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March 13, 2024

Yildiz Palumbo, P.E.
New York State Department of Environmental Conservation
47-40 21st Street,
Long Island City, NY 11101

RE: NYSDEC BCP # C224274
Soil Vapor Extraction Pilot Test Work Plan
100 Union Avenue
Brooklyn, New York

Dear Yildiz:

Goldberg Zoino & Associates, P.C. d/b/a GZA GeoEnvironmental of New York (GZA) is pleased to provide this Soil Vapor Extraction (SVE) Pilot Test Work Plan for the property located at 100 Union Avenue, Brooklyn New York (the Site). The Site is enrolled in the New York State Department of Environmental Conservation (NYSDEC) Brownfield Cleanup Program (BCP) as site number C224274. GZA submitted a Remedial Action Work Plan (RAWP) in September 2023 which recommended a SVE to control potential off-site migration of chlorinated volatile organic compounds (cVOCs) in soil gas. On December 1, 2023, NYSDEC requested that a pilot test work plan be submitted to allow for the construction of the SVE system while awaiting redevelopment of the Site. Therefore, as requested, this pilot test work plan is submitted for your review and approval. We anticipate conducting the pilot test within 8 weeks of your approval of this work plan and submitting a design report within 8-10 weeks of completion of the pilot test.

BACKGROUND

The Site is located at 100 Union Avenue, Brooklyn, NY. The New York City Tax Assessor identifies the Site as Block 2242, Lot 3. Currently the Site is vacant. Surface cover is mostly concrete with patches of vegetation at the Site. Adjoining properties consist of various land uses including multi-story residential apartments, commercial, parking, industrial, institutions and vacant properties. The Site is about 10,566 square ft. and bounded by Middleton Street to the north, a small parking area (Lot 2) and multi-story residential building (Lot 1) to the south/southeast, Union Avenue to the west, and a New York City Transit (NYCT) substation (Lot 57) and multi-story residential buildings (Lots 15 and 7502) to the east.

The Site was occupied by a church and residential dwelling between 1887 and 1935. The Site became vacant and undeveloped in 1950. The Site was utilized for auto sales with a one-story building in the northern portion between 1965 and 1991, and as an auto repair shop and junkyard from 1992. The site is currently vacant. Operations involving auto sales and auto repair shop, and auto service garages typically utilize chemical agents, petroleum and/or hazardous materials, the discharge of which may have adversely impacted the environmental quality of the property.

Environmental Investigation activities were initiated in January 2014 and completed with additional sampling performed as the Remedial Investigation (RI) in August 2020. RI activities included the following scope of work: (i) delineation of the horizontal and vertical extent of impacted soils, groundwater, and soil vapor on Site; (ii) assessment of the potential fate and transport of contaminants; and (iii) data collection to allow for evaluation of potential remedial alternatives for exposure mitigation.

The following is a brief presentation of the RI findings[1]:

1. Elevation of the ground surface at the property ranges from approximately 14.5 to 15.5 feet above mean sea level (NAVD 88).
2. Based on information obtained from permanent monitoring wells installed on-Site, depth to groundwater ranged from approximately 7 to 10 feet below ground surface at the Site.
3. Groundwater on Site flows from the north-northeast to south-southwest beneath the Site.
4. During the remedial investigation, urban fill composed of brown medium sand with some medium gravel and cinders was identified throughout the Site between 0 to 8 ft below ground surface (bgs). Native brown to gray silty sand was identified below the fill layer at most locations explored at the Site between 8 and 14 ft bgs. Localized one- to two-foot lenses of dark brown silt, white fine sand, or medium sand, with organics, were identified beneath the fill layer and above the silty sand layer in portions of the Site. A clay layer was observed beneath the fill layer or silty sand between depths of about 8 and 14 ft bgs. Bedrock was not encountered.
5. Soil samples collected and analyzed during the RI contained metals including arsenic, barium, cadmium, copper, lead, mercury, silver and/or zinc above Unrestricted Use Soil Cleanup Objectives (UUSCOs) in shallow and intermediate samples across the Site. With the exception of samples collected from SP-6 and MW-2a, concentrations of arsenic, barium, cadmium, lead, and mercury also exceeded Restricted Residential Soil Cleanup Objectives (RRSCOs). And, concentrations of Arsenic, barium, cadmium and lead also exceeded Commercial Use Soil Cleanup Objectives (CSCOs) in some borings.

   Seven semi-volatile organic compounds (SVOCs) including benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene were detected at concentrations above their Track 1 UUSCOs and/or Track 2 RRSCOs in shallow samples across the site. The SVOCs detected are polycyclic aromatic hydrocarbon (PAH) compounds.

   The only volatile organic compound (VOC) detected in soil samples is acetone in one of the samples (SP-8(9-9.5’)). However, acetone is a common laboratory solvent/contaminant and appears in environmental datasets as low concentration false positive detects.

   Polychlorinated Biphenyls (PCBs), pesticides/herbicides, or polyfluoroalkyl substances (PFAS) were not detected at concentrations greater than the UUSCOs in any of the soil samples collected.
6. Of the nine groundwater samples collected from the site (MW-1 through MW-5, and MW-1a through MW-4a), tetrachloroethene (PCE) was detected above its NYSDEC Ambient Water Quality Standard (AWQS) of 5 µg/L at locations MW-4 and MW-4a in the northern portion of the Site with concentrations ranging from 14 to 19 µg /L. Methylene chloride was detected in groundwater above its AWQS of 5 µg/L at location MW-4 at a concentration of 11 µg/L.

   Groundwater samples collected and analyzed during the RI showed SVOCs including benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, bis(2-ethylhexyl)phthalate chrysene, indeno(1,2,3-cd)pyrene, and phenol above their respective AWQS.

   Groundwater samples collected and analyzed during the RI contained metals including iron, lead, manganese, magnesium, selenium, and sodium above AWQSs across the Site,

[1] Sample and well locations noted herein are depicted in Figures 4 through 7 of the RAWP.

PCBs or pesticides/herbicides were not detected at concentrations greater than the AWQS in the groundwater samples collected.
Five of the groundwater samples (MW-1a through MW-4a, and MW-5) that contained perfluorooctanoic acid (PFOA) and/or perfluorooctanesulfonic acid (PFOS) at concentrations above their respective screening level of 10 ng/L under NYSDEC's Part 375 Remedial Programs, one groundwater sample (MW-3a) exhibited PFOA and PFOS at a combined (total) concentration of 1,896 ng/L, above its screening level of 500 ng/L under NYSDEC's Part 375 Remedial Programs

7. Of the seven soil gas samples collected during the RI, PCE was detected in all of the soil vapor samples and ranged from 1.2 µg/m^3 (SV-3) to 1,450 µg/m^3 (SV-5). Trichloroethene (TCE) was detected in 4 of 7 samples and ranged in concentration from 2.42 µg/m^3 (SV-6) to 61.3 µg/m^3(SV-5).

The proposed remedy consists of the following:

1. The site remedy aims to achieve a Track 4 cleanup by excavating soils that exceed restricted-residential SCOs. The entire footprint of the new structure will be excavated to a depth of approximately 2 feet below grade and the remaining footprint of the Site (parking area) will be excavated to a depth of approximately 1 foot below grade for development purposes. Approximately, 1,050 tons (700 cubic yards) of soil will be excavated and removed from this Site for remedial purpose.
2. Periodic groundwater monitoring of cVOCs will be performed to evaluate the analytical results with respect to the applicability of Monitored Natural Attenuation (MNA) as the groundwater remedy for this Site.
3. Installation of a sub-slab depressurization system (SSDS) is planned. Piping for an SSDS will be installed for the mitigation of detected soil vapors on the Site. The SSDS will consist of two separate loops consisting of a network of horizontal pipe set in the middle of a gas permeable layer immediately beneath the building slab and vapor barrier system. The horizontal piping will consist of perforated or slotted schedule 40, 4-inch diameter polyvinyl chloride (PVC) pipe connected to a 4-inch diameter cast iron riser pipe that penetrates the slab and travels through the building to above the roof. The gas permeable layer will consist of an 8-inch thick gas permeable aggregate layer of 3/4" Blue Stone. The riser pipe will be finished at the roof line with a 4-inch goose neck pipe to limit rain infiltration. If necessary, the system will be hardwired to include a blower installed on the roof line and a pressure gauge and alarm located in an accessible area in the basement, which will provide a vacuum draw on the underslab gas permeable aggregate layer. Following SSDS installation, a vapor barrier system consisting of a vapor barrier beneath the building slab and on the outside wall of the subgrade foundation sidewalls will be installed to mitigate soil vapor migration into the building. The vapor barrier will consist of a 20-mil VaporBlock® Plus™ 20 (or equivalent) below the slab under the full building area and outside the sub-grade foundation sidewalls. The active SSDS is an Engineering Control for the remedial action. The remedial engineer will certify in the Final Engineer Report (FER) that the active SSDS was designed and properly installed to establish a vacuum in the gas permeable layer and a negative (decreasing outward) pressure gradient across the building slab to prevent vapor migration into the building.
4. A portion of the first floor will be constructed and operated as a parking garage with high volume air exchange provided by a mechanical ventilation system in conformance with the NYC Building Code.
5. Due to the potential for off-site migration of contaminated soil vapor to adjacent residential occupied buildings, a full-scale SVE system will be designed and installed to address the potential off-site migration of cVOC contaminated soil vapor in the northeast section of the site where PCE concentrations were elevated in groundwater (19 ppb) and soil vapor (1,450 ug/m^3).
6. A Site Management Plan (SMP) for long term management of remaining contamination, as required by the Environmental Easement, including plans for: (1) Institutional and Engineering Controls, (2) monitoring, (3) operation and maintenance and (4) reporting will be established.

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7. An Environmental Easement, including Institutional and Engineering Controls, to prevent future exposure to contamination remaining at the Site [a copy of the Environmental Easement will be provided in the Site Management Plan ("SMP")] will be recorded.

This report presents a work plan to evaluate design requirements for the SVE System

SOIL VAPOR EXTRACTION (SVE) SYSTEM

A full-scale SVE system will be installed in the northeastern corner of the Site to remediate cVOC contamination identified during the investigation, and to prevent off-site migration.

As indicated on **Figure 1**, the soil gas with elevated cVOCs are located on the northeastern portion of the Site. The full-scale SVE system is expected to target the northeastern property line to prevent cVOCs from migrating off-Site and will encompass an area of approximately 2,315 square feet.

The SVE remedial technology involves airflow within the subsurface with an applied vacuum, enhancing the in-situ volatilization of contaminants and capture of soil vapors. The SVE process uses the volatility of the contaminants to allow mass transfer from adsorbed and dissolved phases in soil and groundwater to the vapor phase, where it is removed under vacuum, and discharged to the atmosphere after treating with granular activated carbon (GAC). Airflow is induced in the subsurface by a pressure gradient applied through vertical extraction wells. The negative pressure inside the extraction well will be generated by a vacuum blower, which causes soil vapors to migrate toward the well.

To design a SVE system, subsurface airflow pathways and extraction flow rates must be properly understood. The airflow field developed is dependent on many factors: the level of applied vacuum, available screen interval in the vadose zone, porosity, soil air permeability and its spatial variation, and depth to groundwater. Prior to designing or installation of a full-scale SVE system, GZA will conduct a pilot study at the Site to evaluate the applicability of this technology; obtain design parameters including radius of influence (ROI), applied vacuum, sustainable flowrates, vapor contaminant loadings; and promote remedial efficiency associated with the full-scale system.

SVE PILOT STUDY

GZA will perform the SVE pilot test in a small portion of the impacted area shown in **Figure 1**. The SVE pilot test will be conducted over a 3-day period. During the pilot study, GZA will install one 2-inch SVE well (SVE-1) at the former location of soil gas sample SV-5, where the maximum total VOC concentration was observed (1,707 $\mu g/m^3$). The SVE well (SVE-1) will be constructed using 2-inch diameter schedule 40 PVC riser pipe, and a 2-inch diameter, 0.020-inch slot, schedule 40 PVC screen. The screen will be installed from approximately 3 to 10 ft bgs, based on an estimated groundwater depth of 8-10 feet bgs. Before installing the extraction well, GZA will confirm groundwater depth and adjust well depths accordingly. The SVE well will be screened above the groundwater table.

Approximately six (6) vapor monitoring points (VP-1 through VP-6) will be installed at respective intervals of 5, 10, 15, 20, 25 and 30 feet from the SVE-1 to determine the ROI of the induced vacuum. VP-2 and VP-4 monitoring points will be installed to the north of SVE-1 and constructed using 1-inch diameter schedule 40 PVC riser pipe, and a 1-inch diameter, 0.020-inch slot, schedule 40 PVC screen. The screens will be installed from approximately 3 to 10 ft bgs or above water table. VP-1, VP-3, VP-5, and VP-6 will be installed to the south of the extraction well and constructed using 1-inch diameter schedule 40 PVC riser pipe, and a 1-inch diameter, 0.020-inch slot, schedule

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40 PVC screen. The SVE well and the monitoring points and extraction well will be installed using direct push technology and will be outfitted with flush mount covers and hydraulic cement seals. Well and piping details are shown in **Figure 2**.

A skid mounted unit will be temporarily mobilized to the Site. The blower capable of developing 40 inches of water column and an air flow rate of 150 cubic feet per minute (CFM) will be used for the pilot test. The skid mount unit will be equipped with an air-water separator (knockout drum) and two (2) 200 pounds (lbs) granular activated carbon vessels connected in series. The blower will be connected to the SVE-1 well using 2-inch flexible hosing. The vapors will be treated using GAC prior to discharging into the atmosphere.

The pilot test will be conducted in two (2) phases, with each phase having a specific goal. The phases and goals are listed below:

Phase	**Goals**
Phase I: SVE Well (SVE-1) Step Test	Develop vacuum vs. flow relationship for SVE-1
Phase II: SVE Well Long-Term Test	Estimate vapor loading, at an optimal flow rate determined during Phase I, and ROI

An initial shakedown test will be conducted prior to starting with the step-test to get familiar with the system capacity and controls and it will be conducted at low and maximum sustainable applied vacuum.

The procedures for each individual phase of the pilot test are provided below. For the first phase of the pilot test, vacuum will be applied at SVE-1 and the vacuum will be monitored at four (4) different air flow settings. The four (4) different vacuum setting tests are referred to as a step-test. Each step of the test will be performed for approximately three (3) hours, to allow for induced vacuum to equalize in the subsurface. These tests will be used to evaluate the relationship of air vacuum vs. distance relationship and identify an optimal flow rate. The vacuum and flow rate will be controlled with the use of a dilution valve located on the blower. The dilution valve is opened to lower the vacuum and flow rate and closed to increase the vacuum and flow rate.

For planning purposes, initial vacuum settings for the step-test phase are (to be verified as described below):

- 10 CFM;
- 25 CFM;
- 50 CFM; and
- 70 CFM.

Induced vacuum readings in the unsaturated zone will be collected from adjacent vapor points. Vacuum readings will be collected using calibrated magnehelic gauges and appropriate piping adaptors that will be placed on each vapor point. Multiple magnehelic gauges with different incremental ranges will be required. At a minimum, GZA will be equipped with the following magnehelic gauges 0 – 0.25 inches-water column (IW); 0 – 1 IW; 0 – 10 IW; 0 – 20 IW and 0 – 100 IW.

<u>System Shakedown</u>

- Calibrate/check magnehelic gauges prior to test start

- Run SVE blower with the dilution valve closed to determine the maximum achievable flow rate and vacuum. If water is sucked from the well, gradually open the dilution valve to determine the maximum flow rate without extracting water.
- Take induced vacuum readings at each vapor point to get an idea of the magnitude/level of response.
- Confirm proposed flow rates fall into a range of approximately 50%, 75% and 100% of the maximum sustainable applied vacuum.

Phase I: Step Test

- Induced vacuum readings are taken by temporarily connecting the magnehelic gauge to the vapor probe adaptor, creating a tight seal and covering the rear ports on the gauge. During this test, all vapor points should have vacuum readings. Positive readings (pressure) may be observed and should be clearly labeled on the data sheet with a plus sign (+).
- Applied vacuum and air flow at the extraction well (SVE-1) will be recorded and checked every ten (10) minutes (see **Table 1**) for the first 30 minutes, then 30 minutes apart for the remainder of the test.
- Field staff will ensure that readings are coordinated.
- VPs will be sealed between readings.
- When readings begin to stabilize, induced/applied vacuum readings will then be collected every 30 minutes.
- At least three (3) rounds of system PID readings (influent, mid-carbon and effluent) will be collected for each stage of the test, PID measurements to be recorded on **Table 1**.
- When readings have stabilized, and the test has been run for at least 120 – 180 minutes, that step of the test will be terminated.
- The dilution valve will be adjusted for the next test prior to shutting down the blower (bump up flow rate to next level) and note it on **Table 1**.
- The subsurface will be allowed to stabilize for approximately 20 to 30 minutes prior to the next test step.
- The same procedure will be repeated for all four (4) flow rate steps. A separate data sheet will be used to document the monitoring for each step.
- Prior to shutdown of the system; a round of air sampling will be conducted from the influent and effluent air sampling ports. The air samples will be collected over a 30-minute period, using a regulator calibrated for a 30-minute collection time. Air samples will be submitted to a New York certified laboratory for VOC analysis using the TO-15 method.
- One round of perimeter air quality monitoring will be performed using a PID, (at background and test area locations) at the beginning and end of each step. The observed values will be recorded in a field book.

Phase II: Long Term SVE Test

- After concluding Phase I testing a full scale SVE test will be run for several hours (4 to 8 hours) at a minimum.
- Test will be run at the optimal sustainable/allowable flow rate setting obtained from Phase I.
- VP readings/measurements will be obtained every 5 minutes for the first 30 minutes, and then every 30 minutes after stabilization throughout the test and recorded in **Table 2**.
- PID readings will be taken every 30 minutes to one (1) hour. System readings will be recorded at the beginning of the test and checked every 30 minutes. Any changes will be noted and recorded.
- Prior to shutdown of the system; a round of air samples will be collected from the influent and effluent air sampling ports. The air samples will be collected over a 30-minute period, using a regulator calibrated for a 30-minute collection time. Air samples will be submitted to a New York State certified laboratory for VOC analysis using the TO-15 method.

- Three (3) rounds of perimeter air quality monitoring will be performed using the PID, (at background and test area locations) at the beginning, during, and after the long-term test.

EVALUATION OF PILOT TEST RESULTS

Analytical laboratory data from SUMMA canisters, vacuum monitoring point measurements and airflow measurements at the discharge stack will be used to design the full-scale system. The following factors will be used to evaluate the viability of a full-scale system:

- Induced/applied vacuum
- Air flow
- Contaminant concentrations in the effluent
- Operating vacuum condition
- Radius of influence
- Treatment unit size

FULL-SCALE SVE DESIGN AND CONSTRUCTION

Data collected from the pilot test will be used to evaluate and calculate the design parameters for the full-scale SVE system, including; required flow rate, applied vacuum, and ROI for the SVE well. The remedial equipment will be sized to match the designed flow rate from each well and vacuum required during SVE system operation. A target vacuum of at least -0.10 IW at each vapor monitoring point will be required for the full-scale design. The proposed full-scale system will be installed with permanent extraction wells and below-grade piping connecting to a below grade header. The full-scale system will also include a series of vacuum monitoring wells in a network. A mobile SVE system trailer will house the blower, air-water separator, controls, GAC drums and other system components.

GAC LOADING/EMISSION CALCULATIONS

The soil gas results from the northeast portion of the Site were used to calculate VOC removal rate, GAC requirements, and emission concentrations anticipated during the pilot test. Maximum concentrations for each detected compound from samples SV-1 through SV-7 were used in the calculations.

The estimated VOC emission estimated in **Table 3** yields 0.00031 pounds of potential VOC emissions during the pilot study, and the VOC removal calculation in **Table 4** yields 0.043 pounds of VOC removal from the subsurface during the pilot study. The calculation represents a maximum loading scenario for the pilot test; running the blower for 12 hours (entire length of the pilot test), at 150 CFM (maximum flow rate the blower will run). Emission concentrations in **Table 3** are calculated based on a 90% removal efficiency in each GAC vessel (2 total). GZA will vent the post-treatment vapors via a 10-foot high stack.

Assuming a carbon consumption rate of 1 g of carbon for each adsorbed 100 mg of VOCs, the calculation in **Table 4** represents a maximum GAC loading scenario for the pilot test. The emission piping will connect to two carbon drums in series. Each drum contains 200 pounds of granular activated carbon for a total of 400 lbs. The carbon use estimated calculation (**Table 4**) yields a saturation loading of approximately 0.43 pounds for each 12-hour operation period at 150 cfm. Given the calculated time to primary drum saturation, breakthrough is not expected during the pilot test. Breakthrough is defined as greater than 1 ppmV total VOC, measure between primary and secondary drums by a PID with an 11.7 eV lamp. The unsaturated GAC will be used for the full-scale design and the changeout frequency will be evaluated based on the results of the pilot test. See **Table 4** for GAC requirements for the pilot test.

In accordance with DAR-1 Guidance and Flowchart 1 within the guidance, pilot test activities qualify as a "trivial activity" under New York Codes, Rules and Regulations (6 CRR 201 – 3.3 - Item #30), and therefore do not require air modeling or permitting under Part 212.

Please let us know if you have any questions.

Sincerely,
GZA GEOENVIRONMENTAL OF NEW YORK

David Winslow, Ph.D., P.G.
Principal

Ernest Hanna, P.E.
Senior Principal

Bhuvnesh Parekh, P.E.
Associate Principal

Attachments:
Table 1 – Phase I Induced Vacuum Data Sheet
Table 2 – Phase II SVE System Log Sheet
Table 3 – VOC Mass Emission Calculations
Table 4 – Granular Activated Carbon Calculations
Figure 1 – Soil Vapor Sample and Analytical Results Map
Figure 2 – SVE Well and Piping Details

Cc:
Harolyn Hood, NYSDOH
Jane OConnell, NYSDEC
Andre Obligado, NYSDEC

TABLES

Table 1 - Induced Vacuum Data Sheet
Phase I: Step Test
SVE System Pilot Test
100 Union Avenue, Brooklyn, NY

Project Name: 100 Union Avenue
Project Number: 12.0076932.00
Date: ______
Weather: ______
Personnel: ______
Vapor Extraction Well(s): SVE-1
Test Start Time: ______ **Test End Time:** ______

Test Phase: ______
Notes: ______

Time of Readings	Elapsed Time	Air Flow	Observation Points													
			SVE-1		VP-1		VP-2		VP-3		VP-4		VP-5		VP-6	
			VAC	PID	VAC	PID	VAC	PID	VAC	PID	VAC	PID	VAC	PID	VAC	PID
hr:min	min	CFM	in-H20	ppm	in-H20	ppm	in-H20	ppm	in-H20	ppm	in-H20	ppm	in-H20	ppm	in-H20	ppm

Vac: Vacuum in inches of water
ppm: parts per million

Table 2 - SVE System Log Sheet
Phase II: Long Term SVE Test
SVE System Pilot Test
100 Union Avenue, Brooklyn, NY

Project Name: 100 Union Avenue
Project Number: 12.0076932.00
Date: ____________
Weather: ____________
Personnel: ____________

Test: ____________
Extraction Well: SVE-1
SVE Start: ____________
SVE Stop: ____________
Notes: ____________

Vac: Vacuum
in-H20: Inches of Water
F: Degree Farenheit
CFM Cubic Feet per Minute
ppm: Parts Per Million

Time	Elapsed Time	Header #1 Vac	Header #1 DP	Header #1 Flow	Header #1 PID	Manifold Vac	Manifold DP	Manifold Flow	Manifold PID	Pre-filter Vac	Pre-filter DP	Pre-Filter Flow	Post Filter Vac	Post Filter DP	Post Filter Flow	Dilution Air Vac	Post Dilution DP	Post Dilution Flow
hr:min	min	in-H20	in-H20	CFM	ppm	in-H20	in-H20	CFM	ppm	in-H20	in-H20	CFM	in-H20	in-H20	CFM	in-H20	in-H20	CFM

Table 2 - SVE System Log Sheet
Phase II: Long Term SVE Test
SVE System Pilot Test
100 Union Avenue, Brooklyn, NY

Time	Elapsed Time	Effluent Temp	Effluent Pressure	SVE Blower Run Time	Pre-GAC PID	Pre-GAC Pressure	Mid-GAC PID	Mid-GAC Pressure	Post-GAC PID	Post-GAC Pressure					
hr:min	min	F	psi	min	ppm	psi	ppm	psi	ppm	psi					

Table 3 - VOC Mass Emission Calculations
SVE System Pilot Test
100 Union Avenue, Brooklyn, NY

Compound	Concentration*		Factor of Safety	Design Concentration	Removal Rate**			Emission Rate***	
	$\mu g/m^3$	lbs/ft^3		lbs/ft^3	lbs/min	lbs/hr	lbs/year	lbs/hr	lbs/12 hours
1,1 Dichloroethene	2.11	1.31E-10	20%	1.58E-10	2.37E-08	0.00000	0.012	1.42E-08	1.70E-07
1,1,1-Trichloroethane	12	7.48E-10	20%	8.97E-10	1.35E-07	0.00001	0.071	8.07E-08	9.69E-07
1,2,4-Trichlorobenzene	9.24	5.76E-10	20%	6.91E-10	1.04E-07	0.00001	0.054	6.22E-08	7.46E-07
1,2,4 Trimethylbenzene	200	1.25E-08	20%	1.50E-08	2.24E-06	0.00013	1.179	1.35E-06	1.61E-05
1,3,5 Trimethylbenzene	50	3.11E-09	20%	3.74E-09	5.61E-07	0.00003	0.295	3.36E-07	4.04E-06
1,3-Dichlorobenzene	19.5	1.21E-09	20%	1.46E-09	2.19E-07	0.00001	0.115	1.31E-07	1.57E-06
2-Butanone	76	4.73E-09	20%	5.68E-09	8.52E-07	0.00005	0.448	5.11E-07	6.14E-06
2,2,4-Trimethylpentane	20.8	1.30E-09	20%	1.55E-09	2.33E-07	0.00001	0.123	1.40E-07	1.68E-06
4 Methyl 2 Pentanone	6.19	3.86E-10	20%	4.63E-10	6.94E-08	0.00000	0.036	4.16E-08	5.00E-07
4-Ethyltoluene	140	8.72E-09	20%	1.05E-08	1.57E-06	0.00009	0.825	9.42E-07	1.13E-05
Acetone	382	2.38E-08	20%	2.86E-08	4.28E-06	0.00026	2.251	2.57E-06	3.08E-05
Benzene	37	2.30E-09	20%	2.77E-09	4.15E-07	0.00002	0.218	2.49E-07	2.99E-06
Carbon Disulfide	6	3.74E-10	20%	4.49E-10	6.73E-08	0.00000	0.035	4.04E-08	4.84E-07
Chlorobenzene	1.56	9.72E-11	20%	1.17E-10	1.75E-08	0.00000	0.009	1.05E-08	1.26E-07
Chloroform	5.76	3.59E-10	20%	4.31E-10	6.46E-08	0.00000	0.034	3.88E-08	4.65E-07
cis-1,2-Dichloroethene	11.5	7.16E-10	20%	8.60E-10	1.29E-07	0.00001	0.068	7.74E-08	9.28E-07
Cyclohexane	1.5	9.34E-11	20%	1.12E-10	1.68E-08	0.00000	0.009	1.01E-08	1.21E-07
Ethylbenzene	433.8	2.70E-08	20%	3.24E-08	4.86E-06	0.00029	2.557	2.92E-06	3.50E-05
Methylene Chloride	14	8.72E-10	20%	1.05E-09	1.57E-07	0.00001	0.083	9.42E-08	1.13E-06
n-heptane	21	1.31E-09	20%	1.57E-09	2.35E-07	0.00001	0.124	1.41E-07	1.70E-06
n-hexane	88	5.48E-09	20%	6.58E-09	9.87E-07	0.00006	0.519	5.92E-07	7.10E-06
o-xylene	86	5.36E-09	20%	6.43E-09	9.64E-07	0.00006	0.507	5.79E-07	6.94E-06
p,m -xylene	170	1.06E-08	20%	1.27E-08	1.91E-06	0.00011	1.002	1.14E-06	1.37E-05
Tertiary butyl Alcohol	376	2.34E-08	20%	2.81E-08	4.22E-06	0.00025	2.216	2.53E-06	3.04E-05
Tetrachloroethylene	1450	9.03E-08	20%	1.08E-07	1.63E-05	0.00098	8.546	9.76E-06	1.17E-04
Tetrahydrofuran	33.9	2.11E-09	20%	2.53E-09	3.80E-07	0.00002	0.200	2.28E-07	2.74E-06
Toluene	98	6.11E-09	20%	7.33E-09	1.10E-06	0.00007	0.578	6.59E-07	7.91E-06
Trichloroethene	61.3	3.82E-09	20%	4.58E-09	6.87E-07	0.00004	0.361	4.12E-07	4.95E-06
Total VOCs	3,813	2.38E-07	20%	2.85E-07	4.28E-05	0.0026	22.47	0.00003	3.08E-04

Max Flow Rate: 150 CFM
Potential VOC Emission During Pilot Test: **0.00031** lbs

Notes:
- Calculation assumes operation of two treatment wells simultaneously
- *Contaminant concentrations based on maximum compound concentrations from vapor samples SV-1 though SV-7
- **Removal Rate is based on the maximum design flow rate of 150 CFM
- ***Emission rate estimate is based on 90% efficiency per GAC vessel, with a 99.0% overall efficiency, because the vapors will be treated with two carbon vessels connected in series. Emission rate is given over 12 hours (the assumed length of the pilot test)

Table 4 - Granular Acitvated Carbon Calculations
SVE Pilot Test
100 Union Avenue, Brooklyn, NY

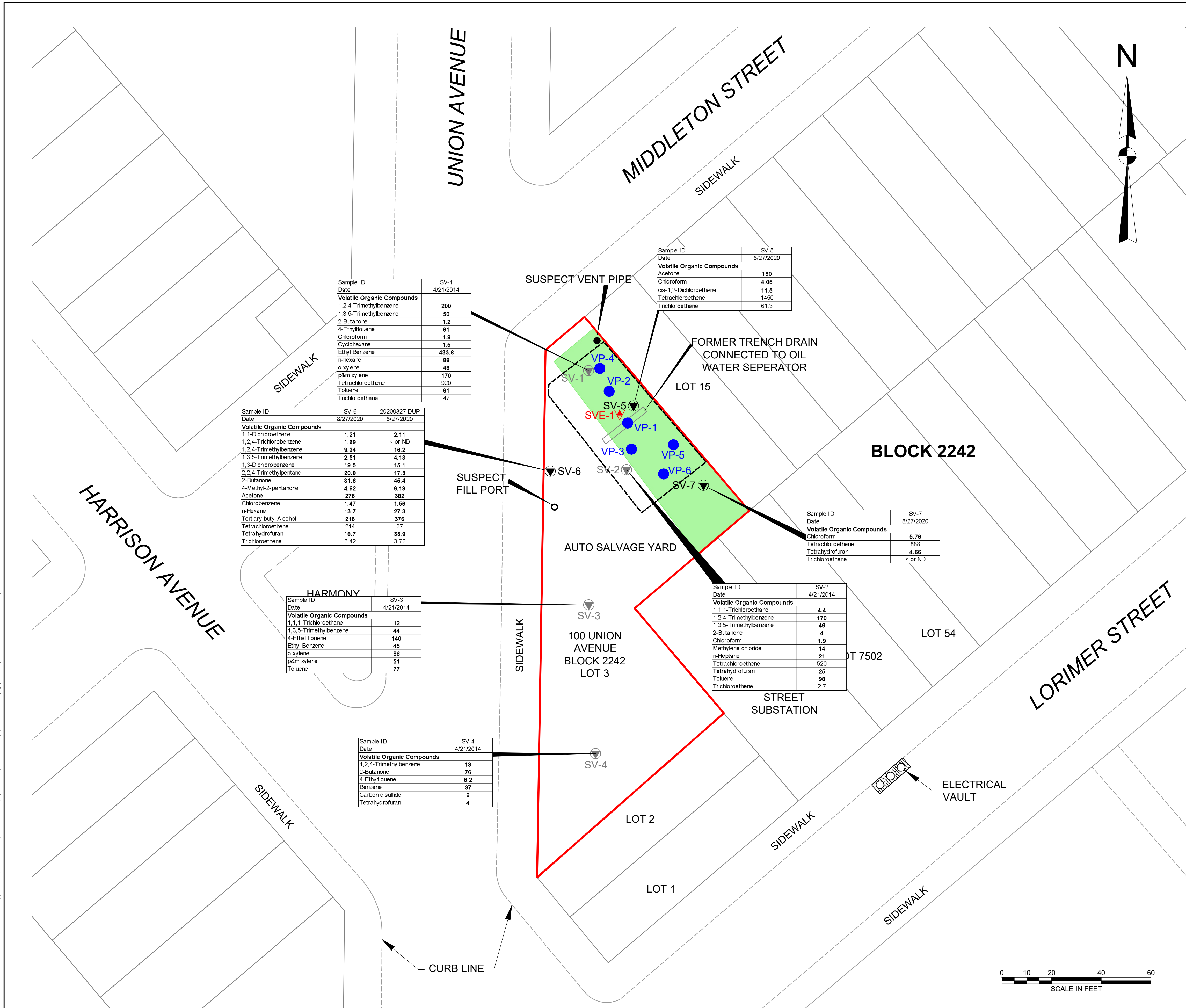
Max Flow Rate: **150** CFM

Compound	Max Vapor Conc (ug/m^3)	kg/m^3	lbs/m^3	lbs/ft^3	lbs/min	lbs/hour	lbs/day (24 hours)	Expected VOC lbs for Pilot Test (12 hours)
1,1 Dichloroethene	2.11	2.11E-09	4.64E-09	1.31E-10	1.97E-08	1.18E-06	2.84E-05	1.42E-05
1,1,1-Trichloroethane	12	1.20E-08	2.64E-08	7.48E-10	1.12E-07	6.73E-06	1.61E-04	8.07E-05
1,2,4-Trichlorobenzene	9.24	9.24E-09	2.03E-08	5.76E-10	8.63E-08	5.18E-06	1.24E-04	6.22E-05
1,2,4 Trimethylbenzene	200	2.00E-07	4.40E-07	1.25E-08	1.87E-06	1.12E-04	2.69E-03	1.35E-03
1,3,5 Trimethylbenzene	50	5.00E-08	1.10E-07	3.11E-09	4.67E-07	2.80E-05	6.73E-04	3.36E-04
1,3-Dichlorobenzene	19.5	1.95E-08	4.29E-08	1.21E-09	1.82E-07	1.09E-05	2.62E-04	1.31E-04
2-Butanone	76	7.60E-08	1.67E-07	4.73E-09	7.10E-07	4.26E-05	1.02E-03	5.11E-04
2,2,4-Trimethylpentane	20.8	2.08E-08	4.58E-08	1.30E-09	1.94E-07	1.17E-05	2.80E-04	1.40E-04
4 Methyl 2 Pentanone	6.19	6.19E-09	1.36E-08	3.86E-10	5.78E-08	3.47E-06	8.33E-05	4.16E-05
4-Ethyltoluene	140	1.40E-07	3.08E-07	8.72E-09	1.31E-06	7.85E-05	1.88E-03	9.42E-04
Acetone	382	3.82E-07	8.40E-07	2.38E-08	3.57E-06	2.14E-04	5.14E-03	2.57E-03
Benzene	37	3.70E-08	8.14E-08	2.30E-09	3.46E-07	2.07E-05	4.98E-04	2.49E-04
Carbon Disulfide	6	6.00E-09	1.32E-08	3.74E-10	5.61E-08	3.36E-06	8.07E-05	4.04E-05
Chlorobenzene	1.56	1.56E-09	3.43E-09	9.72E-11	1.46E-08	8.75E-07	2.10E-05	1.05E-05
Chloroform	5.76	5.76E-09	1.27E-08	3.59E-10	5.38E-08	3.23E-06	7.75E-05	3.88E-05
cis-1,2-Dichloroethene	11.5	1.15E-08	2.53E-08	7.16E-10	1.07E-07	6.45E-06	1.55E-04	7.74E-05
Cyclohexane	1.5	1.50E-09	3.30E-09	9.34E-11	1.40E-08	8.41E-07	2.02E-05	1.01E-05
Ethylbenzene	433.8	4.34E-07	9.54E-07	2.70E-08	4.05E-06	2.43E-04	5.84E-03	2.92E-03
Methylene Chloride	14	1.40E-08	3.08E-08	8.72E-10	1.31E-07	7.85E-06	1.88E-04	9.42E-05
n-heptane	21	2.10E-08	4.62E-08	1.31E-09	1.96E-07	1.18E-05	2.83E-04	1.41E-04
n-hexane	88	8.80E-08	1.94E-07	5.48E-09	8.22E-07	4.93E-05	1.18E-03	5.92E-04
o-xylene	86	8.60E-08	1.89E-07	5.36E-09	8.04E-07	4.82E-05	1.16E-03	5.79E-04
p,m -xylene	170	1.70E-07	3.74E-07	1.06E-08	1.59E-06	9.53E-05	2.29E-03	1.14E-03
Tertiary butyl Alcohol	376	3.76E-07	8.27E-07	2.34E-08	3.51E-06	2.11E-04	5.06E-03	2.53E-03
Tetrachloroethylene	1450	1.45E-06	3.19E-06	9.03E-08	1.35E-05	8.13E-04	1.95E-02	9.76E-03
Tetrahydrofuran	33.9	3.39E-08	7.46E-08	2.11E-09	3.17E-07	1.90E-05	4.56E-04	2.28E-04
Toluene	98	9.80E-08	2.16E-07	6.11E-09	9.16E-07	5.49E-05	1.32E-03	6.59E-04
Trichloroethene	61.3	6.13E-08	1.35E-07	3.82E-09	5.73E-07	3.44E-05	8.25E-04	4.12E-04
1,2,4 Trimethylbenzene	2540	2.54E-06	5.59E-06	1.58E-07	2.37E-05	1.42E-03	3.42E-02	1.71E-02
TOTAL		**6.35E-06**	**1.40E-05**	**3.96E-07**	**5.94E-05**	**3.56E-03**	**8.55E-02**	**0.0427**

Estimated VOC Removal During PT (lbs): **0.0427** (12 Hours)

Anticipated Adsorption Rate: 100 mg/g carbon (low estimate)
Amount of contaminant adsorbed during PT: 0.0427 lbs
1.94E-02 kg
1.94E+04 mg
194 grams of GAC required
0 kg
Amount of GAC required for the PT: **0.43** lbs

FIGURES



Sample ID	SV-1
Date	4/21/2014
Volatile Organic Compounds	
1,2,4-Trimethylbenzene	**200**
1,3,5-Trimethylbenzene	**50**
2-Butanone	**1.2**
4-Ethyltlouene	**61**
Chloroform	**1.8**
Cyclohexane	**1.5**
Ethyl Benzene	**433.8**
n-hexane	**88**
o-xylene	**48**
p&m xylene	**170**
Tetrachloroethene	920
Toluene	**61**
Trichloroethene	47

Sample ID	SV-5
Date	8/27/2020
Volatile Organic Compounds	
Acetone	**160**
Chloroform	**4.05**
cis-1,2-Dichloroethene	**11.5**
Tetrachloroethene	1450
Trichloroethene	61.3

Sample ID	SV-6	20200827 DUP
Date	8/27/2020	8/27/2020
Volatile Organic Compounds		
1,1-Dichloroethene	**1.21**	**2.11**
1,2,4-Trichlorobenzene	**1.69**	< or ND
1,2,4-Trimethylbenzene	**9.24**	**16.2**
1,3,5-Trimethylbenzene	**2.51**	**4.13**
1,3-Dichlorobenzene	**19.5**	**15.1**
2,2,4-Trimethylpentane	**20.8**	**17.3**
2-Butanone	**31.6**	**45.4**
4-Methyl-2-pentanone	**4.92**	**6.19**
Acetone	**276**	**382**
Chlorobenzene	**1.47**	**1.56**
n-Hexane	**13.7**	**27.3**
Tertiary butyl Alcohol	**216**	**376**
Tetrachloroethene	214	37
Tetrahydrofuran	**18.7**	**33.9**
Trichloroethene	2.42	3.72

Sample ID	SV-7
Date	8/27/2020
Volatile Organic Compounds	
Chloroform	**5.76**
Tetrachloroethene	888
Tetrahydrofuran	**4.66**
Trichloroethene	< or ND

Sample ID	SV-3
Date	4/21/2014
Volatile Organic Compounds	
1,1,1-Trichloroethane	**12**
1,3,5-Trimethylbenzene	**44**
4-Ethyl tlouene	**140**
Ethyl Benzene	**45**
o-xylene	**86**
p&m xylene	**51**
Toluene	**77**

Sample ID	SV-2
Date	4/21/2014
Volatile Organic Compounds	
1,1,1-Trichloroethane	**4.4**
1,2,4-Trimethylbenzene	**170**
1,3,5-Trimethylbenzene	**46**
2-Butanone	**4**
Chloroform	**1.9**
Methylene chloride	**14**
n-Heptane	**21**
Tetrachloroethene	520
Tetrahydrofuran	**25**
Toluene	**98**
Trichloroethene	2.7

Sample ID	SV-4
Date	4/21/2014
Volatile Organic Compounds	
1,2,4-Trimethylbenzene	**13**
2-Butanone	**76**
4-Ethyltlouene	**8.2**
Benzene	**37**
Carbon disulfide	**6**
Tetrahydrofuran	**4**

LEGEND:

- SITE
- FORMER ONE STORY TOW TRUCK GARAGE FOOTPRINT
- SVE SYSTEM TARGET AREA/FULL SCALE IMPACTED AREA
- SV-# SOIL VAPOR PROBE LOCATION INSTALLED IN AUGUST 2020 BY GZA GEOENVIRONMENTAL, INC.
- SV-# HISTORIC SOIL VAPOR PROBE LOCATION INSTALLED IN MAY 2017 BY HYDRO TECH ENVIRONMENTAL ENGINEERING & GEOLOGY
- VP-# VAPOR MONITORING POINTS
- SVE-# VAPOR EXTRACTION WELL

GENERAL NOTES:

1. BASEMAP DEVELOPED FORM NEW YORK CITY DEPARTMENT OF CITY PLANNING MAPPLUTO VERSION 19V1.
2. SIZE OF VAPOR MONITORING POINTS AND VAPOR PROBES NTS.

CHEMBOX KEY

Compound	Soil Gas Criteria		
Units(ug/m3)	NYSDOH AGV[1]	NYSDOH 2003 Fuel Oil Study[2]	EPA Data 2001 BASE 90th Percentile Value[3]
Volatile Organic Compounds			
1,1,1-Trichloroethane	-	2.5	20.6
1,1-Dichloroethene	-	0.4	<0.7
1,2,4-Trichlorobenzene	-	0.5	<6.8
1,2,4-Trimethylbenzene	-	9.8	9.5
1,3,5-Trimethylbenzene	-	3.9	3.7
1,3-Dichlorobenzene	-	0.5	<2.4
2,2,4-Trimethylpentane	-	5	-
2-Butanone	-	16	12
4-Ethyltlouene	-	-	3.6
4-Methyl-2-pentanone	-	1.9	6
Acetone	-	115	98.9
Benzene	-	13	9.4
Carbon disulfide	-	-	4.2
Chlorobenzene	-	0.4	<1.1
Chloroform	-	1.1	1.2
cis-1,2-Dichloroethylene	-	0.4	<1.9
Cyclohexane	-	-	4.2
Dichlorodifuromethane	-	10	16.5
Ethylbenzene	-	6.4	5.7
Ethyl Acetate	-	-	5.4
Isopropanol	-	-	250
Methylene chloride	60	16	10
n-Heptane	-	18	-
n-Hexane	-	14	10.2
o-Xylene	-	7.1	7.9
p/m-Xylene	-	11	22.2
Tertiary butyl Alcohol	-	-	3.1
Tetrachloroethene	30	2.5	15.9
Tetrahydrofuran	-	0.8	-
Toluene	-	57	43
Trichloroethene	2	0.5	4.2
Trichlorofluromethane	-	12	18.1

Notes:

BOLD: Results exceed the corresponding published background concentrations.
< or ND: Less than the standards or not detected
1. New York State Health Department of Health Air Guidance Values (NYSDOH AGV).
2. Table C1. NYSDOH 2003: Study of volatile organic chemicals in air of fuel oil heated homes, upper fence indoor air.
3. Table C2. EPA 2001: Building assessment and survey evaluation (BASE) databae, SUMMA[a] canister method, 90th percentile indoor air.

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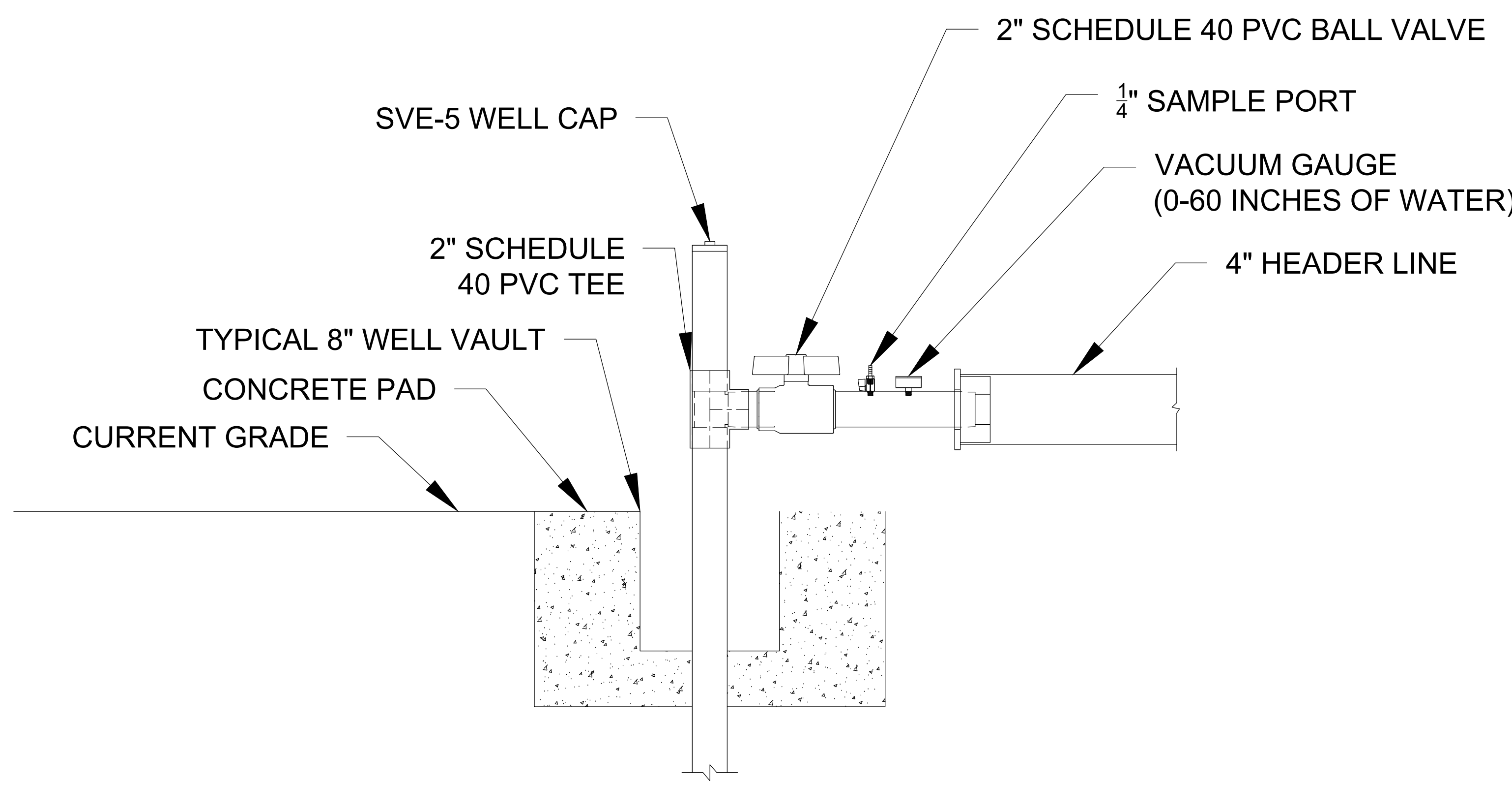
100 UNION AVENUE SITE REDEVELOPMENT
100 UNION AVENUE
BROOKLYN, NEW YORK

SOIL VAPOR SAMPLE AND ANALYTICAL RESULTS AND PROPOSED SVE PILOT TEST LAYOUT

PREPARED BY: GZA GeoEnvironmental of NY, Engineers and Scientists, www.gza.com

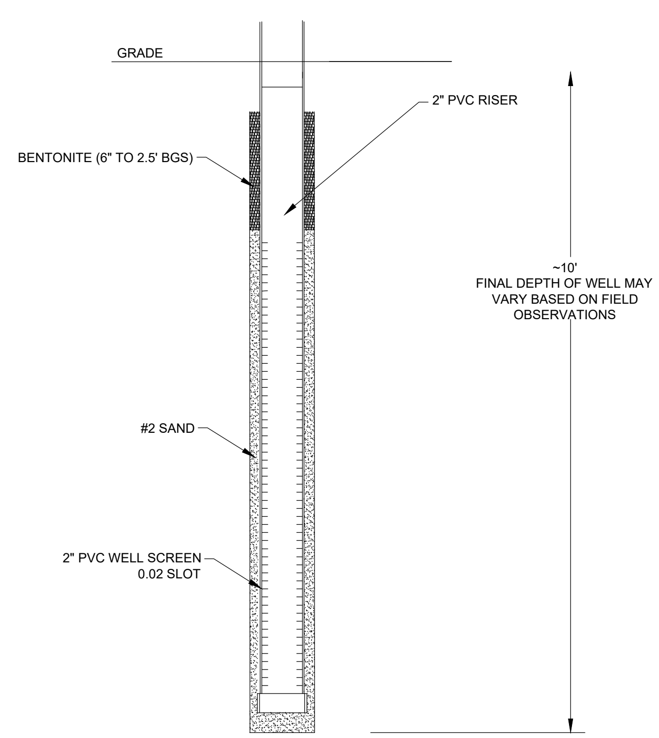
PREPARED FOR: 100 UNION HOLDINGS, LLC

PROJ MGR: MH	REVIEWED BY: MM	CHECKED BY: MH	FIGURE
DESIGNED BY: MH	DRAWN BY: MM	SCALE: 1" = 20'	1
DATE: DEC 2023	PROJECT NO. 12.0076932.00	REVISION NO.	SHEET NO.



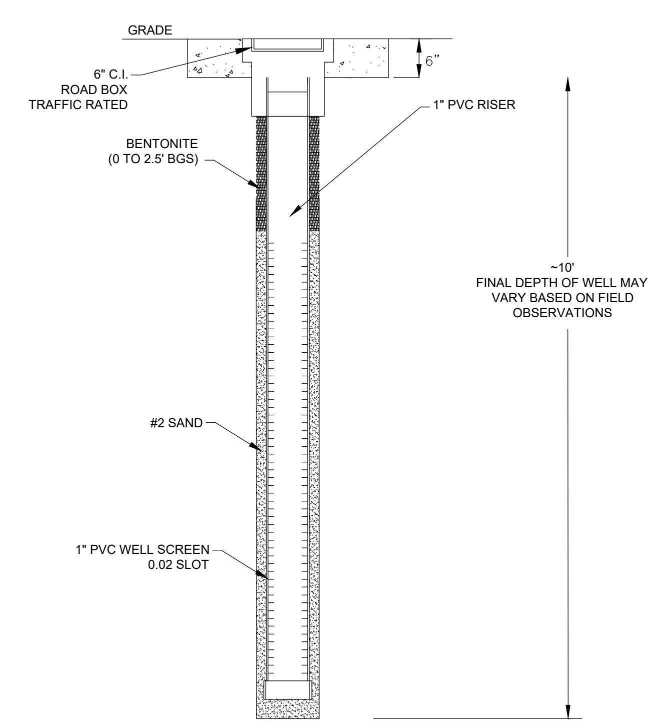
DETAIL 1 - SVE ABOVE GROUND CONNECTION

NOT TO SCALE



DETAIL 2 - 2" SOIL VAPOR EXTRACTION POINT

NOT TO SCALE



DETAIL 3 - 1" VAPOR MONITORING POINT

NOT TO SCALE

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100 UNION AVENUE
BROOKLYN, NEW YORK

SVE WELL AND PIPING DETAILS

PREPARED BY: GZA GeoEnvironmental of NY, Engineers and Scientists, www.gza.com		PREPARED FOR: 100 UNION HOLDINGS, LLC	
PROJ MGR: MH	REVIEWED BY: MM	CHECKED BY: MH	FIGURE
DESIGNED BY: MH	DRAWN BY: MM	SCALE: 1" = 20'	2
DATE: DEC 2023	PROJECT NO. 12.0076932.00	REVISION NO.	SHEET NO.

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GZA GeoEnvironmental, Inc.