

388 Bridge Street Site
388 Bridge Street
Brooklyn, New York
Block 152, Lots 118 and 37

BCP Site # C224134

PRE-DESIGN REMEDIAL INVESTIGATION REPORT

Prepared For:

384 Bridge Street, LLC
c/o Stahl Real Estate Company Inc.
277 Park Ave
New York, NY 10172
FLS Project Number: 10149-001-6

Submitted to:

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Division of Environmental Remediation
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May 2010

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Professional Engineer's Certification

I, Arnold F. Fleming, certify that this report was prepared under my direct supervision.

**PRE-DESIGN REMEDIAL INVESTIGATION REPORT
(PRIR)
388 Bridge Street
Brooklyn, NY**

**Brownfield Site
C224134**

May 2010

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1.0 INTRODUCTION

Pursuant to the Brownfield Cleanup Agreement effective on August 13, 2009 between 384 Bridge Street, LLC (the Volunteer) and the New York State Department of Environmental Conservation (NYSDEC), and on behalf of Stahl Real Estate, Arnold F. Fleming, P.E./Fleming-Lee Shue, Inc. (collectively, FLS) has prepared this Pre-design Remedial Investigation Report (PRIR) for the parcel known as 388 Bridge Street (hereafter referred to as “the Site”). A Remedial Investigation Report (RIR) describing the results of previous investigations, including the Supplemental Remedial Investigation (SRI) performed by FLS in September 2009, was submitted to NYSDEC in January 2010. The recommendations in the RIR included additional pre-design sampling of groundwater and soil vapor, and a soil vapor extraction (SVE) pilot test prior to design of a site-wide SVE system. This PRIR describes the results of the additional groundwater/soil gas investigation and also provides the SVE pilot test report.

The Site is located in downtown Brooklyn in the mid-block between Willoughby Street to the north and Fulton Street to the south. The legal description of the Site is Block 152, Lots 37 and 118. Figure 1 provides a Site Location Map and a Site Plan is provided as Figure 2. The Site is bordered to the east by Bridge Street and to the west by Lawrence Street. Lots 122 (Golden Crust Eatery) and Lot 18 (ASA Institute of Business) border Lot 118 (fronting Lawrence Street), to the north and south, respectively. Lot 37 (fronting Willoughby Street) is bordered to the north by Saint Joseph Catholic High School and a portion of a five-story commercial building, Lots 33 and 31, respectively, and to the south by a fabric discount store (Lot 6). The Site measures approximately 20,350 square feet and has historically been used for both residential and commercial purposes.

The Site is subject to a New York City “e” designation requiring that the soils and groundwater be tested for contamination and that a remediation plan be prepared to the satisfaction of the New York City Department of Environmental Protection (NYCDEP). The NYCDEP-approved remediation plan includes removal of all soil down to 25 feet below grade to accommodate a basement that will cover the entire development site. A vapor barrier and a sub-slab depressurization system will be installed beneath the basement slab to minimize the potential for vapor intrusion into the proposed building, which is primarily residential. No groundwater remediation was required by NYCDEP as part of the approved remediation plan.

When construction began in 2008, petroleum was observed during excavation of fuel oil storage tanks and NYSDEC Spill #0801499 was opened for the Site. In addition to the petroleum, groundwater sampling performed on the site indicated elevated levels of tetrachloroethene (PCE), the solvent used in dry cleaning. A portion of the Site was historically used by a dry cleaner. There have also been several other dry cleaners historically located in the vicinity of the Site.

A new 51-story building with mixed use and multiple cellar levels is proposed to be built on the currently vacant Site. The building design includes 349 residential cooperatives in

the upper tower while the lower levels will include retail space, a sub-surface parking garage and a health club. The approximate construction cost for the development is \$200,000,000.

Based on reports compiled by the U.S. Geological Survey, the property lies at an elevation of approximately 45 feet above mean sea level (msl), with the surrounding area sloping slightly to the northeast, towards the Brooklyn Navy Yard/East River. The eastern portion of the Site along Bridge Street was excavated to a depth of 25 feet below sidewalk grade (ft-bsg) to accommodate sub-cellars for the proposed building. The Lot 118 portion of the Site, which borders lot 37 to the west along Lawrence Street, was excavated to form a ramp to provide equipment access to the Site. The Site excavation along Bridge Street is supported by lagging and extends beyond the sidewalk to the edge of the street, a distance of approximately ten feet beyond the property line. Along the north side of Lot 37, extending south along the east side of the Site, the adjacent buildings are underpinned with a concrete wall extending from the bottom of the adjacent building foundation to below the depth of the excavation on the Site. The buildings abutting the Site to the southeast and south have deep basements extending to the depth of the on-site excavation.

Because of the delay in beginning construction of the building on the Site, the New York City Department of Buildings (DOB) requested that the Site be filled temporarily to support the foundations of the buildings located to the north and south. The Site is currently backfilled to 13 ft-bsg.

1.1 Objectives

Based on the results of the SRI, performed by FLS in September 2009, and described in the RIR submitted to NYSDEC in January 2010, a Pre-design Remedial Investigation (PRI) was proposed to:

- confirm a trend of significantly decreasing concentrations of chlorinated solvents noted between the 2008 and 2009 sampling events, signifying continuing natural attenuation of PCE.
- assess the extent of the soil vapor contamination in the remaining portion of the Site west of MS-6S, along the south portion of the Site, and along Bridge Street;
- provide additional information to be used for development of a remedial strategy to address groundwater and soil vapor at the Site for inclusion in the Remedial Action Work Plan (RAWP).

The PRIR included sampling of existing shallow groundwater monitoring wells, the installation of ten (10) soil vapor points, and implementation of an SVE pilot test in preparation for design of a site-wide SVE system. The PRIR was performed in March and April 2010 in accordance with the sampling plan presented with the RIR and approved by the NYSDEC on February 18, 2010.

1.2 Summary of Historical Documentation and Reports

FLS reviewed the following documentation regarding historical environmental and geotechnical investigations at the Site. Summaries and findings of these prior investigations are discussed in Section 2.3 of the RIR which, along with the other historical reports, is included as Appendix A of this PRIR.

- Phase I Environmental Site Assessment, prepared by EMTEQUE for 384 Bridge Street, LLC, dated February 2007.
- Limited Subsurface Investigation, prepared by EMTEQUE for 384 Bridge Street, LLC, dated February 2007.
- Limited Phase II Subsurface Investigation, prepared by EMTEQUE for 384 Bridge Street, LLC, dated March 2007.
- Remedial Action Plan, prepared by EMTEQUE for 384 Bridge Street, LLC, dated March 2007.
- Subsurface Geotechnical Investigation Report, prepared by Meuser Rutledge Consulting Engineers (MRCE) for 384 Bridge Street, LLC dated May 21, 2007.
- Post-Excavation Soil Sampling and Soil Vapor Sampling, performed by EMTEQUE for 384 Bridge Street, LLC, September 2008.
- Additional Subsurface Investigation Report, prepared by FLS for 384 Bridge Street, LLC,, dated March 2009.
- Remedial Investigation Report, prepared by FLS for 384 Bridge Street, LLC, dated January 2010.

2.0 SITE BACKGROUND

The Site is located in a mixed-use commercial area of the Borough of Brooklyn, New York. Historic Sanborn fire insurance maps, from 1887 to 1996 indicate that the Site has previously been used for both residential and commercial purposes. Also, the 1950 Sanborn map depicts the Site with multiple commercial businesses including a dry cleaning facility. Sanborn maps show that a dry cleaner operated on the Site until at least 1982. An interview with the former property lessee and images obtained from Google Maps indicate that Bridge Cleaners occupied the Site from 1986 through 2006, when the establishment moved across the street and south of the Site to 403 Bridge Street. In early 2008, Bridge Cleaners relocated to 204 Livingston Street, approximately 800 feet south of the Site. Additionally, in 1997, a dry cleaning operation started at 381 Bridge Street, across the street and northeast of the Site (Figure 2). DOB records indicate that, as of 2004, this dry cleaner no longer occupied the 381 Bridge Street address. Additional information regarding the Site background can be found in Section 2.0 of the RIR included in Appendix A.

2.1 Geology

The Site is mapped on the *Brooklyn, NY-NY* Quadrant 7.5 Minute Topographic Map, published by the United States Geological Survey (USGS). Review of the topographic map indicates that the Site is located approximately 45 feet msl.

As indicated in the MRCE May 2007 subsurface geotechnical investigation report, there are two strata under the Site and surrounding area. The upper stratum is a fill material with thicknesses ranging from three to 17 feet. The stratum below the fill layer is a natural glacial till deposit consisting of very compacted to compacted, brown to red-brown, fine- to coarse-grained sand and gravel with a trace of cobbles and boulders. The underlying till layer becomes less compacted and consists of coarse-grained sand intermixed with some gravel at and below the water table. The glacial till stratum extends to 100 ft-bsg and is underlain by highly consolidated Gardiner's clay.

Findings of the SRI indicate that the Site was excavated to the depth of 25 ft-bsg to accommodate sub-cellars for the proposed building. However, based on the delay in starting construction on the development site, the NYCDOB requested that, prior to foundation construction, the Site be temporarily filled to support the foundations of the buildings abutting the Site. The Site was backfilled with 12 feet of mole rock (pulverized bedrock resulting from tunneling for subway construction) to raise the Site grade to 13 ft-bsg. Brown, medium- to coarse-grained sand intermixed with some gravel was present in soil borings from just below the mole rock fill to 42 ft-bsg.

2.2 Hydrogeology

The Site-specific hydrogeological information was obtained during the 2008 Additional Subsurface Investigation (ASI) and the SRI conducted in September 2009.

Groundwater

Groundwater was encountered at approximately 43 to 45 ft-bsg. The local groundwater flow was assumed to be south/southwest toward the East River; however, based on five monitoring events conducted over four months in 2008 and groundwater elevation that were collected from four wells, groundwater at the Site was determined to be flowing to the northeast. This localized groundwater flow direction may be influenced by the subway tunnels located north and southwest of the site and pumping operations at a Metropolitan Transportation Authority (MTA) de-watering station located within 1.5 miles northeast of the Site.

Three additional shallow monitoring wells were installed in September 2009, subsequent to backfilling of the Site to 13 ft-bsg. These wells were installed to supplement the network of on- and off-Site wells. Both existing and newly installed monitoring wells were surveyed and depth to groundwater measurements were collected from all wells over a two-week period. A groundwater flow contour map was constructed and groundwater flow to the northeast was established, thereby confirming the 2008 findings. The groundwater flow map is provided as Figure 3.

Groundwater in the New York City area is not used as a potable (drinking) water source. New York City residents receive their drinking water supply from surface reservoirs located in upstate New York.

Surface Water

No surface water bodies exist on the Site. The closest surface water body is the East River, located approximately 3,000 feet west of the Site.

2.3 FLS December 2008 Lot 118 Investigation

On December 23, 2008, Fleming-Lee Shue, Inc. (FLS) performed a subsurface investigation on Lot 118 located at the southwestern portion of the 388 Bridge Street Site. The subsurface investigation included collection of groundwater and soil vapor samples. The purpose of this investigation was to determine if the subsurface soils, groundwater, and soil vapor on Lot 118 had been impacted by the solvent PCE and other VOCs which had been detected in the soil vapor and groundwater on Lot 37 during a previous investigation.

The investigation consisted of the following:

- Installation of three temporary groundwater wells; one well located approximately 15 feet from the Lot 37/Lot 118 boundary and approximately 5 feet from the

south wall of Lot 118 (SS-1W); one well located approximately 15 feet from the Lot 37/Lot 118 boundary and approximately 5 feet from the north wall of Lot 118 (SS-2W); and one well located approximately 17 feet from the Lot 37/Lot 118 boundary and approximately 6-7 feet from the north wall of Lot 118 (SS-3W). One groundwater sample was collected from each temporary well.

- Installation of three soil vapor points and collection of one soil vapor sample from each point. Soil vapor points (SV-3, SV-4, and SV-5) were installed in the vicinity of the temporary well locations. Each soil vapor sample was collected at two feet above the soil/groundwater interface (approximately 16 feet below Site grade).

Temporary monitoring wells and soil vapor sampling locations are shown on Figure 4. The investigation findings are summarized below:

- Groundwater analytical results were compared to the NYSDEC TOGS Class GA Standards. Laboratory analysis revealed that the chlorinated solvent tetrachloroethene (PCE) was detected in all three samples with the following concentrations: SS-1W at 28.5 ug/l; SS-2W at 98.1 ug/l and SS-3W at 24.1 ug/l. All detected PCE levels in the groundwater samples were above the Class GA Standard of 5 ug/l. The elevated PCE levels detected in the on-Site groundwater could potentially be associated with the former on-Site dry cleaning operations; based on groundwater flow direction, the former on-Site dry cleaning operation was downgradient or crossgradient from Lot 118.
- Concentrations of PCE, and its degradation products, TCE, and DCE were detected above the NYSDOH Guidelines in soil vapor samples SV-3 and SV-5. Most notably, PCE was detected at concentrations ranging between 2,990 and 11,500 ug/m³, exceeding the New York State Department of Health (NYSDOH) Guideline Values. These elevated vapor concentrations could potentially be associated with the former on-Site dry cleaning operations.

2.4 Summary of FLS 2009 Supplemental Remedial Investigation (SRI)

Based on the data collected from the previous Site investigations (included in Appendix A) and subsequent discussions with NYSDEC, FLS recommended that an additional subsurface investigation be conducted at the Site, including soil, soil vapor, and groundwater sampling, the installation of four additional groundwater monitoring wells, and the performance of slug tests. The purpose of the September 2009 investigation was to assess the presence of contaminated soil on the Site, which may be a contributing source of the observed PCE groundwater contamination, and to determine the nature and extent of contamination that may have originated at the Site. An additional objective was to estimate the hydraulic conductivity present on Site in order to better calculate groundwater flow measurements.

The investigation consisted of the following:

- installation of three on-Site soil borings and one soil boring along the sidewalk of Lawrence Street and collection of soil samples;
- installation and sampling of one deep and three shallow monitoring wells (installed at the aforementioned soil boring locations and labeled MW-5, MW-6S, MW-6D, MW-7)
- performance of slug tests in the three newly-installed 4-inch wells (one deep and two shallow); and
- collection of soil vapor samples from two locations: three samples were collected at each location at depths of 20, 24, and 28 feet below existing Site grade (ft-beg).

Soil borings, monitoring wells, and soil vapor sampling locations are shown on Figure 6 of the RIR and available in Appendix A.

The investigation findings are summarized below:

- low levels of chlorinated solvents including PCE were detected in five of the six soil samples collected. However, all volatile organic compounds (VOCs) were detected below the Part 375 Unrestricted Use Soil Cleanup Objectives (UUSCOs) listed in Table 375-6.8(a) of Part 375 of Title 6 of the Official Compilation of Codes, Rules and Regulations of the State of New York (NYCRR). Additionally, total organic carbon (TOC) was not detected in any of the soil samples;
- newly-installed and existing monitoring wells were sampled and analyzed for Target Compound List (TCL) VOCs, nitrate, sulfate, and dissolved organic carbon (DOC). A total of eight samples were collected from one deep and seven shallow monitoring wells. No VOCs were detected above the New York State Class GA groundwater standards and guidance values, in the NYSDEC Division of Water Technical and Operational Guidance Series (TOGS) 1.1.1, *Ambient Water Quality Standards and Guidance Values* (“Class GA Standards”) in the deep groundwater sample. Chlorinated solvent contamination was detected in six of the seven shallow groundwater samples, most notably PCE and its degradation products, trichloroethylene (TCE) and cis-1,2-dichloroethylene (DCE). [Note that the trans-1,2-dichloroethylene isomer was not detected above the Class GA Standards in any groundwater sample.] PCE concentrations ranged from 11.9 parts per billion (ppb) in MW-5 to 220 ppb in MW-1, exceeding the Class GA Standard of 5 ppb. DCE was detected in groundwater samples MW-1 and MW-3 at concentrations of 8.1 and 10.6 ppb, respectively, exceeding the Class GA Standard of 5 ppb. TCE was not detected above the Class GA Standard of 5 ug/L in any of the seven shallow groundwater samples. Chloroform, a common laboratory contaminant, was detected in groundwater sample MW-7 at a concentration of 14.3 ppb, exceeding the Class GA Standard of 7.0 ppb. Overall

concentrations of PCE were 62% lower in the 2009 sampling round compared to the 2008 FLS sampling round;

- The results of the slug test data analysis indicate that hydraulic conductivity values are 8.9×10^{-2} and 5.7×10^{-2} centimeters per second (cm/sec) in the two shallow wells tested. The geometric mean, which describes the average hydraulic conductivity for a hydrologic unit, was determined by taking the natural log of each value, finding the mean of the natural logs and then obtaining the exponential (e^x) of that value. The average hydraulic conductivity for the shallow aquifer is 7.1×10^{-2} cm/sec (201 feet/day) which corresponds to literature values for a coarse sand aquifer material; and
- In each soil vapor sample collected, PCE and/or TCE were detected at concentrations exceeding the NYSDOH Air Guidance Values (AGVs), as listed in the NYSDOH Final Guidance for Evaluating Vapor Intrusion in the State of New York, October 2006 (Vapor Intrusion Guidance Document). DCE, another chlorinated organic solvent breakdown product, was also present at elevated levels. In addition to the aforementioned chlorinated hydrocarbons, petroleum related compounds, benzene, toluene, ethylbenzene, and xylenes (BTEX) were detected at levels exceeding the NYSDOH Air Guidance Values (AVGs) in three samples collected from one location.

3.0 PRE-DESIGN REMEDIAL INVESTIGATION (PRI) METHODOLOGY

This section details the methodology employed to conduct the PRI activities performed by FLS in March and April 2010 as outlined in the sampling plan presented with the RIR and approved by NYSDEC on February 18, 2010. The work included the sampling of all shallow monitoring wells; the installation and sampling of ten temporary soil vapor points; and the performance of an SVE pilot test which included installation one 4-inch soil vapor extraction well and four 2-inch soil vapor monitoring points. These activities are described in the following sections.

3.1 Groundwater Sample Collection

Seven shallow wells installed by FLS in October 2008 and September 2009, including MW-1, MW-2, MW-3, MW-4, MW-5, MW-6S, and MW-7, were purged and sampled on March 9, 10, and 11, 2010. A low-flow sampling pump (bladder pump) was used to purge and sample each monitoring well to minimize chemical and hydrological disturbances in and around the well. Prior to purging, an electronic interface meter was used to measure the water level and thickness of free product, if any. Groundwater samples were not collected until individual field parameters were stabilized, or until three well volumes were purged. The sampling locations are shown on Figure 5.

A total of seven groundwater samples were collected and analyzed. One field blank and two trip blanks samples were also analyzed.

Groundwater samples were placed in laboratory-prepared pre-preserved jars, labeled, sealed, and placed in a chilled cooler for shipment to Accutest Laboratories (Accutest) of Dayton, New Jersey, an NYSDOH-approved Environmental Laboratory Accreditation Program (ELAP)-certified laboratory. The groundwater samples were analyzed for TCL VOCs by Environmental Protection Agency (EPA) Method 8260, nitrate, sulfate, and DOC. The field blank and trip blanks were analyzed for TCL VOCs.

In order to determine the geochemical characteristics of the groundwater below the Site, the following parameters were measured in the field using an overflow cell with a direct reading meter at the well head:

- Dissolved oxygen (DO)
- pH, conductivity, and temperature
- Oxidation-reduction potential (ORP)
- Iron (II) – Ferrous Iron

The volume of water purged and the field parameter measurements were recorded in a field logbook. Geochemical parameters were recorded during, after, and before purging.

3.2 Soil Vapor Sampling

Soil vapor sampling was conducted in order to delineate the extent of soil vapor contamination outside the northeast corner of Lot 37, west of MW-6S, along the south portion of the Site, and along Bridge Street. The samples were collected every 25 feet for a total of 10 sample locations. Originally, 11 sample locations were proposed; however, only 10 samples were collected as one could not be collected due to its location within the on-Site elevator pit. The sampling locations are shown on Figure 5.

Ten soil vapor samples were collected at each sampling location at depths of 24 ft-beg. Samples were collected with a geoprobe, using a $\frac{5}{8}$ -inch diameter retractable stainless steel sampling probe consisting of a 1.5-inch long hardened point and a 6-inch long perforated vapor intake. Once the soil vapor sampling probe was driven to the depth of 24 feet below grade, the outer protective casing was retracted to obtain the soil vapor sample through a $\frac{1}{4}$ -inch polyethylene tube attached to the sampling probe. The borehole above the sampling probe to grade was sealed using bentonite to prevent the mixture of ambient air and soil vapors. Ambient air was purged from each borehole by attaching the surface end of the $\frac{1}{4}$ polyethylene tube to an air valve attached to a vacuum pump. The vacuum pump facilitated the removal of three volumes of air (volume of the sample probe and tube) prior to each sample collection. The flow rate for both purging and collecting samples did not exceed 0.2 liter per minute.

The soil vapor samples were screened using a photoionization detector (PID) and collected in six-liter SUMMA canisters. The SUMMA canisters were directly attached to the tubing, and the valve opened immediately prior to collecting the sample. A one-hour regulator was used with a laboratory individually-cleaned SUMMA canister for the collection of each soil vapor sample. The soil vapor samples were analyzed for VOCs by EPA Method TO-15 by Accutest .

Once the soil vapor sample was collected, the sampling probe was withdrawn, cleaned and decontaminated. The sampling location was backfilled and sealed. The geoprobe was moved approximately 25 feet from the sample location and the process was repeated.

3.3 Soil Vapor Extraction (SVE) Well Installation

One 4-inch SVE well was installed in the area of the highest PCE soil vapor and on-Site groundwater concentrations (northeast corner of the Site). Four 2-inch temporary pressure monitoring points were installed at 5 feet, 15 feet, 25 feet, and 50 feet from the extraction well to serve as observation points (PV-05, PV-15, PV-25, and PV-50).

The SVE well (SVE-1) was installed to a depth of 26 ft-beg, approximately five feet above the groundwater table. SVE-1 consists of 10 feet of 4-inch diameter 0.02-inch slotted Schedule (SCH) 40 polyvinyl chloride (PVC) well screen threaded to 4-inch diameter SCH 40 PVC riser to surface. An 11-foot #40 sand filter pack was installed around the well screen followed by two feet of bentonite and neat Portland cement to surface.

The vapor monitoring points were installed to a depth of 26 feet below Site grade with 10 feet of 2-inch diameter 0.02-inch slotted Schedule (SCH) 40 PVC well screen threaded to 2-inch diameter SCH 40 PVC riser to surface. An 11-foot #40 sand filter pack was installed around the well screen followed by two feet of bentonite and neat Portland cement to surface.

SVE and pressure monitoring point locations are depicted on Figure 1 and SVE and monitoring point construction details are depicted on Figure 2 within the Pilot Test Report, provided as Appendix B.

3.4 SVE Pilot Test

Four temporary pressure monitoring points (P-5, P-15, P-25 and P-50), for pilot test monitoring, were installed around SVE-1 to monitor the effectiveness of the SVE pilot test, as previously discussed.

A positive displacement (PD) blower was utilized for the SVE pilot test. Vacuum levels of 20, 40, 50, 60 and 70 inches of water (H₂O) were applied during the SVE pilot test to evaluate corresponding flow rates and radii of influence. Vacuum readings were collected from P-5, P-15, P-25, and P-50 at approximately 10-minute intervals during each vacuum-rate-portion of the SVE pilot test, which were each conducted for approximately 40 minutes.

Prior to carbon treatment, water separated from the vapor was directed through a moisture knock-out tank. SVE off-gas was filtered through granular activated carbon (GAC) canisters and monitored by a photoionization detector (PID), pre- and post-carbon canisters, at 10-minute intervals. One off-gas air sample was collected for each vacuum level from a point prior to the off-gas entering the activated carbon canisters. A total of four off-gas air samples were collected; each sample was analyzed by EPA Method TO-15 for VOCs.

3.5 Investigation Derived Waste (IDW) Management

Well development and purge water was staged in 55-gallon drums for disposal. FLS labeled each drum with the contents and date when waste accumulation began. The drums are currently scheduled for removal from the Site by Clean Venture, Inc. of Elizabeth, New Jersey and transported to Cycle Chem Inc. in Elizabeth, New Jersey in accordance with all federal and state regulatory requirements.

During the SVE pilot test, no soil or groundwater was collected. The drums of GAC utilized during the pilot test are being tested for waste characteristics by the Toxicity Characteristic Leaching Procedure (TCLP) and will be disposed under applicable city,

state, and/or federal regulations. A copy of the waste manifest will be included in the forthcoming RAWP.

4.0 PRE-DESIGN REMEDIAL INVESTIGATION (PRI) FINDINGS

The following section discusses the results and findings of the 2010 PRI, which included groundwater and soil vapor sampling as well as an SVE pilot test. Summaries of the laboratory analytical data are provided in Tables 1, 2, and 4. The complete laboratory data packages (on CD) are provided in Appendix C.

4.1 Groundwater Results

All shallow monitoring wells were sampled on March 9, 10, and 11 2010. Groundwater samples were analyzed for TCL VOCs, nitrate, sulfate, and DOC. Groundwater analytical results are summarized in Tables 1 and 2. VOC analytical results were compared to the Class GA Standards and are discussed below.

Volatile Organic Compounds (VOCs)

Laboratory analytical results for VOCs in groundwater are summarized in Table 1. The combined 2008, 2009, and 2010 results for detected VOCs in groundwater, are presented in Figure 6.

PCE was detected in six of the seven groundwater samples. PCE concentrations ranged from 13.9 ppb in MW-6S to 93.7 ppb in MW-4, exceeding the Class GA standard of 5 ppb. DCE and TCE were not detected above their Class GA standard of 5 ppb in any of the seven groundwater samples. Concentrations at the northern end of the Site (monitoring wells MW-1 and MW-6S, and off-site MW-3) decreased significantly compared with the sampling results from 2009, and continued the significant decreasing trend noted in 2009. The highest PCE concentration in the 2010 sampling was detected in monitoring well MW-4 located at the southwest (upgradient) corner of the Site.

Groundwater Geochemical Parameters

Geochemical parameters were analyzed in groundwater as they are indicators of natural attenuation. Previously, aerobic conditions were found to be present in the subsurface and the geochemical parameter sampling was done to confirm that the aerobic conditions are still dominant. Each groundwater sample was analyzed by the laboratory for nitrate, sulfate, and DOC. Groundwater geochemistry data is presented in Table 2.

Additionally, the following geochemical parameters were collected in the field using a flow-through cell with a direct reading meter at the well head:

- DO
- pH, conductivity, and temperature
- ORP
- Iron (II) – Ferrous Iron

Field-measured groundwater geochemical data is presented in Table 3. Under aerobic conditions, bacteria use oxygen as the terminal acceptor of electrons removed from oxidized organic compounds. Anaerobic degradation takes place in environments without oxygen. The terminal acceptor of electrons in an anaerobic environment includes (in order of preference): nitrates, sulfates, iron and carbon dioxide.

The DO measurements ranged between 4.45 milligrams per liter (mg/L) in MW-1 to 10.77 mg/L in MW-4, indicating an aerobic environment. Nitrate concentrations above 1 mg/L, sulfate concentrations above 20 mg/L and Iron (II) concentrations below 1 mg/L are indicative of an aerobic environment. Nitrate measurements ranged between 5.9 mg/L (MW-5) and 13.7 mg/L (MW-3). Sulfate measurements ranged between 59.0 mg/L (MW-5) and 220 mg/L (MW-2). Iron (II) concentrations in groundwater were non-detect in all samples collected except sample MW-7 which had a concentration of 0.09 mg/L. ORP measurements were all positive, ranging between 14 millivolts (mV) (MW-6S) and 58 mV (MW-5). Positive ORP measurements are indicative of an aerobic environment. Based on the geochemical parameters results, aerobic conditions predominate in the subsurface.

4.2 Soil Vapor Results

Soil vapor samples were analyzed for VOCs using EPA Method TO-15. Soil vapor analytical results are summarized in Table 4 and detected VOCs in soil vapor samples are presented in Figure 7. Analytical results were compared to values from both the NYSDOH AGVs and background levels referenced in the NYSDOH Vapor Intrusion Guidance Document, including the *Study of Volatile Organic Chemicals in Air of Fuel Oil Heated Homes 1997-2003* (NYSDOH, 2005b) and the *1994-1998 Office Indoor Air Evaluation* (EPA, 2001).

PCE and/or TCE were detected above the NYSDOH AGVs in each soil vapor sample collected during this investigation. PCE, with an AGV of 100 micrograms per cubic meter (ug/m^3), was detected in all ten samples at concentrations ranging from 963 ug/m^3 in sample ASV-5 to 4,540 ug/m^3 in sample ASV-3. TCE, with an AGV of 5 ug/m^3 , was detected in all ten samples with concentrations ranging from 76.3 ug/m^3 in sample ASV-2 and 229 ug/m^3 in sample ASV-9. AGVs have not been published for DCE and vinyl chloride (VC), which are the remaining two breakdown compounds from PCE. DCE was detected in all ten samples at concentrations ranging from 133 ug/m^3 in sample ASV-10 to 404 ug/m^3 in sample ASV-8. VC was detected in one of the ten soil vapor samples; ASV-8 at 13 ug/m^3 .

In addition to the aforementioned chlorinated hydrocarbons, petroleum related compounds, benzene, toluene, and xylenes were also detected at levels exceeding the NYSDOH AGVs in all samples.

4.3 SVE Pilot Test Results

Vacuum influences were observed in P-05 through P-50 during all phases of the pilot test and generally decreased with distance at the same rate regardless of the applied vacuum. Vacuum influence of up to 0.7”-H₂O, at both 60 and 70”-H₂O of applied vacuum, was observed at the furthest pressure monitoring point, P-50, located 49 feet away from SVE-1.

The mass flow rates of PCE during each phase of the pilot test were generally very similar. However, the highest observed mass flow rate occurred during the 50”-H₂O of applied vacuum portion of the test at a removal rate of approximately 6 grams per minute (g/min) or approximately 0.013 pound per minute (lb/min). This rate is expected to decrease as the SVE system runtime progresses.

The SVE will be designed to treat a total of 1.4 pounds of volatile contaminant mass from on-Site. The assumed design radius of influence (ROI) is 50 feet. This is based on the measured responses in the pressure monitoring points at 50”-H₂O applied vacuum.

A more detailed description of the SVE pilot test results and off-gas air sample results are found in the Pilot Test Report and provided as Appendix B.

5.0 CONCLUSIONS AND RECOMMENDATIONS

The following conclusions are based on the findings of the PRI.

5.1 Groundwater

Chlorinated solvent contamination, particularly PCE, was detected in six of the seven groundwater samples. PCE concentrations ranged between 13.9 ppb to 93.7 ppb, exceeding the Class GA Standard of 5 ppb. PCE daughter compounds, DCE and TCE were not detected above their respective Class GA standards in any of the seven groundwater samples. Levels of PCE and TCE detected in the groundwater from downgradient wells (MW-1, MW-2, MW-3 and MW-6S) were on average 40% lower than those detected in the 2009 and 75% lower than those detected in the 2008 FLS investigations. Levels of DCE in groundwater throughout the Site were on average 59% lower than those detected in the 2009 FLS investigation. Levels of PCE and TCE detected in the groundwater from upgradient/crossgradient wells (MW-4, MW-5, and MW-7), however, slightly increased from the concentration detected in the 2009 sampling. Based on the groundwater gradients and the relatively high hydraulic conductivity, it is likely that VOCs detected in wells MW-4, MW-5, and MW-7 result from off-site sources of contamination.

Concentrations of PCE and its daughter compounds at the northern end of the Site (monitoring wells MW-1 and MW-6S, and off-site MW-3) decreased significantly compared with the sampling results from 2009, and continued the significant decreasing trend noted in 2009. The highest PCE concentration in the 2010 sampling was detected in monitoring well MW-4 located at the southwest (upgradient) corner of the Site.

Groundwater geochemical parameters were measured in the field (DO, pH, conductivity, temperature, ORP, and Iron II) and analyzed in the laboratory (nitrate, sulfate, and DOC) in order to determine if the geochemical environment is aerobic or anaerobic. Based on the collected groundwater geochemical data results, the groundwater beneath the Site is aerobic and reductive dechlorination is not likely to occur and the oxidative condition is remains predominant.

5.2 Soil Vapor

Elevated levels of PCE and its degradation products TCE, and DCE were detected in all eleven samples. Elevated levels of BTEX were also detected in all of the samples collected.

PCE was detected in all ten samples with concentrations ranging between 963 $\mu\text{g}/\text{m}^3$ in sample ASV-5 to 4,540 $\mu\text{g}/\text{m}^3$ in sample ASV-3. PCE concentrations in groundwater samples from locations near the soil vapor sampling locations are 13.9 and 50.1 ppb, respectively.

5.3 SVE Pilot Test and Off-Gas

Conclusions regarding the SVE Pilot Test and off-gas sampling are discussed in the Pilot Test Report and provided as Appendix C.

5.4 Site Model

Elevated levels of chlorinated organic solvent compounds were encountered in groundwater and soil vapor samples collected at the Site during subsurface investigations performed by EMTEQUE in September 2008 and FLS in October 2008 and September 2009. Only traces of solvent compounds, at concentrations below the UUSCOs, were detected in the Site soils during these investigations; however, as part of the Site redevelopment, soil was excavated to a depth of 25 ft-bsg and removed for off-Site disposal thereby reducing the potential for an existing on-Site source. Other potential sources are off-Site drycleaners adjacent and/or nearby to the Site.

Organic solvents in soil gas were found to be present at elevated levels across the Site including Lot 37 and the eastern portion of Lot 118. The extent of the organic vapor contamination in the soils under the remaining portion of Lot 118 could not be determined due to the presence of the till layer and Site entrance ramp from Lawrence Street which was an impediment to drilling in this area.

The concentrations of organic solvent compounds detected in groundwater samples collected in the 2010 PRI at the north and northeast portion of the Site continued the downward trend observed over time and were significantly lower than those detected in the 2009 SRI and other prior investigations. However, organic solvent concentrations in groundwater at the south and southwest portions of the Site remained similar to previous levels. As groundwater flows to the northeast, MW-4 and MW-5 are considered upgradient and MW-7 is considered crossgradient. The detection of organic solvent contamination in the wells located in the upgradient portion of the Site suggests a potential off-Site source or a regional background contamination condition.

The steady decrease in chlorinated solvents contamination observed over time indicates that natural attenuation is occurring on-Site. NYSDEC defines natural attenuation as “Relying on natural (physical, chemical, or biological) processes to reduce mass, toxicity, mobility, volume or concentration of compounds in earth or groundwater.”¹ The processes potentially occurring on-Site include a combination of dispersion; dilution; sorption; and volatilization. There are three Site-specific factors supporting these natural attenuation processes:

1. The former Site buildings were removed and Site soil was excavated to a depth of 25 ft-bsg by June 2008, which resulted in the highly consolidated till layer being removed. A large volume of rain water has percolated through the sand layer at

¹ <http://www.dec.ny.gov/regulations/4632.html>

- the bottom of the excavation and reached the groundwater system. The open-air excavation also provides oxygen to the subsurface;
2. the hydraulic conductivity for the aquifer was estimated to be 7.1×10^{-2} cm/sec (201 feet/day) which corresponds to a coarse sand aquifer material; and
 3. the groundwater velocity was estimated to be 1.49 feet/day.

The integration of these factors support the natural attenuation mechanisms. Therefore, the decreasing trend in the groundwater for chlorinated organic solvent contamination may be attributed to natural attenuation.

6.0 REFERENCES

Brassington R, 1988. *Field Hydrogeology*. Geological Society of London Handbook Series. Open University Press.

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Phase I Environmental Site Assessment, prepared by EMTEQUE, dated February 2007.

Limited Subsurface Investigation, prepared by EMTEQUE for NYCDEP, dated February 2007.

Limited Phase II Subsurface Investigation, prepared by EMTEQUE for NYCDEP, dated March 2007.

Remedial Action Plan, prepared by EMTEQUE for NYCDEP, dated March 2007.

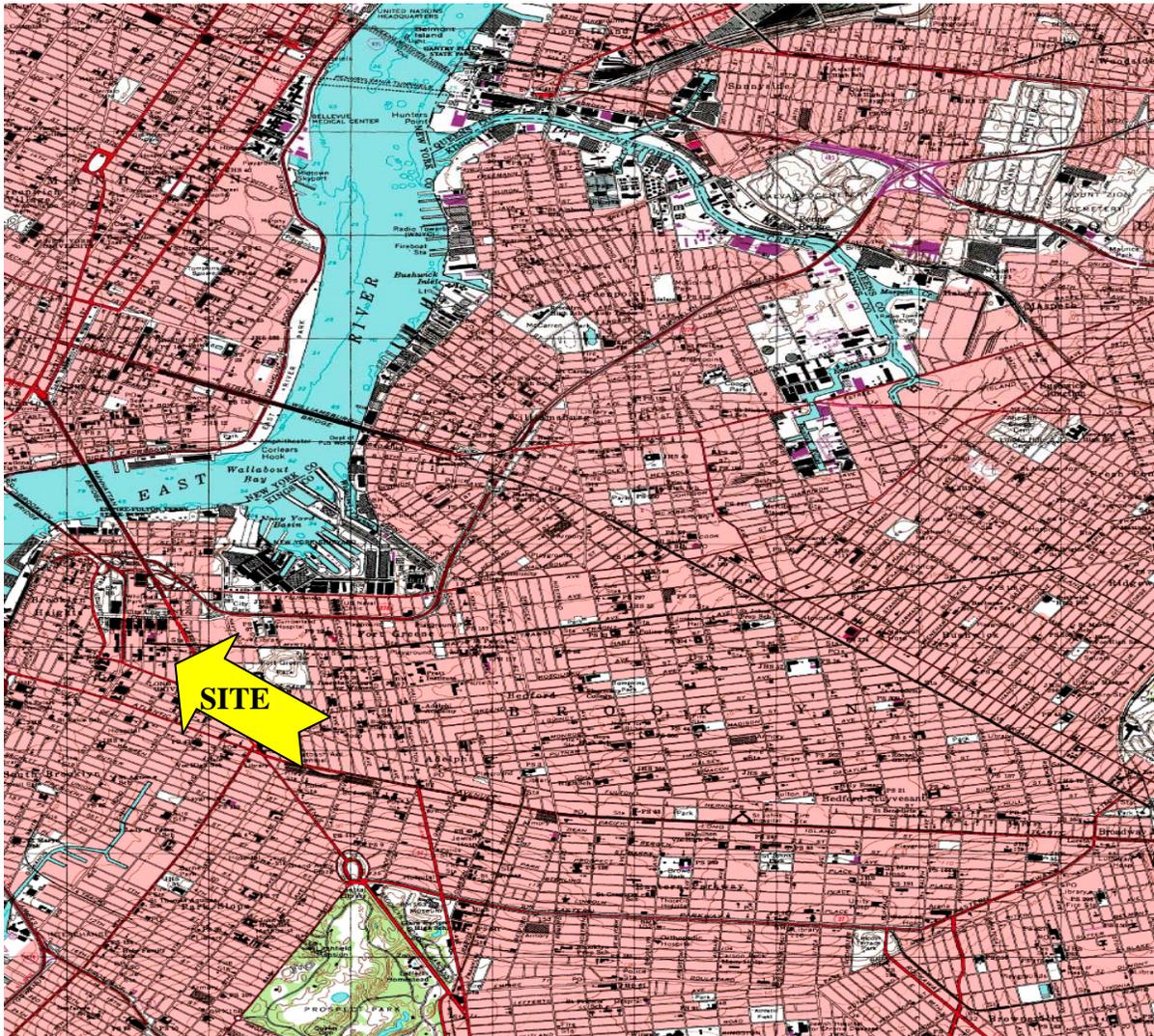
Subsurface Geotechnical Investigation Report, prepared by Meuser Rutledge Consulting Engineers for 384 Bridge Street, LLC dated May 21, 2007.

Post-Excavation Soil Sampling and Soil Vapor Sampling, performed by EMTEQUE for NYCDEP, September 2008.

Additional Subsurface Investigation Report, prepared by FLS for NYSDEC, dated March 2009.

Remedial Investigation Report, prepared by FLS for NYSDEC, dated January 2010.

FIGURES



Site: *Brooklyn Quadrangle USGS Topographic Map (79287)*
Obtained from United States Geological Survey topography compiled 1961



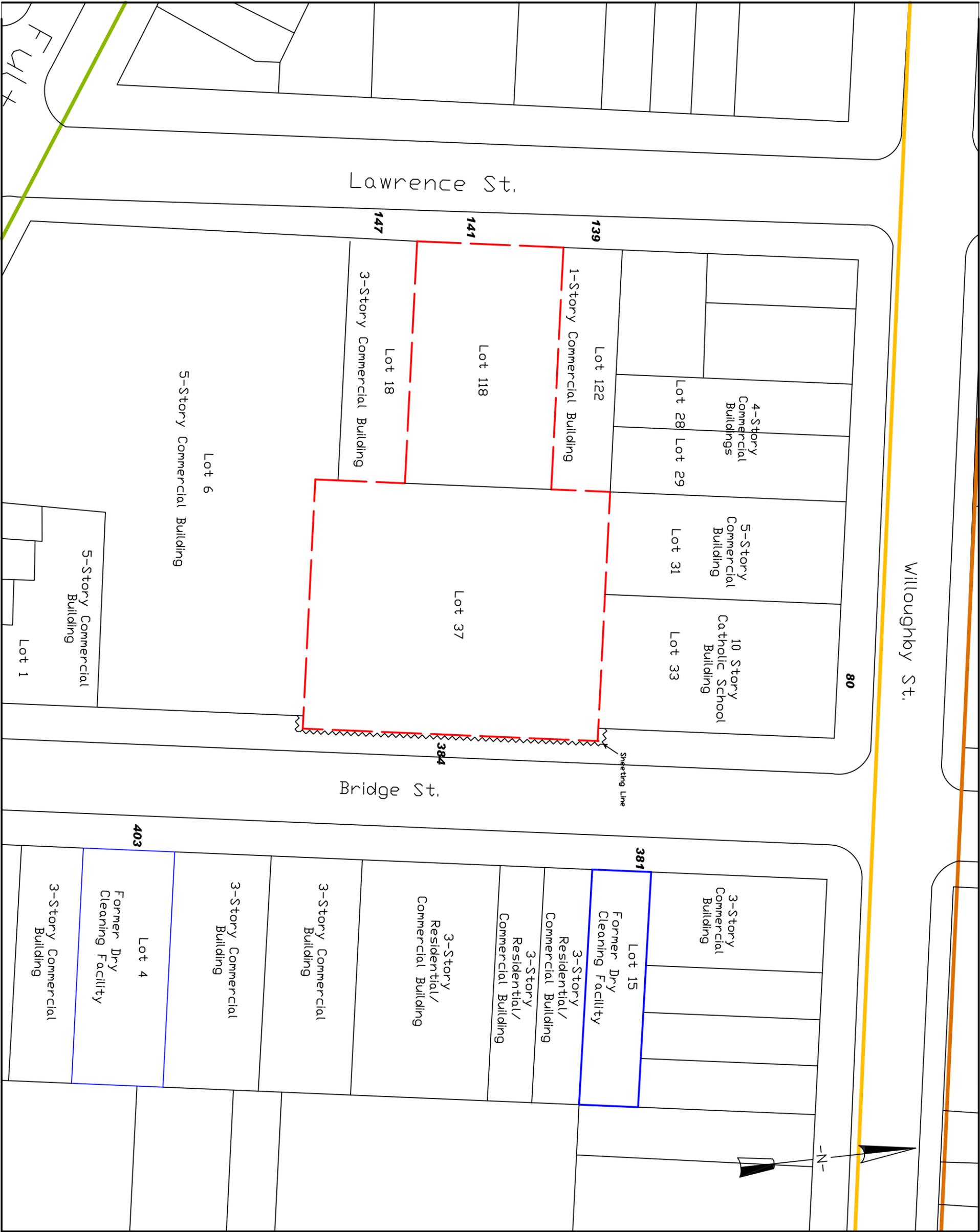
FIGURE 1: SITE LOCATION MAP

SITE: 384 Bridge Street
Brooklyn, New York

Willoughby St.

Lawrence St.

Bridge St.



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158 West 29th Street, 9th Fl.
New York, NY 10001

384 Bridge Street
Brooklyn, NY

FIGURE 2

SITE PLAN

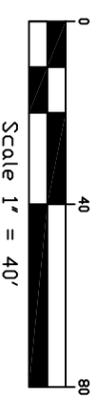
Date
November 2009

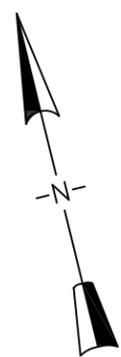
Project Number
10149-001-1

LEGEND

384 Site Address

--- Site Boundary

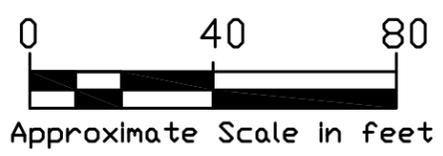
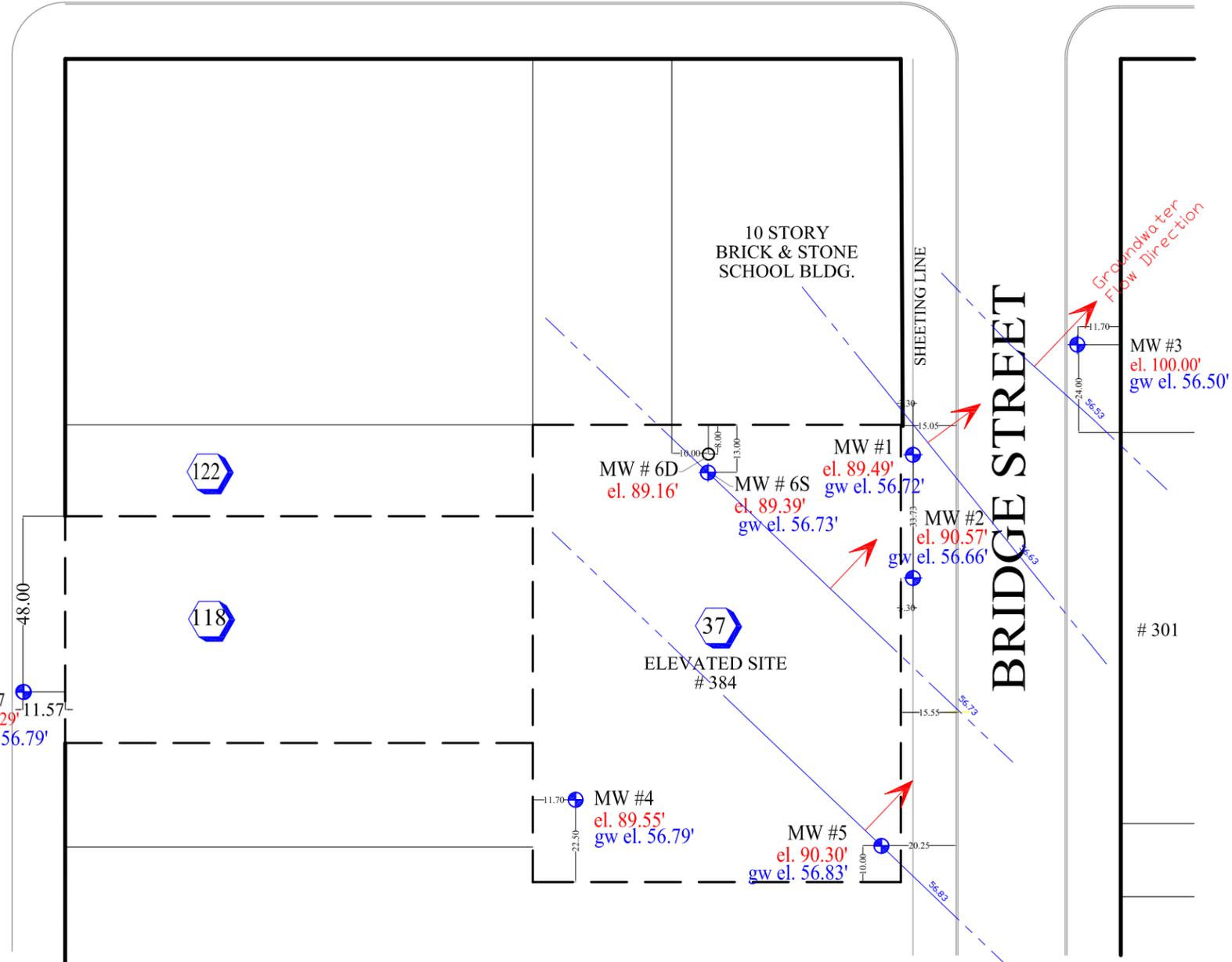




WILLOUGHBY STREET

LAWRENCE STREET

BRIDGE STREET



Map Source: Monitoring Well Survey December 3,2008 Fehring Surveying , P.C.



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Project Number
10149-001-8

388 Bridge St.
Brooklyn, NY

Date
May 2010

FIGURE 3

**GROUNDWATER
FLOW
CONTOUR MAP**

LEGEND

-  Monitoring Well
-  Lot Number
-  Site Boundary

Willoughby St.

10 Story
Catholic School
Building

Lawrence St.

Block 152
SV-5 #
Lot 118

SS-2V #
SV-4

SS-3V

SS-1V #
SV-3

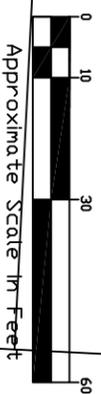
Block 152
Lot 37

384

Bridge St.

381
Former Dry Cleaning Facility

N



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384 Bridge Street
Brooklyn, NY

FIGURE 4

LOT 118 SOIL VAPOR AND GROUNDWATER SAMPLING LOCATIONS

Date
May 2010

Project Number
10149-001-8

LEGEND

- 384 Site Address
- Site Boundary
- ⊕ Groundwater Sampling Location
- ⊕ Soil Vapor Sampling Location



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Brooklyn, NY

FIGURE 5

Pre-Design Soil Vapor and Groundwater Sampling Plan

Date
May 2010

Project Number
10419-001-8

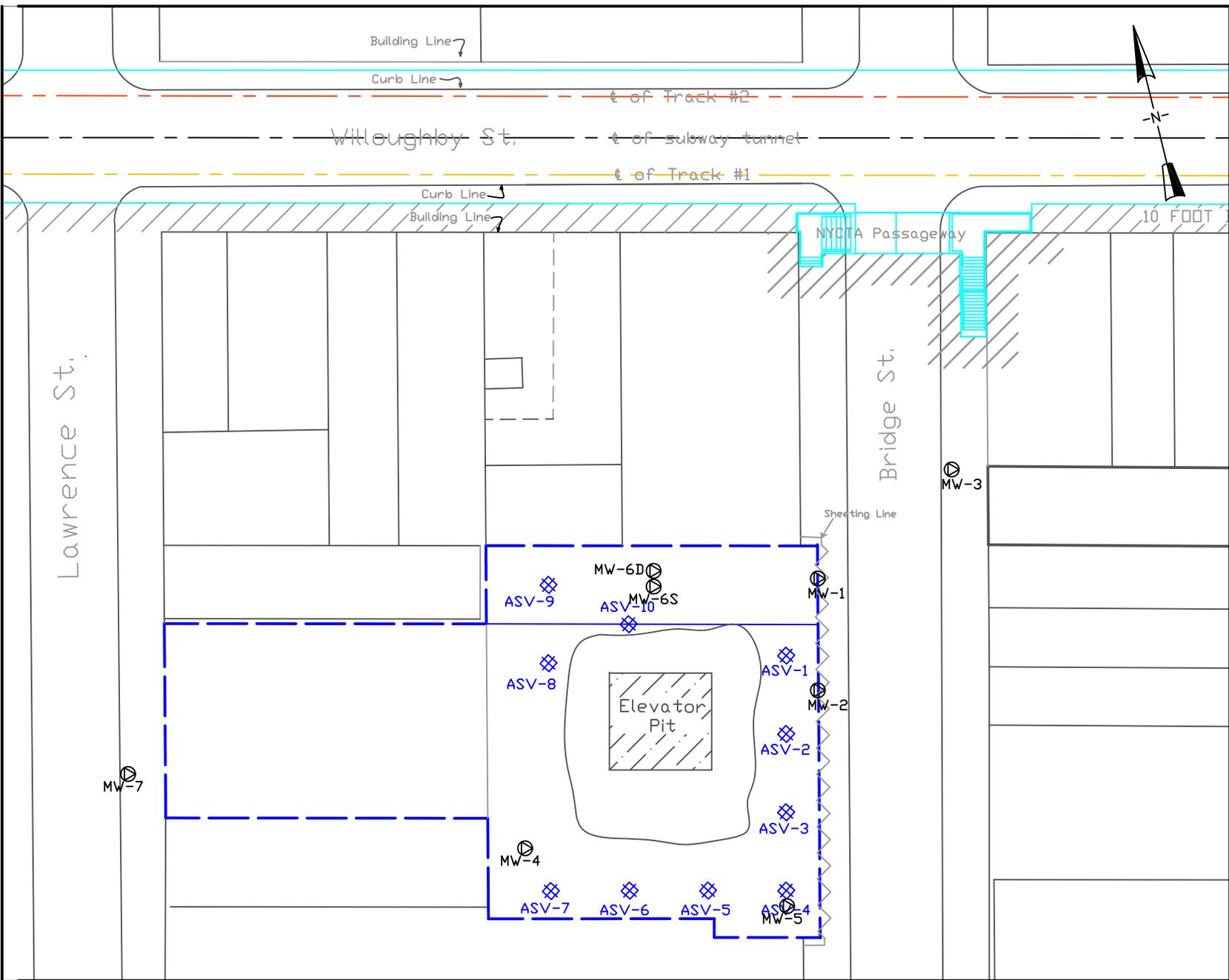
LEGEND

- Site Boundary
- SubSlab Sample
- Groundwater Monitoring Well
- Soil Vapor Point

Sample results concentration are in $\mu\text{g}/\text{m}^3$
 ND = Non Detect
 NA = Not Analyzed
 PCE = Tetrachloroethylene
 DCE = cis-1,2-DCE
 VC = Vinyl Chloride



Scale 1' = 30'





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FIGURE 6

Chlorinated Solvent Concentrations in Groundwater FLS Investigations 2008, 2009 and 2010

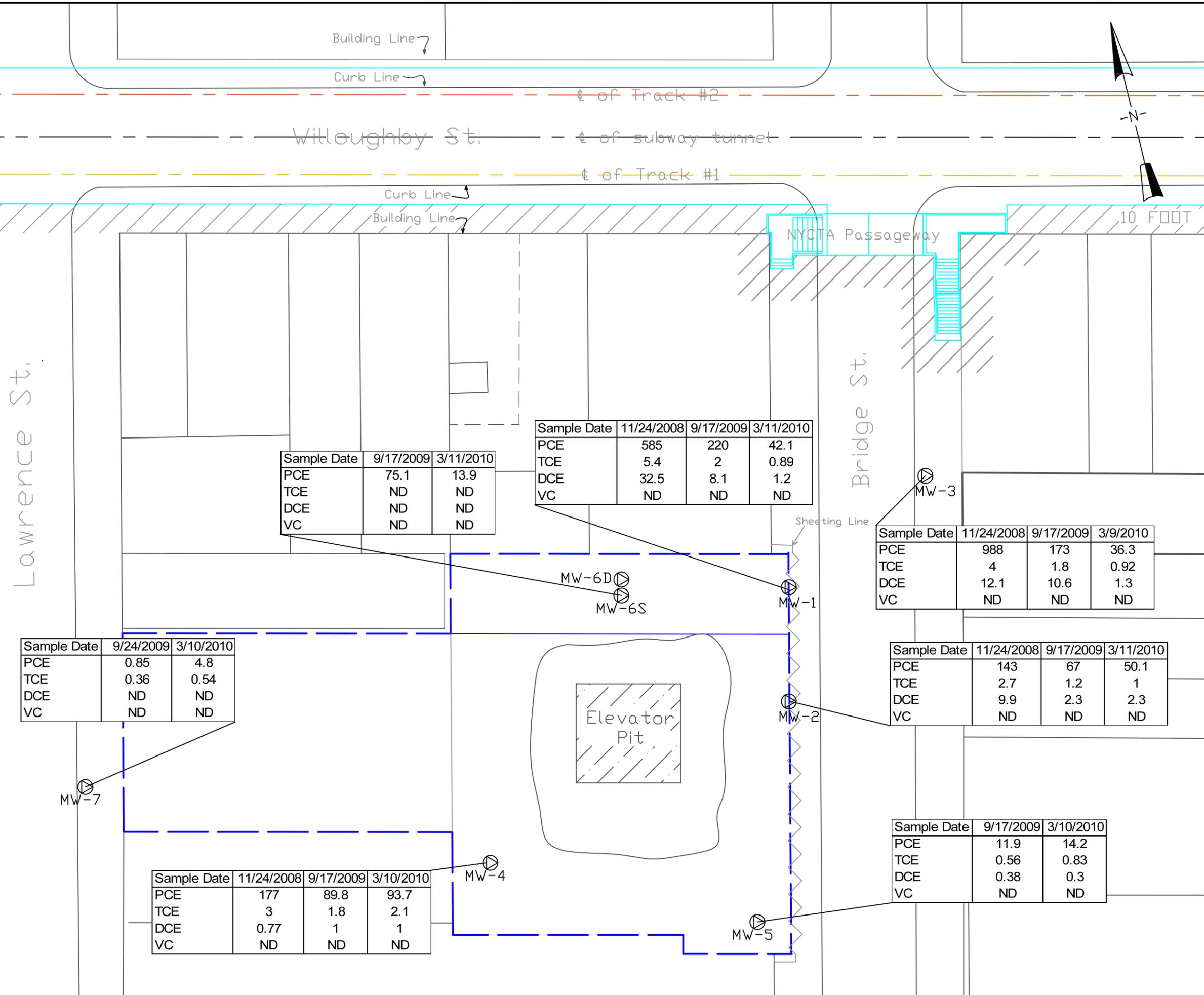
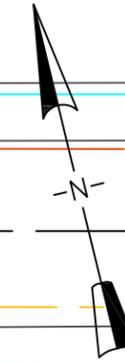
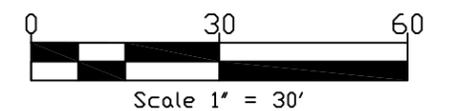
Date
May 2010

Project Number
10419-001-8

LEGEND

- Site Boundary
- SubSlab Sample
- Groundwater Monitoring Well
- Soil Vapor Point

Sample results concentration are in $\mu\text{g}/\text{m}^3$
 ND = Non Detect
 PCE = Tetrachloroethylene
 TCE = Trichloroethylene
 DCE = cis-1,2-DCE
 VC = Vinyl Chloride





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Brooklyn, NY

FIGURE 7

Pre-Design Soil Vapor Investigation and Delineation

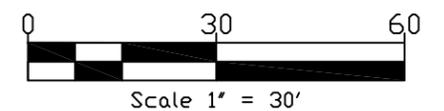
Date
May 2010

Project Number
10419-001-8

LEGEND

- Site Boundary
- SubSlab Sample
- Groundwater Monitoring Well
- Soil Vapor Point

Sample results concentration are in $\mu\text{g}/\text{m}^3$
 ND = Non Detect
 PCE = Tetrachloroethylene
 TCE = Trichloroethylene
 DCE = cis-1,2-DCE
 VC = Vinyl Chloride



Lawrence St.

Willoughby St.

Bridge St.

Building Line

Curb Line

Centerline of Track #2

Centerline of subway tunnel

Centerline of Track #1

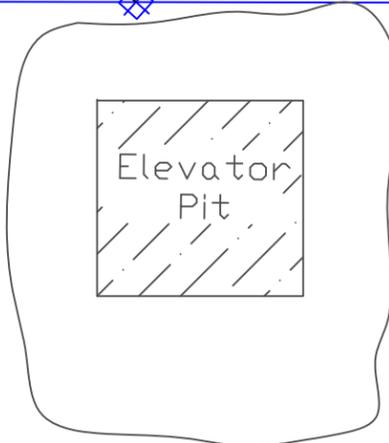
Curb Line

Building Line

NYCTA Passageway

10 FOOT

Sheeting Line



Sample Date	3/18/2010
PCE	997
TCE	86
DCE	133
VC	ND

Sample Date	3/18/2010
PCE	2730
TCE	229
DCE	295
VC	ND

Sample Date	3/18/2010
PCE	1060
TCE	125
DCE	4040
VC	13

Sample Date	3/19/2010
PCE	2830
TCE	175
DCE	305
VC	ND

Sample Date	3/19/2010
PCE	2570
TCE	141
DCE	337
VC	ND

Sample Date	3/18/2010
PCE	2860
TCE	78.5
DCE	180
VC	ND

Sample Date	3/18/2010
PCE	3680
TCE	76.3
DCE	169
VC	ND

Sample Date	3/18/2010
PCE	4540
TCE	110
DCE	235
VC	ND

Sample Date	3/18/2010
PCE	2090
TCE	126
DCE	297
VC	ND

Sample Date	3/19/2010
PCE	963
TCE	85.5
DCE	254
VC	ND

ASV-9

ASV-10

ASV-8

ASV-1

ASV-2

ASV-3

ASV-7

ASV-6

ASV-5

ASV-4

TABLES

Table 1
Volatile Organic Compounds
in Groundwater Samples

384 Bridge Street
Brooklyn, NY

Client ID Lab Sample ID Date Sampled	NYSDEC TOGS 1.1.1 Class GA Ambient Water Quality Standards and Guidance values	MW-1	MW-1	MW-1	MW-2	MW-2	MW-2	MW-3	MW-3	MW-3	MW-4	MW-4	MW-4		
		JA6416-1 11/24/2008	JA28279-4 9/17/2009	JA41687-3 3/11/2010	JA6416-2 11/24/2008	JA28279-1 9/16/2009	JA41687-1 3/11/2010	JA6416-3 11/24/2008	JA28279-5 9/17/2009	JA4156-1 3/9/2010	JA6416-4 11/24/2008	JA28279-3 9/17/2009	JA4156-3 3/10/2010		
		Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
GC/MS Volatiles (ppb or ug/l)															
Acetone	50.0	ND		ND		ND		ND		ND		ND		ND	
Benzene	1.0	ND		ND		ND		ND		ND		ND		ND	
Bromodichloromethane	50.0	ND		ND		ND		ND		ND		ND		ND	
Bromoform	50.0	ND		ND		ND		ND		ND		ND		ND	
Bromomethane	5.0	ND		ND		ND		ND		ND		ND		ND	
2-Butanone (MEK)	50.0	ND		ND		ND		ND		ND		ND		ND	
Carbon disulfide	NS	ND		ND		ND		ND		ND		ND		ND	
Carbon tetrachloride	5.0	ND		ND		ND		ND		ND		ND		ND	
Chlorobenzene	5.0	ND		ND		ND		ND		ND		ND		ND	
Chloroethane	5.0	ND		ND		ND		ND		ND		ND		ND	
Chloroform	7.0	1.6	J	1.1		0.93	J	1.8		1.0		0.81	J	1.9	
Chloromethane	NS	ND		ND		ND		ND		ND		ND		ND	
Dibromochloromethane	50.0	ND		ND		ND		ND		ND		ND		ND	
1,1-Dichloroethane	5.0	ND		ND		ND		ND		ND		ND		ND	
1,2-Dichloroethane	0.6	ND		ND		ND		ND		ND		ND		ND	
1,1-Dichloroethene	5.0	ND		ND		ND		ND		ND		ND		ND	
cis-1,2-Dichloroethene	5.0	32.5		8.1		1.2		9.9		2.3		2.3		12.1	
trans-1,2-Dichloroethene	5.0	ND		ND		ND		ND		ND		ND		ND	
1,2-Dichloroethene (total)	NS	32.5		8.1		1.2		9.9		2.3		2.3		12.1	
1,2-Dichloropropane	1.0	ND		ND		ND		ND		ND		ND		ND	
cis-1,3-Dichloropropene	NS	ND		ND		ND		ND		ND		ND		ND	
trans-1,3-Dichloropropene	NS	ND		ND		ND		ND		ND		ND		ND	
Ethylbenzene	5.0	ND		ND		ND		ND		ND		ND		ND	
2-Hexanone	50.0	ND		ND		ND		ND		ND		ND		ND	
Methyl Tert Butyl Ether	10.0	ND		ND		ND		ND		ND		ND		ND	
4-Methyl-2-pentanone(MIBK)	NS	ND		ND		ND		ND		ND		ND		ND	
Methylene chloride	5.0	ND		ND		ND		ND		ND		ND		ND	
Styrene	5.0	ND		ND		ND		ND		ND		ND		ND	
1,1,2,2-Tetrachloroethane	5.0	ND		ND		ND		ND		ND		ND		ND	
Tetrachloroethene	5.0	585.0		220.0		42.1		143.0		66.9		50.1		988.0	
Toluene	5.0	ND		ND		ND		ND		ND		ND		ND	
1,1,1-Trichloroethane	5.0	ND		ND		ND		ND		ND		ND		ND	
1,1,2-Trichloroethane	1.0	ND		ND		ND		ND		ND		ND		ND	
Trichloroethene	5.0	5.4		2.0		0.89	J	2.7		1.2		1.0		4.0	
Vinyl chloride	2.0	ND		ND		ND		ND		ND		ND		ND	
Xylene (total)	5.0	ND		ND		ND		ND		ND		ND		ND	

Notes:

Highlighted cells exceed guidance values

Samples analyzed for VOCs by EPA Method 8260

NS = No Standard

Qualifiers

U = Analyte not detected at or above reporting limit.

J = Value is estimated (greater than detection limit but below reporting limit).

Table 1
Volatile Organic Compounds
in Groundwater Samples

384 Bridge Street
Brooklyn, NY

Client ID Lab Sample ID Date Sampled	NYSDEC TOGS 1.1.1 Class GA Ambient Water Quality Standards and Guidance values	MW-5 JA28279-2 9/16/2009	MW-5 JA4156-4 3/9/2010	MW-6S JA28085-1 9/16/2009	MW-6S JA41687-2 3/11/2010	MW-6D JA28085-2 9/16/2009	MW-7 JA28747-3 9/23/2009	MW-7 JA4156-2 3/10/2010	FB-091609 JA28085-3 9/16/2009	FB-091709 JA28279-6 9/17/2009	FB-092309 JA28747-2 9/23/2009	FB-031010 JA4156-2 3/10/2010	TB-091609 JA28085-4 9/16/2009	TB-091709 JA28279-7 9/17/2009
		Result Q	Result Q	Result Q	Result Q	Result Q	Result Q	Result Q	Result Q	Result Q	Result Q	Result Q	Result Q	Result Q
GC/MS Volatiles (ppb or ug/l)														
Acetone	50.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzene	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromodichloromethane	50.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromoform	50.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromomethane	5.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Butanone (MEK)	50.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Carbon disulfide	NS	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Carbon tetrachloride	5.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chlorobenzene	5.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloroethane	5.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloroform	7.0	0.91 J	0.92 J	0.86 J	ND	3.0	14.3	6.5	ND	ND	ND	ND	ND	ND
Chloromethane	NS	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibromochloromethane	50.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloroethane	5.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichloroethane	0.6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloroethene	5.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
cis-1,2-Dichloroethene	5.0	0.38 J	0.30 J	1.4	ND	0.46 J	ND	ND	ND	ND	ND	ND	ND	ND
trans-1,2-Dichloroethene	5.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichloroethene (total)	NS	0.38 J	0.30 J	1.4	ND	0.46 J	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichloropropane	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
cis-1,3-Dichloropropene	NS	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
trans-1,3-Dichloropropene	NS	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	5.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Hexanone	50.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methyl Tert Butyl Ether	10.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Methyl-2-pentanone(MIBK)	NS	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methylene chloride	5.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Styrene	5.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2,2-Tetrachloroethane	5.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Tetrachloroethene	5.0	11.9	14.2	75.1	13.9	3.5	0.85 J	4.8	ND	ND	ND	ND	ND	ND
Toluene	5.0	0.61 J	ND	ND	ND	0.54 J	ND	ND	ND	ND	ND	ND	ND	ND
1,1,1-Trichloroethane	5.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2-Trichloroethane	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trichloroethene	5.0	0.56 J	0.83 J	1.8	ND	3.9	0.36 J	0.54 J	ND	ND	ND	ND	ND	ND
Vinyl chloride	2.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Xylene (total)	5.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Notes:

Highlighted cells exceed guidance values

Samples analyzed for VOCs by EPA Method 8260

NS = No Standard

Qualifiers

U = Analyte not detected at or above reporting limit.

J = Value is estimated (greater than detection limit but below reporting limit).

**Table 2
General Chemistry of Groundwater**

**388 Bridge Street
Brooklyn, NY**

Client ID	MW-1		MW-1		MW-2		MW-2		MW-3		MW-3		MW-4		MW-4	
Lab Sample ID	JA28279-4		JA41687-3		JA28279-1		JA41687-1		JA28279-5		JA41563-1		JA28279-3		JA41563-3	
Date Sampled	9/17/2009		3/11/2010		9/16/2009		3/11/2010		9/17/2009		3/9/2010		9/17/2009		3/10/2010	
	Result	Q														
General Chemistry (mg/l)																
Nitrogen, Nitrate	6.4		7.0		6.6		8.5		9.5		13.7		6.3		7.6	
Nitrogen, Nitrite	<0.010		<0.010		<0.010		<0.010		<0.010		<0.010		<0.010		<0.010	
Nitrogen, Nitrate + Nitrite	6.4		7.0		6.6		8.5		9.5		13.7		6.3		7.6	
Sulfate	110		87.8		57.1		220		56.3		99.8		82.5		141	
Disolved Organic Carbon	2.1		5.4		1.8		5.8		2.5		1.2		1.8		1.0	

**Table 2
General Chemistry of Groundwater**

**388 Bridge Street
Brooklyn, NY**

Client ID Lab Sample ID Date Sampled	MW-5 JA28279-2 9/16/2009		MW-5 JA41563-4 3/9/2010		MW-6S JA28085-1 9/16/2009		MW-6S JA41687-2 3/11/2010		MW-6D JA28085-2 9/16/2009		MW-7 JA28747-3 9/23/2009		MW-7 JA41563-2 3/11/2010	
	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
General Chemistry (mg/l)														
Nitrogen, Nitrate	4.6		5.9		8.7		8.8		4.3		10.5		12.3	
Nitrogen, Nitrite	<0.010		<0.010		<0.010		<0.010		<0.010	<	0.24		0.02	
Nitrogen, Nitrate + Nitrite	4.6		5.9		8.7		8.8		4.3		10.7		12.3	
Sulfate	49.6		59.0		204		132		51.7		66.0		97.8	
Disolved Organic Carbon	1.8		1.8		2.5		5.6		1.9		1.8		2.0	

Table 3
Field Measured Groundwater Geochemistry Parameters

Project: Bridge Street
Location: 388 Bridge Street

FLS Project Number: 10149-001-8
Samplers: AB, BM

Well Identification	MW-1	MW-2	MW-3	MW-4	MW-5	MW-6S	MW-7
Date	3/11/2010	3/11/2010	3/9/2010	3/10/2010	3/10/2010	3/11/2010	3/10/2010
PID (ppm)	0.0	0.0	67.1	0.1	0.0	0.0	0.3
Total Depth of Well (ft)	39.75	43.0	54.96	35.65	42.22	40.5	51.85
Initial Depth to Water (ft)	32.67	33.77	43.36	32.64	33.31	32.51	43.34
Water Column (ft)	7.08	9.2	11.60	3.01	8.91	8.0	8.51
Well Inner Diameter (inches)	2	2	2	2	4	4	2
Well Inner Diameter (ft)	n/a						
Static Water Volume (gal)*	1.15404	1.50449	1.8908	0.49063	5.81823	5.21747	1.38713
Three Well Volumes to purge (gal)	3.46212	4.51347	5.6724	1.47189	17.5	15.7	4.16139
Depth to Product (ft)	n/a						
Product Thickness (ft)	n/a						
PURGING INFORMATION							
Purge Method	Bladder Pump						
Time Begin Purge	11:40	10:30	11:35	10:35	11:50	13:12	8:30
Time End Purge	12:35	11:08	11:55	11:05	12:57	13:35	9:00
Flow Rate (gpm)	0.1	0.1	0.1	0.1	0.3	0.3	0.1
Total Purge Vol. (gal)	5	5	6	4	18	16	5
Post-Purge DTW (ft) (80% Recovery**)	32.67	33.77	43.36	32.64	33.31	32.51	43.34
Recharge Wait Time (min)	n/a						
PRE-PURGE							
Temperature (C)	16.91	15.5	16.5	17.98	15.85	14.82	18.05
Conductivity (mS/cm)	0.119	0.167	0.131	61.2	0.111	79.2	0.174
pH (s.u.)	7.76	7.78	6.91	7.82	7.69	8.1	7.55
Turbidity (NTUs)	907	300	608	759	601	87.9	870
ORP	44	52	36	39	58	14	43
Iron	0	0	0.0	0.0	0.0	0.00	0.09
D.O. (mg/L)	4.45	9.23	7.09	10.77	5.89	9.03	8.14
Color	clear/sheen	clear	clear	clear	clear/sheen	clear	clear
Odor	yes	none	none	none	none	none	none
POST-SAMPLE							
Sample Time	12:35	11:08	12:05	11:05	13:10	13:35	9:05
DTW (ft)	32.67	33.77	43.36	32.64	33.31	32.51	43.34
Temperature (C)	17.05	16.51	16.66	17.29	16.22	14.77	18.40
Conductivity (ms/cm)	0.128	0.18	0.128	63.7	0.117	80.4	0.196
pH (s.u.)	7.69	7.67	7.23	7.78	7.69	8.18	7.58
Turbidity (NTUs)	118	116	2.4	45.3	103	75	65.9
ORP	27	49	35	38	26	12	39
Iron	0	0	0.0	0.0	0.0	0	0.09
D.O. (mg/L)	3.6	7.88	6.43	10.76	3.11	8.46	8.64
Color	clear/sheen	clear	clear	clear	clear/sheen	clear	clear
Odor	yes	none	none	none	none	none	none
COMMENTS							
All dtw readings were taken from top of casing (toc)							

Notes:

* Static Water Volume = 5.8752*D²*WC where D and WC are in feet.

** 80% Recovery is calculated by subtracting 80% of water column height from the total depth [TD-(.80xWC)].

D = Well Diameter (ft)

WC = Water Column (ft)

PID = Photoionization Detector

PPM = Parts per Million

GPM = Gallons per Minute

DTW = Depth to Water

ft = Feet

gal = Gallons

min = Minutes

C = degrees Celcius

mS/cm = MilliSiemens per Centimeter

s.u. = Standard Units

NTUs = Nephelometric Turbidity Units

mg/L = Milligrams per Liter

Table 4
Volatile Organic Compounds
in Soil Vapor Samples

388 Bridge Street
Brooklyn, NY

Client ID Lab Sample ID Date Sampled	NYSDOH Study Homes in NYS 1997-2003		EPA Database Offices 1994-1998		NYSDOH Air Guidance Value µg/m3	ASV-1	ASV-2	ASV-3	ASV-4	ASV-5	ASV-6	ASV-7	ASV-8	ASV-9	ASV-10	
	Indoor µg/m ³	Outdoor µg/m ³	Indoor µg/m ³	Outdoor µg/m ³		JA42227-4 3/18/2010	JA42227-5 3/18/2010	JA42227-6 3/18/2010	JA42227-7 3/18/2010	JA42300-1 3/19/2010	JA42300-2 3/19/2010	JA42300-3 3/19/2010	JA42227-1 3/18/2010	JA42227-2 3/18/2010	JA42227-3 3/18/2010	
	Result	Q	Result	Q		Result	Q	Result								
GC/MS Volatiles (µg/m3)																
Acetone	10-46	3.9-23	32-60	15-32	NS	119	69.4	94.5	44.7	106	72.7	104	77.0	112	153	
1,3-Butadiene	NS	NS	NS	NS	NS	ND										
Benzene	1.2-5.7	<0.25-2.6	2.1-5.1	1.2-3.7	NS	6.1 J	5.4 J	4.8 J	6.7	6.1	7.3	8.6	8.0	14	9.3	
Bromodichloromethane	NS	NS	NS	NS	NS	ND										
Bromoform	NS	NS	NS	NS	NS	ND										
Bromoethane	NS	NS	NS	NS	NS	ND										
Bromoethene	NS	NS	NS	NS	NS	ND										
Benzyl Chloride	NS	NS	NS	NS	NS	ND										
Carbon disulfide	NS	NS	NS	NS	NS	ND	ND	ND	1.6 J	ND	ND	10	5.0	6.2	3.0	
Carbon tetrachloride	NS	NS	NS	NS	NS	ND										
Chlorobenzene	NS	NS	NS	NS	NS	ND										
Chloroethane	NS	NS	NS	NS	NS	ND	ND	ND	10	5.9	8.8 J	12	7.8	7.8 J	5.4	
Chloroform	<0.25-0.54	<0.25	<0.5	<0.4	NS	ND										
Chloromethane	NS	NS	NS	NS	NS	ND										
3-Chloropropene	NS	NS	NS	NS	NS	ND	ND	ND	ND	ND	1.1	ND	ND	ND	ND	
2-Chlorotoluene	NS	NS	NS	NS	NS	ND										
Carbon tetrachloride	NS	NS	NS	NS	NS	ND	ND	ND	3.1	ND	ND	ND	ND	ND	ND	
Cyclohexane	NS	NS	NS	NS	NS	ND	ND	ND	3.1 J	ND	ND	ND	6.1	18	2.4 J	
1,1-Dichloroethane	<0.25	<0.25	<0.5	<0.4	NS	ND										
1,1-Dichloroethylene	NS	NS	NS	NS	NS	ND										
1,2-Dibromoethane	NS	NS	NS	NS	NS	ND										
1,2-Dichloroethane	NS	NS	NS	NS	NS	ND										
1,2-Dichloropropane	NS	NS	NS	NS	NS	ND										
1,4-Dioxane	NS	NS	NS	NS	NS	ND	ND	ND	3.7 J	3.7 J	ND	5.4 J	11	7.9 J	7.9	
Dichlorodifluoromethane	NS	NS	NS	NS	NS	ND	1.2	ND	ND							
Dibromochloromethane	NS	NS	NS	NS	NS	5.9 J	7.1 J	13	27	27	39	39.6	44.4	15	16	
trans-1,2-Dichloroethylene	NS	NS	NS	NS	NS	180	169	238	289	254	337	305	404	295	139	
cis-1,2-Dichloroethylene	NS	NS	NS	NS	NS	ND	5.1	ND	7.2							
cis-1,3-Dichloropropene	NS	NS	NS	NS	NS	12	ND	ND	ND	ND	ND	ND	5.1	ND	7.2	
m-Dichlorobenzene	NS	NS	NS	NS	NS	ND										
o-Dichlorobenzene	NS	NS	NS	NS	NS	ND										
p-Dichlorobenzene	NS	NS	NS	NS	NS	ND										
trans-1,3-Dichloropropene	NS	NS	NS	NS	NS	50.7	14	10	18	27.3	9.0 J	23.6	54.6	40.5	53.7	
Ethanol	NS	NS	NS	NS	NS	5.6 J	6.5 J	7.4 J	3.2 J	6.1	9.6	7.8 J	8.7	10	10	
Ethylbenzene	0.43-2.8	ND0.25-0.61	ND1.6-3.4	ND1.4-1.6	NS	19	ND									
Ethyl Acetate	NS	NS	NS	NS	NS	ND	4.5	ND	4.8							
4-Ethyltoluene	NS	NS	NS	NS	NS	ND										
Freon 113	NS	NS	NS	NS	NS	ND										
Freon 114	NS	NS	NS	NS	NS	7.8 J	6.1 J	5.7 J	7.4	5.3	7.8 J	8.6	7.8	14	9.0	
Heptane	NS	NS	NS	NS	NS	ND										
Hexachlorobutadiene	NS	NS	NS	NS	NS	9.5	9.5	7.0	14	6.7	9.9	12	7.8	19	11	
Hexane	NS	NS	NS	NS	NS	ND										
2-Hexanone	NS	NS	NS	NS	NS	ND										
Isopropyl Alcohol	NS	NS	NS	NS	NS	ND	3.8	6.3 J	3.8							
Methylene chloride	0.39-6.3	<0.25-0.87	<1.7-5.0	<1.8-3.0	60	5.3 J	ND	ND	16	26	9.7	5.9	10	10	10	
Methyl ethyl ketone	NS	NS	NS	NS	NS	ND	ND	ND	ND	2.3 J	ND	ND	ND	ND	ND	
Methyl Isobutyl Ketone	NS	NS	NS	NS	NS	ND										
Methyl Tert Butyl Ether	NS	NS	NS	NS	NS	ND	136	50.8	44.7	ND	76.8	50.0	182	94.0	94.0	
Propylene	NS	NS	NS	NS	NS	ND										
Styrene	<0.25-0.68	<0.25	<1.8	<1.6	NS	ND	ND	ND	4.1 J	2.9 J	ND	7.6 J	7.6	6.5 J	ND	
1,1,1-Trichloroethane	NS	NS	NS	NS	NS	ND										
1,1,2,2-Tetrachloroethane	ND0.25	ND0.25	NS	NS	NS	ND										
1,1,2-Trichloroethane	NS	NS	NS	NS	NS	ND										
1,2,4-Trichlorobenzene	NS	NS	NS	NS	NS	8.8 J	9.3 J	14	ND	4.6	8.8 J	8.8 J	16	16	17	
1,2,4-Trimethylbenzene	NS	NS	NS	NS	NS	ND	5.4	5.9 J	5.4							
Tertiary Butyl Alcohol	NS	NS	NS	NS	NS	ND	3.7 J	ND	2.3 J							
Tetrachloroethene	<0.25-1.2	<0.25-0.34	<1.9-5.9	<1.4-3.0	NS	ND	ND	ND	ND	2.3 J	ND	4.2 J	1.9 J	ND	2.5	
Tetrachloroethylene	NS	NS	NS	NS	100	2860	3680	4540	2090	963	2570	2830	1080	2730	997	
Tetrahydrofuran	NS	NS	NS	NS	NS	ND	ND	ND	ND	4.7	ND	ND	ND	ND	ND	
Toluene	4.2-25	0.65-3.3	10.7-26	5.9-16	NS	27	26	28	40.7	30	38.4	38.1	38.1	45.2	38.4	
Trichloroethylene	NS	NS	NS	NS	5	76.8	76.8	110	126	85.6	141	176	125	229	86.0	
Trichlorofluoromethane	NS	NS	NS	NS	NS	9.6 J	13	20	40	32	48	97.2	25	25	11	
Vinyl chloride	NS	NS	NS	NS	NS	ND	13	ND	ND							
Vinyl Acetate	NS	NS	NS	NS	NS	ND										
p-Xylene & m-Xylene	0.52-4.7	<0.25-0.69	4.1-12	<3.6-7.3	NS	23	26	31	5.6	23	38	30	36	41	41	
o-Xylene	0.39-3.1	<0.25-0.74	<2.4-4.4	<1.4-2.6	NS	7.8 J	8.7	10	ND	6.9	12	9.6	13	15	14	
Xylenes (total)	NS	NS	NS	NS	NS	30	34	41	5.8	30	50.0	40	49.1	56.5	54.3	

Notes:
Highlighted cells exceed guidance values
Samples analyzed for VOCs by EPA Method TO-15
NS = No Standard

Qualifiers:
U = Analyte not detected at or above reporting limit.
J = Value is estimated (greater than detection limit but below reporting limit).

Appendix A
Prior Investigation Reports (on CD)

Appendix B
2010 FLS Pilot Test

388 Bridge Street Site
388 Bridge Street
Brooklyn, New York
Block 152, Lots 118 and 37

BCP Site # C224134

SOIL VAPOR EXTRACTION (SVE) PILOT TEST REPORT

Prepared For:
384 Bridge Street, LLC
c/o Stahl Real Estate Company Inc.
277 Park Ave
New York, NY 10172
FLS Project Number: 10149-001-6

Submitted to:
New York State Department of Environmental Conservation
Division of Environmental Remediation
625 Broadway, 12th Floor
Albany, N.Y. 12233-7016

May 2010

Arnold F. Fleming, P.E. &



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FIGURES

- Figure 1 SVE Pilot Test Layout
Figure 2 SVE Well and Pressure Monitoring Point Construction Logs

ATTACHMENTS

- ATTACHMENT A SVE Pilot Test Data Log, Summary Graph and Tabulated
Summary of Off-gas Sample Results
ATTACHMENT B Soil Permeability Calculations
ATTACHMENT C Laboratory Analytical Report (on CD)

1.0 INTRODUCTION

Arnold F. Fleming, P.E. & Fleming-Lee Shue, Inc. (collectively “FLS”) proposed a soil vapor extraction (SVE) pilot test at 388 Bridge Street in Brooklyn, New York (the “Site”) in a letter dated March 30, 2009 to the New York State Department of Environmental Conservation (NYSDEC); the pilot test was approved on February 18, 2010. Included below are a summary of the site characteristics, the SVE pilot test methodology and the findings as well as conclusions and recommendations. The pilot test showed that SVE would be an effective remedy to concentrations of chlorinated organic solvents present in the soil gas at the 388 Bridge Street site.

1.1 *Site Characteristics*

Analytical results from the most recent Site investigation, conducted April 2010, indicated that concentrations of tetrachloroethylene (PCE) in soil vapor were detected as high as 4,540 micrograms per cubic meter ($\mu\text{g}/\text{m}^3$) and concentrations of PCE in groundwater were detected as high as 93.7 micrograms per liter ($\mu\text{g}/\text{L}$).

Lithologic logs from on-Site investigations indicate that there are two strata under the Site and surrounding area. The upper stratum is fill material with thicknesses ranging from three to 17 feet. The stratum below the fill layer is a natural glacial till deposit consisting of very compacted to compacted, brown to red-brown, fine- to coarse-grained sand and gravel with a trace of cobbles and boulders. The underlying till layer becomes less compacted and consists of coarse-grained sand intermixed with some gravel at and below the water table. Groundwater beneath the Site was encountered at depths ranging from approximately 30 to 32 feet below existing Site grade (ft-beg) and was encountered at 43 to 45 feet below surrounding sidewalk grade (ft-bsg) along Bridge Street. The glacial till stratum extends to 100 ft-bsg and is underlain by highly consolidated Gardiner’s clay.

The Site was previously excavated to approximately 25 ft-bsg, however, because of the delay in beginning construction of the building on the development Site, the New York City Department of Buildings (NYCDOB) requested that the Site be filled temporarily to support the foundations of the buildings located to the north and south. The Site is currently backfilled with 12 feet of mole rock (pulverized bedrock resulting from tunneling for subway construction) to raise the Site grade to 13 ft-bsg.

Since the Site has been excavated to 25 ft-bsg, no fill material other than the imported mole rock was encountered. Soil borings from just below the mole rock fill to 42 ft-bsg indicate native soils consist of brown, medium- to coarse-grained sand intermixed with some gravel. The till beneath the Site ranges from dense to medium density and has a moderate liquid permeability. Very little fines (silt or clay) were present in the soils below the Site. Groundwater beneath the Site was encountered at depths ranging from approximately 30 to 32 ft-beg and was encountered at 43 to 45 ft-bsg along Bridge Street. The on-Site groundwater flow direction is to the northeast.

1.2 Soil Vapor Extraction (SVE)

SVE is an accepted and proven in-situ technique in which the volatilization of volatile organic compounds (VOCs) is induced in the soil and the constituents are removed in extracted vapor.

The removal rate of VOCs by SVE may be controlled by one or more of the following processes: advection, volatilization, desorption and diffusion. During SVE, as air is drawn through the soil pore space, VOCs volatilize and are carried with the air to extraction wells via advection. This removal induces further volatilization from the impacted soils. Impacted areas that are not in direct contact with the advective air flow rely on diffusion of VOCs toward zones of enhanced air flow.

The extent to which VOCs volatilize into the vapor phase is governed by the physical properties of the compounds, including the Henry's Law constant and vapor pressure. The Henry's Law constant describes the equilibrium partitioning of a chemical between the vapor phase and aqueous phase. The larger the Henry's Law constant, the more the constituent tends to partition into the vapor phase. The vapor pressure of a chemical describes the tendency of a chemical to evaporate and is described as the pressure exerted by that compound in the vapor phase at equilibrium with the pure compound (in solid or liquid form) in a closed system. Compounds with a Henry's Law constant greater than 0.01 (dimensionless) and a vapor pressure greater than 0.5 millimeters of mercury (mm) of mercury (Hg) are generally amenable to removal by SVE (USEPA, 1997).

The contamination present on-Site consists primarily of PCE for which the Henry's Law constant is 0.0177 and the vapor pressure is 18.5 mm Hg and therefore is amenable to remediation by SVE.

The contemplated SVE system would consist of vacuum extraction wells screened through the proposed treatment zone, which is located from 16 to 26 ft-beg.

Air sparging is a technique often used in conjunction with SVE and which entails injecting air into the groundwater to increase the removal rate of VOCs from the groundwater to the soil vapor. The use of sparging was rejected because of the risk of intrusion into adjacent buildings and the nearby subway tunnel if the SVE system did not capture all of the sparged air.

2.0 OBJECTIVE

The objective of the SVE pilot test was to evaluate Site-specific design parameters for an SVE system to be incorporated into a Remedial Action Work Plan (RAWP). The primary parameters to be determined for the SVE system are the soil permeability, zone of influence, operating vacuum, vapor extraction flow rates and PCE removal rates.

2.1 SVE Pilot Test Design

The SVE pilot test utilized one vertical SVE well (SVE-1) located in the area of the highest PCE impacts to both soil vapor and on-Site groundwater based on past sampling results¹, and was installed to a total depth of approximately 26 ft-beg (approximately 39 ft-bsg). The placement of the SVE-1 well screen was located approximately five feet above the groundwater table. SVE-1 was screened from approximately 16 to 26 ft-beg and consisted of ten feet of 4-inch diameter 0.02-inch slotted Schedule (SCH) 40 polyvinyl chloride (PVC) well screen threaded to 4-inch diameter SCH 40 PVC riser to surface. An 11-foot #40 sand filter pack was installed around the well screen and riser followed by one foot of bentonite and neat Portland cement to surface. SVE-1 placement and construction is consistent with the expected full-scale SVE design.

Four temporary pressure monitoring points (P-05, P-15, P-25 and P-50), for pilot test monitoring, were installed around SVE-1 to monitor the effectiveness of the SVE pilot test. The pressure monitoring points were screened from approximately 16 to 26 ft-beg and consisted of ten feet of 2-inch diameter 0.02-inch slotted SCH 40 PVC well screen threaded to 2-inch diameter SCH 40 PVC riser. The distances of the pressure monitoring points from SVE-1, in increasing order from P-05 to P-50, were measured to be approximately 4, 15, 25 and 49 feet.

SVE and pressure monitoring point well locations are depicted on **Figure 1** and SVE and pressure monitoring well construction details are depicted on **Figure 2**.

3.0 SUMMARY OF FIELD ACTIVITIES

A positive displacement (PD) blower was utilized for the SVE pilot test. Blower vacuum levels of 20, 40, 50, 60 and 70 inches of water ("H₂O) were applied during the SVE pilot test to evaluate corresponding flow rates and radii of influence. Vacuum readings were collected from P-05 through P-50 utilizing a factory-calibrated Extech differential pressure manometer at approximately 10-minute intervals during each vacuum-rate-portion of the SVE pilot test, which were each conducted for approximately 40 minutes.

SVE off-gas was filtered through two 55-gallon drums of granulated activated carbon (GAC) and analyzed by a photoionization detector (PID) – pre- and post-carbon treatment – at 10-minute intervals. One pre-carbon treatment off-gas air sample was collected into a batch-certified clean 6-liter SUMMA canister during each vacuum level. Each sample was transported under chain-of-custody documentation to Accutest Laboratories of Dayton, New Jersey and analyzed by Environmental Protection Agency (EPA) Method TO-15 for VOCs.

A detailed pilot test data log is included as **Attachment A**.

3.1 Investigation Derived Waste (IDW)

¹ Recent groundwater sampling has shown that PCE concentrations in groundwater in the area of the SVE pilot test have decreased significantly compared to past sample results.

During the pilot test, no soil or groundwater IDW was generated. The drums of GAC utilized during the pilot test will be disposed of under applicable city, state, and/or federal regulations. A copy of the waste manifest will be included under separate cover.

4.0 RESULTS

Vacuum influences were observed in P-05 through P-50 during all phases of the pilot test and generally decreased with distance at the same rate regardless of the applied vacuum. As detailed in the SVE pilot test data summary included in **Attachment A**, vacuum influence of up to 0.7"-H₂O, at both 60 and 70"-H₂O of applied vacuum, was observed at the furthest pressure monitoring point, P-50, located 49 feet away from SVE-1.

Soil permeability calculations were performed for each pilot test phase and are included in **Attachment B**. According to the calculations, the soil permeability (k) ranges from 9,466 to 21,702 Darcys.

PID readings collected during the pilot test indicated volatile organic compound (VOC) concentrations of up 183.9 parts per million (ppm). For the purposes of SVE design, it is assumed that the VOC concentration is comprised entirely of PCE. Laboratory analytical results for air samples collected from the SVE effluent indicated concentrations of PCE of up to 480,000 micrograms per cubic meter (µg/m³). The laboratory analytical report is included in **Attachment C**.

The mass flow rates of PCE during each phase of the pilot test were generally very similar. However, the highest observed mass flow rate occurred during the 50"-H₂O of applied vacuum portion of the test at a removal rate of approximately 6 grams per minute (g/min) or approximately 0.013 pound per minute (lb/min). This rate is expected to decrease as the SVE system runtime progresses.

The total mass from on-Site to be treated through the SVE system is based on the size of the treatment zone (a ten-foot thick interval over the entire areal extent of the Site) and the assumed concentrations. Below are the calculations for the mass estimate of PCE volume in the soil vapor:

$$\begin{aligned} & \text{Volume of Treatment Zone} * \text{Porosity} * \text{Concentration of PCE} = \text{Mass of PCE in Soil Vapor} \\ & [(20,350 \text{ square feet}) * (10 \text{ foot treatment zone}) * (1/30.959 \text{ cubic meter/cubic foot})] * \\ & \quad \quad \quad [(20\% \text{ porosity})] * \\ & [(480,000 \text{ micrograms/cubic meter}) * (1/453,000,000 \text{ pounds/microgram})] \\ & \quad \quad \quad = 1.4 \text{ pounds} \end{aligned}$$

Additional mass may be collected from the off-Site areas within the design radius of influence (ROI). The SVE will be designed to treat a total of 1.4 pounds of on-Site volatile contaminant

mass plus any off-Site components that will be determined at a later date. The porosity is based on typical ranges for sand/till².

The zone of influence at 50"-H₂O applied vacuum is at least 50 feet. This is based on the measured responses in the pressure monitoring points. The graph showing the vacuum versus distance from SVE-1 is included on the graph in **Attachment A**. The measured vacuum at 49 feet, with 50"-H₂O applied vacuum, is 0.6" H₂O. This is above the typical design response of 0.1"-H₂O. The final ROI will be determined during the design of the system.

Attachment A provides a full summary of pilot test configurations, vacuums, OVM readings, analytical results, and a graph depicting vacuum influence verses distance from the applied vacuum.

² Applied Hydrogeology, Fourth Edition; C.W. Fetter; Prentice Hall, Inc. 2001

5.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the results of the pilot test, it has been determined that SVE will likely be an effective technology for full-scale on-Site soil vapor remediation.

Vacuum influences were observed in P-05 through P-50 during all phases of the pilot test. As detailed in the pilot test data log and depicted on the graph included in **Attachment A**, vacuum influence in P-05 through P-50 generally decreased with distance at the same rate, regardless of the applied vacuum.

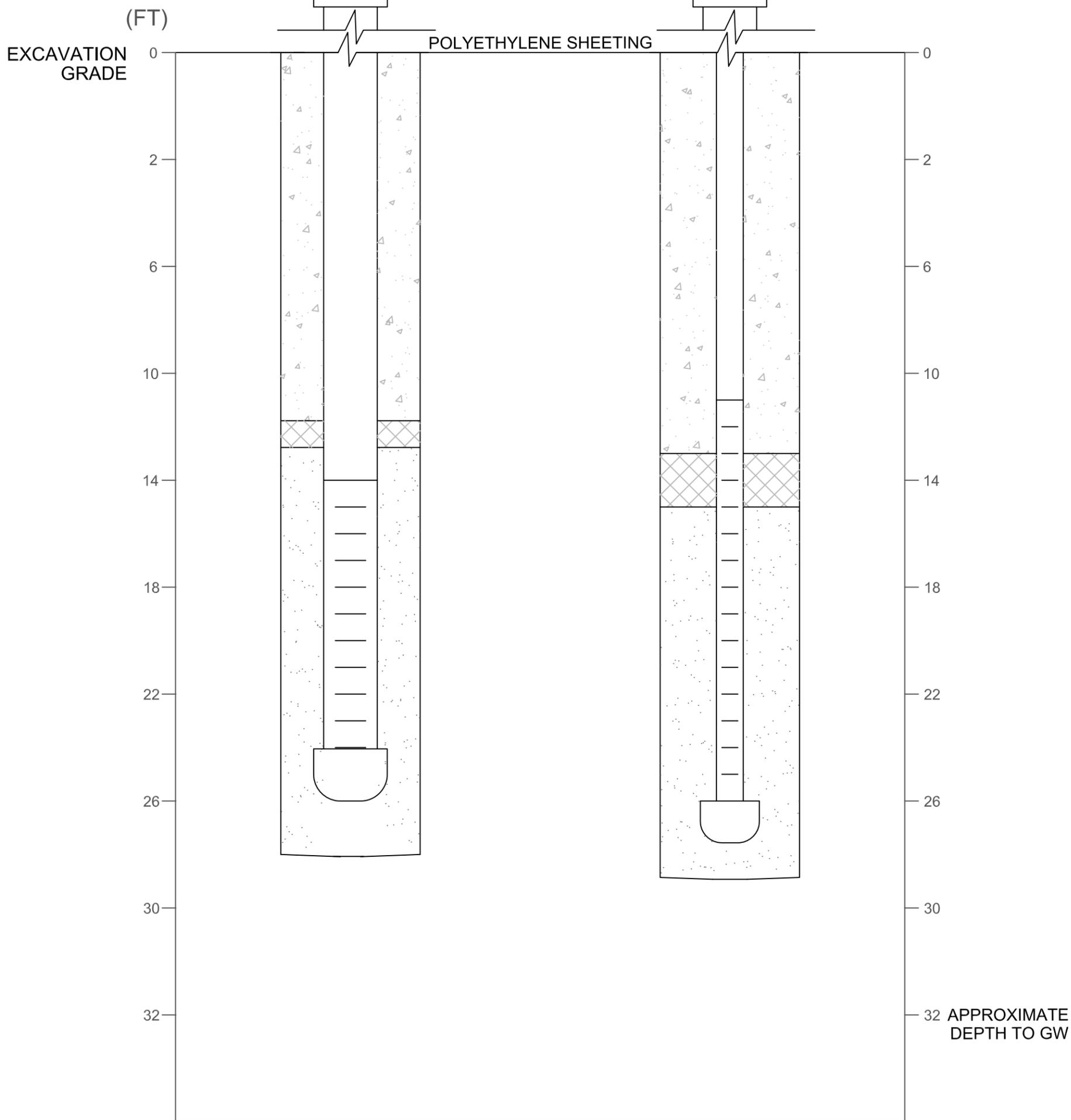
The mass flow rate of PCE was highest during the 50"-H₂O portion of the test and was calculated to be approximately 0.013 lb/min. This rate is expected to decrease as the SVE system runtime progresses. The zone of influence at 50"-H₂O applied vacuum, which resulted in a wellhead vacuum of approximately 11.5"-H₂O, was at least 50 feet.

Based on the pilot test results, a full-scale SVE system will be designed. The SVE system will consist, at a minimum, of a series of soil vapor extraction points, piping, a blower, pressure gauges and activated carbon off-gas treatment.

FIGURES

SVE - 1

P-05, 15, 25, 50



Scale: NTS



Environmental Management & Consulting

158 West 29th Street, 9th Fl.
New York, NY 10001

Project Number

100149-001-8

383 Bridge Street
Brooklyn, NY

Date
May 2010

FIGURE 2

**EXTRACTION WELL
AND PRESSURE
MONITORING POINT
CONSTRUCTION**

LEGEND

-  Portland Cement
-  Bentonite Pellats
-  #2 Morie Sand Filter Pack

388 Bridge Street – Brooklyn, NY

ATTACHMENT A

SVE Pilot Test Data Log, Summary Graph and Tabulated Summary of Off-gas Sample Results

**TABLE 1
SVE PILOT TEST DATA SUMMARY**

388 Bridge Street
Brooklyn, New York
FLS Project No. 10149-006-08

Time	System Parameters								SVE-1		P-05	P-15	P-25	P-50
	4" Before Knock-Out Tank Vacuum	4" Blower Vacuum	Outlet Pressure	Wellhead Flow Rate	Bleed Air Vacuum	Effluent PID	Post Treatment PID	PCE Concentration ($\mu\text{g}/\text{m}^3$)**	Well Head Vacuum	Flow Rate	Vacuum	Vacuum	Vacuum	Vacuum
Unit	"H ₂ O	"H ₂ O	"H ₂ O	cfm	"H ₂ O	ppm	ppm		"H ₂ O	cfm	"H ₂ O	"H ₂ O	"H ₂ O	"H ₂ O
1130*	0	0	0	0	0	--	0		0	0	0	0	0	0
1155	20	15	0.25	400	22	--	0		6.3	400	2.5	1	0.7	0.3
1205		15	0.25	400	26	--	0		6.35	400	2.6	1.1	0.7	0.3
1215		16	0.25	400	28	--	0		6.35	400	2.7	1.15	0.8	0.3
1225		15	0.25	400	25	--	0		6.3	400	2.7	1.1	0.75	0.3
1235	40	42	0.8	390	35	64.1	0		10	390	4.1	1.8	1.3	0.6
1245		42	0.8	390	37	70.1	0		10	390	4.15	1.8	1.3	0.5
1255		42	0.8	390	37	77	0	439000	10	390	4.1	1.8	1.2	0.5
1305		42	0.8	390	37	183.9	0		10	390	4.1	1.8	1.2	0.5
1315	50	42	0.8	385	54	92.4	0		11.5	385	4.7	2	1.4	0.6
1325		44	0.8	385	54	94.7	0	480000	11.5	385	4.7	2.1	1.4	0.6
1335		56	1	385	54	103	0.05		11.4	385	4.6	2	1.3	0.6
1340	60	56	1.4	375	64	101	1.6		12.7	375	5.1	2.3	1.5	0.7
1350		56	1.4	375	64	105	0.5	452000	12.6	375	5.1	2.2	1.5	0.7
1400		56	1.4	375	64	85.3	0.4		12.5	375	5	2.1	1.3	0.7
1410		56	1.4	375	64	107	0.2		12.5	375	5	2.1	1.5	0.7
1415	70	62	1.6	370	67	109	1.6	428000	13.4	370	5.3	2.3	1.6	0.7
1425		62	1.6	370	67	111	0.2		13.4	370	5.4	2.4	1.6	0.7
1435		62	1.6	370	67	117	1		13.4	370	5.4	2.3	1.6	0.7
1445		62	1.6	370	67	120	0.7		13.4	370	5.3	2.3	1.6	0.7
Distance From SVE-1											4 ft	15 ft	25 ft	49 ft

Notes:
 *Baseline value
 **As determined by laboratory analysis
 "H₂O = inches of water
 cfm = cubic feet per minute
 ppm = parts per million
 PID = photoionization device reading

Table 2
Volatile Organic Compounds
in Off-Gas Samples

388 Bridge Street
Brooklyn, NY

Client ID Lab Sample ID Date Sampled	NYSDOH Study Homes in NYS 1997-2003		EPA Database Offices 1994-1998		NYSDOH Guidance Value	SVE-10 JA44395-1 4/15/2010	SVE-12 JA44395-2 4/15/2010	SVE-13 JA44395-3 4/15/2010	SVE-14 JA44395-4 4/15/2010				
	Indoor µg/m ³	Outdoor µg/m ³	Indoor µg/m ³	Outdoor µg/m ³	µg/m ³	Result	Q	Result	Q	Result	Q	Result	Q
GC/MS Volatiles (µg/m3)													
Acetone	10-46	3.9-23	32-60	15-32	NS	1040		454	J	276		ND	
1,3-Butadiene	NS	NS	NS	NS	NS	ND		ND		ND		ND	
Benzene	1.2-5.7	<0.25-2.6	2.1-5.1	1.2-3.7	NS	ND		ND		ND		ND	
Bromodichloromethane	NS	NS	NS	NS	NS	ND		ND		ND		ND	
Bromoform	NS	NS	NS	NS	NS	ND		ND		ND		ND	
Bromomethane	NS	NS	NS	NS	NS	ND		ND		ND		ND	
Bromoethene	NS	NS	NS	NS	NS	ND		ND		ND		ND	
Benzyl Chloride	NS	NS	NS	NS	NS	ND		ND		ND		ND	
Carbon disulfide	NS	NS	NS	NS	NS	ND		ND		ND		ND	
Carbon tetrachloride	NS	NS	NS	NS	NS	ND		ND		ND		ND	
Chlorobenzene	NS	NS	NS	NS	NS	ND		ND		ND		ND	
Chloroethane	NS	NS	NS	NS	NS	ND		ND		ND		ND	
Chloroform	<0.25-0.54	<0.25	<0.5	<0.4	NS	ND		ND		ND		ND	
Chloromethane	NS	NS	NS	NS	NS	ND		ND		ND		ND	
3-Chloropropene	NS	NS	NS	NS	NS	ND		ND		ND		ND	
2-Chlorotoluene	NS	NS	NS	NS	NS	ND		ND		ND		ND	
Carbon tetrachloride	NS	NS	NS	NS	NS	ND		ND		ND		ND	
Cyclohexane	NS	NS	NS	NS	NS	ND		ND		ND		ND	
1,1-Dichloroethane	<0.25	<0.25	<0.5	<0.4	NS	ND		ND		ND		ND	
1,1-Dichloroethylene	NS	NS	NS	NS	NS	ND		ND		ND		ND	
1,2-Dibromoethane	NS	NS	NS	NS	NS	ND		ND		ND		ND	
1,2-Dichloroethane	NS	NS	NS	NS	NS	ND		ND		ND		ND	
1,2-Dichloropropane	NS	NS	NS	NS	NS	ND		ND		ND		ND	
1,4-Dioxane	NS	NS	NS	NS	NS	ND		ND		ND		ND	
Dichlorodifluoromethane	NS	NS	NS	NS	NS	ND		ND		ND		ND	
Dibromochloromethane	NS	NS	NS	NS	NS	ND		ND		ND		ND	
trans-1,2-Dichloroethylene	NS	NS	NS	NS	NS	2450		2880		3820		3150	
cis-1,2-Dichloroethylene	NS	NS	NS	NS	NS	ND		ND		ND		ND	
cis-1,3-Dichloropropene	NS	NS	NS	NS	NS	ND		ND		ND		ND	
m-Dichlorobenzene	NS	NS	NS	NS	NS	ND		ND		ND		ND	
o-Dichlorobenzene	NS	NS	NS	NS	NS	ND		ND		ND		ND	
p-Dichlorobenzene	NS	NS	NS	NS	NS	ND		ND		ND		ND	
trans-1,3-Dichloropropene	NS	NS	NS	NS	NS	580	J	ND		97.0		ND	
Ethanol	NS	NS	NS	NS	NS	ND		ND		ND		ND	
Ethylbenzene	0.43-2.8	ND0.25-0.61	ND1.6-3.4	ND1.4-1.6	NS	ND		ND		ND		ND	
Ethyl Acetate	NS	NS	NS	NS	NS	ND		ND		ND		ND	
4-Ethyltoluene	NS	NS	NS	NS	NS	ND		ND		ND		ND	
Freon 113	NS	NS	NS	NS	NS	ND		ND		ND		ND	
Freon 114	NS	NS	NS	NS	NS	ND		ND		ND		ND	
Heptane	NS	NS	NS	NS	NS	ND		ND		ND		ND	
Hexachlorobutadiene	NS	NS	NS	NS	NS	ND		ND		ND		ND	
Hexane	NS	NS	NS	NS	NS	ND		ND		ND		ND	
2-Hexanone	NS	NS	NS	NS	NS	ND		ND		ND		ND	
Isopropyl Alcohol	NS	NS	NS	NS	NS	ND		ND		ND		ND	
Methylene chloride	0.38-6.3	<0.25-0.87	<1.7-5.0	<1.8-3.0	60	ND		ND		90.0		ND	
Methyl ethyl ketone	NS	NS	NS	NS	NS	ND		ND		ND		ND	
Methyl Isobutyl Ketone	NS	NS	NS	NS	NS	ND		ND		ND		ND	
Methyl Tert Butyl Ether	NS	NS	NS	NS	NS	ND		ND		103		ND	
Propylene	NS	NS	NS	NS	NS	ND		ND		ND		ND	
Styrene	<0.25-0.68	<0.25	<1.8	<1.6	NS	ND		ND		ND		ND	
1,1,1-Trichloroethane	NS	NS	NS	NS	NS	ND		ND		ND		ND	
1,1,2,2-Tetrachloroethane	ND0.25	ND0.25	NS	NS	NS	ND		ND		ND		ND	
1,1,2-Trichloroethane	NS	NS	NS	NS	NS	ND		ND		81.7	J	ND	
1,2,4-Trichlorobenzene	NS	NS	NS	NS	NS	ND		ND		ND		ND	
1,2,4-Trimethylbenzene	NS	NS	NS	NS	NS	ND		ND		ND		ND	
Tertiary Butyl Alcohol	NS	NS	NS	NS	NS	ND		ND		ND		ND	
Tetrachloroethene	<0.25-1.2	<0.25-0.34	<1.9-5.9	<1.4-3.0	NS	ND		ND		ND		ND	
Tetrachloroethylene	NS	NS	NS	NS	100	439000		480000		452000		428000	
Tetrahydrofuran	NS	NS	NS	NS	NS	321	J	ND		161		ND	
Toluene	4.2-25	0.68-3.3	10.7-26	5.9-16	NS	ND		ND		ND		ND	
Trichloroethylene	NS	NS	NS	NS	5	1320		1620		1780		1850	
Trichlorofluoromethane	NS	NS	NS	NS	NS	ND		ND		ND		ND	
Vinyl chloride	NS	NS	NS	NS	NS	ND		ND		ND		ND	
Vinyl Acetate	NS	NS	NS	NS	NS	ND		ND		ND		ND	
p-Xylene & m-Xylene	0.52-4.7	<0.25-0.69	4.1-12	<3.6-7.3	NS	ND		ND		ND		ND	
o-Xylene	0.39-3.1	<0.25-0.74	<2.4-4.4	<1.4-2.6	NS	ND		ND		ND		ND	
Xylenes (total)	NS	NS	NS	NS	NS	ND		ND		ND		ND	

Notes:

Highlighted cells exceed guidance values

Samples analyzed for VOCs by EPA Method TO-15
NS = No Standard

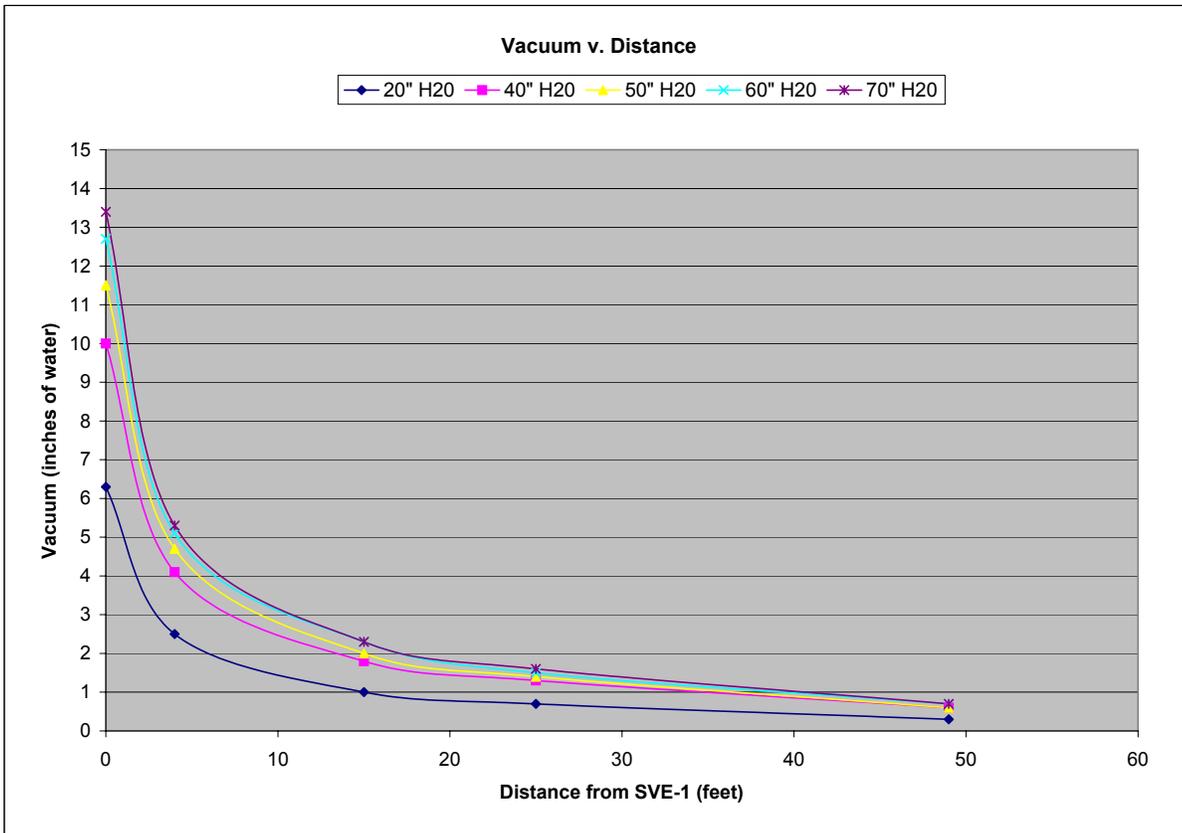
Qualifiers:

U = Analyte not detected at or above reporting limit.

J = Value is estimated (greater than detection limit but below reporting limit).

Pilot Test Summary Graph
388 Bridge Street, Brooklyn, NY

SVE-1	P-05	P-15	P-25	P-50
0	4	15	25	49
6.3	2.5	1	0.7	0.3
10	4.1	1.8	1.3	0.6
11.5	4.7	2	1.4	0.6
12.7	5.1	2.3	1.5	0.7
13.4	5.3	2.3	1.6	0.7



388 Bridge Street – Brooklyn, NY

ATTACHMENT B

Soil Permeability Calculations

ATTACHMENT B
Soil Permeability Calculation Summary
388 Bridge Street, Brooklyn NY

$$k = \frac{Q \mu_a \ln(R_w / R_{pz})}{\pi H P_w [1 - (P_{pz} / P_w)^2]}$$

k = air permeability of soil (m²)
 Q = wellhead airflow (m³/s)
 μ_a = viscosity of air (kg/[m*s])
 R_w = extraction well radius (m)

R_{pz} = distance to piezometer (m)
 H = extraction well screen length (m)
 P_w = extraction well vacuum (kg/[m*s²])
 P_{pz} = piezometer vacuum (kg/[m*s²])

Test 1 (wellhead vacuum = 6.35 inches of water)

	k (m ²)	k (darcys)
PZ-1	1.74752E-08	17,707
PZ-2	2.05165E-08	20,788
PZ-3	2.25112E-08	22,809
PZ-4	2.51702E-08	25,504
Average =	2.14183E-08	21,702

Test 2 (wellhead vacuum = 10 inches of water)

	k (m ²)	k (darcys)
PZ-1	1.0653E-08	10,794
PZ-2	1.27339E-08	12,903
PZ-3	1.39519E-08	14,137
PZ-4	1.5605E-08	15,812
Average =	1.32359E-08	13,411

Test 3 (wellhead vacuum = 11.5 inches of water)

	k (m ²)	k (darcys)
PZ-1	9.13287E-09	9,254
PZ-2	1.09418E-08	11,087
PZ-3	1.19511E-08	12,109
PZ-4	1.33837E-08	13,561
Average =	1.13524E-08	11,503

Test 4 (wellhead vacuum = 12.6 inches of water)

	k (m ²)	k (darcys)
PZ-1	8.08773E-09	8,195
PZ-2	9.72689E-09	9,856
PZ-3	1.06174E-08	10,758
PZ-4	1.19024E-08	11,185
Average =	1.00836E-08	9,998

Test 5 (wellhead vacuum = 13.4 inches of water)

	k (m ²)	k (darcys)
PZ-1	7.49053E-09	7,590
PZ-2	8.9881E-09	9,107
PZ-3	9.85127E-09	9,982
PZ-4	1.10386E-08	11,185
Average =	9.34213E-09	9,466

Reference: A Practical Approach to the Design, Operation, and Monitoring of In-Situ Venting Systems by P.C. Johnson, C.C. Stanley, M.W. Kemblowski, D.L. Byers, and J.D. Colhart. Groundwater Monitoring Review. Spring 1990.

388 Bridge St, Brooklyn, NY
FLS Project No. 10149-001

ATTACHMENT C

Laboratory Analytical Report

Appendix C
Laboratory Data Packages (on CD)