



## **SITE CHARACTERIZATION**

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### **PHASE V DATA SUMMARY REPORT**

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### **WORK ASSIGNMENT D004433-22B**

**MEEKER AVENUE PLUME TRACKDOWN  
GREENPOINT/EAST WILLIAMSBURG INDUSTRIAL AREA**

**SITE NO. 2-24-121  
KINGS (C), NY**

Prepared for:  
NEW YORK STATE  
DEPARTMENT OF ENVIRONMENTAL CONSERVATION  
625 Broadway, Albany, New York  
Alexander B. Grannis, Commissioner

DIVISION OF ENVIRONMENTAL REMEDIATION  
REMEDIAL BUREAU B

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**Final  
October 2009**

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**FINAL**

**OCTOBER 2009**

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## LIST OF ACRONYMS AND ABBREVIATIONS

|             |                                             |
|-------------|---------------------------------------------|
| ADT         | Aquifer Drilling and Testing, Inc.          |
| aka         | also known as                               |
| amsl        | above mean sea level                        |
| ASP         | Analytical Services Protocol                |
| bgs         | below ground surface                        |
| BP          | British Petroleum                           |
| BQE         | Brooklyn-Queens Expressway                  |
| C&D         | construction and demolition                 |
| CD          | compact disc                                |
| CO          | carbon monoxide                             |
| COC         | chain-of-custody                            |
| Con Edison  | Consolidated Edison Company of New York     |
| Con-Test    | Con-Test Analytical Laboratory              |
| DCA         | dichloroethane                              |
| DCE         | dichloroethene, aka dichloroethylene        |
| DEP         | Department of Environmental Protection      |
| DNAPL       | dense non-aqueous phase liquid              |
| DOB         | Department of Buildings                     |
| DOT         | Department of Transportation                |
| DSNY        | City of New York Department of Sanitation   |
| DUSR        | Data Usability Summary Report               |
| EDR         | Environmental Data Resources, Inc.          |
| ELAP        | Environmental Laboratory Approval Program   |
| EM          | electromagnetic                             |
| EPM         | Environmental Planning and Management, Inc. |
| ESA         | environmental site assessment               |
| FAP         | Field Activities Plan                       |
| FDNY        | New York City Fire Department               |
| FID         | flame ionization detector                   |
| FOIL        | Freedom of Information Law                  |
| FSP         | Field Sampling Plan                         |
| GeoLogic-NY | GeoLogic NY, Inc.                           |
| GPR         | ground penetrating radar                    |
| HASP        | Health and Safety Plan                      |
| HC-V        | Hampton-Clarke, Inc.- Veritech Laboratory   |
| HDPE        | high-density polyethylene                   |
| HSA         | hollow stem auger                           |
| ID          | inside diameter                             |
| IDW         | investigation derived wastes                |
| Inc.        | Incorporated                                |
| L           | liter                                       |
| LEL         | lower explosive limit                       |



**LIST OF ACRONYMS AND ABBREVIATIONS**  
**(Continued)**

|                   |                                                                                    |
|-------------------|------------------------------------------------------------------------------------|
| LNAPL             | light non-aqueous phase liquid                                                     |
| mg/kg             | milligrams per kilogram (parts per million)                                        |
| MIP               | membrane interface probe                                                           |
| mL                | milliliter                                                                         |
| MW                | monitoring well                                                                    |
| MTBE              | Methyl tert-butyl ether                                                            |
| NAPL              | non-aqueous phase liquid                                                           |
| NAVD              | North American Vertical Datum                                                      |
| NYC               | New York City                                                                      |
| NYCRR             | New York Codes, Rules and Regulations                                              |
| NYS               | New York State                                                                     |
| NYSDEC            | New York State Department of Environmental Conservation                            |
| NYSDOH            | New York State Department of Health                                                |
| NYSDOT            | New York State Department of Transportation                                        |
| OD                | outside diameter                                                                   |
| PCB               | polychlorinated biphenyl                                                           |
| PCE               | perchloroethene, aka tetrachloroethene or tetrachloroethylene or perchloroethylene |
| PID               | photoionization detector                                                           |
| PMWP              | Project Management Work Plan                                                       |
| ppbv              | parts per billion by volume                                                        |
| PPE               | personal protective equipment                                                      |
| ppm               | parts per million                                                                  |
| PVC               | polyvinyl chloride                                                                 |
| QA                | quality assurance                                                                  |
| QAPP              | Quality Assurance Project Plan                                                     |
| QC                | quality control                                                                    |
| RQD               | rock quality designation                                                           |
| RSI               | Radar Solutions International                                                      |
| SAP               | Sampling and Analysis Plan                                                         |
| TAGM              | Technical and Administrative Guidance Memorandums                                  |
| TCE               | trichloroethene, aka trichloroethylene                                             |
| TCL               | target compound list                                                               |
| TIC               | tentatively identified compound                                                    |
| TOGS              | Technical and Operational Guidance Series                                          |
| µg/kg             | micrograms per kilogram (parts per billion)                                        |
| µg/L              | micrograms per liter (parts per billion)                                           |
| µg/m <sup>3</sup> | micrograms per cubic meter                                                         |
| UHP               | ultra high purity                                                                  |
| URS               | URS Corporation                                                                    |
| USCG              | United States Coast Guard                                                          |
| USEPA             | United States Environmental Protection Agency                                      |
| VOC               | volatile organic compound                                                          |
| WA                | Work Assignment                                                                    |
| Zebra             | Zebra Environmental Corporation                                                    |

## **1.0 INTRODUCTION**

This Site Characterization Phase V Data Summary Report has been prepared to summarize the field activities and analytical results for the Meeker Avenue Plume Trackdown Site in the Greenpoint/East Williamsburg Industrial Area section of Brooklyn, New York. The work for this site was originally issued to URS Corporation (URS) as Work Assignment (WA) No. D004433-22. In accordance with the NYSDEC Scope of Work (NYSDEC, February 1, 2007), URS prepared a Project Management Work Plan (PMWP) and budget estimate (Final, April 2007), a Field Activities Plan (URS, April 2007) which includes the Field Sampling Plan (FSP) and Quality Assurance Project Plan (QAPP), and a Health and Safety Plan (HASP, April 2007).

The field investigation was performed in four phases, according to the original scope of work issued to URS. Based on the recommendations in the Phase IV Data Summary Report for additional work at the site, unused budget was reallocated to fund a portion of the additional work (i.e., Phase V). The rebudget was approved by the Department in June 2009 as WA No. D004433-22B. The Phase V investigation area was limited to the area of the site north of Meeker Avenue. This report presents data and information gathered prior to and during the Phase V field investigation, which was conducted from June 15 through July 13, 2009.

### **1.1 Site Background**

The Meeker Avenue Plume Trackdown Site is located in the Greenpoint/East Williamsburg Industrial Area section of the Borough of Brooklyn, New York (Figure 1). Geographical, site use and background information is provided in the following sections.

#### **1.1.1 Site Location and Description**

The Meeker Avenue Plume Trackdown site investigation area (Figure 2) is located in a region of historic petroleum refining and storage operations that occupied a significant portion of the Greenpoint area. By 1870 over 50 refineries were located along the banks of Newtown Creek. 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 along the northeastern portion of the site along Newtown Creek, north of Bridgewater

Street, between Meeker Avenue and Apollo Street. Peerless Importers, Incorporated (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 (Roux, October 14, 2005). The current BP property was determined to be the source of the petroleum free product plume. Investigation and remediation activities were conducted by Roux Associates Inc. (Roux Associates) on behalf of ExxonMobil from 1990 to the present and have further defined 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 approximately 4,542,065 gallons since it became operational in 1995 (Roux, July 31, 2009). The current Off-Site Plume area boundary measured by Roux Associates on May 7, 2009 (Roux, July 31, 2009) is shown on Figure 2.

The original Meeker Avenue Plume Trackdown site investigation area was bounded by the former ExxonMobil Brooklyn Refinery/current BP Terminal to the north (Norman Avenue/Bridgewater Street), Newtown Creek to the east, Lombardy Street to the south, and Kingsland Avenue to the west (Figure 2). During the first phase of fieldwork (May 7 through July 10, 2007), the southern boundary of the site investigation area along Lombardy Street between Porter and Morgan Avenues was extended three blocks south to Richardson Street. During the second phase of fieldwork (November 5 through December 27, 2007), the southern boundary of the site investigation area along Richardson Street between Vandervoort and Morgan Avenues was extended one block south to Frost Street. During the third phase of fieldwork (May 5 through July 24, 2008), the southern boundary was additionally extended one block south to Withers Street between Vandervoort and Morgan Avenues. In addition, the boundary in the northwestern corner of the site investigation area was extended west from Kingsland Avenue between Norman and Nassau Avenues to Monitor Street. A review of historical data during the fourth phase of fieldwork (November 3 through December 8, 2008) indicated that several additional potential sources of contamination may

exist north of Norman Avenue, between Kingsland Avenue and Monitor Street. Therefore, the boundary in the northwestern corner of the site investigation area was extended approximately 1 block north of Norman Avenue, between Kingsland Avenue and Monitor Street.

The areas located north of Nassau Avenue, east of Van Dam Street, and south of Meeker Avenue are primarily used for commercial/industrial purposes. Residential areas are located in both the northwestern portion of the site (extending from Van Dam Street between Nassau and Meeker Avenues, to the western site boundary) and within the southern portion of the site (along Beadel Street from Morgan to Porter Avenues, and along Vandervoort Avenue from Lombardy Street to Division Place).

Based on the results of several investigations conducted in the area (see Section 1.1.2 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 this investigation in order to determine the source(s) of this contamination.

### **1.1.2 Previous Investigations**

#### ***Impact Environmental Consulting, Inc. - March 1998***

In March 1998, Impact Environmental Consulting, Inc. (Impact Environmental) conducted a Phase I Environmental Site Assessment (ESA) at 46-60 Anthony Street/ 95 Lombardy Street for ACME Architectural Products Inc., of Brooklyn, New York (Impact Environmental, March 30, 1998a). A copy of the Phase I ESA may be found in PDF format on a compact disc which is included in Appendix A of the Phase IV Data Summary Report (URS, May 2009). The property historically had been utilized for iron working, metal shearing and finishing operations. At the time of the ESA, operations at the property included office space and operational space. The operational space was utilized for the machining, finishing, and storage of materials and products used in the manufacture of doors and knock down frames. The ESA identified a number of potential contamination sources that existed on the property due to current and/or past site activities. Numerous floor drains were identified throughout the building and their outfall locations were

unknown. It was suspected that some drains may have discharged directly to on-site soils. Several underground storage tanks (USTs) and aboveground storage tanks (ASTs) were identified and had been used for fuel oil storage or storage of degreasing products. It was noted that at the time of the ESA the facility was using a phosphate wash and rinse as a degreaser. During a personal interview, it was revealed that any regulated waste (i.e., waste paint, waste oil, waste degreaser and waster water precipitate) generated at the property was stored in the yard at 72 Anthony Street prior to disposal.

### ***Impact Environmental Consulting, Inc. - March 1998***

In March 1998, Impact Environmental conducted a Phase I ESA at 72 Anthony Street for ACME Architectural Products Inc., of Brooklyn, New York (Impact Environmental, March 30, 1998b). A copy of the Phase I ESA may be found in PDF format on a compact disc which is included in Appendix A of the Phase IV Data Summary Report (URS, May 2009). The property historically had been utilized as a brass foundry and civilian observation patrol. Operations on the property at the time of the ESA included office space and operational space. The operational space was utilized for the grinding, sanding and finishing of steel doors. The investigation identified a number of potential contamination sources that existed on the property due to current and/or past site activities. Numerous floor drains were identified throughout the building and their outfall locations were unknown. It is suspected that some drains may have discharged directly to on-site soils. One UST and one AST dip tank existed and were used for fuel oil storage and storage of degreasing products, respectively. It was noted that at the time of the ESA, the facility was using a phosphate wash and rinse as a degreaser. It was also noted that the floor of the room containing the AST dip tank was impacted by the release of degreasers from the dip tank. In addition, significant storage of portable chemical containers was observed in the building. A paint room was identified in the center of the building, as was an associated paint storage room. The floor of the paint room was significantly stained by painting operations. Floor drains were observed in the paint storage room. A chemical storage area existed outside and to the east of the building and a bermed, concrete storage pad was also observed. Numerous chemical containers were noted outside the building and consisted of 55-gallon drums and smaller containers of primers, cutting oils, hydraulic oils, waste water, xylene, waste paints, adhesives, waste degreasers, steam cleaners and waste oil contaminated absorbents. However, most of the drums were located outside the bermed, concrete storage pad and

were uncovered or missing screw caps. Two dry wells were identified along the south side of the building. In addition, during a personal interview it was revealed that the property previously maintained two dip tanks for degreasing. It was noted that a Phase I ESA was previously performed on the property in June 1995 by Conestoga-Rovers & Associates (CRA). The CRA Phase I revealed that 1,1,1-trichloroethane (1,1,1-TCA ) was formerly utilized in the dip tanks and that a floor drain was observed under one of the dip tanks.

### ***Impact Environmental Consulting, Inc. - June 1998***

In June 1998, Impact Environmental conducted a Phase II ESA at 46-60 Anthony Street/ 95 Lombardy Street for ACME Architectural Products Inc., of Brooklyn, New York (Impact Environmental, July 8, 1998). A copy of the Phase II ESA may be found in PDF format on a compact disc which is included in Appendix A of the Phase IV Data Summary Report (URS, May 2009). The scope of the Phase II ESA was based on the recommendations of the Phase I ESA (Impact Environmental, March 30, 1998a) and included a remote survey [ground penetrating radar (GPR)] of a floor drain located in the northeast portion of the building and the collection of a sample from 0-2 feet below ground surface (bgs) below the floor drain. The remote survey conducted confirmed that the floor drain directly discharged to the subsurface soils. A soil sample collected from the 0-2 foot interval below the floor drain contained the VOCs, PCE and TCE, at 1,190 and 99.2 µg/kg respectively. In addition, the semi-volatile organic compounds (SVOCs) di-n-butylphthalate, pyrene and bis(2-Ethylhexyl) phthalate were detected at 4,460, 539 and 1,690 µg/kg respectively. Metals which included arsenic (4.93 µg/kg), barium (114 µg/kg), cadmium (6.53 µg/kg), chromium (123 µg/kg), lead (906 µg/kg) and mercury (0.045 µg/kg) were detected. Cadmium, chromium and lead exceeded their respective criteria found in the Technical and Administrative Guidance Memorandum (TAGM) #4046, *Determination of Soil Cleanup Objectives and Cleanup Levels* (NYSDEC, January 24, 1994). The Phase II ESA concluded that on-site operations had impacted the environmental quality beneath the property and recommended that corrective actions were required to mitigate the contaminated soil associated with the floor drain.

***Environmental Planning and Management, Inc. – September 2005***

In September 2005, Environmental Planning and Management, Inc., (EPM) completed an investigation for the New York State (NYS) Department of Transportation (DOT) in connection with the Kosciuszko Bridge Project (EPM, January 2006). The investigation included the collection and analysis of soil and groundwater samples. PCE was detected at 7,760 µg/kg in the 0-4 foot bgs sample from boring SB-29 (southeastern corner at the intersection of Gardner Avenue and Thomas Street). PCE was also detected at 89.9, 569, and 1, 060 micrograms per liter (µg/L) in ExxonMobil wells MW-018 (eastern side of Vandervoort Avenue between Anthony and Cherry Streets), MW-023 (southwestern corner at the intersection of Gardner Avenue and Thomas Street), and MW-030 (eastern side of Varick Avenue between Anthony and Cherry Streets), respectively.

***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 10,200 micrograms per cubic meter (µg/m<sup>3</sup>) at the monitoring point located on the southwestern corner of the Vandervoort Avenue and Anthony Street intersection, and 7,050 µg/m<sup>3</sup> 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 Off-Site Plume area. In addition, TCE was detected at 4,500 µg/m<sup>3</sup> at the monitoring point located on the western side of Apollo Street between Nassau Avenue and Meeker Avenue, and 151,000 µg/m<sup>3</sup> at the monitoring point on the western side of Morgan Avenue between Nassau Avenue and Norman Avenue. 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  $\mu\text{g}/\text{m}^3$  at the monitoring point located at the northwestern corner of the intersection of Morgan and Nassau Avenues, and 930  $\mu\text{g}/\text{m}^3$  at the monitoring point on the western side of Van Dam Street between Nassau and Meeker Avenues. Elevated concentrations of TCE were detected at 8,200  $\mu\text{g}/\text{m}^3$  at the monitoring point on the eastern side of Apollo Street between Bridgewater Street and Nassau Avenue, and 700  $\mu\text{g}/\text{m}^3$  at the monitoring point on the northwestern corner of the intersection of Morgan and Nassau Avenues.

## **1.2 Findings of Previous Phases of Site Investigation Fieldwork**

To date, URS has conducted five phases of site investigation fieldwork at the Meeker Avenue Plume Trackdown site. Plate 1 shows all monitoring wells installed and sampled by URS, direct-push groundwater sample boring locations, direct push soil sample boring locations, membrane interface probe boring locations, and ExxonMobil monitoring wells sampled by URS. Plate 2 shows all soil-gas conduit locations installed and sampled by URS. The following sections discuss the findings from the Phase I, Phase II, Phase III and Phase IV site investigations.

### **1.2.1 Summary of Phase I Findings**

The 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. Field activities associated with the Phase I field investigation included: obtaining historical information reports (e.g., Sanborn maps) from Environmental Data Resources, Inc.; utility locating by a private subcontractor; manual and/or Vac-Tron® utility clearance for monitoring well installation; installation of 23 permanent soil-gas



conduits; installation of 20 groundwater monitoring wells; collection of 27 soil-gas samples from 21 newly installed and 6 existing soil-gas conduits; collection of 26 soil samples from 20 monitoring well borings; collection of 28 groundwater samples from 20 newly installed and 8 existing monitoring wells; daily pick-up of investigation-derived waste for disposal and a site survey. 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 from both north and south of Meeker Avenue indicated that PCE and TCE have impacted soil-gas quality, as shown on Figures 3 and 4. Elevated soil-gas concentrations appear to be associated near locations that potentially have used PCE and TCE (i.e., a former metal working facility, a research lab, two former dry cleaners, and a dye works).
- A soil sample from the 5-6 feet bgs interval from monitoring well location DEC-016 that is located adjacent to a former brass foundry was the only sample that exceeded TAGM 4046 criteria, with 220 milligrams per kilogram (mg/kg) of PCE.
- Groundwater samples from both north and south of Meeker Avenue indicated that groundwater has been impacted above Class GA groundwater standards for both PCE and TCE, as shown on Figures 5 and 6. Elevated groundwater concentrations appear to be associated near locations that potentially have used PCE and TCE (i.e., two former dry cleaners, a former dry cleaners/dye works, a drum recycling facility, a research lab, a former brass foundry, two metal working facilities, and a former soap manufacturer).

Phase I recommendations for Phase II fieldwork included the installation of additional soil-gas conduits to further delineate impacted soil-gas both north and south of Meeker Avenue. Direct-push soil borings were recommended in the vicinity of DEC-016 to delineate the horizontal and vertical extent of PCE impacted subsurface soil. Direct-push groundwater sampling was recommended south of Meeker Avenue and east of Porter Avenue to aid in the delineation of PCE and TCE impacted groundwater in this area. Based on the impacts to groundwater quality by PCE

and TCE, additional monitoring wells were recommended to delineate the horizontal extent of the PCE and TCE impacts and to help distinguish potential point sources.

### **1.2.2 Summary of Phase II Findings**

The 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, soils and/or groundwater at locations where elevated concentrations of PCE and/or TCE were encountered during the Phase I field investigation. Field activities associated with the Phase II field investigation included: a review of historical information reports (e.g., Sanborn maps) from Environmental Data Resources, Inc.; utility locating by a private subcontractor; manual and/or Vac-Tron® utility clearance for monitoring well installation; installation of 28 permanent soil-gas conduits; advanced 11 direct-push borings; advanced 15 direct-push groundwater sample locations; installation of 14 groundwater monitoring wells; collection of 55 soil-gas samples from 28 newly installed and 27 existing soil-gas conduits; collection of 30 soil samples from 11 direct-push borings and 14 monitoring well borings; collection of 14 groundwater samples from 15 direct-push groundwater sample locations; collection of 44 groundwater samples from 14 newly installed and 30 existing monitoring wells; daily pick-up of investigation derived waste for disposal and a site survey. 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 appears to be five areas of elevated soil-gas concentrations within the site boundary, as shown on Figures 7 and 8. The horizontal extent of impacted soil-gas was not fully determined at three of the five areas. The impacted soil-gas plumes in the area south of Meeker Avenue appear to have coalesced. However, the individual areas are apparent.
- Analytical results from soil samples indicated that a shallow source of impacted soil exists in the vicinity of the northeastern corner of the building located at 72 Anthony Street. Soil samples from boring SB-08 confirmed the presence of PCE in shallow soils at a

concentration that exceeded TAGM 4046 criteria. Soil boring SB-08 is located within 20 feet of monitoring well DEC-016. The results of the sample from SB-08 confirm the results of soil samples taken from DEC-016 during the Phase I field investigation.

- There appears to be five potential source areas within the site boundary where dissolved phase chlorinated solvents have adversely impacted the shallow groundwater, as shown on Figures 9 and 10. The horizontal extent of impacted shallow groundwater was not fully determined at four of the five potential source areas. The potential impact of dissolved phase chlorinated solvents to deeper groundwater was not investigated at the five potential sources during Phase II fieldwork.

Phase II recommendations for Phase III fieldwork included the installation of additional soil-gas conduits to fill existing data gaps and further delineate the horizontal extent of impacted soil-gas, that has not been determined at three of the five potential sources. Direct-push soil borings were recommended in the vicinity of DEC-031 to locate and delineate the horizontal and vertical extent of PCE impacted subsurface soils near the former dry cleaner. Direct-push groundwater sampling was recommended to the north and east of DEC-018 to aid in the delineation of PCE and TCE impacted shallow groundwater. Additional water table (shallow) monitoring wells were recommended to fill existing data gaps and further delineate the horizontal extent of impacted groundwater that has not been determined at four of the five potential sources. In addition, deep monitoring wells were recommended at each of the five potential source areas to assess the impact of dissolved phase chlorinated solvents to deeper groundwater.

### **1.2.3 Summary of 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 in the Phase II Final Data Summary Report (URS, April 2008) concerning the horizontal extent of impacted soil-gas at three of the five areas identified; determine if impacted soils existed at one potential source area; the horizontal extent of impacted shallow groundwater at four of the five potential sources; and to assess the vertical extent of impacted groundwater at each of the five potential sources. In addition, the NYSDEC directed URS to assess and delineate any chlorinated solvent impacts to soil and

groundwater in the vicinity of the EPM soil boring located at the southeastern intersection of Gardner Avenue and Thomas Street (see Section 1.1.2). Field activities associated with the Phase III field investigation included: submitted Freedom of Information Law (FOIL) requests to the New York City (NYC) Fire Department (FDNY), NYC Department of Buildings (DOB) and, NYC Department of Environmental Protection (DEP) for records on potential sources; utility locating by a private subcontractor; manual and/or Vac-Tron® utility clearance for monitoring well installation; installation of 14 permanent soil-gas conduits; advanced 24 direct-push borings; advanced 20 direct-push groundwater sample locations; installation of 16 shallow and 8 deep groundwater monitoring wells; collection of soil-gas samples from 14 newly installed soil-gas conduits; collection of 38 soil samples from 24 direct-push borings and 24 monitoring well borings; collection of 20 ground water samples from 20 direct-push groundwater sample locations; collection of 59 groundwater samples from 24 newly installed and 35 existing monitoring wells; collection of one dense non-aqueous phase liquid (DNAPL) sample for analysis; daily pick-up of investigation derived waste for disposal; and a site survey. 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 five areas of elevated soil-gas concentrations identified within the site boundary during Phase II field investigation were further delineated during Phase III, as shown on Figures 11 and 12. The horizontal extent of impacted soil-gas was not fully delineated at two of the five areas.
- Soil borings performed in the vicinity of the EPM soil boring located at the southeastern intersection of Gardner Avenue and Thomas Street did not indicate the presence of chlorinated solvent impacted soils in this area.
- A Dense Non-Aqueous Phase Liquid (DNAPL) containing 700,000 mg/kg (i.e., 70%) PCE was identified in monitoring well DEC-024D.

- The results of groundwater samples collected during Phase III has allowed URS and the NYSDEC to identify four sources of dissolved phase chlorinated solvents in the shallow groundwater, as shown on Figures 13 and 14. 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.

#### **1.2.3.1 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 four sources and two potential sources are discussed below.

##### **1.2.3.1.1 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.
- The former and current metal works located at 95 Lombardy (Brooklyn Tax District, Block 02819, Lot 0008) was identified as a source of groundwater contamination. Based on

Sanborn map data, the facility has been utilized from the 1930s to the present as a metal fabricator and painting facility. ACME Steel is listed in the EDR report as a generator of F001 waste (spent halogenated solvents used in degreasing) for this facility. Monitoring wells DEC-005 and DEC-005D are located on the western side of the building on Vandervoort Avenue. Groundwater samples from these wells indicate significant TCE contamination and the potential presence of DNAPL given the increasing TCE concentrations with depth.

- A former brass foundry located at 72 Anthony Street (Brooklyn Tax District, Block 02820, Lot 0005) was identified as a source of soil and groundwater contamination. Based on Sanborn map data, the facility was utilized as a brass foundry from the mid 1960s to approximately 1993. ACME Steel is listed in the EDR report as a generator of F001 waste (spent halogenated solvents used in degreasing) for this facility. Soil samples from DEC-016 and SB-08, located at the northeastern corner of the facility along Anthony Street, indicate shallow PCE contaminated soils are located adjacent to this facility. Monitoring wells DEC-016 and DEC-016D are located on the Anthony Street (north) side of the facility. Groundwater samples from these wells indicate significant PCE and TCE contamination.
- The former Klink Cosmo Cleaners, located at 364 Richardson Street (Tax District of Brooklyn, Block 02860, Lot 0001) was identified as a source of groundwater contamination. The facility is shown on Sanborn Maps to be a clothing warehouse from the mid 1950s until some time after 1995. Klink Cosmo Cleaners is listed in the EDR report as a generator of F002 waste (spent halogenated solvents) for this facility. Monitoring wells DEC-031 and DEC-031D are located on the southwestern corner of Vandervoort Avenue and Richardson Street (northeast building corner). Soil-gas and groundwater samples indicate significant PCE and TCE contamination at the northeastern corner of the building.

#### **1.2.3.1.2 Potential Sources**

- The facility that contained a former soap manufacturer and lacquer storage, located at 171 Lombardy Street (Brooklyn Tax District, Block 02821, Lot 0001), is 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 western side of the building, near Lombardy Street. Groundwater samples from these wells indicate significant PCE and TCE contamination. The PCE and TCE contamination in the shallow groundwater zone is centered on DEC-018, suggesting the contamination is near its source.

- The former Curtis Electro N.Y., Inc. facility located at 126 Cherry Street (Brooklyn Tax District, Block 02814, Lot 0010), is a potential source of groundwater contamination. Based on Sanborn map data, the facility was utilized as a light fixture manufacturer from the mid 1960s until some time after 1995. Monitoring wells DEC-049 and DEC-049D are located adjacent to the facility on the corner of Stewart Avenue and Cherry Street. Groundwater samples these wells indicate significant PCE and TCE contamination that increase with depth.

Phase III recommendations included the installation of shallow groundwater wells to assist in determining the horizontal extent of the dissolved phase plume originating from near DEC-018/018D and if the impacted groundwater found at well pair DEC-049/049D is associated with the dissolved phase plume originating from near DEC-018/018D. In addition, deep monitoring wells were recommended to assess the impact of dissolved phase chlorinated solvents to deeper groundwater and to determine the horizontal extent of impacted deep groundwater. Four Membrane Interface Probe (MIP) borings were recommended on private property to assist in determining both the horizontal and vertical extent of impacted groundwater. The MIP borings were recommended because it was likely that the property owners would be more inclined to allow temporary operations on their property that would be performed relatively quickly (i.e., one to two days) instead of permanent monitoring points (i.e., monitoring wells).

#### **1.2.4 Summary of Phase IV Findings**

The Phase IV field investigation was conducted from November 3 through December 8, 2008. The purpose of the Phase IV fieldwork was to assist in determining: the horizontal extent of the dissolved phase plume originating from near DEC-018/018D; if the impacted groundwater found at

well pair DEC-049/049D is associated with the dissolved phase plume originating from near DEC-018/018D; the impact of dissolved phase chlorinated solvents to deeper groundwater; and the horizontal extent of impacted deep groundwater. 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. Field activities associated with the Phase IV field investigation included: a review of Sanborn maps; a review of additional responses to FOIL requests by the FDNY, NYC DOB and NYC DEP on suspected sources; utility locating by a private subcontractor; manual and/or Vac-Tron® utility clearance at monitoring well and membrane interface probe (MIP) boring locations; installation of 3 shallow and 5 deep groundwater monitoring wells; collection of 5 soil samples from 8 monitoring well borings; collection of 21 groundwater samples from 8 newly installed and 13 existing monitoring wells; daily pick-up of investigation derived waste for disposal; and a site survey. A complete description of the field investigation and results may be found in the Phase IV Data Summary Report (URS, May 2009).

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

- Data collected at the MIP boring locations has shown that dissolved phase chlorinated solvents have impacted shallow and deep groundwater moving beneath the City of New York Department of Sanitation (DSNY) property located at the southeastern corner of the intersection of Varick Avenue and Cherry Street. Based on this data, it has been determined the concentrations of PCE and TCE that was detected in DEC-049 and DEC-049D during Phase III groundwater sampling are more likely related to the impacted groundwater originating from near DEC-018/DEC-018D. No separate source of PCE and/or TCE exists near DEC-049 and DEC-049D as previously hypothesized.



- The soil data collected during Phase IV fieldwork is similar to that found during previous phases of fieldwork (i.e., Phase I, II and III) in the area south of Meeker Avenue.
- The results of the groundwater sample collected during Phase IV has allowed URS and the NYSDEC to identify the area in the immediate vicinity of DEC-018 as a potential source of PCE and TCE in the shallow groundwater (Figures 15 and 17). The horizontal extent of PCE and TCE in the shallow groundwater has been delineated to the west, north, and east. PCE and TCE concentrations decrease by up to four orders of magnitude in wells downgradient and sidegradient from DEC-018. PCE and TCE degradation products have typically been found at the highest concentrations in shallow groundwater wells located closest to the Off-Site Plume area boundary. This is most likely caused by the degradation of the non-chlorinated hydrocarbons associated with the Off-Site Plume, which has produced an oxygen-deficient environment. The southern/southeastern extent of PCE and TCE in the shallow groundwater has not been delineated.
- It has been found that deep groundwater, centered on MW-097/MW-097D, has been significantly impacted by both PCE and TCE (Figures 16 and 18). Concentrations decrease by one to two orders of magnitude moving to the east and south away from the well. The horizontal extent of PCE and TCE in deep groundwater has not fully been determined. Data gaps exist to the north and west of MW-097/MW-097D. The horizontal extent of the PCE impacted deep groundwater occupies a larger footprint than the horizontal extent of PCE in the shallow groundwater. This suggests that multiple shallow sources are contributing to the PCE and TCE, which have been found in the deep groundwater zone. The full vertical extent of impacted groundwater has not been determined.
- The former Curtis Electro N.Y., Inc. facility, which was located at 126-140 Cherry Street (Tax District of Brooklyn, Block 02814, Lot 0010), is no longer considered a potential source of groundwater contamination. Based upon data obtained during the Phase IV investigation, it has been determined the concentrations of PCE and TCE that were detected previously in DEC-049 and DEC-049D, which are adjacent to the former Curtis Electro N.Y., Inc. facility, are likely related to the impacted groundwater originating from near DEC-

018/DEC-018D (i.e., further upgradient). No separate source of PCE and/or TCE exists near DEC-049 and DEC-049D as previously hypothesized.

#### **1.2.4.1 Phase IV Source Characterization**

Using data obtained during the four Phases of the investigation performed by URS, it has been determined that there are four sources and seven potential sources of PCE and TCE contamination within the study area. Additional information gathered from the FOIL requests, a review of certificates of occupancy, and a review of additional reports has been incorporated in the descriptions of each source and potential source.

##### **1.2.4.1.1 Sources**

No additional sources were identified based on the Phase IV fieldwork. However, the four source areas identified during Phase III were listed as NYSDEC Class 2 Inactive Hazardous Waste Disposal Sites in January 2009. The source areas and their NYSDEC Site ID Numbers are listed below.

- 1) An identified source of groundwater contamination is the building 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). The site is listed as NYSDEC Site Number 2-24-129.
- 2) A source of groundwater contamination is the former Klink Cosmo Cleaners, which was located at 368 Richardson Street (Tax District of Brooklyn, Block 02860, Lot 0001). The site is listed as NYSDEC Site Number 2-24-130.
- 3) A source of groundwater contamination is a former and current metal works, which is located at 95 Lombardy Street (Tax District of Brooklyn, Block 02819, Lot 0008) and 46-60 Anthony Street (Tax District of Brooklyn, Block 02819, Lot 0011). The site is listed as NYSDEC Site Number 2-24-131.

- 4) A source of soil and groundwater contamination is a former brass foundry and a stainless steel door finishing facility operated by ACME Architectural Products, Inc., located at 72 Anthony Street (Tax District of Brooklyn, Block 02820, Lot 0005) and 90 Anthony Street (Tax District of Brooklyn, Block 02820, Lot 0001). The site is listed as NYSDEC Site Number 2-24-132.

#### **1.2.4.1.2 Potential Sources**

A total of seven additional potential source areas have been identified within the study area. The seven potential source areas have been identified as areas where additional information needs to be gathered to determine if any of these areas are responsible for, or are contributing to, the presence of PCE and/or TCE in the environment. A brief description of each potential source is given below.

- 1) 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), 347-353 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.
- 2) 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.
- 3) 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 0084) 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.

- 4) 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.
- 5) 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 is adjoining 157 Lombardy Street to the east.
- 6) 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.
- 7) 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.

The Phase IV recommendations were made based upon data collected over the four phases of fieldwork and the results of new Sanborn and FOIL data. For the area north of Meeker Avenue, in the vicinity of the former Spic and Span Cleaners and Dyers, Inc., the recommendations included the installation of five shallow monitoring wells to assist in determining if there are additional potential sources of PCE and TCE impacting shallow groundwater. Four deep monitoring wells were recommended to assist in determining impacts of PCE and TCE to deep groundwater in the area north

and west of the former Spic and Span Cleaners and Dyers, Inc. In addition, the deep wells would assist in determining if there are additional potential or contributing sources of PCE and TCE impacting deep groundwater. Finally, the deep wells would assist in determining the potential presence of DNAPL if the clayey silt unit is encountered, as found in well DEC-024D. It was recommended that all deep wells be constructed of a 10-foot long stainless steel screen equipped with a 2-foot sump and stainless steel riser. Stainless steel was recommended due to presence of DNAPL and the incompatibility between PCE and/or TCE and PVC materials. During field activities, a DNAPL gauging event would be performed at DEC-024D. If DNAPL is present in DEC-024D, the well would be decommissioned and a replacement well, DEC-024DR would be installed adjacent to DEC-024D. The replacement well would be of similar construction as the four new deep wells. A round of groundwater samples would be collected from 9 new and 12 existing wells and analyzed for TCL VOCs plus TICs by 8260B.

For the area south of Meeker Avenue, in the vicinity of the Phase IV investigation area, the recommendations included the installation of four shallow monitoring wells to assist in determining if there are additional potential sources contributing to the PCE and TCE impacted shallow groundwater found in the vicinity of DEC-018/018D. Six deep monitoring wells were recommended to assist in determining impacts of PCE and TCE to deep groundwater in the area to south and southwest of well pair DEC-018/018D. The new deep wells would also assist in determining if PCE and TCE impacted groundwater is associated with an upgradient source and/or if there are any additional potential sources contributing to the impacted deep groundwater. Three top of clay wells were recommended to assist in determining the vertical extent of PCE and TCE impacted groundwater. The top of clay wells would be advanced to the top of the Raritan Formation, which is anticipated to be found between approximately -47 and -71 feet amsl. It was recommended that all top of clay wells be constructed of a 10-foot long stainless steel screen equipped with a 2-foot sump and 10 feet of stainless steel riser, with PVC riser the remainder of the well string. If DNAPL is encountered in any new monitoring well(s), a DNAPL sample would be collected for laboratory analyses. A round of groundwater samples should be collected from all new and existing DEC wells and ExxonMobil wells and analyzed for TCL VOCs plus TICs by 8260B.

### **1.3 Phase V Investigation Project Objectives and Scope**

The Phase V site investigation was limited to the area north of Meeker Avenue. The purpose of the Phase V fieldwork was to assist in determining:

- the horizontal extent of the dissolved phase plume originating from near the former Spic and Span Cleaners and Dyers, Inc. (DEC-024/024D);
- if there are additional potential sources of PCE and TCE impacting shallow groundwater to the north of the former Spic and Span Cleaners and Dyers, Inc.;
- the horizontal extent of impacted deep groundwater, if present;
- if the clayey silt unit that was encountered in well DEC-024D is present at other well locations in the area;
- the depth and areal extent of the clayey silt unit, if encountered; and
- if DNAPL is present at the top of the clayey silt unit.

The investigation area for Phase V (Figure 19) was limited to the area located north of Nassau Avenue and south of Meserole Avenue between Sutton Street to the east and Monitor Street to the west.

Tasks performed during the Phase V field investigation included:

- Utility locating by Radar Solutions International of Waltham, MA;
- Manual and/or Vac-Tron® utility clearance for monitoring well installation by Aquifer Drilling and Testing, Inc., of New Hyde Park, NY (ADT);
- Installation of 5 shallow and 5 deep groundwater monitoring wells by ADT;
- Collection of 7 soil samples from 10 monitoring well borings for analysis by Hampton-Clarke, Inc. – Veritech Laboratory, of Fairfield, NJ (HC-V);
- Gauging of DNAPL in DEC-024D;
- Collection of a DNAPL sample from DEC-024D for analysis by HC-V;

- Collection of light non-aqueous phase liquid (LNAPL) samples from DEC-034 and DEC-054 for analysis by HC-V;
- Collection of 17 groundwater samples from 8 newly installed and 9 existing monitoring wells for analysis by HC-V;
- Daily pick-up of investigation derived waste for disposal through Frank's Vacuum Truck Service of Niagara Falls, NY and
- Site survey by NAIK Consulting Group, P.C., of Edison, NJ.

#### **1.4 Data Presentation**

This Data Summary Report has six 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 Phase V fieldwork. Section 3 includes a description of the subsurface conditions that have been found at the site. Section 4 includes a description and summary of the analytical results for the soil, non-aqueous phase liquids (NAPLs) and groundwater samples from monitoring wells collected during the Phase V fieldwork. Section 5 consists of the conclusions and recommendations derived from the Phase V field effort. Section 6 contains a list of references cited. Tables, Figures, and Appendices immediately follow the text.

## **2.0 FIELD ACTIVITIES**

Field activities performed during Phase V of the site characterization from June 15 through July 13, 2009 are discussed below.

### **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 boring locations. The jackets were installed by Con-Edison between June 12 and June 15, 2009. Photographs of jacketed overhead wires can be found in Appendix A.

### **2.2 Geophysical Survey for Utility Markouts**

On June 15, 2009, Radar Solutions International (RSI) mobilized a one person crew with 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 drilling for monitoring well installations were proposed.

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 was a Ditch Witch 950 RT locating system, which consists of a locator and a transmitter.

RSI marked utilities and anomalies by spray-painting the outline on the pavement as soon as they were located. A URS geologist supervised and assisted RSI. RSI's report is provided in Appendix B. A photograph of a completed RSI utility mark out can be found in Appendix A.



## **2.3 Groundwater Monitoring Well Installation**

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

### **2.3.1 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. On June 15, 2009, ADT mobilized a Vac-Tron® unit to perform location specific utility clearance at each of the proposed monitoring well locations. A total of 10 out of 14 locations were cleared for monitoring wells between June 15 and 17, 2009. 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. Four locations were abandoned because of underground impediments. 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. The abandoned locations were backfilled using the excavated spoils and temporarily patched with blacktop patch or concrete.

### **2.3.2 Soil Borings**

During the period of June 15 through June 25, 2009, ADT utilized a track-mounted AMS Compact Roto Sonic 17-C drill rig for the installation of 10 monitoring wells at the locations shown on Figure 20. Of the 10 monitoring wells installed during Phase V, five were water table (shallow wells) and the remaining five were deep wells.

The soil borings were advanced using a combination of a 3-inch diameter inner samplers (5 or 10 feet in length) and a 5-inch diameter outer casing. 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. All IDW generated from the

monitoring well installation was containerized in DOT approved 55-gallon drums and picked up by Frank's Vacuum Truck Service on a daily basis for off-site disposal at a permitted facility.

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 just above water table, 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 just above water table was collected. Site photographs are provided in Appendix B, copies of the daily field notes are provided in Appendix C and soil boring logs are provided in Appendix D.

A chain-of custody (COC) form was maintained and accompanied the sample containers to HC-V. The samples were analyzed for TCL VOCs as listed in Table 1, plus TICs following USEPA SW846 Method 8260B.

### **2.3.3 Well Construction**

The five 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 10 to 20 mesh 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 1-foot below grade via tremie pipe.

The five deep monitoring wells were constructed with 10 feet of 2-inch ID, Type 304 stainless steel 0.010-inch slot screen equipped 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 10 to 20 mesh 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 1-foot 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 E.

#### **2.4 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 Wattera 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 and 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 5 well volumes was removed, and water quality parameters had stabilized. Well development logs may be found in Appendix F. Well development water was collected into DOT approved 55-gallon drums and picked up daily by Frank's Vacuum Truck Service for off-site disposal at a permitted facility.

On June 27, 2008, a dark amber colored DNAPL was encountered while developing monitoring well DEC-024DR. Small DNAPL blobs were noticed in the bottom of the parameter cup used to collect a sample aliquot for water quality measurements. The development water from DEC-024DR was collected into a DOT approved 55-gallon drum and picked up that day by Frank's Vacuum Truck Service for off-site disposal at a permitted hazardous waste facility. Site photographs are provided in Appendix B.

#### **2.5 Non-Aqueous Phase Liquid Gauging**

During Phase V fieldwork, DEC-024D was gauged for DNAPL and all monitoring wells sampled were gauged for LNAPL.

##### **2.5.1 Dense Non-Aqueous Phase Liquid Gauging**

On June 22, 2009, URS and Department personnel performed DNAPL gauging at DEC-024D. Prior to gauging, the ground surface around the well was covered with a polyethylene sheet

and headspace readings at the well were measured with a MiniRae 2000 PID for VOCs. The headspace of the well indicated a VOC concentration of >10,000 parts per million (ppm) however, VOC readings in the breathing zone were 0.0 ppm. The gauging was performed using a 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. Approximately 1.5 feet of the string was stained dark brown with DNAPL. The Department directed URS to collect a sample of the DNAPL for laboratory analysis. The sampling of the DNAPL from DEC-024D is discussed in Section 2.6.1.

On June 22, 2009 the Department in consultation with URS decided to refrain from decommissioning DEC-024D at this time as previously planned. This decision was based upon the fact that DEC-024D had not yet been deteriorated by the presence of DNAPL in the well. The well may be decommissioned at a future time when the presence of DNAPL has deteriorated the well to the point that it is no longer usable to gauge and recover DNAPL. The well will no longer be considered usable when a 1.75-inch outside diameter (OD) bailer cannot be lowered to the bottom of the well.

### **2.5.2 Light Non-Aqueous Phase Liquid Gauging**

On July 7, 2009, a round of synoptic groundwater level measurements was obtained from 23 monitoring wells (17 DEC wells and 6 ExxonMobil wells) within the Phase V investigation area using a 100-foot long Solinst oil/water interface probe. The water level measurements are provided in Table 2. LNAPL was detected in DEC-034 and DEC-054 with a thickness of 1.34 and 1.09 feet respectively. The sampling of the LNAPL from monitoring wells DEC-034 and DEC-054 are discussed in Section 2.6.2.

It should be noted that LNAPL was not encountered in monitoring well DEC-034 during Phase III well installation, development and sampling. This well was not sampled during Phase IV.

## **2.6 Non-Aqueous Phase Liquid Sampling**

Three non-aqueous phase liquid (NAPL) samples were collected from wells during the Phase V fieldwork. A DNAPL sample was collected from DEC-024D and LNAPL samples were collected

from DEC-034 and DEC-054. The following sections describe the procedure used to collect these samples and the laboratory analysis performed on the samples.

### **2.6.1 Dense Non-Aqueous Phase Liquid Sampling**

On June 22, 2009, a DNAPL sample was collected from DEC-024D by URS personnel and a Department representative using Level D+ personal protective equipment (PPE) following the gauging event. Prior to sampling, the headspace readings at the well were measured with a MiniRae 2000 PID for VOCs. The headspace of the well indicated a VOC concentration of >10,000 ppm however, VOC readings in the breathing zone were 0.0 ppm. A sample was collected from the bottom of the well using a weighted dedicated/disposable HDPE bailer with nylon rope. 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 Frank's Vacuum Truck Service for off-site disposal at a permitted hazardous waste facility. Site photographs are provided in Appendix B and copies of the daily field notes are provided in Appendix C. The hazardous waste manifest is provided in Appendix H.

A COC form was maintained and accompanied the sample containers to HC-V. The sample was analyzed for: TCL VOCs plus TICs by 8260B and TCL SVOCs plus TICs by 8270C, as listed in Table 1.

### **2.6.2 Light Non-Aqueous Phase Liquid Sampling**

On July 8, 2009, URS and the Department received an e-mail from Roux Associates, acting on behalf of ExxonMobil, asking for permission to collect LNAPL samples from DEC-034 and DEC-054 for analysis. The Department gave a verbal approval on July 8, 2009 for Roux Associates to collect LNAPL samples from these wells and instructed URS to provide access to the wells and to obtain a split-sample for laboratory analysis. On July 9, 2009, Roux Associates, in the presence of URS personnel, collected LNAPL samples from DEC-034 and DEC-054 using dedicated/disposable HDPE bailers and provided URS personnel with split samples.

A COC form was maintained by URS and accompanied the sample containers to HC-V. The sample was analyzed for TCL VOCs plus TICs by 8260B and TCL SVOCs plus TICs by 8270C, as listed in Table 1.

## **2.7 Groundwater Sampling**

From July 7 through July 13, 2009, URS measured depth to groundwater and collected groundwater samples from 17 monitoring wells (8 newly installed DEC wells, 5 existing DEC wells and 4 existing ExxonMobil wells) plus QA/QC samples using low-flow sampling procedures. Roux Associates acting on behalf of ExxonMobil, provided URS with access to the four ExxonMobil well locations (MW-081, MW-083, MW-085, and MW-087). URS provided Roux Associates with split-samples from the ExxonMobil wells. Groundwater samples were not collected from two ExxonMobil locations (MW-084R and MW-086) due to the presence of LNAPL in the wells. Groundwater samples were also not collected from DEC-034 and DEC-054 due to the presence of LNAPL in the wells and DEC-024DR due to the presence of DNAPL in the well.

Prior to sample collection, standing water was purged from each well with a QED SamplePro Micropurge bladder pump using dedicated/disposable bladders and HDPE tubing. 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. Purge logs are provided in Appendix G. Purge water was collected into DOT approved 55-gallon drums, and was picked up daily by Frank's Vacuum Truck Service for proper disposal.

All samples were transported under COC via laboratory courier to HC-V. The samples were analyzed for TCL VOCs as listed in Table 1, plus TICs following USEPA SW846 Method 8260B.

## **2.8 Monitoring Well Maintenance**

During Phase V fieldwork, 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 tamper proof bolts.

During a July 15, 2009 site visit by URS and Department personnel, it was noted that some wells that were not sampled as part of the Phase V fieldwork were in need of repair. The well pad at DEC-010 was broken and in need of replacement. The well pads and flush-mount protective casings at DEC-031 and DEC-031D had been destroyed and are in need of replacement. These repairs will be made during the next visit to the site.

## **2.9 Investigation Derived Waste Disposal**

Frank's Vacuum Truck Service 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 H.

## **2.10 Site Survey**

NAIK Consulting Group surveyed the area, including all new monitoring wells installed and/or sampled 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. Copies of survey field notes and site sketches are provided in Appendix I. A site survey drawing is provided in Appendix J.

### **3.0 SUBSURFACE CONDITIONS**

#### **3.1 Regional Geology**

The site investigation area 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 above mean sea level (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 21). 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). 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 confining unit, and crystalline bedrock (Figure 22). 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 confining unit consists of deltaic clay and silty clay beds and some interbedded sands. The Raritan confining unit has been encountered in three borings performed near the site: 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 confining unit into the underlying crystalline bedrock at a depth of -163 feet amsl.



### **3.2 Site Geology**

The topography of the site investigation area varies from approximately 6 feet above mean sea level (amsl) at the bulkhead along Newtown Creek to approximately 56 feet amsl in the central part of the site area. Based upon subsurface data obtained during this and previous investigations, only the upper glacial aquifer has been penetrated. The following textural units have been found in the upper glacial aquifer in most areas of the site from the surface downward: a fill unit, a sand unit, a discontinuous glacial till unit and, a discontinuous clay/silt unit.

The fill unit thickness varies from approximately 0 to 9 feet thick 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.) and has been found at most boring locations. The sand unit has been found underlying the fill unit at most boring locations and is represented by stratified sands of varying textures containing some to no fines. The entire thickness of the sand unit has not been penetrated. However, it was found to be approximately 100 feet thick at location DEC-016 (Anthony Street between Porter and Varick Avenues). The discontinuous glacial till unit was noted in borings in the western and southwestern portion of the site (i.e., west of Morgan Avenue north of Meeker Avenue and west of Porter Avenue south of Meeker Avenue) and consists of a heterogeneous mixture of sand, silt, and clay and varying amounts of gravel, cobbles and boulders. The discontinuous clay/silt unit has been observed as an inclusive unit within the sand unit and has been observed in most of the borings at the site. The thickness of the clay/silt unit, where present, varies from 0.5 to over 10 feet thick. The presence of the clayey silt unit at well location DEC-024D has resulted in the accumulation of DNAPL at the interface between the sand unit and the inclusive clay/silt unit (approximately 50 feet bgs/ -29.78 feet amsl). The clayey silt unit found at well location DEC-024D has also been found in nearby wells (DEC-023D, DEC-024DR, DEC-035D, DEC-053D and DEC-055D) at depths ranging from 50 feet bgs/ -29.84 feet amsl (DEC-024DR) to 65 feet bgs/-48.80 feet amsl (DEC-023D).

Figure 23 depicts the locations of cross-sections A-A', B-B', C-C', D-D', E-E' and F-F' which are shown on Figures 24 through 29, respectively.

### **3.3 Investigation Area Hydrogeology**

The primary hydrogeologic unit identified beneath the investigation area is the upper glacial aquifer. Perched groundwater has been found in some site borings (DEC-004, DEC-006, DEC-007, DEC-015, DEC-017, DEC-022, DEC-030, SB-008, and SB-011) where clayey silt units are present above the sand unit (i.e., glacial till and or clay/silt unit). The water table surface may be found between approximately 11 and 54 feet bgs depending on the well location. The water table on the northern and northeastern portions of the site 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 around the perimeter of the Off-Site Plume area, which has prevented the expansion of the Off-Site Plume.

On July 7, 2009, a round of synoptic groundwater level measurements was obtained from 23 monitoring wells (15 DEC wells and 6 ExxonMobil wells) within the Phase V investigation area. The water level measurements are provided in Table 2. A potentiometric surface map based on the water level measurements from the shallow wells, using a 0.2-foot contour interval, is provided in Figure 30. A potentiometric surface map based on the water level measurements from the deep wells, using a 0.2-foot contour interval, is provided in Figure 31. Historic water level measurements are also included in Table 2.

The groundwater flow in the Phase V investigation area is north to northeast towards the Off-Site System. The horizontal hydraulic gradient in the Phase V investigation area ranges from 0.0 to 0.023 foot per foot (ft/ft) with the steepest gradients being between DEC-036 and surrounding wells.

The vertical hydraulic gradients in well pairs varied in direction across the Phase V investigation area. Vertical hydraulic gradients in well pair DEC-035/035D was slightly positive or upwards based upon the water level information provided in Table 2. Vertical hydraulic gradients in well pairs DEC-023/023D, DEC-024/024D, DEC-053/053D and DEC-055/055D are slightly negative to negative or downwards based upon the water level information provided in Table 2.

## 4.0 ANALYTICAL RESULTS

The following sections discuss the results of the soil, NAPL and groundwater sample analyses for the Phase V fieldwork at the Meeker Avenue Plume Trackdown site.

### 4.1 Soil Analytical Results

The soil sample results were compared to TAGM 4046 criteria. A summary of the detected TCL VOCs in the Phase V soil samples is presented in Table 3. Results exceeding TAGM 4046 criteria are indicated with a circle. Table 4 provides a historical summary of the detected TCL parameters for all soil samples collected by URS since Phase I in the area north of Meeker Avenue. Table 5 provides a statistical summary of the detected TCL parameters for all soil samples collected by URS since Phase I in the area north of Meeker Avenue 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 Phase V soil samples are presented in the Data Usability Summary Report (DUSR) in Appendix K, on a compact disc. Data summary tables, Form I and Form Ie (TICs) are provided in the DUSR and include the reporting limit for each non-detected compound.

Seven soil samples were collected during the Phase V fieldwork from the monitoring well borings. Several samples had detections exceeding TAGM 4046 criteria (Figure 32). PCE was only detected above the criteria in the 45-46 feet bgs soil sample from DEC-024DR (1,000 mg/kg). DNAPL containing 73% PCE was gauged in the adjacent well DEC-024D at approximately 52½-54 feet bgs (see Section 4.2.1). The PCE found in the soil at DEC-024DR may be the results of lateral spreading of the DNAPL due to the decrease in soil permeability at that depth. PCE was also detected in soil sample DEC-057 19-20 feet bgs (0.02 mg/kg, or ppm), which is just below the water table. DEC-057 is approximately 40 feet north of DEC-024DR. The concentration of PCE in the groundwater sample from well DEC-057 was 0.044 ppm (see Section 4.3.1). It is plausible that the PCE detected in the soil at DEC-057 is from the dissolved phase PCE in the groundwater.

TCE was only detected in sample DEC-024DR 45-46 feet bgs (0.22 mg/kg), below criteria. The soil data collected during Phase V fieldwork is similar to that found during previous phases of

fieldwork in this area of the site. Soil samples from DEC-053 and DEC-054 exceeded criteria for petroleum-related compounds.

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

A summary of the detected TCL VOCs and SVOCs in the NAPL samples collected from monitoring wells during Phase V is presented in Table 6. Table 7 provides a historical summary of the detected TCL parameters for all NAPL samples collected by URS since Phase I in the area north of Meeker Avenue. The complete validated analytical results from the Phase V NAPL samples are presented in the DUSR in Appendix K. 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**

The results from the DNAPL sample collected from monitoring well DEC-024D during the Phase V investigation shows PCE at a concentration 730,000 [milligrams per kilogram (mg/kg)] or 73% and TCE 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), as shown in Table 6. The tentatively identified compounds found in the volatile and semivolatile fractions indicate the presence of petroleum related compounds. These results are consistent with the results of the DNAPL sample collected from this well during Phase III on May 29, 2008.

##### **4.2.2 Light Non-Aqueous Phase Liquid Analytical Results**

In the LNAPL sample from monitoring well DEC-034, PCE was found at a concentration of 1.1 mg/kg (0.00011%), as shown in Table 6. No chlorinated compounds were detected in the LNAPL sample from monitoring well DEC-054. All other compounds detected in sample DEC-034 and DEC-054 can be attributed to petroleum related compounds.

Roux Associates, on behalf of ExxonMobil submitted the LNAPL samples for laboratory analysis of density, viscosity, surface tension and gas chromatographic comparison to select petroleum hydrocarbons. The results of the analysis can be found in Appendix L.

### **4.3 Groundwater Analytical Results**

A summary of the detected TCL VOCs in the Phase V groundwater samples collected from monitoring wells is presented in Table 8. 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 33. Isoconcentration contours of PCE and TCE in the Phase V groundwater samples are shown on Figures 34 through 37. Table 9 provides a statistical summary of the detected parameters for the Phase V groundwater samples as follows: the number of detections; the minimum, maximum and average values; and the location of the maximum value. Table 10 provides a historical summary of the detected parameters for all groundwater samples collected by URS since Phase I in the area north of Meeker Avenue. Table 11 provides a statistical summary of the detected parameters for all samples collected by URS since Phase I in the area north of Meeker Avenue 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 Phase V groundwater samples are presented in the DUSR in Appendix K. Data summary tables, Form I and Form Ie (TICs) are provided in the DUSR and include the reporting limit for each non-detected compound.

#### **4.3.1 Groundwater PCE Detections**

PCE was detected in 6 of the 17 Phase V groundwater samples collected, at concentrations exceeding groundwater criteria. Concentrations exceeding groundwater criteria ranged from 8.5 µg/L to 8,200 µg/L (Figure 33). The highest concentration of PCE was detected at DEC-036 (8,200 µg/L). DEC-024 was the next highest, at 100 µg/L, followed by DEC-053D (55 µg/L), DEC-057 (44 µg/L), DEC-025 (18 µg/L) and DEC-055D (8.5 µg/L).

Figure 34 depicts isoconcentration contours for PCE in the shallow groundwater and includes the locations of potential sources. The concentration of PCE in the existing shallow wells is similar to the concentrations found during the previous groundwater sampling event in the area north of Meeker Avenue (i.e., Phase III). The horizontal extent of PCE impacted shallow groundwater originating from near DEC-024/DEC-024D/DEC-024DR appears to be delineated to the north, east, south and west. Any impacts to the shallow groundwater from the potential sources located north of

Norman Avenue between Kingsland Avenue and Monitor Street could not be determined because a groundwater sample was not collected from DEC-054 due to the presence of LNAPL in the well. The shallow dissolved phase plume originating from DEC-024/DEC-024D/DEC-024DR appears to be moving with groundwater flow towards the north as seen in the concentration found in DEC-057. Monitoring wells east of DEC-034 and south of DEC-025 were not sampled during Phase V, therefore the isoconcentration contours to the south, east and northeast are inferred, based on the results from previous fieldwork in the area north of Meeker Avenue as represented in Figures 5, 9 and 13.

Figure 35 depicts isoconcentration contours for PCE in the deep groundwater and includes the locations of potential sources. It should be noted that the interval of saturated sand that DEC-036 is screened in (approximately -18.65 to -24.69 feet amsl) is closer in elevation to the screened interval of DEC-024D (approximately -23.78 to -33.78 feet amsl) than it is to the screened interval of DEC-024 (approximately -3.5 to -11.45 feet amsl). The relative location of the screened intervals and geologic conditions in the vicinity of DEC-036, DEC-024, DEC-024D, DEC-024DR and DEC-025 are shown in Figures 28 and 29. Therefore DEC-036 is only represented in the deep groundwater isoconcentration contours. The highest concentrations of PCE in groundwater were found near MW-053D and DEC-036. The horizontal extent of PCE in deep groundwater has not been delineated to the north, east and south, but appears to occupy a smaller area compared to PCE in shallow groundwater (see Figure 34). The vertical extent of PCE impacted groundwater has not been determined. 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 2.5.1).

Groundwater and DNAPL samples collected during Phase V have confirmed the potential of a source of PCE in the vicinity of DEC-024/DEC-024D (see Figures 34 and 35). The Phase V samples have found no indication of a potential source of shallow or deep PCE in the vicinity of DEC-053/DEC-053D and DEC-055/DEC-055D. Due to the presence of LNAPL in DEC-054, groundwater was not sampled therefore no conclusion can be drawn about PCE in the area near DEC-054. DNAPL was not encountered during well development of deep wells DEC-023D, DEC-035D, DEC-053D and DEC-055D.

### **4.3.2 Groundwater TCE Detections**

TCE was detected in 2 of the 17 Phase V groundwater samples collected, at concentrations exceeding groundwater criteria, with 63 µg/L at DEC-024 and 2,500 µg/L at DEC-036 (Figure 33). Figure 36 depicts isoconcentration contours for TCE in the shallow groundwater and includes the locations of potential sources. The concentration of TCE in the existing shallow wells is similar to the concentrations found during the previous groundwater sampling event in the area north of Meeker Avenue (i.e., Phase III). The horizontal extent of TCE impacted shallow groundwater appears to be delineated, north, south, east, and west, with concentrations decreasing by up to four orders of magnitude in downgradient and sidegradient wells.

Figure 37 depicts isoconcentration contours for TCE in the deep groundwater and includes the locations of potential sources. As noted in Section 4.3.1, the location of the screened interval of DEC-036, in relation to that of DEC-024 and DEC-024D may indicate that the concentration of TCE found at DEC-036 is more representative of deep groundwater, therefore DEC-036 is only represented in the deep groundwater isoconcentration contours. 2,500 µg/L of TCE was detected in DEC-036. Trace amounts of TCE were detected in the deep groundwater wells (2 µg/L in DEC-053D and 1.1 µg/L in DEC-055D). The horizontal extent of TCE impacted deep groundwater has not been delineated and occupies a slightly smaller area compared to that of the PCE impacted deep groundwater. The vertical extent of TCE impacted groundwater has not been determined. Monitoring wells east of DEC-034 and south of DEC-025 were not sampled during Phase V, therefore the isoconcentration contours to the south, east and northeast are inferred, based on the results from previous fieldwork in the area north of Meeker Avenue as represented in Figures 6, 10 and 14.

### **4.3.3 PCE and TCE Degradation Product Detections**

The presence of PCE and TCE degradation products have also been detected in the Phase V groundwater samples at concentrations exceeding groundwater criteria (Figure 30). The concentration of PCE and TCE degradation products in existing wells is similar to the concentrations found in existing wells during the previous round of groundwater sampling in the area north of Meeker Avenue (i.e., Phase III).

Cis-1,2-DCE was detected above groundwater criteria in 5 of the 17 Phase V groundwater samples, as listed in Table 9. The range of cis-1,2-DCE varied from 11 µg/L to 3,800 µg/L, with the highest concentration detected at DEC-036. Vinyl chloride was detected in 3 of the 17 Phase IV groundwater samples. Vinyl chloride detections ranged from 12 µg/L to 180 µg/L, with the highest concentration detected at DEC-057. Trans-1,2-DCE was detected in 2 samples (DEC-024 - 2.6 µg/L and DEC-057 - 2.1 µg/L).

PCE and TCE degradation products have typically been found at the highest concentrations in wells located closest to the Off-Site Plume area boundary (i.e., DEC-036, DEC-054, and MW-085). This is most likely due to the non-chlorinated hydrocarbons associated with the Off-Site Plume. Fuel hydrocarbons serve as electron donors. Their presence, combined with low redox conditions, can allow bacteria to reductively dechlorinate chlorinated hydrocarbons.



## **5.0 CONCLUSIONS AND RECOMMENDATIONS**

### **5.1 Conclusions**

Based upon the results of the five Phases of the investigation, the following conclusions are provided. Four phases of investigation were performed in the study area north of Meeker Avenue (Phases I, II, III and V). Four phases of investigation were performed in the study area south of Meeker Avenue (Phases I, II, III and IV).

#### **Soils**

Based on the data gathered during the four phases of investigation in the study area north of Meeker Avenue, the soils have adversely been impacted by chlorinated solvents at one location and petroleum related compounds at three locations. Based on a sample collected from DEC-024DR, PCE has impacted soil at levels exceeding TAGM 4046 criteria. DNAPL containing 73% PCE was gauged in the adjacent well DEC-024D at a depth relatively 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 the DNAPL. The horizontal extent of PCE impacted soils has not been determined because PCE has been found in only one location at significant concentrations. Petroleum related compounds have impacted soil at levels exceeding TAGM 4046 criteria at DEC-034, DEC-053 and DEC-054. LNAPL was found in DEC-034 and DEC-054.

#### **Groundwater**

Based on the data gathered during the four phases of investigation in the study area north of Meeker Avenue, the groundwater has adversely been impacted by dissolved phase chlorinated solvents. The investigations to date have identified the area in the immediate vicinity of near DEC-024/DEC-024D/DEC-024DR as a source of PCE and TCE in the shallow groundwater based on the presence of DNAPL in DEC-024D and DEC-024DR. The horizontal extent of PCE and TCE in the shallow groundwater has been delineated. The isoconcentration contours to the south and east are

inferred based on results from previous fieldwork because monitoring wells east of DEC-034 and south of DEC-025 were not sampled during Phase V. PCE and TCE concentrations decrease by up to four orders of magnitude in wells downgradient and sidegradient from DEC-036. However, the concentration of PCE in DEC-036 may also be representative of deeper groundwater conditions. Based on elevation data, the interval of saturated sand that DEC-036 is screened in is closer in elevation to the screened interval of DEC-024D than it is to the screened interval of DEC-024. PCE and TCE degradation products have typically been found at the highest concentrations in shallow groundwater wells located closest to the Off-Site Plume area boundary. This is most likely caused by the presence of fuel hydrocarbons associated with the Off-Site Plume, which provides electron donors, in addition to low redox conditions.

Using the assumption that DEC-036 is considered representative of deep groundwater, it has been found that deep groundwater, centered on DEC-024D, has been impacted by PCE and TCE. The horizontal extent of PCE and TCE in deep groundwater has not fully been determined to the north, east and south. The vertical extent of PCE and TCE impacted groundwater has not been determined.

## **5.2 Source Characterization**

Using data obtained during the five Phases of the investigation performed by URS, it has been determined that there are four sources and seven potential sources of PCE and TCE contamination within the study area.

### **5.2.1 Sources**

No additional sources were identified based on the Phase V fieldwork. However, the four source areas identified during Phase III were listed as NYSDEC Class 2 Inactive Hazardous Waste Disposal Sites in January 2009 and are shown on Figure 38. The source areas and their NYSDEC Site ID Numbers are listed below.

- 1) An identified source of groundwater contamination is the building 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). The site is listed as NYSDEC Site Number 2-24-129.

- 2) A source of groundwater contamination is the former Klink Cosmo Cleaners, which was located at 368 Richardson Street (Tax District of Brooklyn, Block 02860, Lot 0001). The site is listed as NYSDEC Site Number 2-24-130.
- 3) A source of groundwater contamination is a former and current metal works, which is located at 95 Lombardy Street (Tax District of Brooklyn, Block 02819, Lot 0008) and 46-60 Anthony Street (Tax District of Brooklyn, Block 02819, Lot 0011). The site is listed as NYSDEC Site Number 2-24-131.
- 4) A source of soil and groundwater contamination is a former brass foundry and a stainless steel door finishing facility operated by ACME Architectural Products, Inc., located at 72 Anthony Street (Tax District of Brooklyn, Block 02820, Lot 0005) and 90 Anthony Street (Tax District of Brooklyn, Block 02820, Lot 0001). The site is listed as NYSDEC Site Number 2-24-132.

### **5.2.2 Potential Sources**

A total of seven additional potential source areas have been identified within the study area (Figure 39). The seven potential source areas have been identified as areas where additional information needs to be gathered to determine if any of these areas are responsible for, or are contributing to the presence of PCE and/or TCE in the environment. No data was gathered during Phase V that would definitively exonerate any of the potential sources. The presence of LNAPL in DEC-054, which is down gradient of three of the potential sources, prevented the collection of a groundwater sample. Because a groundwater sample was not collected from DEC-054, which is downgradient of these three potential sources, they can not at this time be removed as potential sources based on any analytical data. A brief description of each potential source is given below.

- 1) 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), 347-

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.

- 2) 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.
- 3) 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 0084) 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, exist on Block 02608 Lots 0084 and 0085.
- 4) 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.
- 5) 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 is adjoining 157 Lombardy Street to the east.

- 6) 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.
- 7) 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.

### **5.3 Recommendations**

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

#### **5.3.1 North of Meeker Avenue - Site Characterization**

The recommendations for additional site characterization fieldwork in the area north of Meeker Avenue are as follows:

- Four shallow monitoring wells should be installed at the locations shown on Figure 40 (i.e., PW-1S, PW-2S, PW-3S and PW-4S). These wells will assist in determining the extent/or if there are any additional potential sources contributing to the PCE and TCE impacted shallow groundwater to the north of the former Spic and Span Cleaners and Dyers, Inc. The shallow wells should be constructed with a 15-foot long PVC screen and PVC riser. The rationale for the shallow well locations for the area north of Meeker Avenue can be found in Table 12.

- Seven deep monitoring wells should be installed at the locations shown on Figure 40 (i.e., DEC-036D, DEC-054D, DEC-057D, PW-1D, PW-2D, PW-3D and PW-4D). These wells will further assist in determining the horizontal impacts of PCE and TCE to deep groundwater in the area north, south and east of the former Spic and Span Cleaners and Dyers, Inc. The deep wells will also assist in determining the potential presence of DNAPL if the clayey silt unit, as was found at DEC-024D, is encountered. The deep wells should be advanced approximately 35 feet below the bottom of the existing shallow well at each location or to the top of a less permeable unit (i.e., glacial till and or clay/silt unit). Split spoon samples should be collected continuously from the bottom of the existing borings (e.g., starting at approximately 35 feet bgs), or from the top of the clayey silt unit. The deep wells should be constructed with a 10-foot long stainless steel screen equipped with a 2-foot sump and 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. The rationale for the deep well locations for the area north of Meeker Avenue can be found in Table 12.
- Up to two soil samples should be collected from each boring location: one soil sample from the interval just above water table; the second sample from the interval exhibiting odors, staining, or the highest PID reading. If no odors, staining, or elevated PID reading are encountered, then only one sample from the interval just above water table should be collected, as per the Field Activities Plan (URS, April 2007). 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 and TCL SVOCs plus TICs by 8270C.
- A complete round of groundwater samples should be collected from all new and existing DEC wells and ExxonMobil wells that are highlighted on Figure 40 (for a total of 41 wells). The groundwater samples should be analyzed for TCL VOCs plus TICs by 8260B. Prior to the start of groundwater sampling, a synoptic round of water levels

should be collected from all DEC wells located north of Nassau Avenue and the ExxonMobil wells selected for groundwater sampling.

- If LNAPL is encountered in monitoring wells selected for sampling, a groundwater sample should be collected from the well using one of the procedures outlined below. LNAPL was previously encountered in DEC-034, DEC-054, MW-084R and MW-086. Gauge the thickness of the LNAPL. Using a capped tremie pipe, lower the capped end of the pipe into the well to a depth at least 1 foot below the LNAPL layer. Secure the tremie pipe to limit movement. Push out the cap through 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 should be attached to the tremie pipe for retrieval. Purge and sample the groundwater in accordance with the procedures outlined in the FSP. Alternatively, a discrete interval sampler (i.e., Solinst Model 425) which also prevents the groundwater sample from coming in contact with LNAPL can be used. Operating instructions for the Solinst Model 425 are provided in Appendix M.
- A DNAPL gauging event should be performed at all existing and new deep and top of clay wells to determine if there is evidence of DNAPL and measure the amount (thickness) in each well, if present.
- Replace flush-mount protective casing and well pads at DEC-010, DEC-031 and DEC-031D.

### **5.3.2 South of Meeker Avenue - Site Characterization**

The recommendations for additional site characterization fieldwork in the area south of Meeker Avenue are as follows:

- Four shallow monitoring wells should be installed at the locations shown on Figure 41 (i.e., PW-9, PW-10, PW-11 and PW-12). These wells will assist in determining if there are additional potential sources contributing to the PCE and TCE impacted shallow groundwater found in the vicinity of DEC-018/018D. The wells should be constructed with a 15-foot long PVC screen and PVC riser. The rationale for the shallow well locations for the area south of Meeker Avenue may be found in Table 13.

- Four deep monitoring wells should be installed at the locations shown on Figure 41 (i.e., DEC-040D, DEC-041D, MW-030D and PW-9D). These wells will assist in the delineation of the deeper groundwater to south and southwest of well pair DEC-018/018D. The new deep wells will also assist in determining if PCE and TCE impacted groundwater is associated with an upgradient source and/or if there are any additional potential sources contributing to the impacted deep groundwater. With the exception of MW-030D, the deep wells should be advanced approximately 35 feet below the bottom of the existing shallow well at each location or to the top of a less permeable unit (i.e., glacial till and or clay/silt unit). Split spoon samples should be collected continuously from the bottom of the existing borings (e.g., starting at approximately 35 feet bgs) or from the top of a clayey silt unit. For well MW-030D, split spoon samples should be collected continuously from the ground surface. The wells should be constructed with a 10-foot long PVC screen and PVC riser. The rationale for the deep well locations for the area south of Meeker Avenue may be found in Table 13.
- Three top of clay wells should be installed at the locations shown on Figure 41 (i.e., DEC-018TC, DEC-041TC and MW-097TC) to determine the vertical extent of PCE and TCE impacted groundwater. The top of clay wells should be advanced to the top of the Raritan Formation, which is anticipated to be between approximately -47 and -71 feet amsl. Split spoon samples should be collected continuously from the bottom of the existing borings to the top of the Raritan Formation (e.g., starting at 92 feet bgs at DEC-018TC, 63 feet bgs at DEC-041TC and 76 feet bgs at MW-097TC). The wells should be constructed with a 10-foot long stainless steel screen equipped with a 2-foot sump, 10 feet of stainless steel riser above the screen and PVC riser the remainder of the well string. A stainless steel screen has been recommended due to the incompatibility between PCE and/or TCE and PVC materials. The recommendation for using stainless steel was based on the increasing concentrations of PCE and TCE with depth and the possibility of DNAPL being encountered at the top of the Raritan Formation. The rationale for the top of clay well locations for the area south of Meeker Avenue may be found in Table 13.



- Up to two soil samples should be collected from each boring location: one soil sample from the interval just above water table; the second sample from the interval exhibiting odors, staining, or the highest PID reading. If no odors, staining, or elevated PID reading are encountered, then only one sample from the interval just above water table should be collected, as per the Field Activities Plan (URS, April 2007). 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 and TCL SVOCs plus TICs by 8270C.
- A complete round of groundwater samples should be collected from all new and existing DEC wells and ExxonMobil wells that are highlighted on Figure 41 (for a total of 40 wells). The groundwater samples should be analyzed for TCL VOCs plus TICs by 8260B. A synoptic round of water levels should be collected in the wells to be sampled prior to the start of groundwater sampling.
- A DNAPL gauging event should be performed at all existing and new deep and top of clay wells to determine if there is evidence of DNAPL and measure the amount (thickness) in each well, if present.

### **5.3.3 North of Meeker Avenue - RI/FS**

Recommendations for additional fieldwork related to future RI/FS activities in areas north of Meeker Avenue are presented below. These recommendations are provided for consideration by the NYSDEC and should be included, but are not limited to, additional fieldwork that may be necessary for a comprehensive RI/FS.

- Four shallow monitoring wells should be installed at the locations shown on Figure 40 (i.e., PW-5S, PW-6S, PW-7S and PW-8S). These wells will assist in determining the extent of the PCE and TCE impacting shallow groundwater to the east and south of the former Spic and Span Cleaners and Dyers, Inc. The shallow wells should be constructed

with a 15-foot long PVC screen and PVC riser. The rationale for the shallow well locations for the area north of Meeker Avenue can be found in Table 14.

- Four deep monitoring wells should be installed at the locations shown on Figure 40 (i.e., PW-5D, PW-6D, PW-7D and PW-8D). These wells will further assist in determining the horizontal extent of PCE and TCE in deep groundwater in the area, south and east of the former Spic and Span Cleaners and Dyers, Inc. The deep wells will also assist in determining the potential presence of DNAPL if a clayey silt unit, as was found at DEC-024D, is encountered. The deep wells should be advanced approximately 35 feet below the bottom of the existing shallow well at each location or to the top of a less permeable unit (i.e., glacial till and or clay/silt unit). Split spoon samples should be collected continuously from the bottom of the existing borings (e.g., starting at approximately 35 feet bgs), or from the top of a clayey silt unit. The deep wells should be constructed with a 10-foot long stainless steel screen equipped with a 2-foot sump and 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. The rationale for the deep well locations for the area north of Meeker Avenue can be found in Table 14.
- One top of clay monitoring well should be advanced at the location shown on Figure 40 (i.e., DEC-024TC). The purpose of this well is to determine the vertical extent of PCE and TCE impacted groundwater. This well should be constructed as a described below; with a permanent 5-inch ID carbon steel casing being advanced and grouted 5 feet into the top of the clayey silt unit found at DEC-024D and DEC-024DR (approximately 50 feet bgs). The top of clay well should be advanced to the top of the Raritan Formation, which is anticipated to be between approximately -47 and -71 feet amsl. Split spoon samples should be collected continuously from the bottom of the permanent casing to the top of the Raritan Formation (e.g., starting at approximately 50 feet bgs). The well should be constructed with a 10-foot long stainless steel screen equipped with a 2-foot sump, 10 feet of stainless steel riser above the screen and PVC riser the remainder of the well string. A stainless steel screen has been recommended due to the incompatibility between PCE and/or TCE and PVC materials. The recommendation for using stainless steel was based on the increasing concentrations of PCE and TCE with depth and the

possibility of DNAPL being encountered at the top of the Raritan Formation. The rationale for the top of clay well location for the area north of Meeker Avenue can be found in Table 14.

#### **5.3.4 South of Meeker Avenue - RI/FS**

Recommendations for additional fieldwork related to future RI/FS activities in areas south of Meeker Avenue are presented below. These recommendations are provided for consideration by the NYSDEC and should be included, but are not limited to, additional fieldwork that may be necessary for a comprehensive RI/FS.

- Two deep monitoring wells should be installed at the locations shown on Figure 41 (i.e., DEC-006DD and DEC-043D). The new deep wells will assist in determining the horizontal extent of PCE and TCE impacted groundwater associated with an upgradient source (i.e., former Klink Cosmo Cleaners). The deep wells should be advanced approximately 35 feet below the bottom of the existing shallow well at each location or to the top of a less permeable unit (i.e., glacial till and or clay/silt unit). Split spoon samples should be collected continuously from the bottom of the existing borings (e.g., starting at approximately 35 feet bgs) or from the top of a clayey silt unit. The wells should be constructed with a 10-foot long PVC screen and PVC riser. The rationale for the deep well locations for the area south of Meeker Avenue may be found in Table 15.

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