow and top of clay wells at DEC-035/035TC, DEC-062/062TC, and DEC-063/063TC were positive or downwards (0.058 to 0.093 ft/ft, respectively). A vertical hydraulic gradient could not be calculated at DEC-058/058TC due the presence of LNAPL in DEC-058. Vertical hydraulic gradients between the deep and top of clay wells at DEC-035D/035TC, DEC-058D/058TC, DEC-062D/062TC, and DEC-063D/063TC were positive or downwards (0.012 to 0.103 ft/ft, respectively).

3.6.2 **Slug Test Results**

Slug test results are presented on Table 3-3. In all cases, the rising head and falling head results were well within one order of magnitude of each other. The representative hydraulic conductivity (K) was computed as the geometric mean of the rising and falling head values. In cases where a constant static head was not established prior to the start of the falling head test, and since rising head tests are considered to be more representative of hydraulic conductivity (Bouwer, 1989), the K value considered to be representative is the rising head value (DEC-058D, DEC-060D, DEC-061D, and DEC-062D).

The hydraulic conductivity in the overburden ranged from $2.91 \times 10^{-2}$ cm/sec (DEC-063S) to $8.32 \times 10^{-5}$ cm/sec (DEC-060S). In the shallow overburden, the mean value of K is $8.03 \times 10^{-3}$ cm/sec for the sand clayey silt/sand unit, and $3.15 \times 10^{-4}$ cm/sec for the sandy silt. In the deep overburden, the mean value of K is $1 \times 10^{-3}$ cm/sec for the sand/silty sand, and $9.32 \times 10^{-5}$ cm/sec for the sandy silt.

3.7 **Surface Water and Hydrology**

The site slopes slightly to the west and north and is bounded by streets on the north and east. The surface of the site is entirely covered by buildings and/or pavement/sidewalks. Minimal onsite ponding was observed during field investigations. There are stormwater drop inlets (DIs) on the northeast corner of the site along Kingsland Avenue near Norman Avenue. Three additional DIs are located near the intersection of Norman Avenue and Kingsland Avenue. DI locations are shown on the site survey, which may be found in Appendix L.

The nearest surface water body is Newtown Creek located approximately 1,500 feet northeast of the site. Newtown Creek is classified as a Class SD (marine waters) surface water body by the
NYSDEC. The best usage of Class SD waters is fishing. These waters shall be suitable for fish, shellfish, and wildlife survival. The classification may be given to those waters that, because of natural or man-made conditions, cannot meet the requirements of primary and secondary contact recreation and fish propagation. While Newtown Creek may not be suitable for swimming and other recreational activities that involve human contact with surface water, individuals use Newtown Creek for swimming. Water is not withdrawn from Newtown Creek for potable use. Numerous stormwater drains from surrounding roadways and permitted Spill Discharge Elimination System (SPDES) outfalls discharge into Newtown Creek, including those discharging groundwater collected and treated on the nearby Exxon/Mobil remediation site.

Surface water levels within Newtown Creek vary depending on the tide. High tide in Newtown Creek is generally at an elevation of 4 to 5 feet; low tide is generally at an elevation of 0 to 1 feet (www.saltwatertides.com).

3.8 Utilities

Utilities on and near the site include underground water, electric, natural gas, sanitary and storm sewer. Overhead electric and communication lines run north-south adjacent to the site within the western sidewalk along Kingsland Avenue and east-west within the north sidewalk along Norman Avenue. Fire hydrants are located on Kingsland Avenue and Norman Avenue. Approximate utility information is provided on the site survey which may be found in Appendix L.

3.9 Standards, Criteria and Guidance Values

For each medium, detected concentrations of individual contaminants were compared to applicable standards, criteria and guidance values (SCGs). The site-specific SCGs were determined for the individual media as follows:

Soil

Three sources of soil SCGs are considered appropriate for this site: site-specific background soil samples, NYSDEC Part 375, and NYSDEC CP-51.

On August 3, 2011, eight soil samples were obtained from the 0 to 2-foot depth interval from eight locations in Monsignor McGolrick Park as part of the SC Phase VI field activities. These
samples were analyzed for TCL/TAL contaminants. Detected concentrations will be considered to be representative of site-specific background for the Spic and Span site. These soil background concentrations will be included as soil SCGs on the soil analytical tables presented in Section 4.

A summary of the detected analytical results in the background soil samples compared to unrestricted and protection of groundwater SCGs is presented in Table 3-4. Table 3-4 lists the detected analytical results for background soil samples within/near residences compared to residential SCGs for RI soil samples. Results exceeding criteria are indicated with circles and/or squares on the table. Table 3-5 provides a statistical summary of the detected TCL parameters for background soil samples as follows: the number of detections; the minimum, maximum and average values; the location and depth of the maximum value, and the number of exceedances of unrestricted use criteria. One VOC, toluene, was detected below unrestricted use criteria at six of the eight sampling locations. As indicated on Table 3-5, SVOCs, including PAHs, were detected in the majority of samples. One SVOC, di-n-butylphthalate, exceeded unrestricted use criteria at one location (SS-02). The pesticides dichlorodiphenyldichloroethane (4,4’-DDD), dichlorodiphenyldichloroethylene (4,4’-DDE), and dichlorodiphenyltrichloroethane (4,4’-DDT) were detected in all samples and exceeded unrestricted use criteria at all locations. Additionally, dieldrin exceeded unrestricted use criteria at two locations; gamma-chlordane was detected at three locations below unrestricted use criteria.

Metals which exceeded unrestricted use criteria in all samples include: copper, iron, lead, and mercury. Additionally, arsenic exceeded unrestricted use criteria at five locations, and zinc exceeded unrestricted use criteria at one location.

Since the detected concentrations of di-n-butylphthalate, 4,4’-DDD, 4,4’-DDE, 4,4’-DDT, dieldrin, arsenic, copper, iron, lead, mercury, and zinc exceeded unrestricted use criteria in the background soil samples, these contaminants are considered to be present as background conditions for the site. The maximum concentration of each contaminant detected at concentrations exceeding unrestricted use criteria is included as the soil background concentration and presented on the soil analytical results tables in Section 4.

Part 375 criteria are considered as SCGs for soil samples in conjunction with CP-51 criteria. CP-51 supplements Part 375 by providing criteria for contaminants previously included under TAGM 4046 where values were not included in Part 375. Hereafter, mention of Part 375 includes
incorporation of CP-51 criteria values. Part 375 unrestricted use criteria are considered to assist in the development of a remedial alternative capable of achieving unrestricted future use, as required by DER-10 Section 4.4 (b) 3 ii. In addition, criteria for the Protection of Groundwater are considered as SCGs for contaminants which exceed groundwater SCGs. These are identified in Section 4.

Soil samples were obtained from soil borings on properties zoned residential and/or manufacturing by the NYC Department of City Planning. The zoning classification for the property of location of the soil boring is a consideration in the determination of the appropriate soil SCGs. The majority of properties within the investigation area north of Nassau Avenue and west of Kingsland Avenue are zoned residential. The majority of properties south of Nassau Avenue to the Brooklyn Queens Expressway are zoned manufacturing. The majority of properties east of Kingsland Avenue are zoned manufacturing. A few dual-zoned residential and manufacturing properties are present.

As discussed in Section 3.2, properties located in the manufacturing districts in NYC may be either industrial or commercial use. However, land uses allowed within manufacturing districts include residential use either within special mixed use districts or by special permit. Therefore, residences may be present on properties throughout the entire investigation area. Therefore, the soil SCGs considered appropriate for the site are residential criteria (as opposed to commercial or industrial criteria). Part 375 restricted residential and residential land use soil cleanup criteria for the soil samples are used on the soil analytical data tables in Section 4.

**Groundwater**

The SCGs for groundwater are the Class GA standards and guidance values presented in NYSDEC Technical and Operational Guidance Series (TOGS) 1.1.1 Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations, June 1998 (including subsequent revisions). These groundwater SCGs are included on the groundwater analytical tables presented in Section 4.

**Surface Water/ Sediments**

No surface water or sediment samples were collected therefore no SCGs were determined.
Soil Vapor

There are no criteria for soil vapor analytical data.
4.0 NATURE AND EXTENT OF CONTAMINATION

The following sections discuss the results of the soil, NAPL, groundwater and soil vapor/air sample analyses for the RI fieldwork at the Spic and Span site.

4.1 Soil Analytical Results

4.1.1 RI Phase I and SC Phases I through V Soil Analytical Results

Thirty-eight soil samples were collected during RI Phase I from 29 locations during the period January 25 through February 17, 2011. At some locations, more than one sample was obtained from multiple depths. Including all soil samples from RI Phase I and the SC Phases I through V. 61 soil samples were obtained from 49 borings and 40 soil-gas locations in the Spic and Span area. The soil sample results were compared to appropriate Part 375 criteria identified for the soil samples discussed in Section 3.11.

A summary of the detected analytical results in all soil samples were compared to soil background concentrations, unrestricted use, and protection of groundwater SCGs is presented in Table 4-1. Table 4-2 lists the detected analytical results for soil samples as compared to residential and restricted residential SCGs for all soil samples. Table 4-3 provides a statistical summary of the detected TCL parameters for all soil samples collected from RI Phase I and the SC Phases I through V in the Spic and Span area as follows: the number of detections; the minimum, maximum and average values; and the location and depth of the maximum value. The complete validated analytical results from the RI Phase I soil samples are presented in the Data Usability Summary Report (DUSR) in Appendix N, on a compact disc (CD). Data summary tables, Form I and Form Ie (TICs) are provided in the DUSR and include the reporting limit for each non-detected compound. RI Phase I and the SC Phases I through V soil data exceeding criteria is presented on Figure 4-1A for Unrestricted Use and Protection of Groundwater and Figure 4-1B for Restricted Residential and Residential Use.

Background, Unrestricted Use, and Protection of Groundwater Soil Criteria

Soil sample results were compared to unrestricted use and protection of groundwater criteria. VOCs, including PCE and its degradation products, were detected and exceeded unrestricted use criteria. Locations which exceeded criteria for unrestricted use also exceeded protection of groundwater criteria. PCE exceeded unrestricted and protection of groundwater criteria in previously installed borings in DEC-024DR (1,000 mg/kg at 45-46 feet bgs) and DEC-025D (140 mg/kg at 0-1.5
feet bgs; 1,300 mg/kg at 1.5-2.5 feet bgs). DNAPL containing 73% PCE was gauged in the adjacent well DEC-024D at approximately 52.5-54 feet bgs. PCE found in soil at DEC-024DR may be the result of lateral spreading of the DNAPL due to the decrease in soil permeability at that depth.

PCE exceeded criteria in well borings to the south of DEC-025D: SSB-03 (2,000 mg/kg at 1-1.5 feet bgs; 110 mg/kg at 5.5-6 feet bgs), SSB-06 (1,200 mg/kg at 13-13.5 feet bgs), and SSB-08 (1,300 mg/kg at 0.5-1 foot bgs). PCE exceeded criteria in one of the two well borings to the west of DEC-025D: SSB-05 (34 mg/kg at 8.5-9 feet bgs), and in two of the four well borings to the north of DEC-025D: SSB-04 (1.8 mg/kg at 22-22.5 feet bgs) and SG-071 (200 mg/kg at 0.5-1 feet bgs).

TCE exceeded criteria in SSB-06 (0.49 mg/kg at 13-13.5 feet bgs) and SSB-08 (21 mg/kg at 0.5-1 feet bgs). Cis-1,2-DCE exceeded criteria in SSB-08 (0.35 mg/kg at 0.5-1 feet bgs).

Soil samples previously collected from DEC-034, DEC-053 and DEC-054 located north and northeast of the Spic and Span site exceeded criteria for petroleum-related compounds [acetone in DEC-053 (0.074 mg/kg at 8-9 feet bgs), benzene in DEC-053 (1.3 mg/kg at 14-15 feet bgs) and DEC-054 (0.84 mg/kg at 14-15 feet bgs; 0.83 mg/kg at 18-19 feet bgs), isopropylbenzene in DEC-034 (2.4 mg/kg at 14-15 feet bgs), DEC-053 (14 mg/kg at 14-15 feet bgs) and DEC-054 (34 mg/kg at 14-15 feet bgs; 35 mg/kg at 18-19 feet bgs), and xylenes in DEC-053 (3.4 mg/kg at 14-15 feet bgs)]. RI Phase I boring DEC-058 is located in the same general location as DEC-034, DEC-053 and DEC-054 and exceeded the criteria for isopropylbenzene (3.5 mg/kg at 14-15 feet bgs).

**Residential and Restricted Residential Soil Criteria**

Soil sample results were compared to restricted residential and residential use criteria as presented on Table 4-2. PCE exceeded both restricted residential and residential use criteria in DEC-024DR (1,000 mg/kg at 45-46 feet bgs), DEC-025D (140 mg/kg at 0-1.5 feet bgs and 1,300 mg/kg at 1.5-2.5 feet bgs), SG-071 (200 mg/kg at 0.5-1 feet bgs), SSB-03 (2,000 mg/kg at 1-1.5 feet bgs and 110 mg/kg at 5.5-6 feet bgs), SSB-05 (34 mg/kg at 8.5-9 feet bgs), SSB-06 (1,200 mg/kg at 13-13.5 feet bgs), and SSB-08 (1,300 mg/kg at 0.5-1 feet bgs).

Additionally, TCE exceeded the residential use criteria, but not the restricted residential use criteria, in SSB-08 (21 mg/kg at 0.5-1 feet bgs). The concentration of TCE in SSB-08, along with the presence of low-levels of other VOCs indicates that PCE has undergone degradation at this location. As discussed above, all the locations which exceeded either residential criteria, DEC-025D, SG-071,
SSB-03, SSB-05, SSB-06 and SSB-08, appear to be a separate source than from operations at the Spic and Span site.

4.1.1.1 **Summary of RI Phase I and SC Phases I through V Soil Analytical Results**

A potential source of PCE exists within the soils surrounding monitoring wells DEC-025/025D. The PCE detection in DEC-025D appears to be a separate PCE source from that found at the Spic and Span site, as observations of PCE were at a depth immediately below the concrete sidewalk indicating a near surficial release of PCE. SSB-01 through SSB-10 were installed during the RI Phase I field activities in the vicinity of DEC-025/025D to assess the horizontal and vertical extent of PCE impacted soils. The borings were advanced with a Geoprobe® direct-push unit which encountered refusals at shallow depth thus did not allow delineation of the full horizontal and vertical extent of PCE impacted soils in this area. Additional drilling was conducted during the SC Phase VI field effort using a sonic drill rig.

Soil samples previously collected from DEC-034, DEC-053 and DEC-054 located north and northeast of the Spic and Span site which exceeded criteria for petroleum-related compounds and are most likely associated with petroleum impacts from the ExxonMobil Off-Site Plume.

4.1.2 **RI Phase II and SC Phase VI Soil Analytical Results**

Soil samples collected during the SC Phase VI and RI Phase II were compared to appropriate Part 375 criteria identified for the soil samples discussed in Section 3.11.

A summary of the detected analytical results in soil samples were compared to soil background concentrations, unrestricted use, and protection of groundwater SCGs is presented in Table 4-4 for VOCs and in Table 4-5 for SVOCs, pesticides/PCBs, metals, cyanide, and TOC. Table 4-6 lists the detected analytical results for soil samples as compared to residential and restricted residential SCGs for VOCs and in Table 4-7 for SVOCs, pesticides/PCBs, metals, cyanide, and TOC. The complete validated analytical results from the RI Phase II and SC Phase VI soil samples are presented in the DUSR in Appendix N, on a CD. Data summary tables, Form I and Form Ie (TICs), are provided in the DUSR and include the reporting limit for each non-detected compound. RI Phase II and the SC Phase VI soil data exceeding criteria is presented on Figure 4-2A for Unrestricted Use and Protection of Groundwater and Figure 4-2B for Restricted Residential and Residential Use. A
summary of these detected analytical results in all soil samples collected to date within the Spic and Span area compared to soil background concentrations, unrestricted use and protection of groundwater SCGs is presented in Table 4-8 for VOCs. The summary for all for SVOCs, pesticides/PCBs, metals and TOC can be found in Table 4-5 since these parameters had only been analyzed for in RI Phase II and SC Phase VI soil samples. Table 4-9 lists the detected analytical results for soil samples as compared to residential and restricted residential SCGs for VOCs. The summary for all for SVOCs, pesticides/PCBs, metals, cyanide, and TOC can be found in Table 4-7 since these parameters had only been analyzed for in RI Phase II and SC Phase VI soil samples. Table 4-10 provides a statistical summary of the detected TCL parameters for all soil samples collected to date within the Spic and Span area.

**Background, Unrestricted Use, and Protection of Groundwater Soil Criteria**

During the SC Phase VI field activities, soil samples were collected from soil borings SSB-11 through SSB-14, which are located around the east and north sides of the Former Spic and Span Cleaners building and from SSB-15 through SSB-24 located in the vicinity of DEC-025/025D which is adjacent to 300 Kingsland Avenue. VOCs, including PCE and its degradation products, were detected and exceeded unrestricted use criteria. Locations which exceeded criteria for unrestricted use also exceeded protection of groundwater criteria in all but one sample collected. The highest concentration of PCE was detected in sample SSB-11 (190,000 mg/kg 15-16 feet bgs). PCE was also detected above criteria in SSB-11 (3.5 mg/kg 24-25 feet bgs, 1.4 mg/kg 53-54 feet bgs), SSB-15 (4.6 mg/kg 0-0.5 feet bgs, 1.4 mg/kg 16.5-17.5 feet bgs), SSB-16 (980 mg/kg 1-2 feet bgs, 910 mg/kg 14-15 feet bgs, 3.1 mg/kg 26-27 feet bgs), SSB-18 (3 mg/kg 10-11 feet bgs), and SSB-22 (4.5 mg/kg 22.5-23.5 feet bgs).

TCE exceeded unrestricted use criteria in SSB-11 (110 mg/kg 15-16 feet bgs), SSB-13 (2.3 mg/kg 14-15 feet bgs, 24 mg/kg 19-20 feet bgs, 0.67 mg/kg 24-25 feet bgs), and SSB-16 (1.4 mg/kg 14-15 feet bgs). Additional VOCs which exceeded unrestricted use criteria include in SSB-11 at 15-16 feet bgs (1,1,1-trichloroethane 17 mg/kg; 1,1-dichloroethene 5.2 mg/kg; 1,2,4-trichlorobenzene 34 mg/kg, cis-1,2-DCE 21 mg/kg), and SSB-12 (isopropylbenzene 4.5 mg/kg 20-21 feet bgs).

In addition, soil samples from SSB-11 through SSB-15 were analyzed for SVOCs, pesticides, PCBs, metals, and total organic carbon, as indicated on Table 4-5. Non-VOCs which exceeded
unrestricted use criteria include: pesticides in SSB-11 (0-5 and 15-16 feet bgs) and SSB-15 (0-5 feet bgs); calcium in the majority of samples including SSB-11 (0-5, 46-47 and 53-54 feet bgs), SSB-12 (44-45 feet bgs), and SSB-15 (33-34 and 40-41 feet bgs); total chromium in SSB-11 (0-5 feet bgs), hexavalent chromium in SSB-11 (46-47 feet bgs); iron in all soil samples; zinc in SSB-11 (15-24 feet bgs); and aluminum and nickel in SSB-15 (40-41 feet bgs).

During the RI Phase II field activities, soil samples were collected from soil borings SSB-25 through SSB-33 which were located along the western side of Kingsland Avenue south of DEC-024, as well as samples from the soil borings associated with monitoring wells DEC-003DD, DEC-058TC, DEC-083D, DEC-085, DEC-086, and DEC-087D. The highest concentration of PCE was detected in sample SSB-29 (290,000 mg/kg 56-57 feet bgs). PCE was also detected above criteria in SSB-26 (230,000 mg/kg 16-17 feet bgs, 8.5 mg/kg 18-19 feet bgs), SSB-28 (14,000 mg/kg 16.5-17.5 feet bgs, 3.1 mg/kg 25-26 feet bgs), SSB-29 (2,800 mg/kg 15.5-16.5 feet bgs, 8.5 mg/kg 17-17.5 feet bgs, 32 mg/kg 64-65 feet bgs), SSB-30 (1,200 mg/kg 15-16 feet bgs, 1.6 mg/kg 20-21 feet bgs, 170,000 mg/kg 54-55 feet bgs), SSB-32 (16 mg/kg 17-18 feet bgs, 2,500 mg/kg 19-20 feet bgs, 11 mg/kg 21-22 feet bgs, 27,000 mg/kg 37-38 feet bgs, 32,000 mg/kg 47-48 feet bgs, 22,000 mg/kg 52-53 feet bgs, 30 mg/kg 57-58 feet bgs), and SSB-33 (270 mg/kg 20-21 feet bgs, 29,000 mg/kg 45-46 feet bgs, 75 mg/kg 59-60 feet bgs). PCE also exceeded unrestricted and protection of groundwater criteria in DEC-003DD (3 mg/kg at 70-75 feet bgs), DEC-058TC (11 mg/kg at 55-56 and 10 mg/kg at 61-62 feet bgs).

TCE exceeded unrestricted use criteria in SSB-26 (5.4 mg/kg 16-17 feet bgs), SSB-28 (2.4 mg/kg 16.5-17.5 feet bgs), SSB-29 (6.1 mg/kg 15.5-16.5 feet bgs), SSB-29 (180 mg/kg 56-57 feet bgs), SSB-30 (24 mg/kg 15-16 feet bgs), SSB-30 (65 mg/kg 54-55 feet bgs), SSB-31 (12 mg/kg 18-5-19.5 feet bgs), SSB-32 (29 mg/kg 37-38 feet bgs, 20 mg/kg 47-48 feet bgs), and SSB-33 (6.7 mg/kg 20-21 feet bgs, 45 mg/kg 45-46 feet bgs). Additional VOCs which exceeded unrestricted and protection of groundwater criteria include: SSB-26 (cis-1,2-DCE 3.3 mg/kg 16-17 feet bgs and vinyl chloride 0.048 mg/kg 16-17 feet bgs), SSB-30 (cis-1,2-DCE 0.36 mg/kg 15-16 feet bgs), SSB-31 (cis-1,2-DCE 0.64 mg/kg 18.5-19.5 feet bgs and isopropylbenzene 2.4 mg/kg 18.5-19.5 feet bgs), and SSB-32 (1,2,4-trichlorobenzene 8.1 mg/kg 37-38 feet bgs and 8.5 mg/kg 47-48 feet bgs). Additionally, cis-1,2-DCE exceeded unrestricted use and protection of groundwater criteria in DEC-003DD (0.38 mg/kg at 70-75 feet bgs); and xylene exceeded criteria in DEC-068D (1.3 mg/kg 14-15 feet bgs).
Residential and Restricted Residential Soil Criteria

VOCs which exceeded residential and/or restricted residential use criteria include: PCE in DEC-058TC (11 mg/kg at 55-56 and 10 mg/kg at 61-62 feet bgs), SSB-11 (190,000 mg/kg 15-16 feet bgs), SSB-26 (230,000 mg/kg 16-17 feet bgs and 8.5 mg/kg 18-19 feet bgs), SSB-28 (14,000 mg/kg 16.5-17.5 feet bgs), SSB-29 (2,800 mg/kg 15.5-16.5 feet bgs), SSB-29 (8.5 mg/kg 17-17.5 feet bgs, 290,000 mg/kg 56-57 feet bgs, 32 mg/kg 16-64 feet bgs), SSB-30 (1,200 mg/kg 15-16 feet bgs, 170,000 mg/kg 54-55 feet bgs), SSB-32 (16 mg/kg 17-18 feet bgs, 2,500 mg/kg 19-20 feet bgs, 11 mg/kg 21-22 feet bgs, 27,000 mg/kg 37-38 feet bgs, 32,000 mg/kg 47-48 feet bgs, 22,000 mg/kg 52-53 feet bgs, 30 mg/kg 57-58 feet bgs), SSB-33 (270 mg/kg 20-21 feet bgs, 29,000 mg/kg 45-46 feet bgs, 75 mg/kg 59-60 feet bgs); and TCE in SSB-11 (110 mg/kg 15-16 feet bgs), SSB-29 (180 mg/kg 56-57 feet bgs), SSB-30 (24 mg/kg 15-16 feet bgs, 65 mg/kg 54-55 feet bgs), SSB-31 (12 mg/kg 18.5-19.5 feet bgs), SSB-32 (29 mg/kg 37-38 feet bgs, 20 mg/kg 47-48 feet bgs), and SSB-33 (45 mg/kg 45-46 feet bgs). In addition, non-VOCs which exceeded residential and/or restricted residential use criteria include iron in all samples from SSB-11 through SSB-15.

4.1.2.1 Summary of RI Phase II and SC Phase VI Soil Analytical Results

Spic and Span Building Source Area

A shallow source of PCE and DNAPL has been identified within the inclusive sand layer between approximately SSB-026 and SSB-032 at approximately 12.0 to 24.0 feet bgs (Figure 4-3 A). The inclusive sand layer contains elevated concentrations of PCE and DNAPL. The bottom of the northern extent of the inclusive sand layer near SSB-032 contains vertical sand stringers saturated with DNAPL, down to approximately 63 feet bgs in SS-029 and SSB-030. These sand stringers represent a vertical pathway from the shallow zone through the glacial till unit into the lower sand unit at approximately 25 to 55 feet bgs. DNAPL was noted in sand stringers which are present in SSB-30 at a depth of 17 feet to an approximate depth of 63 feet bgs, near the top of the lower permeability clayey silt. The northern edge of the inclusive sand layer is approximately 35 feet south of DEC-024D and DEC-024DR, where DNAPL has also been identified at the top of the clayey silt unit. The north/south (horizontal) extent of the inclusive sand layer appears to have been delineated and a vertical profile has been established as depicted in Figure 4-3A. The eastern extent of the impacted soil has not been delineated and is assumed to extend under Kingsland Avenue. The western extent of
the impacted soil has not been delineated because it likely extends beneath the Former Spic and Span building and possibly into the court yard, which is situated approximately 19 feet from the western curb line of Kingsland Avenue. The courtyard area may have been used to load and unload dry cleaning product materials.

**300 Kingsland Avenue Source Area**

A shallow source of PCE contamination was identified in the vicinity of DEC-025/025D, which is located on the east side of Kingsland Avenue, south of the Spic and Span site, adjacent to 300 Kingsland Avenue. The highest concentration of PCE (2,000 mg/kg) was found within the top 2.5 feet, below the sidewalk at SSB-03 and in the top 2.5 feet at both DEC-025D and SSB-08 (1,300 mg/kg at both). SSB-16, which is located approximately 10 feet south of DEC-025D, had the highest PID readings (336 to 1,528 ppm) in the upper 20 feet. Below 20 feet, PID readings in SSB-16 decreased to 0 ppm at depths below 26.0 feet bgs. The remainder of the borings around DEC-025 and DEC-025D had significantly lower PID readings. It appears that the most PCE impacted soil is within the top 15 feet of soil, between 10 feet north and 20 feet south of DEC-025 and DEC-025D (Figure 4-3B). The north/south horizontal extent of the impacted soil appears to have been delineated and a vertical profile established. The eastern extent of the impacted soil near DEC-025/025D has not been delineated and may extend beneath the building at 300 Kingsland Avenue. The western extent of the impacted soil has not been delineated and is assumed to extend under Kingsland Avenue.

**4.2 Non-Aqueous Phase Liquid Analytical Results**

A summary of the detected TCL VOCs and SVOCs in the NAPL (LNAPL and DNAPL) samples collected by URS during Phase I through Phase VI of the SC and from the RI Phase I is presented in Table 4-11. The complete validated analytical results from the RI NAPL samples are presented in the DUSR in Appendix N on a CD. Data summary tables, Form I and Form Ie (TICs) are provided in the DUSR and include the reporting limit for each non-detected compound.

**4.2.1 Dense Non-Aqueous Phase Liquid Analytical Results**

No DNAPL samples were obtained during the RI Phase I or Phase II field activities. The results of DNAPL samples collected during SC Phases I through VI are presented on Table 4-11. Sample results are summarized below.
DNAPL was detected in DEC-024D and DEC-024DR during the SC Phase VI field investigation. A sample was collected from DEC-024DR on November 9, 2011. PCE was detected at a concentration of 110,000,000 µg/kg (11%); TCE was detected at 220,000 µg/kg; cis-1,2-DCE was detected at 7,300 µg/kg; and 1,2,4-trichlorobenzene was detected at 9,400 µg/kg in DEC-024DR during the SC Phase VI investigation. Laboratory measured parameters from the DNAPL sample from DEC-024DR include: viscosity of 1.21 centipoise, surface tension of 26.4 dynes/cm, and specific gravity of 1.2942.

A DNAPL sample was collected from monitoring well DEC-024D during SC Phase V field activities, on June 22, 2009. PCE was detected at a concentration of 730,000 mg/kg or 73% and TCE was detected at 720 mg/kg (0.072%). 1,2,4-Trichlorobenzene, 1,1-biphenyl and bis(2-ethylhexyl)phthalate were also detected in the DNAPL, at significantly lower concentrations. The tentatively identified compounds found in the volatile and semi-volatile fractions indicate the presence of petroleum related compounds. These results were consistent with the results of the DNAPL sample collected from this well during Phase III on May 29, 2008. DNAPL sample results are summarized below.

<table>
<thead>
<tr>
<th>Sample ID</th>
<th>Specific Gravity</th>
<th>Viscosity (centipoise)</th>
<th>Surface Tension (dynes/cm)</th>
<th>PCE Concentration (mg/kg)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEC-024DR</td>
<td>1.2942</td>
<td>1.211</td>
<td>26.4</td>
<td>110,000 (11%)</td>
<td>URS, November 9, 2011</td>
</tr>
<tr>
<td>DEC-024D</td>
<td>NM</td>
<td>NM</td>
<td>NM</td>
<td>730,000 (73%)</td>
<td>URS, June 22, 2009</td>
</tr>
<tr>
<td>DEC-024D</td>
<td>NM</td>
<td>NM</td>
<td>NM</td>
<td>700,000 (70%)</td>
<td>URS, May 29, 2008</td>
</tr>
</tbody>
</table>

NM = not measured
**4.2.2 Light Non-Aqueous Phase Liquid Analytical Results**

LNAPL has been found in DEC-034, DEC-053, DEC-054, and DEC-058. LNAPL was collected for analysis from DEC-034, DEC-053, and DEC-054. LNAPL in DEC-058 has not been sampled to date. The results of LNAPL samples collected during SC Phases I through VI and RI Phase I are presented on Table 4-11 and are summarized below.

A LNAPL sample was collected by URS during the RI Phase I fieldwork from DEC-053 on March 9, 2011. During the SC Phase V fieldwork, Roux Associates, on behalf of ExxonMobil in July 2009, submitted LNAPL samples from DEC-034 and DEC-054 for laboratory analysis of density, viscosity, surface tension and gas chromatographic comparison to select petroleum hydrocarbons.

In the LNAPL sample from monitoring well DEC-034, PCE was found at a concentration of 1.1 mg/kg (0.00011%). In the LNAPL samples from monitoring wells DEC-053 and DEC-054, methylcyclohexane and BTEX were detected; no chlorinated compounds were detected. All other compounds detected in samples DEC-034, DEC-053 and DEC-054 were attributed to petroleum related compounds. The forensic analysis of the LNAPL from DEC-053 determined that the primary constituents were leaded and unleaded gasoline, with lesser amounts of fuel oil and other petroleum related compounds. The META forensic report is provided in Appendix O. LNAPL sample results are summarized below.

<table>
<thead>
<tr>
<th>Sample ID</th>
<th>Specific Gravity</th>
<th>Viscosity (centipoise)</th>
<th>Surface Tension (dynes/cm)</th>
<th>PCE Concentration (mg/kg)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEC-034</td>
<td>0.8218</td>
<td>2.14</td>
<td>25.3</td>
<td>1.1</td>
<td>URS/Roux split, July 9, 2009</td>
</tr>
<tr>
<td>DEC-054</td>
<td>0.8019</td>
<td>1.46</td>
<td>22.9</td>
<td>ND</td>
<td>URS/Roux split, July 1, 2009</td>
</tr>
<tr>
<td>DEC-053</td>
<td>0.7852</td>
<td>NM</td>
<td>NM</td>
<td>ND</td>
<td>URS, March 9, 2011; gasoline and petroleum compounds</td>
</tr>
</tbody>
</table>

NM = not measured
ND = not detected
4.3 Groundwater Analytical Results

RI Phase I

A summary of the detected TCL VOCs in the RI Phase I groundwater samples collected from monitoring wells is presented in Table 4-12. Results exceeding TOGS No. 1.1.1 Class GA groundwater criteria are indicated with a circle. The locations of detected VOCs that have exceeded their respective criteria are shown on Figure 4-4. Isoconcentration contours of PCE in the RI Phase I groundwater samples are shown on Figures 4-5 and 4-6 for the shallow and deep overburden, respectively. Table 4-13 provides a statistical summary of the detected parameters for the RI Phase I groundwater samples as follows: the number of detections; the minimum, maximum and average values; and the location of the maximum value. The complete validated analytical results from the RI Phase I groundwater samples are presented in the DUSR in Appendix N on a CD. Data summary tables, Form I and Form Ie (TICs) are provided in the DUSR and include the reporting limit for each non-detected compound.

RI Phase II

A summary of the detected TCL VOCs in the RI Phase II groundwater samples collected in January 2012 from monitoring wells is presented in Table 4-14. Results exceeding TOGS No. 1.1.1 Class GA groundwater criteria are indicated with a circle. The locations of detected VOCs that have exceeded their respective criteria are shown on Figure 4-7. Isoconcentration contours of PCE in the RI Phase II groundwater samples are shown on Figures 4-8 and 4-9 for the shallow and deep overburden, respectively. Table 4-15 provides a statistical summary of the detected parameters for the RI Phase II groundwater samples as follows: the number of detections; the minimum, maximum and average values; and the location of the maximum value. Table 4-16 provides a historical summary of the detected parameters for all groundwater samples collected to date in the Spic and Span area. Table 4-17 provides a statistical summary of the detected parameters for all groundwater samples collected to date in the Spic and Span area as follows: the number of detections; the minimum, maximum and average values; and the location of the maximum value. The complete validated analytical results from the RI Phase II groundwater samples are presented in the DUSR in Appendix N on a CD. Data summary tables, Form I and Form Ie (TICs) are provided in the DUSR and include the reporting limit for each non-detected compound.
Groundwater and DNAPL samples collected during SC Phase III, V, and VI have confirmed a source of PCE in the vicinity of DEC-024/DEC-024D. The horizontal extent of DNAPL has not been determined as it has only been found in DEC-024D and DEC-024DR (gauged approximately 1.5 feet of 73% PCE in DEC-024D, as discussed in Section 4.2.1).

4.3.1 **Groundwater PCE Detections**

**RI Phase I**

PCE was detected in 23 of the 36 groundwater samples collected during the RI Phase I, at concentrations exceeding groundwater criteria ranging from 6 µg/L to 76,000 µg/L (Figure 4-4). The highest concentration of PCE in the shallow groundwater was detected at DEC-060 (20,000 µg/L), followed by DEC-058 (18,000 µg/L) and DEC-036 (7,400 µg/L). The highest concentration of PCE in the deep groundwater was detected at DEC-057D (76,000 µg/L), followed by DEC-060D (19,000 µg/L), DEC-058D (14,000 µg/L), and DEC-036D (6,100 µg/L).

Figure 4-5 depicts isoconcentration contours for PCE in the shallow groundwater from analytical data collected during the RI Phase I. The concentrations of PCE in shallow wells near the Spic and Span site (DEC-058, DEC-060) is greater than the concentrations found during the previous groundwater sampling events in the Spic and Span site. The shallow dissolved phase plumes appears to have migrated downgradient of the Spic and Span site, moving with shallow groundwater flow towards the northeast, east and south.

Figure 4-6 depicts isoconcentration contours for PCE in the deep groundwater from analytical data collected during the RI Phase I. A groundwater sample was not collected from DEC-024D and DEC-024DR due to the presence of DNAPL in the wells. The plume appears to have migrated downgradient of the Spic and Span site, to a greater extent than in the shallow overburden, moving with deep groundwater flow towards the north and northeast.

**RI Phase II**

PCE was detected in 48 of the 58 groundwater samples collected during the RI Phase II, at concentrations exceeding groundwater criteria ranging from 6 µg/L to 37,000 µg/L (Figure 4-7). The highest concentration of PCE in the shallow overburden was detected at DEC-060 (22,000 µg/L), followed by DEC-058 (13,000 µg/L), and DEC-057 (8,400 µg/L). The highest concentration of PCE
in the deep overburden was detected at DEC-057D (37,000 µg/L), followed by DEC-058D (35,000 µg/L), DEC-060D (13,000 µg/L), and DEC-003DD (11,000 µg/L).

Figure 4-8 depicts isoconcentration contours for PCE in the shallow groundwater from analytical data collected during RI Phase II. The concentrations of PCE in shallow wells near the Spic and Span Site is similar to the concentrations found during the RI Phase I groundwater sampling events in the Spic and Span area. The shallow dissolved phase plume appears to have migrated downgradient of the Spic and Span Site, moving with shallow groundwater flow towards the northeast, east and south. The easterly component of the plume has expanded with the addition of DEC-037R, which was installed during the SC Phase VI field activities.

Figure 4-9 depicts isoconcentration contours for PCE in the deep overburden from analytical data collected during RI Phase II. A groundwater sample was not collected from DEC-024D and DEC-024DR due to the presence of DNAPL in the wells. The plume appears to have migrated downgradient of the Spic and Span Site, to a greater extent than in the shallow overburden, moving with deep groundwater flow towards the northeast, east and with a southerly component. The easterly component of the plume has expanded with the addition of DEC-003DD.

PCE was detected in 2 of the 4 top of clay wells sampled during the RI Phase II, but not at concentrations exceeding groundwater criteria [DEC-058TC (1.0 µg/L) and DEC-063TC (3.0 µg/L)].

4.3.2 Groundwater TCE Detections

**RI Phase I**

TCE was detected in 16 of the 36 groundwater samples collected during the RI Phase I, at concentrations exceeding groundwater criteria ranging from 8 µg/L to 3,700 µg/L. The highest concentration of TCE in the shallow overburden was detected at DEC-058 (3,700 µg/L), followed by DEC-060 (3,300 µg/L) and DEC-036 (1,500 µg/L). The highest concentration of TCE in the deep overburden was detected at DEC-060D (1,600 µg/L), followed by DEC-058D (870 µg/L), and DEC-036D (530 µg/L).

**RI Phase II**

TCE was detected in 28 of the 58 groundwater samples collected during the RI Phase II, at concentrations exceeding groundwater criteria ranging from 6 µg/L to 3,900 µg/L. The highest
concentration of TCE in the shallow overburden was detected at DEC-060 (3,900 µg/L), followed by DEC-058 (2,400 µg/L), and DEC-085 (1,200 µg/L). The highest concentration of TCE in the deep overburden was detected at DEC-058D (2,300 µg/L) followed by DEC-060D (1,700 µg/L) and DEC-037R (860 µg/L). TCE was not detected in the 4 top of clay wells.

4.3.3 PCE and TCE Degradation Product Detections

RI Phase I

PCE and TCE degradation products were detected in the RI Phase I groundwater samples at concentrations exceeding groundwater criteria (Figure 4-4). Cis-1,2-DCE was detected above groundwater criteria in 14 of the 36 RI groundwater samples during RI Phase I. During RI Phase I, the range of cis-1,2-DCE varied from 7 µg/L to 14,000 µg/L, with the highest concentration detected at DEC-058 followed by DEC-060 (6,900 µg/L) and DEC-060D (3,800 µg/L). Trans-1,2-DCE exceeded criteria in 4 RI Phase I samples with the highest concentrations in DEC-060 (45 µg/L). Vinyl chloride exceeded criteria in 10 of the 36 Phase 1 RI groundwater samples. Vinyl chloride exceeding criteria ranged from 5 µg/L to 3,200 µg/L, with the highest concentration detected at DEC-058 followed by DEC-057 (610 µg/L) in RI Phase I samples.

Similar to wells with PCE and TCE, degradation products have typically been found in monitoring wells to the northeast and east of the Spic and Span Site (i.e., DEC-036/036D, DEC-057, DEC-058/058D, and DEC-060/060D), indicating the degradation of the plume due to reductive dechlorination. This is most likely due to the non-chlorinated hydrocarbons associated with the ExxonMobil Off-Site Plume. Fuel hydrocarbons serve as electron donors. Their presence, combined with low redox conditions, can allow bacteria to reductively dechlorinate chlorinated hydrocarbons. Compounds related to petroleum products (i.e., 1,2,4-trichlorobenzene, 1,4-dichlorobenzene, benzene, isopropylbenzene and/or methyl tert-butyl ether) have been detected above criteria in wells DEC-023, DEC-024, DEC-034, DEC-053, DEC-054, DEC-057/057D and DEC-058.

RI Phase II

PCE and TCE degradation products were detected in the RI Phase II groundwater samples at concentrations exceeding groundwater criteria (Figure 4-7). Cis-1,2-DCE was detected above groundwater criteria in 22 of the 58 Phase 2 RI Phase II groundwater samples. During RI Phase II,
the range of cis-1,2-DCE varied from 9 µg/L to 6,100 µg/L with the highest concentration detected at DEC-060 and DEC-060D, followed by DEC-058 (4,700 µg/L). Trans-1,2-DCE exceeded criteria in 11 RI Phase II samples with the highest concentrations in DEC-058 (53 µg/L). Vinyl chloride exceeded criteria in 15 of the 58 RI Phase II groundwater samples ranging from 3 µg/L to 1,800 µg/L, with the highest concentration detected in DEC-058 followed by DEC-024 (200 µg/L) in RI Phase II samples.

The presence of PCE and TCE degradation products during the RI Phase II is similar to those found during the RI Phase I. Degradation products have been typically found in monitoring wells to the northeast and east of the Spic and Span site (i.e., DEC-037R/037D, DEC-058/058D, DEC-060/060D, and MW-057), indicating the degradation of the plume due to reductive dechlorination. This is most likely due to the non-chlorinated hydrocarbons associated with the ExxonMobil Off-Site Plume. Fuel hydrocarbons serve as electron donors.

4.3.4 Summary of Groundwater Analytical Results

PCE and its degradation products were detected in numerous groundwater monitoring wells in both the shallow and deep overburden groundwater. High concentrations of PCE were detected adjacent to the Spic and Span site in DEC-057 and DEC-057D at concentrations of 8,400 and 37,000 µg/L; downgradient of the site in DEC-058 and DEC-058D, to the northeast, at concentrations of 13,000 and 35,000 µg/L, respectively; to the east in DEC-060 and DEC-060D at concentrations of 22,000 and 13,000 µg/L, respectively, and in DEC-036 and DEC-036D at concentrations of 4,200 and 4,500 µg/L, respectively; and to the southeast in DEC-003DD at a concentration of 11,000 µg/L, and DEC-061 and DEC-061D at concentrations of 1,400 and 8,200 µg/L, respectively. PCE and its degradation products were not detected in the upgradient top of clay monitoring well (DEC-035TC). PCE was detected in 2 of the 4 top of clay wells sampled during the RI Phase II, but not at concentrations exceeding groundwater criteria [DEC-058TC (1.0 µg/L) and DEC-063TC (3.0 µg/L)].

TCE and cis-1,2-DCE were generally detected above criteria where PCE was detected. Vinyl chloride was detected above criteria generally to the north and east of the site, as well as in DEC-024; the maximum vinyl chloride concentration was detected in DEC-058 immediately downgradient of the site and adjacent to the ExxonMobil property. Additionally BTEX and/or fuel-related compounds were detected in DEC-053, DEC-054, DEC-058D, and DEC-037R.
Based upon the RI Phase II sampling event, the dissolved phase chlorinated solvent plume in shallow and deep overburden groundwater is slightly larger in aerial extent as compared to the RI Phase I sampling event. This may be an artifact due to the additional monitoring wells installed during the SC Phase VI and RI Phase II field work, in which the monitoring well array expanded. PCE appears to have migrated downgradient of the Spic and Span Site in the direction of groundwater flow, towards the northeast, east and with a southerly component. Higher concentrations of PCE were generally detected in the deep overburden as compared to the shallow overburden (i.e., DEC-057 vs. DEC-057D, DEC-058 vs. DEC-058D and the presence of DNAPL containing 11-73% PCE in DEC-024D and DEC-024DR). In the deep overburden groundwater (i.e., approximately 60 feet bgs), migration has also occurred to the southeast. The dissolved chlorinated solvent plume in the deep groundwater appears to be impacted by both the presence of DNAPL at the Spic and Span site (i.e., DEC-024D and DEC-024DR) and the presence of PCE soil contamination at 300 Kingsland Avenue (i.e., DEC-025 and DEC-025D). The plume is spreading with groundwater flow towards the northeast and east with a southerly component, and via downward migration to deeper geologic zones (down to approximately 60 – 65 feet bgs). Although PCE was detected in 2 of the 4 top of clay wells sampled during the RI Phase II, the concentrations did not exceed groundwater SCGs. PCE was detected in top of clay wells located adjacent to the Spic and Span Site (i.e., DEC-063TC) and downgradient to the northeast (i.e., DEC-058TC). The vertical extent of PCE and TCE impacted groundwater extends down to the top of the clayey silt unit, approximately 60 – 65 feet bgs. The dissolved phase groundwater plume appears to be spreading laterally along the clayey silt interface.

4.4 Soil Gas Analytical Results

4.4.1 RI Phase I

The locations of the VOCs detected in soil gas during the RI Phase I including PCE and its breakdown products are shown on Figure 4-10. Isoconcentration contours of PCE and TCE in the RI Phase I soil gas samples are shown on Figures 4-11 and 4-12, respectively. A summary of detected VOCs in the soil-gas and ambient air samples collected during the RI Phase I is presented in Table 4-18. Table 4-19 provides a statistical summary of the detected parameters for the RI Phase I air and soil gas samples as follows: the number of detections; the minimum, maximum and average values; and the location of the maximum value. The complete validated analytical results from the RI air and soil
gas samples are presented in the DUSR in Appendix N. Data summary tables and Form I’s are provided in the DUSR and include the reporting limit for each non-detected compound.

During the RI Phase I, PCE was detected at concentrations ranging from non-detect to a high of 8,200,000 µg/m³ at location SG-071, which may be attributed to an apparent source area in the vicinity of location DEC-025D and in soil samples from borings SSB-01 to SSB-10 and SG-071. PCE concentrations were high both northwest (SG-067 at 18,000 µg/m³), south (SG-070 at 1,100 µg/m³, SG-073 at 24,000 µg/m³ and SG-074 at 1,200 µg/m³) and west (SG-069 at 12,000 µg/m³) of this source area. Isoconcentration contours of PCE in the RI Phase I soil-gas samples are shown on Figure 4-11.

During the RI Phase I, the concentration of TCE was significantly higher than the PCE concentrations at SG-004, SG-065 and SG-072. Location SG-065 had concentrations of PCE at 330 µg/m³ and TCE at 1,500 µg/m³. On Morgan Avenue, location SG-004 had a PCE concentration of 1,300 µg/m³ and a TCE concentration of 32,000 µg/m³. Location SG-072 had a PCE concentration of 92 µg/m³ and TCE at 1,300 µg/m³. The majority of remaining soil gas locations had PCE and/or TCE concentrations less than at location SG-065. It should be noted that 1,1,1-trichloroethane was also found in several of the soil gas samples, with the highest concentration at location SG-004 at 1,100 µg/m³. Isoconcentration contours of TCE in the RI Phase II soil-gas samples are shown on Figure 4-12.

4.4.2 RI Phase II

The locations of the VOCs detected in soil gas during the RI Phase II including PCE and its breakdown products are shown on Figure 4-13. A summary of detected VOCs in the soil-gas and ambient air samples collected during the RI Phase II is presented in Table 4-20. Table 4-21 provides a statistical summary of the detected parameters for the RI Phase II air and soil gas samples as follows: the number of detections; the minimum, maximum and average values; and the location of the maximum value. Table 4-22 provides a historical summary of the detected parameters for all air and soil gas samples collected by URS in the Spic and Span site area since SC Phase I. Table 4-23 provides a statistical summary of the detected parameters for all samples collected by URS since the SC Phase I in the Spic and Span area as follows: the number of detections; the minimum, maximum and average values; and the location of the maximum value. The complete validated analytical results from the RI air and soil gas samples are presented in the DUSR in Appendix N. Data summary tables
and Form I’s are provided in the DUSR and include the reporting limit for each non-detected compound.

During the RI Phase II, PCE was detected at concentrations ranging from non-detect to a high of 6,000,000 µg/m³ at location SG-071, which may be attributed to an apparent source area in the vicinity of location DEC-025D. PCE concentrations were high directly east of the site (SG-099 at 1,000,000 µg/m³ and SG-051 at 150,000 µg/m³), and southeast of the site (SG-102 at 14,000 µg/m³ and SG-103 at 43,000 µg/m³). Isoconcentration contours of PCE in the RI Phase II soil-gas samples are shown on Figure 4-14.

During the RI Phase II, concentrations of TCE were greater than concentrations of PCE in many of the soil gas samples, especially along Morgan Avenue (SG-108 at 2,500 µg/m³, SG-072 at 4,800 µg/m³, SG-109 at 700 µg/m³, SG-076 at 820 µg/m³, SG-111 at 61 µg/m³), and the south side of Sutton Avenue (SG-075 at 54 µg/m³, SG-007 at 300 µg/m³), and along the north side of the site (SG-0-65 at 1,200 µg/m³). Isoconcentration contours of TCE in the RI Phase II soil-gas samples are shown on Figure 4-15.

Additional VOCs detected in many of the soil-gas samples include: benzene, toluene, ethylbenzene, and xylene and related compounds (e.g., 1,2,4-trimethylbenzene), hexane-related compounds (e.g., cyclohexane, n-hexane), and 1,1,1-trichloroethane. These contaminants suggest possible petroleum or fuel source(s).

Four ambient air samples were collected during RI Phase II field investigations to represent background air conditions. Concentrations of detected VOCs ranged from 0.053 to 110 µg/m³. VOCs detected in all four of these samples include acetone, benzene, dichlorodifluoromethane, ethanol, toluene, and xylene. Additional VOCs detected in at least one ambient air sample include 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, 1,3-butadiene, 4-ethyltoluene, 4-methyl-2-pentanone, chloromethane, cyclohexane, ethylbenzene, isopropyl alcohol, MEK, methylene chloride, n-heptane, n-hexane, PCE, TCE, and trichlorofluoromethane.

**4.4.3 Summary of Soil-Gas Results**

Soil-gas in the Spic and Span has been adversely impacted by the presence of PCE, TCE and their daughter products. The source of the elevated soil-gas concentrations appears to be centered adjacent to and immediately down gradient of the Spic and Span site (SG-67 and SG-99), nearby 300
Kingsland Avenue (SG-071, SG-012, and SG-013) and mid-block on Morgan Avenue (SG-004 and SG-008). The elevated concentrations mid-block on Morgan Avenue coincide with the location of elevated concentrations obtained by Roux from a temporary soil-gas point installed in September 2005 (see Section 1.2.1) which, historically has higher TCE concentrations than PCE concentrations.

The approximate size of the PCE and TCE plumes from RI Phase I and II are similar in size and appear to also mimic the extent of the dissolved phase shallow groundwater plume. The exception to this is the concentrations that exist mid-block on Morgan Avenue appear to indicate a separate source of soil-gas TCE contamination exists. The mid-block area of Morgan Avenue previously housed the Herzberg’s Fine Art Dyeing, Inc. (1942), Taylor and Co. Inc. which was a foundry (1942-1980), Baltic Metal Works (1951-1965), and United Resin Products, Inc. (1979-present).
5.0 CONTAMINANT FATE AND TRANSPORT

This section describes fate and transport processes that may influence the behavior of the contaminants detected at the site. The discussion emphasizes the processes that are essential in evaluating potential exposure of human and environmental receptors to site contaminants detected at concentrations above SCGs. The following items are presented in this section:

- General description of fate and transport processes occurring in soil, groundwater and soil vapor/air systems.
- Identification and description of properties of contaminants detected above SCGs in the various media at the site.
- Media-specific and contaminant-specific evaluation of potential fate and transport mechanisms occurring at the site.

5.1 General Description of Fate and Transport Mechanisms

This section provides general descriptions of the fate and transport processes that can occur in the environment in which samples were collected as part of the site investigations. In addition, the site characteristics that can affect these processes are discussed.

5.1.1 Transport Processes

Contaminant transport in the subsurface can occur as movement of dissolved contaminants in groundwater; and/or as migration of volatilized contaminants in soil vapor. The primary transport mechanisms are advection, dispersion, and partitioning of mass.

Mass partitioning is a process in which contaminants move between different environmental media in response to concentration gradients. For example, contaminants dissolved in groundwater may sorb (i.e., attach) onto soil particles or volatilize into the soil vapor. The process may involve mass transfer in any direction between any of the environmental media. The net result of mass partitioning is the distribution of the contaminant between all phases that remain in physical contact with each other. Typically, mass partitioning acts to inhibit the migration of contaminants in groundwater or soil vapor by immobilizing a part of the mass in the soil matrix (retardation). However, the process may be reversed, resulting in the slow release of the sorbed contamination into the groundwater or soil vapor.
In the unsaturated zone (i.e., between the ground surface and the water table), the total mass of a contaminant is partitioned between the dissolved phase (soil moisture), the gas phase (soil vapor), and the solid phase (soil matrix). In the saturated zone, the soil vapor phase is absent and the partitioning occurs only between the soil matrix and groundwater. Under equilibrium conditions, each phase contains a fraction of the total contaminant mass present in the system (i.e., total of both phases equals 100 percent of the contaminant mass present). The relative mass fractions are determined by the properties of each contaminant and by the nature of the soil matrix. Equilibrium conditions may be disturbed by phenomena such as migration of contaminated groundwater or soil vapor into an area, or removal of contaminant mass from one of the media through degradation processes or gravity flow. Under these circumstances, concentration gradients are created resulting in the occurrence of mass transfer between the media.

The contaminant mass sorbed onto the soil matrix is essentially immobile. The exception is the mass in the topmost soil layer, which can be transported by processes capable of moving soil particles (wind, surface water runoff). However, since soil within most of the site area is not exposed due to impervious surface cover including pavement, sidewalks and buildings, this is not a significant transport pathway. Sorbed contaminants generally act as a source for the dissolved and gas phases.

Transport of contaminants dissolved in the soil moisture in the unsaturated zone is generally limited as a result of very low flow rates in the absence of full saturation. The only significant mechanisms may be driven by water level fluctuations (such as tidal influences and groundwater levels impacted by recovery wells on nearby properties under remediation) and gravity-driven downward flow during wet-weather periods, or possibly sewer lines which may be leaking and/or act as preferential pathways. Such vertical transport of contaminants acts as a source for the saturated zone below.

The contaminant mass contained within the soil vapor and within groundwater in the saturated zone is more mobile. Soil vapor can migrate in both vertical and horizontal directions in response to pressure gradients. The migration can create a discharge of contaminants into the atmosphere or building basements, or act as a source of contamination for groundwater in the saturated zone. Migrating soil vapor may transfer mass into the soil matrix and soil moisture in previously uncontaminated areas, thus increasing the areal extent of soil contamination in the unsaturated zone.
The primary transport mechanisms for contaminants dissolved in groundwater are advection and dispersion. Advection is the movement of the dissolved contaminants carried by the flow of groundwater. Dispersion refers to dissolved contaminants spreading due to the presence of non-uniformities in the groundwater flow field. Dispersion results in a general widening of a plume, as well as smearing of the plume boundaries. The magnitude of dispersion is site specific and is generally difficult to measure. Processes similar to those that occur for soil vapor can enable dissolved contaminants to reach a previously uncontaminated area and enter other environmental media.

Contamination migrating with soil vapor or groundwater constantly interacts with the soil matrix. The driving forces behind this process are created by concentration gradients between different phases and the properties of the contamination and the soil matrix. Contaminant mass may either sorb from the mobile soil vapor or groundwater onto the soil particles or it may undergo a reverse process of desorption.

In the case of sorption, contaminant mass is transferred from the mobile medium into the immobile soil medium. This phenomenon tends to decrease the velocity of contaminant migration, and is consequently referred to as retardation. The magnitude of the retardation depends on the properties of each contaminant and the soil matrix. The key indicator parameter for the retardation properties of the soil is the organic carbon content. Measured values of total organic carbon in soil at the site are summarized in the table below.
Total Organic Carbon Concentration By Geologic Unit

<table>
<thead>
<tr>
<th>Sample ID</th>
<th>Depth (ft) bgs</th>
<th>Total Organic Carbon Concentration (mg/kg)</th>
<th>Geologic Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSB-11</td>
<td>0-5</td>
<td>1,300</td>
<td>Fill Unit</td>
</tr>
<tr>
<td>SSB-11</td>
<td>15-16</td>
<td>2,630</td>
<td>Inclusive Sand Unit</td>
</tr>
<tr>
<td>SSB-11</td>
<td>24-25</td>
<td>6,560</td>
<td>Glacial Till Unit</td>
</tr>
<tr>
<td>SSB-11</td>
<td>46-47</td>
<td>2,930</td>
<td>Sand Unit</td>
</tr>
<tr>
<td>SSB-11</td>
<td>53-54</td>
<td>732</td>
<td>Clayey Silt Unit</td>
</tr>
<tr>
<td>SSB-12</td>
<td>0-5</td>
<td>3,650</td>
<td>Fill Unit</td>
</tr>
<tr>
<td>SSB-12</td>
<td>16-17</td>
<td>8,660</td>
<td>Glacial Till Unit</td>
</tr>
<tr>
<td>SSB-12</td>
<td>20-21</td>
<td>1,070</td>
<td>Sand Unit</td>
</tr>
<tr>
<td>SSB-12</td>
<td>44-45</td>
<td>1,340</td>
<td>Fine Sand and Silt Unit</td>
</tr>
<tr>
<td>SSB-15</td>
<td>0-5</td>
<td>3,490</td>
<td>Fill Unit</td>
</tr>
<tr>
<td>SSB-15</td>
<td>16.5-17.5</td>
<td>1,634</td>
<td>Sand Unit</td>
</tr>
<tr>
<td>SSB-15</td>
<td>33-34</td>
<td>1,180</td>
<td>Sand Unit</td>
</tr>
<tr>
<td>SSB-15</td>
<td>40-41</td>
<td>1,010</td>
<td>Fine Sand and Silt Unit</td>
</tr>
</tbody>
</table>

Soils with high organic carbon content sorb dissolved contaminants more readily and create a more significant retardation effect than soil with limited, or no organic carbon content. Desorption is the reverse process. Contamination is transferred from the soil matrix into the groundwater or soil vapor. As a result, soil containing contaminant mass may act as a source if exposed to less-contaminated soil vapor or groundwater. Desorption from soil into the soil vapor or groundwater is increasingly inhibited by increasing content of organic carbon in the soil.

5.1.2 Mass Destruction Processes

In the urban environment of the Spic and Span site, contaminant mass in the soil is not exposed at the ground surface. Contaminant mass contained within the saturated zone is not exposed to sunlight or the atmosphere. Therefore, abiotic mass destruction processes that rely on the presence of air or exposure to sunlight (such as hydrolysis and photolysis) have little impact within the subsurface and will not be discussed further.
The most significant mass destruction process that takes place in subsurface environments is microbial degradation. The most significant microbial degradation processes for organic contaminants that operate in groundwater systems are: biological oxidation (aerobic and anaerobic); reductive dechlorination; and cometabolic degradation. During degradation, organic compounds are transformed into daughter forms, which may be recalcitrant or further degradable. Daughter compounds can be either more or less toxic than the parent compounds. If a contaminant degrades into a sequence of degradable daughter compounds, it is ultimately fully metabolized into such compounds as carbon dioxide, methane, water, and chloride. The contaminants at the Spic and Span site, PCE and TCE, degrade to dichloroethene (1,2-DCE) and vinyl chloride (VC), as shown on Figure 5-1. Ultimately, PCE and TCE metabolize into carbon dioxide and ethene.

5.2 Fate and Transport of Site Contaminants

5.2.1 Contaminants of Concern

Primary contaminants of concern identified at the site belong to the group of VOCs. The VOCs (primarily PCE and TCE) detected in the onsite soil, soil gas and groundwater are predominantly chlorinated hydrocarbons. Other VOCs, such as toluene (a BTEX compound), were also detected. However, the detections of other VOCs were localized and the concentrations were orders-of-magnitude lower than those of chlorinated compounds.

5.2.2 Properties

VOCs

VOCs, including PCE, TCE, and 1,2-DCE, are generally moderately to highly soluble in water. They readily volatilize into the atmosphere or soil gas. At the surface, VOCs generally decay under the action of sunlight and upon the exposure to the atmosphere. Dissolved VOCs are transported by advection and dispersion in groundwater. The same processes of advection and dispersion are responsible for the migration of VOCs in the atmosphere or the soil gas. These compounds have low to moderate organic carbon-to-water partitioning coefficients and do not readily partition into the soil, making them relatively mobile in the environment.
In the subsurface environment, chlorinated VOCs, including PCE, TCE and 1,2-DCE, undergo reductive dechlorination under anaerobic conditions but are typically recalcitrant under aerobic conditions. BTEX compounds are relatively degradable under aerobic conditions and also degrade under anaerobic conditions, albeit at slower rates.

**NAPL**

Visible PCE DNAPL was observed in the soil at several locations including in SSB-030, SSB-032, and in well borings DEC-024D and DEC-024DR. Visible PCE DNAPL was observed at depths between 18 and 28 feet bgs and 40 – 48 feet bgs in SSB-032; 50 – 60 feet in SSB-030; and is accumulating in monitoring wells DEC-024D and DEC-024DR at approximately 50 – 54 feet bgs. Recovery rates of PCE DNAPL during well development in DEC-024D and DEC-024DR was approximately less than 1 gallon of PCE per event, in which approximately 55 gallons of groundwater was removed via pumping with a submersible pump at a rate of approximately 1 gallon per minute. DNAPL analytical results indicate the DNAPL is comprised of primarily PCE measured at concentrations between 11% and 73% with a reported specific gravity of 1.2942, viscosity of 1.211 centipoise, and surface tension of 26.4 dynes/cm.

DNAPL is generally not degradable in the subsurface. The high concentrations of hydrocarbons contained in DNAPL are lethal to microorganisms. The constituents in DNAPL may dissolve in groundwater and/or volatilize becoming mobile in the environment. Therefore, DNAPLs in the subsurface environment generally undergo gradual transformation, as volatile and soluble compounds are gradually removed. DNAPL migration depends mostly on the physical properties and nature of the subsurface materials. DNAPLs typically migrate downward within the aquifer, until encountering a lower permeability unit. At that point, DNAPLs can migrate under the influence of the slope of the lower permeability unit and/or hydraulic gradients.

**5.2.3 Source(s) of Contamination**

In the past, the Spic and Span site was utilized as a dry cleaning facility. PCE is the main ingredient of the solvent used in dry cleaning. The original source of the PCE contamination is likely to be leakage from any storage tanks and/or dry cleaning machines, drains which may have been used for disposal, and/or spills occurring during handling. The spilled dry cleaning solvent resulted in DNAPLs which contain high concentrations of PCE.
An apparent additional source of PCE has been identified adjacent to 300 Kingsland Avenue. The horizontal and vertical extent of this source has not yet been delineated. However, the mechanism by which the source acts on the environment can be described based on the known factors, such as the nature of the chlorinated solvents and the observed distribution and level of the soil and ground water contamination.

Following the release of PCE, it migrates downward under the influence of gravity as a separate-phase liquid proceeding through the unsaturated zone. However, PCE is heavier than water and the downward migration continues after the spill reaches the saturated zone. During the migration, the total mass of PCE present in a flowable form is continuously depleted by the process of absorption within the soil. The migrating front leaves behind a zone where soil contains PCE in the form of separate-phase ganglia, immobilized between the soil particles and held in place by surface forces. If the PCE liquid encounters an impermeable barrier, such as a clayey silt layer, it comes to rest on the surface of the barrier in the form of pools. However, if no such barrier is present and the aquifer is thick, all of the PCE mass is eventually absorbed and immobilized within the soil.

The zone of PCE ganglia and the liquid pools (if present) form the source of contamination within the aquifer. PCE constantly dissolves in ground water (saturated zone) and soil gas (unsaturated zone), initiating mass transfer and destruction processes described in Section 5.1.2.

5.2.4 Fate and Transport in the Unsaturated Zone

5.2.4.1 Migration

The propagation of contaminants in the unsaturated zone is dominated by two processes: migration of the dissolved phase from infiltrating precipitation and migration of the volatilized contaminants in the soil gas. Migration of the contamination adsorbed into soil with the fugitive dust emissions or surface runoff will not be an issue at this Site due to the impervious nature of the surface cover.

Most of the soil at the site is located under a relatively impervious cover (either pavement or buildings). Drop inlets (DIs) which lead to the storm sewers are present along the roadways. Infiltration from precipitation across the site area is limited to the cracks and joints of the pavement and concrete surfaces. Therefore, the extent of the infiltration-induced migration is likely to be
limited. The process is of little significance in the overall balance of mass transfer occurring at the site.

Contaminants of concern enter the soil gas through the process of volatilization. The site is almost entirely paved, and the thickness of the unsaturated zone is high. Therefore, the sources of contamination are not in close contact with the atmosphere. As a result, the lateral migration of the gas phase of the contamination is likely to be significant. Separated from the direct contact with the atmosphere, the soil gas will tend to migrate laterally, possibly at great distances, and seek discharge points at discrete locations, such as basements or underground sewer pipes.

The site contains virtually little unvegetated and unpaved areas. Therefore, it does not generate fugitive dust emissions. Likewise, the erosion and transport of surface soil by runoff is very limited. Contamination adsorbed into soil is unlikely to migrate via the pathways of dust emissions or runoff transport.

5.2.4.2 Degradation

Generally, the occurrence and rates of unsaturated zone degradation have to be determined by means of field studies, such as, for example, respiration tests. However, this is only appropriate for contaminants that can be aerobically degraded. PCE is not readily aerobically degradable. Rates of biological degradation depend largely on the presence of water. In the unsaturated zone, sufficient water may not be present continuously, thus limiting the potential for the growth of microorganisms.

The site area is mostly paved. The unsaturated zone is not exposed to the action of sunlight and high temperature in the summer. Therefore, rates of abiotic degradation are likely to be very low, even in the top-most layers. In general, rates of contaminant degradation in the unsaturated zone are expected to be relatively low, although PCE degradation to TCE is apparent in soil sample SSB-08 (at 0.5-1 foot bgs) is indicated in Section 4.1.

5.2.5 Fate and Transport in the Saturated Zone

5.2.5.1 Migration

Migration in the saturated zone takes place predominantly by means of the transport of the dissolved-phase contamination in groundwater. The dominant factors are the direction of the flow.
within the aquifer, the hydraulic gradient, the hydraulic conductivity of the aquifer material (both the average value and spatial distribution) and the chemical composition of the soil matrix.

The site is located within the Upper Glacial Aquifer. The aquifer is characterized by high hydraulic conductivity and low gradients but vary locally due to the ongoing pumping well network associated with the ExxonMobil Off-Site Product Recovery System. Locally, the average hydraulic conductivity has been estimated to be on the order of $10^{-3}$ cm/s within the sand units, and $10^{-5}$ to $10^{-6}$ cm/s in the clayey silt unit. The flow direction appears to be to the north and northeast, with hydraulic gradients generally on the order of 0.002 ft/ft with greater gradients (up to 0.084 ft/ft) in the immediate vicinity of the site.

The horizontal and vertical extent of the dissolved phase plume has generally been determined, with the exception of the concentrations: beneath the building where the source of PCE contamination is likely located; beneath 300 Kingsland Avenue where a secondary source of PCE is apparent; east and northeast of DEC-037R on Sutton Street; and east of DEC-003DD on Sutton Street. The horizontal extent of the dissolved phase plume in shallow and deep groundwater appears to originate around the Spic and Span site, and a second, as yet unknown source has been identified around DEC-025D near 300 Kingsland Avenue. The dissolved phase plume is spreading with groundwater flow towards the northeast, east, and with a southerly component, and via downward migration to deeper geologic zones (i.e., approximately 60 – 65 feet bgs). Although PCE was detected in 2 of the 4 top of clay wells sampled during the RI Phase II, the concentrations did not exceed groundwater SCGs. PCE was detected in top of clay wells located adjacent to the Spic and Span Site (i.e., DEC-063TC) and downgradient to the northeast (i.e., DEC-058TC). The vertical extent of PCE and TCE impacted groundwater extends down to the top of the clayey silt unit, approximately 60 – 65 feet bgs. The plume appears to be spreading laterally along the clayey silt interface.

5.2.5.2 Degradation

Compounds detected at the site are potentially degradable in groundwater. The bulk of the contamination is present as chlorinated hydrocarbons, especially PCE. The predominant mechanism for the degradation of these compounds is reductive dechlorination. The likelihood of the occurrence of this pathway can be assessed using the following indicators (after the Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Ground Water, USEPA 1998). Table 5-1
summarizes groundwater analytical data that was collected in the vicinity of the Spic and Span area during previous phases of site characterization as well as both phases of the RI. This data includes both laboratory analytical results and field measured results. The October 2011 sampling round results were used to establish the baseline data for future comparison of groundwater sampling data, which will be used to evaluate the potential for natural attenuation. The parameters listed below were considered in assessing the groundwater data.

**pH** - Groundwater pH has an effect on the presence and activity of microbial populations. Generally, microorganisms that are most efficient biodegraders prefer neutral pH values (6 to 8). The range of values allowing the reductive dechlorination to occur is between 5 and 9. The pH values of groundwater samples collected as part of the RI are within the range of pH that is conducive to reductive dechlorination.

**Dissolved Oxygen** - Dissolved oxygen is the most favored electron acceptor in biodegradation of hydrocarbons. Levels of less than 1 mg/L indicate that aerobic degradation has occurred, oxygen has been largely utilized, and a shift to anaerobic processes is taking place. Reductive dechlorination takes place under anaerobic conditions, generally when the dissolved oxygen levels are less than 0.5 mg/L. Typically, the anaerobic environment is created by the degradation of non-chlorinated compounds, such as BTEX. Following that, the likelihood of degradation of chlorinated hydrocarbons becomes high. Figure 5-2 and 5-3 depict the measured values of dissolved oxygen in the shallow overburden and deep overburden (i.e, down to approximately 60 – 65 feet) based upon data collected as part of the January 2012 sampling round. Anaerobic conditions exist in many areas across the site. In the shallow overburden, dissolved oxygen levels below 1 mg/L occur primarily along Kingsland Avenue north and south of Norman Avenue, with a few exceptions at DEC-067, DEC-058 and DEC-086. In the deep overburden, dissolved oxygen levels below 1 mg/L in groundwater is of greater areal extent, and generally extends eastward beneath Sutton Street.

**Ferrous Iron** - Iron-reducing conditions are favorable to the process of reductive dechlorination. Concentrations of ferrous iron higher than 1 mg/L suggest iron reduction is occurring, and thus oxidation/reduction (redox) conditions are suitable for reductive dechlorination. For the January 2012 sampling round, concentrations of ferrous iron above 1 mg/L were reported at DEC-023, DEC-024, DEC-034, DEC-035, DEC-056, DEC-057, DEC-058, DEC-060D, DEC-067, DEC-068, DEC-086, and DEC-087.
**Sulfate** – Sulfate may be used as an electron acceptor after dissolved oxygen has been depleted during anaerobic degradation. Reductive dechlorination can occur under favorable anaerobic conditions with sulfate concentrations below 20 mg/L; however, reductive dechlorination can still occur in groundwater plumes with high levels of sulfate. Detected concentrations of sulfate from the January 2012 sampling round ranged from non-detect in DEC-034 to 213 mg/L in DEC-054D. In samples from DEC-023 and DEC-034, sulfate concentrations were below 20 mg/L.

**Oxidation/Reduction Potential** - Reductive dechlorination becomes possible at levels of less than approximately 50 millivolts (mV). The likelihood of its occurrence is significant for the Oxidation/Reduction Potential (ORP) values less than -100 mV. Figures 5-4 and 5-5 depict the measured values of ORP in the shallow overburden and deep overburden (i.e., approximately 60 – 65 feet bgs) based upon data collected as part of the January 2012 sampling round. Strong reducing conditions exist in many areas across the site. In the shallow overburden, ORP values below 50 mV generally occur along Kingsland Avenue north and south of Norman Avenue, with the exception of DEC-036, DEC-085, and DEC-038. In the deep overburden, ORP values below 50 mV occur generally in all areas, with the exception of DEC-025D, DEC-054D, and DEC-055D. In general, ORP values in the deep overburden indicate stronger reducing conditions compared to the shallow overburden.

**Organic Carbon** - Organic carbon, either naturally occurring or anthropogenic, typically serves as the electron donor required to drive the dechlorination process. Levels above 20 mg/L are favorable. Table 5-1 summarizes the total organic carbon in groundwater during the October 2011 groundwater sampling round. None of the reported concentrations are above 20 mg/L. However, the ExxonMobil Off-Site Plume area (Roux, August 12, 2011) exists immediately north and east of the site area, and the LNAPL as a source of carbon can promote reductive dechlorination.

**Chloride** - Chloride levels two times higher than background may indicate that the compound has been produced as a byproduct of dechlorination. Typically, high chloride levels occur within the downgradient portion of the plume. Detected chloride concentrations from the January 2012 groundwater sampling round ranged from 21 mg/L in DEC-023 and DEC-056, to 1,530 mg/L in DEC-002. Reported concentrations in the upgradient wells DEC-035, DEC-035D, and DEC-035TC were 657 mg/L, 398 mg/L, and 174 mg/L, respectively. Since little to no chlorinated compounds were detected in the top of clay monitoring wells, reported concentrations of chloride likely represent...
naturally occurring conditions in the aquifer. In the shallow and deep overburden groundwater (approximately 60 - 65 feet bgs), no trends in chloride concentrations are apparent.

**Distribution of Chlorinated Species** - Significant degradation of the chlorinated solvents is marked by a shift in the relative concentrations of various compounds. As the degradation progresses, the original compound released into the environment breaks down into the daughter product, where successively more chloride atoms are removed from the compound molecule and replaced with hydrogen. In this case, PCE would shift to TCE, then to DCE and finally to VC. Vinyl chloride is difficult to dechlorinate further (requires very strong reducing conditions), but is readily oxidized under aerobic conditions. Under favorable anaerobic conditions, VC can be reduced to ethene as shown of Figure 5-1.

Figures 5-6 and 5-7 depict the concentrations of TCE in the shallow overburden and deep overburden, respectively, based upon groundwater data collected as part of the January 2012 sampling round. In the shallow overburden, the most concentrated portion of the TCE plume is situated along the east side of Kingsland Avenue, and extends northward to DEC-058 and southward to DEC-061, and eastward to DEC-037R along Sutton Street. In the deep overburden, the most concentrated portion of the TCE plume is situated near DEC-058D and DEC-060D, and extends eastward to DEC-037D.

Figures 5-8 and 5-9 depict the concentrations of cis-1,2-DCE in the shallow overburden and deep overburden, respectively, based upon groundwater data collected as part of the January 2012 sampling round. Concentrations of cis-1,2-DCE are generally higher than the TCE concentrations, however, the horizontal extent of cis-1,2-DCE is very similar to the horizontal extent of TCE in the shallow overburden. There is a greater horizontal extent of cis-1,2-DCE in the deep overburden, as the cis-1,2-DCE plume extends beyond DEC-003DD along Sutton Street.

Figures 5-10 and 5-11 depict the concentrations of VC in the shallow overburden and deep overburden, respectively, based upon groundwater data collected as part of the January 2012 sampling round. VC was detected only sporadically in the shallow overburden, in DEC-058, DEC-057, DEC-024, DEC-085, DEC-060, DEC-034, and DEC-037R. The horizontal extent of VC in the deep overburden is slightly larger than in the shallow overburden, but is generally less concentrated.
Summary

Based upon the data collected to assess the potential for degradation of PCE in the groundwater system as presented above, there is evidence that reductive dechlorination is occurring in the vicinity of the site. Rates of degradation are very difficult to determine due to the unknown quantity of source material present beneath the Spic and Span Site and beneath the 300 Kingsland Avenue building. Based upon the geochemical conditions in the groundwater system, the aquifer is conducive for naturally occurring reductive dechlorination, and therefore, the geochemical conditions could be enhanced via in-situ bioremediation technologies to further promote higher rates of reductive dechlorination.

5.2.5.3 Overall Plume Behavior

RI Phase I

Based upon the observed concentrations of VOCs from the latest groundwater sampling event, the dissolved chlorinated solvent plume appears to originate at the Spic and Span site, and an additional unknown apparent source is present adjacent to 300 Kingsland Avenue. In the shallow groundwater regime, it appears that the chlorinated solvent plume has higher concentrations of PCE immediately north and east of the Spic and Span site, and is more discrete compared to the deeper groundwater regime. In the deeper groundwater regime, the complete horizontal and vertical extent of the chlorinated solvents has not been delineated. The dissolved chlorinated solvent plume in the deeper groundwater regime appears to be impacted by both sources of PCE contamination and is spreading with groundwater movement towards the northeast, east and with a southerly component, and also via downward migration to deeper geologic zones.

RI Phase II

Based upon the January 2012 groundwater sampling event, the horizontal and vertical extent of the dissolved phase groundwater plume has been mostly determined in the shallow overburden and deep overburden, and determined in the top of clay. In the shallow overburden, the dissolved phase plume extends beyond DEC-037R towards the east/northeast on Sutton Street. In the deeper overburden, the dissolved phase plume extends beyond DEC-003DD towards the east. The sources of dissolved phase VOCs are at the Spic and Span Site, in the DNAPL identified in the subsurface
adjacent to the Spic and Span building, and in subsurface soils adjacent to 300 Kingsland Avenue. The source area of DNAPL and dissolved phase concentrations of VOCs beneath these areas has not been delineated; however, the resulting dissolved phase groundwater plume originating from these sources has been mostly delineated, with the exceptions noted above. In the shallow groundwater, it appears that the chlorinated solvent plume has higher concentrations of PCE immediately north and east of the Spic and Span site, and is more discrete compared to the deep groundwater. The dissolved chlorinated solvent plume in the deep groundwater appears to be impacted by three sources of PCE contamination and is spreading with groundwater movement towards the northeast, east and southeast, and also via downward migration to deeper geologic zones from its sources, down to the clayey silt unit at approximately 60 to 65 feet bgs. The lower permeability of the clayey silt unit appears to be inhibiting further downward migration for DNAPLs identified adjacent to the Spic and Span building, as well as the dissolved phase chlorinated solvent plume. For this reason, the dissolved phase chlorinated solvent plume appears to be spreading laterally at greater distances in the deep groundwater (i.e., 60 to 65 feet bgs), compared to shallow groundwater. In the deep groundwater near the top of clay, there is little to no impact from the sources of VOC contamination, indicating that the dissolved phase plume has not reached this impermeable barrier. This portion of the groundwater system will not require remediation.
6.0 QUALITATIVE HUMAN HEALTH RISK ASSESSMENT AND FISH AND WILDLIFE ASSESSMENT

This section will present the Qualitative Human Health Exposure Assessment (HHEA) and the Fish and Wildlife Resources Impact Analysis (FWRIA) for the site. This qualitative HHEA uses data and information collected during the SC Phase I through Phase VI and the RI Phases I and II to assess human health exposure in the immediate and surrounding areas. The qualitative HHEA provides an evaluation of potential adverse health effects under current and potential future site conditions that may result from exposure to contaminants attributable to former activities at the site.

6.1 Qualitative Human Health Exposure Assessment

This qualitative HHEA follows the general format and procedures set forth in the United States Environmental Protection Agency’s (USEPA’s) Risk Assessment Guidance for Superfund (RAGS) (USEPA 1997a). As such, it includes three of the four required components (the fourth component, Risk Characterization, is not included because this assessment is qualitative), which are presented in the following subsections. This qualitative HHEA uses data and information collected during the two phases of the remedial investigation, and appropriate information from site characterization activities to assess human health exposure in the immediate and surrounding areas. The qualitative HHEA provides an evaluation of potential adverse health effects under current and potential future site conditions that may result from exposure to contaminants attributable to former activities at the site.

6.1.1 Identification of Chemicals of Potential Concern

Based upon the analytical data obtained and presented in Section 4, the contaminants of potential concern (CPCs) were selected based on the frequency of detection, range of concentrations, and potential for migration, as well as whether the detected analytes exceeded applicable standards, criteria, or guidance values for the media. A “medium of potential concern” is identified as a physical medium (soil, groundwater, soil vapor) in which one or more contaminants were detected at concentrations exceeding their SCGs.

VOCs were found in most subsurface soil samples collected. Of the soil samples analyzed for SVOCs and pesticides, a few were detected. Metals were detected in all soil samples analyzed for
metals. Soil analytical results were compared to soil background concentrations (surface soil samples from McGolrick Park), and Part 375 unrestricted use criteria as presented on Tables presented in Section 4. Contaminants which exceeded either background concentrations or Part 375 unrestricted use criteria are presented on Table 6-1 as CPCs for soil. These include VOCs and SVOCs.

Several VOCs were detected in groundwater. For groundwater, the SCGs are the NYSDEC Class GA (groundwater) standards and guidance values presented in TOGS 1.1.1, April 2000 (including subsequent revisions). All contaminants detected in groundwater that exceeded SCGs are considered CPCs. Table 6-1 presents a summary of CPCs for groundwater.

Soil gas was also sampled during the investigation and found to be contaminated with VOCs. There are no criteria for soil vapor analytical data; however, the NYSDOH Soil Vapor Guidance Decision Matrix 1 and 2 (NYSDOH, 2006 with 2008 updates) were utilized to evaluate the potential for soil vapor intrusion by reviewing sub-slab vapor concentrations for the VOCs relevant to the Decision Matrices: 250 μg/m³ for TCE, carbon tetrachloride, and VC; and 1,000 μg/m³ for PCE, 1,1,1-trichloroethane, 1,1-dichloroethene, and cis-1,2-dichloroethene. Detected analytical results were sufficiently high for either PCE and/or TCE at many locations to indicate the highest level of action recommended: mitigate. These compounds are therefore considered CPCs for soil gas as indicated on Table 6-1.

6.2 Exposure Pathways

An exposure pathway is the manner by which an individual may come in contact with a contaminant. The elements of a completed exposure pathway include: the contaminated environmental media (i.e., soil, water, or soil gas); the receptor (e.g., construction worker, onsite employee, public) exposed to the contamination; and the routes of exposure or how the contaminant enters the body (i.e., inhalation, ingestion, and/or absorption through the skin). Tables 6-2 and 6-3 present the exposure pathways assessed for the site under current and future land use scenarios, respectively. Direct contact exposure pathways are not complete for the public under current conditions for outdoor air, or for any receptors for groundwater. Potential pathways are complete for onsite employees and for construction workers during intrusive activities under current conditions for subsurface soil and soil vapor/indoor air. The exposure pathways for soil, soil vapor/indoor air and...
outdoor air are potentially complete for future use conditions, if intrusive activities occur. The following subsections discuss the rationale for identifying completed exposure pathways.

6.2.1 **Soil**

The Property is a commercial facility. There is no surface soil onsite since the entire surface of the Property is covered by the building, pavement and/or sidewalks. The limited soil present around trees planted in the sidewalk areas around the Property would be imported topsoil material. While subsurface soil is not accessible to the general public because soil on the Property is entirely covered by the building, pavement and sidewalks, the only potential complete exposure is for construction workers who could come into contact with contaminated soil during intrusive activities. Therefore subsurface soil is considered a potentially complete exposure pathway under the current use scenario for construction workers. Under the future use scenario, intrusive activities from possible construction efforts may result in a completed pathway.

6.2.2 **Soil Vapor/Indoor Air**

Currently, there are employees working within the onsite building. While there are no indoor air or sub-slab sample results, VOCs were detected at relatively high concentrations in soil vapor and shallow soil samples from nearby the property. The potential exists for these high concentrations to be present in soil vapor beneath the onsite building and nearby homes which may be potentially impacting indoor air quality. Therefore, there could be a completed pathway under the current use scenario. In the future use scenario, the potential also exists for CPCs in the soil and soil vapor beneath the building and nearby homes to migrate into the indoor air. Under the current and future use scenarios, construction workers, the public and employees could come into contact with contaminated soil vapor. Therefore soil vapor is considered a potentially completed exposure pathway under the current and future use scenarios for construction workers, the public, and employees.

6.2.3 **Outdoor Air**

Since the entire Property is covered by the onsite building, pavement and/or sidewalks, outdoor air is not impacted under current use conditions. The potential exists for the public to be exposed to contaminants from exposed subsurface soil and/or fugitive dust generated during future construction activities.
6.2.4 **Groundwater**

Under the current use scenario, groundwater is not known to be used as a potable water supply (drinking water is supplied to local residents by the City of New York Water Department) or for any other known industrial purposes in the vicinity of the Property. Therefore, it is not a completed exposure pathway under the current use scenario. It is not anticipated that in the future, onsite groundwater would be used for potable purposes. Construction workers would not be exposed to groundwater contaminants during current or future intrusive activities as the depth to groundwater in the area of the site is a minimum of 11 feet bgs, and generally greater than 14 feet bgs.

6.2.5 **Summary**

Tables 6-2 and 6-3 present a summary of the potential routes of exposure, the potential receptors, the potential completed pathways, and the mitigation which would eliminate and/or control the potential pathways. Under current conditions, potential pathways are complete for construction workers during intrusive activities for subsurface soil and soil vapor, and for onsite employees and nearby residents due to indoor air. Potentially completed pathways exist for future use for subsurface soil and soil vapor for construction workers, outdoor air for the public, and indoor air for onsite employees and nearby residents.

6.3 **Fish and Wildlife Exposure Assessment**

This Fish and Wildlife Resources Impact Analysis has been prepared for the Site located in Brooklyn, Kings County, New York. The Site location is shown on Figure 1-1. An aerial view of the Site and vicinity is presented as Figure 1-2.

The FWRIA follows the guidance provided by the NYSDEC Division of Fish and Wildlife (NYSDEC 1994). The FWRIA is a stepwise process that was developed to determine the nature and extent of ecological impacts from hazardous waste sites in New York State. The objective of Step I of the FWRIA process is to identify fish and wildlife resources that exist on and/or adjacent to the Site.

6.3.1 **Step I.A – Cover Type Map**

An aerial photography-based cover type map of the area within a one-half mile radius of the Site (project area) is presented as Figure 6-1. The Site is zoned M1-1 for a light industrial and
manufacturing district. The Site is currently the location of a commercial business. The project area is highly urbanized with commercial, industrial, residential, and road and utility development. Land use in the surrounding area is predominantly industrial and commercial. A large apartment building complex is located to the west of the Site.

Newtown Creek, designated Class SD marine water by the NYSDEC, is located approximately 1,300 feet northeast of the Site. The SD classification for marine waters indicates a best usage for fishing, but these waters may not support fish propagation. Newtown Creek is an estuary connected with the East River. Newtown Creek was designated as a Superfund site in 2010. The East River is located approximately one mile west of the Site. The East River is classified as a Class I saline surface water. The best usages of Class I waters are secondary contact recreation and fishing. These waters are suitable for fish, shellfish, and wildlife propagation and survival. The East River is a New York State-protected stream.

6.3.2 Step I.B – Description of Fish and Wildlife Resources

6.3.2.1 Fish and Wildlife Resources and Cover Types

There are no NYSDEC Wetlands, Critical Habitats or designated Wild, Scenic or Recreational Rivers mapped within the project area. The project area is composed of three vegetated terrestrial-cultural cover types: mowed grass with trees (associated with residential, recreational or commercial land with greater than 30% tree cover); mowed grass (associated with residential, recreational or commercial land with less than 30% tree cover); and urban vacant lot (associated with vegetated areas with exposed soil, rubble and debris). The remainder of the project area is included in the terrestrial-cultural urban structure exterior cover type. This cover type includes the exterior surfaces of metal, wood or concrete structures such as buildings, roads, storage areas and parking lots.

6.3.2.2 Fauna Expected within each Cover Type and Aquatic Resource

The three terrestrial-cultural cover types in the project area provide limited feeding, resting and breeding habitat for birds and small mammals. Wildlife species typically associated with these cover types in an urbanized environment include Norway rat, house mouse, deer mouse, gray squirrel and several common bird species including American crow, rock pigeon, robin, house sparrow, European starling, red-tailed hawk, American kestrel, herring gull, ring-billed gull and mourning dove.
Spring, winter and fall migrant bird species may pass over the project area or rest and feed in the area on a transient basis. The urban vacant lot and mowed grass cover types may present suitable breeding habitat for killdeer.

The NYSDEC Division of Fish and Wildlife & Marine Resources New York Natural Heritage Program was contacted regarding the presence of State-listed rare, threatened and endangered species or habitats at the Site. In their response letter dated March 21, 2011 (provided in Appendix P), the NYSDEC indicated that:

“We have no records of rare or state-listed animals or plants, significant natural communities or other significant habitats, on or in the immediate vicinity of your site.”

According to the NYSDEC Environmental Resource Mapper, the Site is located within the historic range of the American burying beetle (Nicrophorus americanus). The Site does not provide suitable habitat for the American burying beetle. This species requires natural soil and vegetation resources for propagation. The United States Fish and Wildlife Service (USFWS) website identified the Federally Endangered shortnose sturgeon (Acipenser brevirostrum) as present within Kings County. The USFWS noted that this sturgeon occurs primarily in the Hudson River. The Site would have no impact on this species.

There are no United States Fish and Wildlife Service (USFWS) National Wetland Inventory (NWI) wetlands mapped in the project area.

6.3.2.3 Observations of Stress

No atypical biotic conditions such as reduced vegetative growth and density, wildlife mortality, changes in species assemblages and distribution, or the absence of expected biota have been observed at the Site.

6.3.3 Step LC – Description of Fish and Wildlife Resource Values

Because of its location in an urbanized area and the presence of the building and sidewalks which cover the entire surface of the Site, the Site provides very limited habitat for urban-dwelling wildlife. The Site does not provide any current or potential value to humans as a nature recreation area.
6.3.4 **Step I.D – Identification of Applicable Fish and Wildlife Regulatory Criteria**

No USFWS National Wetland Inventory or State-regulated wetlands or other aquatic resources are located on or adjacent to the Site. The Site does not provide suitable habitat for wildlife other than urban dwelling species. Newtown Creek, located approximately 1,300 feet east of the Site, and the East River, located approximately one mile west of the Site, are regulated by the U.S. Army Corps of Engineers under Section 10 of the Rivers and Harbors Act and Section 404 of the Clean Water Act. They are also regulated by the NYSDEC under Section 401 of the Clean Water Act. The East River is regulated by the State under the Protection of Waters Program (Article 15 of the ECL).

6.3.5 **Summary and Recommendations**

The Site is located in an old, highly developed, urbanized area. Plant communities in the project area include mowed lawn and trees, mowed lawn, and vegetated areas on disturbed sites. These communities are associated with residential, recreational, commercial and industrial areas in the project area. No plant communities were identified on the Site. The results of the FWRIA Step I analysis indicate that there is limited potential for wildlife at the Site. Because of its location in an urbanized area and the presence of the building and sidewalks which cover the entire surface of the Site, the Site provides very little if any suitable habitat for wildlife other than Norway rat, house mouse and perching birds. The Site does not provide any current or potential value to humans as a nature recreation area.
7.0 SUMMARY AND RECOMMENDATIONS

7.1 Summary

Based upon the results of the previous site investigations, the following conclusions are provided. Field investigations performed in the Spic and Span area are the SC Phases I, II, III, V, and VI and the RI Phases I and II.

7.1.1 Geology

- The following textural units have been found in the upper glacial aquifer in most borings, from the surface downward: a fill unit; a glacial till unit; an inclusive sand unit within the glacial till unit; a sand unit; a lacustrine clayey silt unit; a fine sand and silt unit; a sand/sand and gravel unit; and the Raritan Formation. Due to the heterogeneous nature of the geology, some but not all of the units were identified at each boring. The thickness of the upper glacial aquifer in the Spic and Span area is approximately 125.0 to more than 138.0 feet thick.

- An inclusive sand layer containing DNAPL and high PCE concentrations was identified within the glacial till unit in the vicinity of SSB-11, which is located adjacent to the Spic and Span site.

- The top of the Raritan Formation was encountered across the site. The elevation of the Raritan Formation varied between -103.89 to -121.19 feet amsl and has been described as gray with white banding, brown, brownish gray, greenish gray, dark gray to greenish brown, fine sand and silt, clays with carbonized plant fragments and, clays with varying amounts of sand, to silts with varying amounts of sand and clay. The top of the Raritan Formation slopes towards the west and northwest. The Raritan Formation is a well-defined aquiclude regionally and has significant lateral extent. Permeabilities within the unit are less than $10^{-6}$ cm/sec.

- The water table surface may be found between approximately 11 and 25 feet bgs. In the immediate vicinity of the Spic and Span property, the groundwater flow is north to northeast. The horizontal hydraulic gradient ranged from approximately 0.01 to 0.02 ft/ft.
The hydraulic conductivity (K) in the overburden ranged from $2.91 \times 10^{-2}$ cm/sec (DEC-063) to $8.32 \times 10^{-5}$ cm/sec (DEC-060). In the shallow overburden, the mean value of K is $8.03 \times 10^{-3}$ cm/sec for the sand clayey silt/sand unit, and $3.15 \times 10^{-4}$ cm/sec for the sandy silt. In the deep overburden, the mean value of K is $1 \times 10^{-3}$ cm/sec for the sand/silty sand, and $9.32 \times 10^{-5}$ cm/sec for the sandy silt.

During the Phase V investigation in 2009, LNAPL was detected in DEC-034 and DEC-054 with a thickness ranging between 1.34 feet and 1.09 feet, respectively. During the RI Phase I in March 2011, the thickness of LNAPL was observed ranging from absent (0.0 feet) to 3.99 feet in DEC-034; from 0.01 feet to 1.2 feet in DEC-054; and from 0.58 feet to 0.84 feet in DEC-053.

7.1.2 **Soils**

VOCs, including PCE and its degradation products were detected and exceeded unrestricted use criteria in SSB-11, located south of DEC-024, and at several depths (5-6 feet bgs, 15-16 feet bgs, 24-25 feet bgs, and 53-54 feet bgs). The highest concentration of PCE was detected in sample SSB-11 (190,000 mg/kg 15-16 feet bgs). PCE was also detected above criteria in SSB-11 (3.5 mg/kg 24-25 feet bgs, 1.4 mg/kg 53-54 feet bgs), SSB-15 (4.6 mg/kg 0-0.5 feet bgs, 1.4 mg/kg 16.5-17.5 feet bgs), SSB-16 (980 mg/kg 1-2 feet bgs, 910 mg/kg 14-15 feet bgs, 3.1 mg/kg 26-27 feet bgs), SSB-18 (3 mg/kg 10-11 feet bgs), and SSB-22 (4.5 mg/kg 22.5-23.5 feet bgs). TCE exceeded unrestricted use criteria in SSB-11 (110 mg/kg 15-16 feet bgs), SSB-13 (2.3 mg/kg 14-15 feet bgs, 24 mg/kg 19-20 feet bgs, 0.67 mg/kg 24-25 feet bgs), and SSB-16 (1.4 mg/kg 14-15 feet bgs).

**Spic and Span Building Source Area**

A shallow source of PCE and DNAPL has been identified within the inclusive sand layer between approximately SSB-026 and SSB-032 at approximately 12 to 22 feet bgs (Figure 4-3A). The inclusive sand layer contains elevated concentrations of PCE and DNAPL. The bottom of the northern extent of the inclusive sand layer near SSB-032 contains vertical sand stringers saturated with DNAPL, to approximately 63 feet bgs in SS-029 and SSB-030. These sand stringers represent a vertical pathway from the shallow zone through the glacial till unit into the lower sand unit at approximately 25 to 55 feet bgs. DNAPL was noted in sand stringers which are present in SSB-030 at a depth of 17 feet to an approximate depth of 63 feet bgs, near the top of the lower permeability clayey
silt. The northern edge of the inclusive sand layer is approximately 35 feet from DEC-024D and DEC-024DR, where DNAPL has also been identified at the top of the clayey silt unit. The north/south (horizontal) extent of the inclusive sand layer appears to have been delineated and a vertical profile has been established as depicted in Figure 4-3A. The eastern extent of the impacted soil has not been delineated and is assumed to extend beneath Kingsland Avenue. The western extent of the impacted soil has not been delineated because it likely extends beneath the Spic and Span building and possibly into the court yard, which is situated approximately 19 feet from the western curb line of Kingsland Avenue. The courtyard area may have been used to load and unload dry cleaning product materials.

300 Kingsland Avenue Source Area

A shallow source of PCE contamination was identified in the vicinity of DEC-025/025D, which is located on the east side of Kingsland Avenue, south of the Spic and Span site, adjacent to 300 Kingsland Avenue. The highest concentration of PCE (2,000 mg/kg) was found within the top 2.5 feet below the sidewalk at SSB-03 followed by the top 2.5 feet at both DEC-025D and SSB-08 (1,300 mg/kg at both). SSB-15, which is located approximately 10 feet south of DEC-025D, had the highest PID readings (336 to 1,528 ppm) in the upper 20 feet. Below 20 feet, PID readings in SSB-16 decreased to 0 ppm at depths below 26.0 feet bgs. The remainder of the borings around DEC-025 and DEC-025D had significantly lower PID readings. It appears that the most PCE impacted soil is within the top 15 feet of soil, between 10 feet north and 20 feet south of DEC-025 and DEC-025D. The north/south horizontal extent of the impacted soil appears to have been delineated and a vertical profile established. The eastern extent of the impacted soil near DEC-025/025D has not been delineated and may extend beneath the building at 300 Kingsland Avenue. The western extent of the impacted soil has not been delineated and is assumed to extend under Kingsland Avenue.

7.1.3 NAPLs

During the Phase V investigation in 2009, a 1.5-foot thick layer of DNAPL was observed in DEC-024D. During the SC Phase VI and RI Phases I and II, DNAPL was detected, but not in measureable quantities, in both DEC-024D and DEC-024DR. DNAPL samples were collected from DEC-024D during the SC Phases III and V and from DEC-024DR during the SC Phase VI.

The DNAPL sample collected from DEC-024DR during the SC Phase VI fieldwork was collected following the redevelopment of the well which initially contained a trace of DNAPL. This
indicates that DNAPL can be drawn into the wells from the surrounding formation for recovery. Analytical results for the DNAPL found in DEC-024D and DEC-024DR indicated:

- PCE was detected at a concentration of 730,000 mg/kg or 73% and TCE was detected at 720 mg/kg (0.072%). 1,2,4-Trichlorobenzene, 1,1-biphenyl and bis(2-ethylhexyl)phthalate were also detected in the DNAPL, at significantly lower concentrations (0.017% or lower) during the SC Phase V.

- PCE was detected at 110,000,000 µg/kg (11%); TCE was detected at 220,000 µg/kg; cis-1,2-DCE was detected at 7,300 µg/kg; and 1,2,4-trichlorobenzene was detected at 9,400 µg/kg in DEC-024DR during the SC Phase VI.

- Laboratory measured parameters from the DNAPL sample from DEC-024DR include: viscosity of 1.21 centipoise, surface tension of 26.4 dynes/cm, and specific gravity of 1.2942.

LNAPL has historically been measured in several monitoring wells: DEC-024; DEC-034; DEC-053; DEC-054; and DEC-058. During the RI Phase II field activities, on November 23, 2011, LNAPL was detected in DEC-034, DEC-053, DEC-054, and DEC-058 with thicknesses ranging between 0.28 feet and 3.24 feet.

### 7.1.4 Groundwater

PCE and its degradation products were detected in numerous groundwater monitoring wells in both shallow and deep overburden groundwater. High concentrations of PCE were detected adjacent to the Spic and Span building in DEC-057 and DEC-057D at concentrations of 8,400 and 37,000 µg/L, respectively; downgradient of the site in DEC-058 and DEC-058D, to the northeast at concentrations of 13,000 and 35,000 µg/L, respectively; to the east in DEC-060 and DEC-060D at concentrations of 22,000 and 13,000 µg/L, respectively, and in DEC-036 and DEC-036D at concentrations of 4,200 and 4,500 µg/L, respectively; and to the southeast in DEC-003DD at a concentration of 11,000 µg/L, and DEC-061 and DEC-061D at concentrations of 1,400 and 8,200 µg/L, respectively. PCE and its degradation products were not detected in the upgradient top of clay monitoring well (DEC-035TC). PCE was detected in 2 of the 4 top of clay wells sampled during the RI Phase II, but not at concentrations exceeding groundwater criteria [DEC-058TC (1.0 µg/L) and DEC-063TC (3.0 µg/L)].
TCE and cis-1,2-DCE were generally detected above criteria where PCE was detected. Vinyl chloride was detected above criteria generally to the north and east of the site, as well as in DEC-024 at 200 µg/L; the maximum vinyl chloride concentration was detected in DEC-058 at 1,800 µg/L immediately downgradient of the site and adjacent to the ExxonMobil property. Additionally, BTEX and/or fuel-related compounds were detected in DEC-053, DEC-054, DEC-058D, and DEC-037R.

Based upon the January 2012 groundwater sampling event, horizontal and vertical extent of the dissolved phase plume has mostly been determined, with the exception of the concentrations: beneath the building where the source of PCE contamination is likely located; beneath 300 Kingsland Avenue where a secondary source of PCE is apparent; east of DEC-037R in the shallow overburden; and east of DEC-003D in the deeper overburden. The horizontal extent of the dissolved phase plume in shallow and deep groundwater appears to originate around the Spic and Span site, and a second, as yet unknown source has been identified around DEC-025D near 300 Kingsland Avenue. The plume is spreading with groundwater flow towards the northeast, east and with a southerly component, and via downward migration to deeper geologic zones (i.e., approximately 60 – 65 feet bgs). Although PCE was detected in 2 of the 4 top of clay wells sampled during the RI Phase II, the concentrations did not exceed groundwater SCGs. PCE was detected in top of clay wells located adjacent to the Spic and Span site (i.e., DEC-063TC) and downgradient to the northeast (i.e., DEC-058TC). The vertical extent of PCE and TCE impacted groundwater extends down to the top of the clayey silt unit, approximately 60 feet bgs. The plume appears to be spreading laterally along the clayey silt interface.

Based upon the data collected to assess the potential for degradation of PCE in the groundwater system as presented above, there is evidence that reductive dechlorination is occurring in the vicinity of the site. Rates of degradation are very difficult to determine due to the unknown quantity of source material present beneath the Spic and Span site and beneath the 300 Kingsland Avenue building. Based upon the geochemical conditions in the groundwater system, the aquifer is conducive for naturally occurring reductive dechlorination, and therefore, the geochemical conditions could be enhanced via in-situ bioremediation technologies to further promote higher rates of reductive dechlorination.
7.1.5 **Soil-Gas**

Soil-gas in the Spic and Span has been adversely impacted by the presence of PCE, TCE and their daughter products. The source of the elevated soil-gas concentrations appears to be centered adjacent to and immediately downgradient of the Spic and Span site (SG-67 and SG-99), nearby 300 Kingsland Avenue (SG-071, SG-012, and SG-013) and mid-block on Morgan Avenue (SG-004 and SG-008). The elevated concentrations mid-block on Morgan Avenue coincide with the location of elevated concentrations obtained by Roux from a temporary soil-gas point installed in September 2005 (see Section 1.2.1) which, historically has higher TCE concentrations than PCE concentrations.

The approximate size of the PCE and TCE plumes from RI Phase I and II are similar in size and appear to also mimic the extent of the dissolved phase shallow groundwater plume. The exception to this is the concentrations that exist mid-block on Morgan Avenue appear to indicate a separate source of soil-gas TCE contamination exists. The mid-block area of Morgan Avenue previously housed the Herzberg’s Fine Art Dyeing, Inc. (1942), Taylor and Co. Inc. which was a foundry (1942-1980), Baltic Metal Works (1951-1965), and United Resin Products, Inc. (1979-present).

7.1.6 **Qualitative Human Health Exposure Assessment**

Results of the Qualitative Human Health Exposure Assessment indicate that under current conditions, potential pathways are complete for construction workers during intrusive activities for subsurface soil and soil vapor, and for onsite employees and the public due to indoor air. Potentially completed pathways exist for future use for subsurface soil and soil vapor for construction workers, outdoor air for the public, and indoor air for onsite employees and the public.

7.1.7 **Fish and Wildlife Resources Impact Analysis**

Results of the Fish and Wildlife Resources Impact Analysis indicate that the site is located in an old, highly developed, urbanized area. Plant communities in the project area include mowed lawn and trees, mowed lawn, and vegetated areas on disturbed sites. These communities are associated with residential, recreational, commercial and industrial areas in the project area. No plant communities were identified on the site. The results of the FWRIA Step I analysis indicate that there is limited potential for wildlife at the site. Because of its location in an urbanized area and the presence of the building and sidewalks which cover most of the surface of the site, the site provides very little if any
suitable habitat for wildlife other than Norway rat, house mouse and perching birds. The site does not provide any current or potential value to humans as a nature recreation area.

7.2 **Recommendations**

The following recommendations are offered for consideration by the NYSDEC. The recommendations include additional Remedial Investigation/Feasibility Study (RI/FS) activities.

**Source Area(s)**

- Four soil borings should be advanced within the courtyard of the between the Spic and Span buildings. The four soil borings are contingent on gaining access to the courtyard from the building owner(s). The soil borings should be advanced to the top of the lacustrine clayey silt unit (approximately 55-60 feet bgs). Following their completion, the soil borings should be backfilled with bentonite chips to approximately 5 feet bgs, with clean well sand from 0.5-5.0 feet bgs, and with concrete in the top 0.5 feet. The purpose of the soil borings is to determine the horizontal and vertical extent of the shallow source area found in the vicinity of SSB-11 and determine if DNAPL is present at the top of the less permeable lacustrine clayey silt. The rationale for the soil boring locations can be found in Table 7-1 and the proposed locations are shown on Figure 7-1.

- Following the completion of the four soil borings in the courtyard, one monitoring well pair (i.e., shallow and deep) is recommended within the courtyard. The installation of the monitoring well pair is contingent on gaining access to the courtyard from the building owner(s). The exact location of the monitoring well pair should be made based on the data gathered from the four soil borings, and in consultation with the NYSDEC Project Manager. The shallow well should be constructed with a 15-foot long 2-inch ID PVC screen and PVC riser. The deep well should be constructed with 10 feet of 2-inch ID, Type 304 stainless steel 0.010-inch slot screen equipped with a 2-foot sump and Type 304 stainless steel riser. Stainless steel has been recommended due to the possible presence of DNAPL and the incompatibility between PCE and/or TCE and PVC materials. A 00 or 00N size sand pack should be installed from the bottom of the well up to 2 feet above the top of the well screen. A bentonite slurry should then be installed around the riser to an elevation of 1-foot below grade via tremie pipe. An 8-inch
diameter, flush-mount protective casing should complete each well. The rationale for the well pair location in the courtyard can be found in Table 7-1 and the proposed locations are shown on Figure 7-1.

- Up to sixteen soil borings should be advanced within the buildings that housed Spic and Span. The borings should be installed through the building floor slab(s) on either side of the courtyard to assist in delineating the horizontal and vertical extent of the shallow source area found in the vicinity of SSB-11. The borings should be advanced in a grid like pattern using a remote access drill rig(s) or direct-push unit(s). The proposed locations are shown on Figure 7-1.

- Up to five soil samples should be collected from each boring location to establish the full vertical extent of impact within each soil boring. At a minimum, one soil sample should be collected from the interval just above water table; the second sample should be collected from the interval exhibiting odors, staining, or the highest PID reading; and additional samples should be collected below intervals of significant impact. If no odors, staining, or elevated PID reading are encountered, then only one sample from the interval just above the water table should be collected, as per the FAP (URS, April 2010). All soil samples should be analyzed for TCL VOCs plus TICs by 8260B.

- If DNAPL is encountered in any new monitoring well(s) during drilling, well development or purging, a DNAPL sample should be collected for laboratory analyses. The DNAPL sample(s) should be analyzed for TCL VOCs plus TICs by 8260B, TCL SVOCs plus TICs by 8270C, petroleum hydrocarbon scan by 8100 (modified), specific gravity by ASTM D4052, surface tension by ASTM D-971, and viscosity by ASTM D-445.

Based upon a visual inspection inside a portion of the former Spic and Span building on June 4, 2012, several floor grates were observed. The grates should be removed and up to ten sediment samples should be collected and analyzed for TCL VOCs plus TICs by 8260B. A video inspection and Ground Penetrating Radar geophysical survey should be conducted to determine the location of the discharge piping (if any), and a dye tracer test should also be
conducted using an environmentally friendly tracer dye to determine the outflow discharge points from the floor grates (if any).

- One soil vapor extraction (SVE) well should be installed to allow for a SVE pilot test to be performed in the vicinity of the shallow source area near SSB-11. The water table is at an approximate depth of 15 feet bgs. In order to minimize groundwater inflow and capture by the SVE extraction wells, the well screen will be approximately 3 feet above the water table. In order to avoid drawing outdoor air into the well screen (i.e., short-circuiting), the screen will be approximately 7 feet below the ground surface. The SVE well should be screened from approximately 7 to 12 feet bgs. The SVE well should be constructed with 2-inch ID PVC screen and PVC riser. A 00 or 00N size sand pack should be installed from the bottom of the well up to 2 feet above the top of the well screen. Bentonite chips should then be installed around the riser to an elevation of 1-foot below grade and hydrated. A 12-inch diameter, flush-mount protective casing should complete the well. The proposed location of the SVE well is shown on Figure 7-1.

- Three vacuum observation wells should be installed to allow for soil vapor test monitoring. The observation wells should be spaced at 10 and 15 feet laterally from the SVE well and used to establish the radius of influence. Each observation well should be screened from approximately 5 to 15 feet bgs. The observation wells should be constructed with 2-inch ID PVC screen and PVC riser. A 00 or 00N size sand pack should be installed from the bottom of the well up to 2 feet above the top of the well screen. Bentonite chips should then be installed around the riser to an elevation of 1-foot below grade and hydrated. A 12-inch diameter, flush-mount protective casing should complete each well. The proposed locations of the observation wells are shown on Figure 7-1.

- Up to five air sparging wells should be installed in the vicinity of the SVE pilot test area to depths up to 60 feet bgs. The air sparging wells will be used to enhance SVE recovery rates. The air sparging wells should be constructed with 2-inch ID PVC screen in the bottom 2 feet and solid PVC riser. A 00 or 00N size sand pack should be installed from the bottom of the well up to 2 feet above the top of the well screen. Bentonite chips
should then be installed around the riser to an elevation of 1-foot below grade and hydrated. A 12-inch diameter, flush-mount protective casing should complete each well.

- An SVE/Air Sparging pilot test should be performed. A technical memorandum will be compiled detailing the SVE and air sparging test requirements following a discussion with the NYSDEC Project Manager and prior to testing.

**Downgradient Areas**

- One monitoring well pair consisting of one shallow and one deep overburden monitoring well should be installed on the west side Morgan Avenue just south of Norman Avenue. The shallow well should be constructed with a 15-foot long 2-inch ID PVC screen and PVC riser. The deep well should be constructed with 10 feet of 2-inch ID, PVC 0.010-inch slot screen and PVC riser. A 00 or 00N size sand pack should be installed from the bottom of the well up to 2 feet above the top of the well screen. A bentonite slurry should then be installed around the riser to an elevation of 1-foot below grade via tremie pipe. An 8-inch diameter, flush-mount protective casing should complete each well. The rationale for the well pair location can be found in Table 7-1 and the proposed locations are shown on Figure 7-2.

- One monitoring well pair consisting of one shallow and one deep overburden monitoring well should be installed between DEC-003DD and DEC-062 on the west side of Sutton Street. The shallow well should be constructed with a 15-foot long 2-inch ID PVC screen and PVC riser. The deep well should be constructed with 10 feet of 2-inch ID, PVC 0.010-inch slot screen and PVC riser. A 00 or 00N size sand pack should be installed from the bottom of the well up to 2 feet above the top of the well screen. A bentonite slurry should then be installed around the riser to an elevation of 1-foot below grade via tremie pipe. An 8-inch diameter, flush-mount protective casing should complete each well. The rationale for the well pair location can be found in Table 7-1 and the proposed locations are shown on Figure 7-2.

- One shallow overburden replacement monitoring well and one deep overburden monitoring well should be installed on the east side Morgan Avenue adjacent to DEC-001 (DEC-001R and DEC-001D). The shallow well should be constructed with a 15-foot long 2-inch ID PVC screen and PVC riser. The deep well should be constructed with 10 feet
of 2-inch ID, PVC 0.010-inch slot screen and PVC riser. A 00 or 00N size sand pack should be installed from the bottom of the wells up to 2 feet above the top of the well screen. A bentonite slurry should then be installed around the riser to an elevation of 1-foot below grade via tremie pipe. An 8-inch diameter, flush-mount protective casing should complete each well. The rationale for the well pair location can be found in Table 7-1 and the proposed locations are shown on Figure 7-2.
8.0 REFERENCES


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