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1.0 INTRODUCTION

Langan Engineering and Environmental Services, P.C. (Langan) has prepared this Supplemental Subsurface Investigation (SSI) Report and Remedial Action Work Plan (RAWP) on behalf of New York University (NYU), for the property at 4 Washington Square Village located in the Greenwich Village section of Manhattan, New York (herein referred to as the "Site"). The purpose of the SSI was to delineate the extent of groundwater impacts related to New York State Department of Environmental Conservation (NYSDEC) Spill No. 09-10543 and to determine whether two out-of-service 20,000-gallon No. 6 fuel oil underground storage tanks (USTs), identified by NYU as UST No. 003 and UST No. 004, were the source of the release. The SSI included soil and groundwater sampling and was completed between April 9 - 30, 2010. The results of the SSI show that:

- The source of the fuel oil release was UST No. 003;
- Grossly contaminated soil appears to be confined to an area of approximately 3,200 square feet near the eastern portion of the Site building;
- Grossly petroleum-impacted soil does not extend vertically to the water table. Gross petroleum impacts were identified between elevation (el) +12 to +2 feet (ft) relative to the Borough President of Manhattan Datum (BPMD); and
- Groundwater, encountered at about el 0 ft BPMD, has not been significantly impacted as a result of the spill.

The RAWP describes remedial activities to be implemented in coordination with the NYSDEC to satisfy requirements for closure of Spill No. 09-10543. RAWP tasks include UST decommissioning, removal of contaminated soil, installation of a soil vapor extraction system, passive product recovery, importation of clean fill, air monitoring, and preparation of a Remedial Action Report to be submitted to the NYSDEC at the conclusion of the work described in this RAWP.

2.0 PROJECT BACKGROUND

2.1 Site Description

The Site, denoted on Manhattan Borough tax maps as Block 533, Lot 1, is located on the city block bounded by West 3rd Street to the north, Mercer Street to the east, Bleecker Street to the south, and LaGuardia Place to the west. A 17-story residential building with a basement consisting of a sub-basement boiler room and mezzanine level is located at the Site. There are two out-of-service, 20,000 gallon No. 6 fuel oil USTs, identified by NYU as UST No. 003 and UST No. 004, located in a landscaped area on the southern portion of the Site, fronting Bleecker Street. A Site Location Map and Site Plan are included as Figures 1 and 2, respectively.

Generally, the ground surface slopes gently toward the west/northwest. Surface elevations referenced to the BPMD, range from approximately el +33 ft BPMD in the east to el +29 BPMD in the west.

2.2 Site Environmental Conditions

A petroleum release, assumed to be associated with the USTs, was discovered by NYU December 26, 2009. In response to the release, NYU retained Triumvirate Environmental Inc. (Triumvirate) of Somerville, Massachusetts to perform an emergency spill response and limited subsurface investigation. The emergency response and investigation are described in Triumvirate's Spill Response Summary Report dated January 22, 2009. Triumvirate's report is provided in Appendix A and is summarized in Sections 2.2.1 through 2.2.3.

2.2.1 Emergency Spill Response Activities

Emergency spill response activities primarily consisted of:

- Removal and cleaning of oil from all visibly impacted sub-basement surfaces;
- Tank tightness testing of both USTs No. 003 and No. 004;
- Removal of residual petroleum contents of UST No. 003 on December 28, 2009 and UST No. 004 by December 31, 2009; both USTs were subsequently thoroughly cleaned;

- Installation of three product recovery wells in the sub-basement to recover fuel oil. The wells were completed to a depth of about 3.5 to 4 ft below the sub-basement grade (approximately el +8.5 to +8 ft BPMD);
- Sealing visible cracks and holes in the sub-basement and mezzanine with silicone sealant; and
- Installation of a sub-slab depressurization system (SSD) with carbon treatment to mitigate potential vapor intrusion pathways.

Triumvirate estimated that approximately 16,000 gallons of No. 6 fuel oil was released. Approximately 4,600 gallons of fuel oil was recovered by Triumvirate during the emergency response, and approximately 41 gallons of fuel oil have been recovered since the Summary Report was issued.

2.2.2 Limited Subsurface Investigation

A limited sub-surface investigation was conducted by Triumvirate concurrently with the emergency response. Triumvirate's sub-surface investigation consisted of advancement of 35 soil borings, installation of 5 one-inch diameter groundwater monitoring wells, and collection and analysis of 29 soil and 5 groundwater samples. Soil samples were analyzed for total petroleum hydrocarbons (TPH), polycyclic aromatic hydrocarbons (PAHs), and/or forensic fingerprint, and groundwater samples were analyzed for TPH and PAHs. Based on the results of their sub-surface investigation, Triumvirate concluded the following:

- Grossly petroleum contaminated soil is primarily located on the eastern portion of the building at depths of approximately el +12 to +6 ft BPMD, with petroleum impacts about as shallow as el +13 ft BPMD;
- No odors, sheen, or evidence of free product was observed on groundwater at any of the monitoring wells;
- TPH and fingerprint analysis revealed that petroleum contamination is consistent with No. 6 fuel oil impacts;
- The PAHs benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, indeno(1,2,3-cd)pyrene, pyrene, fluoranthene, phenanthrene, naphthalene, and 2-methylnaphthalene were detected above their respective NYSDEC Technical and Administrative Guidance Memorandum #4046 (TAGM) Recommended Soil Cleanup Objectives (RSCOs) in soil;

- The PAHs benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and benzo(k)fluoranthene were detected in the groundwater sample collected from monitoring well MW-3 at concentrations above their respective TAGM groundwater standards/criteria; and
- Groundwater at the down gradient monitoring wells was not impacted by the fuel oil release.

2.2.3 Conclusions

Based on their observations and the data collected during the emergency response and investigation, Triumvirate concluded that the source of the release was UST #3, petroleum-impacted soil is located under the Site building, and that groundwater was not significantly impacted as a result of the spill.

2.3 Regulatory Correspondence

NYSDEC's letter to NYU dated February 23, 2010 indicated that Triumvirate's Spill Response Summary Report was reviewed and that NYU is required to remove or abandon the out-of-service USTs. NYSDEC also requested the installation of additional monitoring wells to delineate the full extent of petroleum contamination. In accordance with the requirements in the February 23, 2010 letter, and a February 23, 2010 telephone conversation between NYSDEC and Langan, a Delineation Work Plan (Work Plan) was prepared by Langan and submitted to the NYSDEC on March 4, 2010. The NYSDEC approved the Work Plan in a letter dated March 30, 2010. A copy of the Work Plan and regulatory correspondence are provided in Appendix B.

3.0 SUPPLEMENTAL SUBSURFACE INVESTIGATION

3.1 Approach and Scope

The purpose of the SSI outlined in the NYSDEC-approved Work Plan was to delineate the extent of groundwater impacts associated with NYSDEC Spill No. 09-10543 and to confirm whether one or both of the out-of-service USTs is the source of the fuel oil release. The scope of the SSI included:

- Decommissioning of five existing 1-inch monitoring wells (MW-1 through MW-5), and re-installation of these wells as 2-inch monitoring wells. MW-1 and MW-2 remain in place and will be abandoned and re-installed as 2-inch wells following UST closure;
- Installation of three additional 2-inch monitoring wells (MW-6 through MW-8). MW-6 and MW-7 were installed in the sub-basement boiler room to evaluate groundwater conditions in an area where grossly contaminated soil is known to be present. MW-8 was installed in the mezzanine to the east of the boiler room to evaluate the eastern extent of petroleum contamination;
- Installation of three soil borings between the USTs and the Site building (SB-1 through SB-3) to confirm the source of the fuel oil release. The approved Work Plan originally proposed four soil borings in this area; however, access was limited to the east of the USTs due to existing piping and the UST No. 003 manway, and field observations during installation of borings SB-1 through SB-3 were deemed sufficient to characterize subsurface conditions and the source of the release;
- Collection of soil samples from boring locations MW-6 through MW-8 and SB-1 through SB-3 for laboratory analysis of Spills Technology and Remediation Series (STARS) volatile organic compounds (VOCs) and semivolatile organic compounds (SVOCs);
- Survey of newly constructed monitoring wells;
- Synoptic gauging of each well to gauge depth to groundwater, measure thickness of light non aqueous phase liquid (LNAPL), if any, and evaluate groundwater flow direction;
- Development of newly installed wells with no measurable LNAPL; and
- Collection of groundwater samples from wells where measurable LNAPL was absent for laboratory analysis of STARS VOCs and SVOCs.

The SSI was implemented in general accordance with the March 4, 2010 Work Plan and April 2010 Site-Specific Health and Safety Plan (HASP). Exceptions to the Work Plan are noted

above, in Section 3.1. The Work Plan and HASP are included in Appendix B. Photographs documenting the implementation of the SSI are included in Appendix C.

3.2 Field Investigation

3.2.1 Utility Clearance

Prior to commencement of ground-intrusive Site work, the New York City One-Call center was contacted to identify subsurface utility services entering the Site. In addition, Diversified Geophysics (Diversified) of New Hyde Park, New York conducted a geophysical survey at the Site to clear proposed boring locations and locate subsurface utilities, the USTs, and associated piping. Diversified used 3M Dynatel® 2250M-iD and Pipehorn® 800 HL pipe and cable locators and a Sensors and Software Noggin®Plus SmartCart ground penetrating radar system (GPR) with a 250 MHz antenna to complete the geophysical survey. Based on the findings of the geophysical survey, there was an approximate 36 inch gap between the northern edge of the USTs and the window wells adjacent to the building, limiting the area through which exterior borings could be advanced. The geophysical survey was conducted under full-time Langan oversight. A copy of the geophysical survey report is included in Appendix D.

3.2.2 Drilling Procedures

Aquifer Drilling and Testing (ADT) of Hyde Park, New York completed the installation of soil borings and monitoring wells between April 10 - 21, 2010. Boring locations MW-3 through MW-8 were advanced with a limited-access, Geoprobe® 420M direct-push sampler to termination depths ranging from el -4 ft BPMD at MW-8 to el -6.5 ft BPMD at MW-4 (i.e., 4 to 6.5 feet below the groundwater table). Soil borings SB-1 through SB-3 were advanced with a track-mounted Roto-Sonic CRS-17-C drill rig. Boring SB-1 was advanced to about 3 ft below the groundwater table, and borings SB-2 and SB-3 were advanced to refusal depth (about 20.5 to 21 ft below sidewalk grade, or el +10.5 to +10 ft BPMD at SB-3 and SB-2, respectively). Refusal depth at each boring was encountered at a depth below the UST pad. Since evidence of fuel oil was not discovered directly underneath the UST No. 004 pad, but was identified directly underneath the UST No. 003 pad, UST No. 003 was considered the source of the fuel oil release; therefore, the objective of the Work Plan was fulfilled and no further investigation was necessary below the refusal depth. Boring locations are presented on Figure 2.

3.2.3 Soil Screening and Sampling

Soil samples were collected continuously from each boring location, screened for organic vapors with a hand-held photo-ionization detector (PID), and inspected for visual and olfactory evidence of contamination. A Langan field inspector also characterized physical properties of the soil, including soil density, grain size, moisture content, etc. Soil descriptions and environmental observations were documented by Langan in soil boring logs. A copy of each log is included in Appendix E.

Two soil samples were collected for laboratory analysis from borings at MW-6, MW-7, MW-8 and SB-1: one from the depth interval exhibiting the greatest signs of contamination that was not grossly contaminated and one sample from the capillary fringe, directly above the water table. Because of the aforementioned refusal encountered at soil borings SB-2 and SB-3 (Section 3.2.2), only one soil sample was collected for laboratory analysis from each of these borings. The sample from boring SB-2 was collected from the depth interval exhibiting the greatest signs of contamination (17 to 19 ft below grade, or about el +14 to +12 ft BPMD). The sample from SB-3 was collected at the termination depth (20 to 20.5 ft below grade, or about el +11 to +10.5 ft BPMD), as no indications of contamination were observed in the boring. Soil samples were not collected at MW-3, MW-4 or MW-5. Soil boring locations are depicted on Figure 2.

Soil samples were collected directly into laboratory-supplied sample jars, sealed, labeled, and placed in an ice chilled cooler. The soil samples were then delivered to Accutest Laboratories (Accutest), a New York State Department of Health (NYSDOH) Environmental Laboratory Approval Program (ELAP)-certified laboratory in Dayton, New Jersey, under proper chain-of-custody procedures. A copy of Accutest's NYSDOH ELAP certification is provided in Appendix F. Samples were analyzed at the laboratory for the STARS list of VOCs and SVOCs, via Environmental Protection (EPA) Method 8260 and EPA Method 8270, respectively.

3.2.4 Monitoring Well Installation

Soil borings were converted to permanent groundwater monitoring wells at locations MW-3 through MW-8. Final well completion depths differed based on location and grade elevation, and are summarized as follows:

- MW-3 and MW-4, located in the lower level garage (grade el +12 ft BPMD), were completed at a depth of about 16 ft below grade (el. -4 ft BPMD);
- MW-6 and MW-7, located in the sub-basement (grade el +12 ft BPMD), were completed at a depth of about 16 ft below grade (el. -4 ft BPMD); and
- MW-5 and MW-8, located in the mezzanine level (grade el +23 ft BPMD), were completed at a depth of about 27 ft below grade (approximate el. -4 ft BPMD).

With the exception of monitoring wells MW-7 and MW-8, all wells were constructed with 2-inch diameter Schedule 40 polyvinyl chloride (PVC) riser with 10-ft of 0.02-inch slotted screen to straddle the water table. At each monitoring well, a clean filter sand pack was placed in the annulus between the borehole and the outside of the screen, from the bottom of the boring to 2 to 3 ft above the screen. A bentonite seal filled the remaining borehole annulus, to approximately 1 ft below grade. Each well was finished with a protective flush-mount, bolt-down road box set into a concrete collar. The exceptions to the standard well construction are as follows:

- MW-7 was installed with 5-ft of screen, extending from about el +1 to -4 ft BPMD) and a clean filter sand pack to about 0.5 ft above the screen (el +1.5 ft BPMD). The well was constructed in this way to prevent migration of fuel oil in the vadose zone (from about el +12 to +2 ft BPMD) to groundwater; and
- MW-8 was installed as a 1-inch diameter well with a 0.01-inch slotted screen. Geoprobe refusal was encountered during four attempts to off-set MW-8 while advancing 3-inch steel casing. Petroleum impacts were not observed at MW-8; therefore, a 1-inch well was considered adequate in meeting the objectives of the SSI.

Monitoring well construction logs are presented in Appendix G and a well construction summary is presented in Table 1.

3.2.5 Monitoring Well Development

With the exception of MW-6 and MW-7, each well was developed on April 21, 2010. Wells were developed by continuous pumping with dedicated polyethylene tubing and either a Waterra Hydrolift pump or a decontaminated, submersible Grundfos pump. Well development was continued until (1) a minimum of three well volumes was removed, (2) the discharge was free of silt or fine sand, and (3) the field parameters, including temperature, pH, conductivity,

oxygen-reduction potential (ORP), dissolved oxygen (DO), and turbidity, stabilized and turbidity levels were below the NYSDEC goal of 50 Nephelometric Turbidity Units (NTUs), within a reasonable time period.

During the April 21, 2009 well development activities, apparent LNAPL was observed in MW-6 and MW-7. Field observations made during monitoring well installation indicated that grossly contaminated soil terminated within the vadose zone, approximately 5 ft above the groundwater table at MW-6 and 2 ft above the groundwater table at MW-7; therefore, LNAPL identified in these wells was considered residual from well installation via direct-push drilling methods. On April 23, 2010, Langan used a peristaltic pump and dedicated tubing to remove LNAPL and a minimum of three well volumes from monitoring wells MW-6 and MW-7. Following the removal of LNAPL from MW-7, Langan continued to develop the well and monitor field parameters. Development of MW-7 ceased when no product was observed in the purged water, field parameters stabilized, and turbidity was below 50 NTU. Water purged from MW-6 did not clear up in a reasonable amount of time to monitor field parameters. Following completion of well development, sorbent booms were inserted into MW-6 and MW-7 to absorb residual LNAPL. Well development logs are presented in Appendix H.

3.2.6 Monitoring Well Survey

Monitoring wells were surveyed by Langan, a New York State-licensed surveyor, on April 23, 2010. Each well was surveyed for horizontal location, top of well casing (measuring point) elevation, and top of ground surface elevation. Monitoring wells were located using ground survey methods with a vertical accuracy of $\pm$0.01 ft and horizontal accuracy of $\pm$0.04 ft. All elevations and horizontal locations were surveyed relative to established Site benchmarks and the BPMD.

3.2.7 Groundwater Sampling

Prior to sampling, sorbent booms were removed from MW-6 and MW-7 and a complete round of synoptic groundwater level readings was collected using a Solinst oil-water interface probe on April 29, 2010. MW-6 and MW-7 were gauged again on April 30 to determine if there was any LNAPL recharge. MW-6 appeared to be free of LNAPL; however, LNAPL remained in MW-7. Due to the presence of LNAPL in MW-7, this well was not sampled. Groundwater

elevations and environmental observations made during the well gauging activities are summarized in Table 2.

On April 29 and 30, 2010, one week after well development, Langan collected groundwater samples from each monitoring well, except MW-7 as noted above. Using the EPA low-flow technique, monitoring wells were purged and sampled with dedicated polyethylene tubing and either a decontaminated, submersible Proactive monsoon pump or decontaminated, submersible QED micropurge bladder pump. During well purging, groundwater was pumped through a flow-through cell and field parameters were measured with a Horiba U-52 water quality multi-meter. Well sampling logs are provided in Appendix H.

After purge water parameters stabilized, groundwater samples were collected directly from the submersible pump discharge line into laboratory supplied sample glassware, sealed, labeled, and placed in ice-chilled coolers. Samples were submitted to Accutest under proper chain-of-custody procedures for analysis of STARS VOCs and SVOCS via EPA Methods 8260 and 8270, respectively.

3.2.8 Equipment Decontamination

Down-hole drilling and sampling equipment, including drill rods, submersible pumps, etc., were decontaminated with Alconox and hot water following completion of each soil boring/monitoring well. Decontamination water was collected into a Department of Transportation (DOT)-approved, 55-gallon drum for temporary storage in the building basement. Off-site disposal of the drums is pending and will be coordinated by NYU.

3.2.9 Investigation Derived Wastes (IDWs) Management

IDW generated during this investigation was containerized in DOT-approved, 55-gallon drums and temporarily stored on-site in the building basement. In total, eight drums of IDW were generated, including one decontamination water drum, four drums of purged groundwater, two drums of personal protective equipment (PPE) and disposable sampling materials, and one drum of petroleum-impacted soil cuttings. Off-site disposal of the drums is pending and will be coordinated by NYU.

3.2.10 Quality Assurance/Quality Control (QA/QC) Procedures

QA/QC samples, including two field blanks and one duplicate sample collected during groundwater sampling were collected over the course of this supplemental investigation. Field blanks and the duplicate sample were submitted to Accutest and analyzed for STARS VOCs and SVOCs via EPA Methods 8260 and 8270, respectively. Trip blank samples accompanied groundwater samples at a rate of one per shipment and were analyzed for STARS VOCs via EPA Method 8260. Trip blanks originated at Accutest, consisted of the same water used in the method blank, accompanied sample containers throughout transport and groundwater sampling activities, and were returned to the laboratory with groundwater samples. In addition, one set of Matrix Spike/Matrix Spike Duplicates (MS/MSD) were collected during each of the soil and groundwater sampling events.

3.3 Results

3.3.1 Field Observations

Field observations are summarized below:

- Grossly petroleum contaminated soil (i.e., soil that contains visibly identifiable free or otherwise readily detectable free or residual product) was encountered at MW-6 from about el +9 to +5 ft BPMD and MW-7 from about el +12 to +2 ft BPMD.
- Other evidence of petroleum impacts, including black staining, petroleum odors, and PID readings greater than background, were observed in soil from about el +17 to -2.5 ft BPMD at SB-1, SB-2, MW-6, and MW-7. Maximum PID readings ranged from 126 parts per million (ppm) at SB-2 to 834 ppm at MW-6.
- Apparent LNAPL was observed in MW-6 and MW-7 during the synoptic gauging. Following development activities and use of sorbent booms to soak up residual product in the wells, MW-6 appeared to be free of LNAPL; however, apparent LNAPL remains in MW-7;
- Due to the presence of LNAPL, MW-7 was not sampled.
- PID readings above background levels were detected in monitoring well headspace during well gauging at MW-3 (110 ppm), MW-6 (265 ppm), and MW-7 (107 ppm), and during well sampling at MW-6 (330 ppm).
- Evidence of petroleum impacts (i.e., PID readings above background levels, visual or

olfactory evidence of contamination, etc.) were not observed at soil boring/monitoring well locations SB-3, MW-4, MW-5, or MW-8.

- Groundwater depths range from el -0.10 ft BPMD at MW-4 to el -0.23 ft BPMD at MW-5. Groundwater flows to the west/southwest toward the Hudson River, at a hydraulic gradient of about 0.0015 ft/ft.

Groundwater elevations and environmental observations made during well gauging are summarized in Table 2. Groundwater contours are presented on Figure 3.

3.3.2 Soil Analytical Results

Ten soil samples were collected and analyzed for STARS VOCs and SVOCS. Soil sample results were compared to the NYSDEC TAGM RSCOs for Fuel Oil Contaminated Soil. The soil analytical results are summarized as follows:

- Nine VOCs were detected in soil samples from SB1, SB2, MW-6, and/or MW-7 at concentrations exceeding their respective TAGM RSCOs. The compounds detected at concentrations greater than the TAGM RSCOs include: benzene (158 to 873 microgram per kilogram [µg/kg] compared to the TAGM RSCO of 60 µg/kg), ethylbenzene (7,100 to 7,980 µg/kg compared to the TAGM RSCO of 5,500 µg/kg), n-propylbenzene (3,720 to 6,090 µg/kg compared to the TAGM RSCO of 3,700 µg/kg), toluene (3,550 to 11,300 µg/kg compared to the TAGM RSCO of 1,500 µg/kg), 1,2,4-trimethylbenzene (28,600 to 52,900 µg/kg compared to the TAGM RSCO of 10,000 µg/kg), 1,3,5-trimethylbenzene (8,960 to 15,200 µg/kg compared to the TAGM RSCO of 3,300 µg/kg), and xylene (4,890 to 52,800 µg/kg compared to the TAGM RSCO of 1,200 µg/kg).
- Seven SVOCs were detected in soil samples from SB1, SB2, MW-6, MW-7, and/or MW-8 at concentrations exceeding their respective TAGM RSCOs. The compounds detected at concentrations greater than the TAGM RSOCs include: benzo(a)anthracene (301 to 5,240 µg/kg compared to the TAGM RSCO of 224 µg/kg), benzo(a)pyrene (515 to 3,000 µg/kg compared to the TAGM RSCO of 61 µg/kg), benzo(b)fluoranthene (358 to 1,890 µg/kg compared to the TAGM RSCO of 220 µg/kg), benzo(k)fluoranthene (320 to 498 µg/kg compared to the TAGM RSCO of 220 µg/kg), chrysene (725 to 11,600 µg/kg compared to the TAGM RSCO of 400 µg/kg), dibenzo(a,h)anthracene (170 to 792 µg/kg compared to the TAGM RSCO of 14.3 µg/kg), and naphthalene (16,200 to 32,100 µg/kg

compared to the TAGM RSCO of 13,000 µg/kg).

- VOCs and SVOCs in soil, other than those noted above, did not exceed their respective TAGM RSCOs.
- Based on a review of Triumvirate's findings, compared with the findings of this SSI, the extent of grossly contaminated soil covers an area of approximately 3,200 square feet near the eastern portion of the Site building.

Laboratory analytical reports, in NYSDOH Analytical Services Protocol (ASP) Category A deliverable format, are provided in full in Appendix I. Soil sample results are summarized in Table 3 and presented in Figure 4.

3.3.3 Groundwater Analytical Results

Six groundwater samples, including one duplicate, were collected from monitoring wells MW-3 through MW-6 and MW-8 and analyzed for STARS VOCs and SVOCS. Groundwater sample results were compared to the NYSDEC TAGM Groundwater Standards/Criteria for Fuel Oil Contaminated Soil. A summary of significant groundwater sample results is provided below:

- The VOCs 1,2,4-trimethylbenzene (9.4 micrograms per Liter [µg/L]) and xylene (14 µg/L) exceeded the TAGM Groundwater Standard of 5 µg/L in the sample collected from MW-6.
- The SVOC naphthalene (22.6 µg/L) was detected at MW-6, exceeding the TAGM Groundwater Standard of 10 µg/L.
- VOCs and SVOCs, other than those noted above, did not exceed their respective TAGM Groundwater Standards/Criteria.

Laboratory analytical reports, in NYSDOH ASP Category A deliverable format, are provided in full in Appendix I. Groundwater sample results are summarized in Table 4 and presented in Figure 5.

3.4 Conclusions

Based on field observations and the analytical data, we provide the following conclusions:

- Petroleum impacts were identified directly underneath UST No. 003 (el. +17 ft BPMD). Petroleum impacts underneath UST No. 004 were first observed 3 feet below the

bottom of the tank at el. +14 ft BPMD. Based on these observations, the source of the fuel oil release is UST No. 003.

- Grossly petroleum impacted soil appears to be limited to an area of 3,200 square feet near the eastern portion of the Site building, and extends vertically from approximately el +12 to +2 ft BPMD; and
- Groundwater was encountered at about el 0 ft BPMD and has not been significantly impacted as a result of the fuel oil release.

4.0 REMEDIAL ACTION WORK PLAN

4.1 Introduction

The Site remediation tasks include:

- Closure of USTs via removal and/or in-place abandonment;
- The removal of petroleum-impacted soil to the extent practical based on structural limitations;
- Importation and placement of clean fill to backfill excavations;
- Installation of a soil vapor extraction system to reduce VOC and SVOC concentrations in the vadose zone, thereby removing the soluble components of fuel oil and mitigating potential impacts to groundwater;
- Passive product recovery; and
- Air monitoring during the remediation.

Remedial measures described herein will be performed in accordance with applicable federal, state and city regulations. Site remedial work shall not commence without NYSDEC approval of this work plan.

4.2 Objectives

Goals for the remedial program have been established through the remedy selection process stated in the New York State Codes, Rules and Regulations (NYCRR) under 6 NYCRR Part 375-1.10. At a minimum, the remedy selected must eliminate or mitigate all significant threats to public health and/or the environment presented by VOC and SVOC impacts at the Site through the proper application of scientific and engineering principles. The remediation goals for this Site are (1) to reduce, to the extent practical, the presence of petroleum-related VOC and SVOC contaminants in the soil and groundwater and (2) the mitigation of human contact with impacted soil.

4.3 Remediation Activities

4.3.1 UST Decommissioning

Since UST No. 3 is the source of the fuel oil release, this tank shall be decommissioned by removal. The UST decommissioning method of UST No. 4 will be determined based on field conditions revealed during removal of UST No. 3. Both USTs will be decommissioned in accordance with NYSDEC STARS Memo #1, the appropriate Spill Prevention Operations Technology Series (SPOTS) guidance documents, and Section 5.5, paragraph (b)5 of the NYSDEC Department of Environmental Remediation Draft Technical Guidance for Site Investigation and Remediation, dated December 2002 (DER-10). Residual sludge and other tank contents are not anticipated since both USTs were emptied and cleaned during the emergency response conducted by Triumvirate.

Petroleum-contaminated soil identified during removal of UST No. 003, and UST No. 004, if applicable, will be excavated and transported to an off-site disposal facility. Petroleum-impacted soil will be live-loaded onto trucks, covered with tarps and transported directly to the disposal facility. Soil that is free of petroleum impacts will be stockpiled on-site and, if considered appropriate backfill material by the geotechnical engineer, will be used to backfill the excavation. The excavation will extend vertically to the depth at which grossly contaminated soil is absent or to the groundwater table, whichever is shallower. The horizontal extents of the excavation will be limited by the 17 story building to the north, Con Edison vaults to the south, and underground utilities to the east.

Post-excavation soil samples will be collected as per the DER-10 requirements. Appropriate sheeting and shoring measures will be implemented during the excavation and removal to protect existing structures and utilities. Following removal of UST No. 003 (and possibly UST No. 004), the UST carcass will be disposed at an appropriate off-site recycling facility.

4.3.2 Impacted Soil Removal and Handling

Grossly petroleum-impacted soils in the building basement will be removed to the extent it can be removed safely, without undermining existing building foundation elements or boilers. Based on a structural analysis conducted by Chen Structure, NYU's structural engineer, we anticipate an approximately 120 square foot (sf) area at the northeast corner of the sub-

basement and an approximately 265 sf area at the southeast corner of the sub-basement can be excavated to an approximate depth of 4 ft below the sub-basement grade (el +12 to +8 ft BPMD). We estimate removal and off-site disposal of approximately 60 cubic yards (CY) of petroleum-impacted material. Anticipated excavation areas are shown on Figure 6.

Upon removal, the excavated materials will be containerized in DOT-approved 55-gallon drums or roll-off containers, and staged on-site in a secure, dedicated location pending waste characterization analysis and off-site disposal. The materials will be classified for waste characterization parameters according to disposal facility requirements, transported under appropriate regulatory permits, and disposed or recycled at a licensed facility permitted to accept the soil. Soil removal operations will be conducted in accordance with NYSDEC Part 360 solid waste regulations and other applicable local, state, and federal regulations.

4.3.3 Importation of Clean Fill

Soils imported to the Site for use as backfill will meet the NYSDEC Part 375 Unrestricted Use criteria. Before soils are delivered to the Site, the Construction Manager will supply NYU's remediation engineer with the name, location, a brief history, and certified analytical test results for soils originating at the proposed site, or facility, for review and verification that they meet Part 375 criteria. Soil that exceeds Part 375 criteria for Unrestricted Use and/or contain organic matter, wood, trash, etc. will not be considered an appropriate material for use as backfill. A demarcation layer (e.g., orange snow fence) will be placed below the imported, clean fill material to identify the boundary between residual petroleum-impacted soil and clean backfill. Both the sub-grade soils and the clean backfill will be compacted following standard construction requirements.

4.3.4 Dewatering

Excavation to the groundwater table is not anticipated during the excavation in the sub-basement or UST No. 003 removal; however, if the groundwater table is encountered, dewatering will be required until clean imported fill is used to backfill the excavation areas. The excavation area will be dewatered using sumps, pumping wells, or other conventional methods.

Water generated as a result of the remediation activities will be transported for off-site disposal or pre-treated as necessary and lawfully discharged to the New York City Department of Environmental Protection (NYCDEP) sewer system under a valid NYCDEP Discharge to Sanitary Sewer System permit. At a minimum, the dewatering treatment system will consist of a standard package treatment system including an oil/water separator, sedimentation tank, bag filters, and activated carbon vessels.

4.3.5 Air Monitoring

Air monitoring will be performed throughout the duration of the remedial excavation work in accordance with the New York State Department of Health (NYSDOH) Generic Community Air Monitoring Plan and will dictate action required to control vapor, odor, and dust emissions. It is anticipated that dust will be generated during implementation of the remedy. Observation of visible dust will trigger additional dust control measures to mitigate the dust condition. Preventative measures for dust generation will include wetting excavation areas as needed and immediately containerizing excavated materials. Volatile organic vapors will be monitored with a PID during all soil activities. Methods for minimizing odors during remedial actions include, but are not limited to: (1) limiting the area of open excavations, (2) shrouding open excavations with tarps and other covers, (3) use of foams to cover exposed odorous soils, (4) use of chemical odorants in spray or misting systems, and (5) use of staff to monitor odors.

4.3.6 Well Decommissioning

Based on their location relative to the proposed excavation areas, it is anticipated that monitoring wells MW-1, MW-2, and MW-6 will be decommissioned prior to the onset of any excavation. These wells will be abandoned in accordance with NYSDEC's Groundwater Monitoring Well Decommissioning Procedures, dated August 2009.

4.3.7 Soil Vapor Extraction System (SVE) System Installation

Due to structural and spatial limitations inside the building, bulk excavation of grossly petroleum impacted soils is not feasible. Grossly contaminated soil that can not be removed via excavation will be treated via an SVE System. The intent of this system is to mitigate the potential of the fuel oil release to impact groundwater by removal of its soluble component (i.e., VOCs and naphthalene). SVE technology is typically applied to sites contaminated with lighter,

more volatile petroleum products such as gasoline rather than the heavier No. 6 fuel oil; however, its applicability at this Site is based on the following rationale:

- No. 6 fuel oil release at the Site is relatively new (i.e., less than 6 months) and contains more volatile components than an aged release;
- Results of Triumvirate's limited subsurface investigation and Langan's SSI have documented elevated concentrations of several VOCs and SVOCs in soil in the unsaturated zone, and limited VOC and SVOC impacts to groundwater;
- SVE technology has been proven effective in reducing concentrations of VOC and certain SVOC constituents in petroleum products adsorbed to soils in the unsaturated zone;
- Installation of an SVE System to reduce VOCs and SVOCs, which are also the most soluble components of the No. 6 fuel oil, in the unsaturated zone will mitigate the spill's potential for future impacts to groundwater;
- Increased air flow through the subsurface via the SVE System may stimulate biodegradation of some of the less volatile components of the No. 6 fuel oil; and
- Installation of the SVE System in the building basement will also mitigate potential vapor intrusion into the building.

The SVE System will primarily consist of:

- Three SVE wells, placed at selected locations throughout the approximately 3,200 sf impacted area in the sub-basement and mezzanine. The wells will be constructed with 2-inch diameter Schedule 40 PVC riser with about 10-ft of 0.02-inch slotted screen, set to encompass the most heavily impacted interval at about el +12 to +2 ft BPMD;
- A SVE vacuum blower rated for a flow of 50 standard cubic feet per minute (scfm) at 40 inches of water column (inch WC) vacuum;
- A moisture separator to protect the vacuum blower from moisture damage; and
- Two vapor-phase granular-coal activated carbon (VGAC) vessels connected in series to treat the air discharge before being released to the atmosphere.

The SVE vacuum blower, moisture separator, and VGAC vessels will be skid-mounted and will be located at the basement mezzanine. The skid-mounted unit will be connected to the SVE

wells via 2-inch diameter Schedule 40 PVC. The proposed SVE System layout is depicted on Figure 7.

Since the volatile portion of the fuel oil is limited, the SVE system will operate continuously for a duration of about 6 months, and intermittent operation of the SVE system thereafter will be performed to capture volatile compounds produced during the breakdown process as fuel oil slowly degrades over time. A Site Management Plan describing the proposed operation, maintenance, and monitoring of the SVE System will be prepared, as described in Section 4.3.11.

4.3.8 Fuel Oil Recovery

In the time leading up to the UST excavation and SVE installation, passive recovery of fuel oil in MW-7 where LNAPL remains will continue. Passive recovery of the No. 6 fuel oil will be accomplished using oil-only sorbent booms. The booms will be periodically inspected and replaced when saturated with oil. After the USTs have been decommissioned and the SVE system installed, vacuum recovery of fuel oil will be considered if oil persists in MW-7. The purpose of passive/vacuum recovery is to limit contact between the residual fuel oil and groundwater, thereby mitigating potential impacts to groundwater as a result of the spill. Used booms and fuel oil will be containerized in DOT-approved, 55-gallon drums and staged on-site in a secure, dedicated location pending off-site disposal at an appropriately licensed facility. A Site Management Plan will be prepared to address the passive recovery, as described in Section 4.3.11.

4.3.9 Quarterly Groundwater Monitoring

Quarterly groundwater sampling will commence within one month following removal of the UST and installation of the SVE system. Following the initial sampling event, groundwater samples will be collected on a quarterly basis for the next 12 months. A complete round of synoptic groundwater level readings will be collected prior to sampling. Monitoring wells will be purged and sampled with dedicated polyethylene tubing and a submersible pump using the EPA low-flow technique. Field parameters including, temperature, pH, conductivity, ORP, DO, and turbidity, will be measured and recorded during purging. After the parameters have stabilized, groundwater samples will be collected directly from the submersible pump discharge line into laboratory supplied sample glassware, sealed, labeled, placed in ice-chilled

coolers, and submitted to a NYSDOH ELAP-accredited laboratory for analysis of STARS VOCs and SVOCS via EPA Methods 8260 and 8270, respectively.

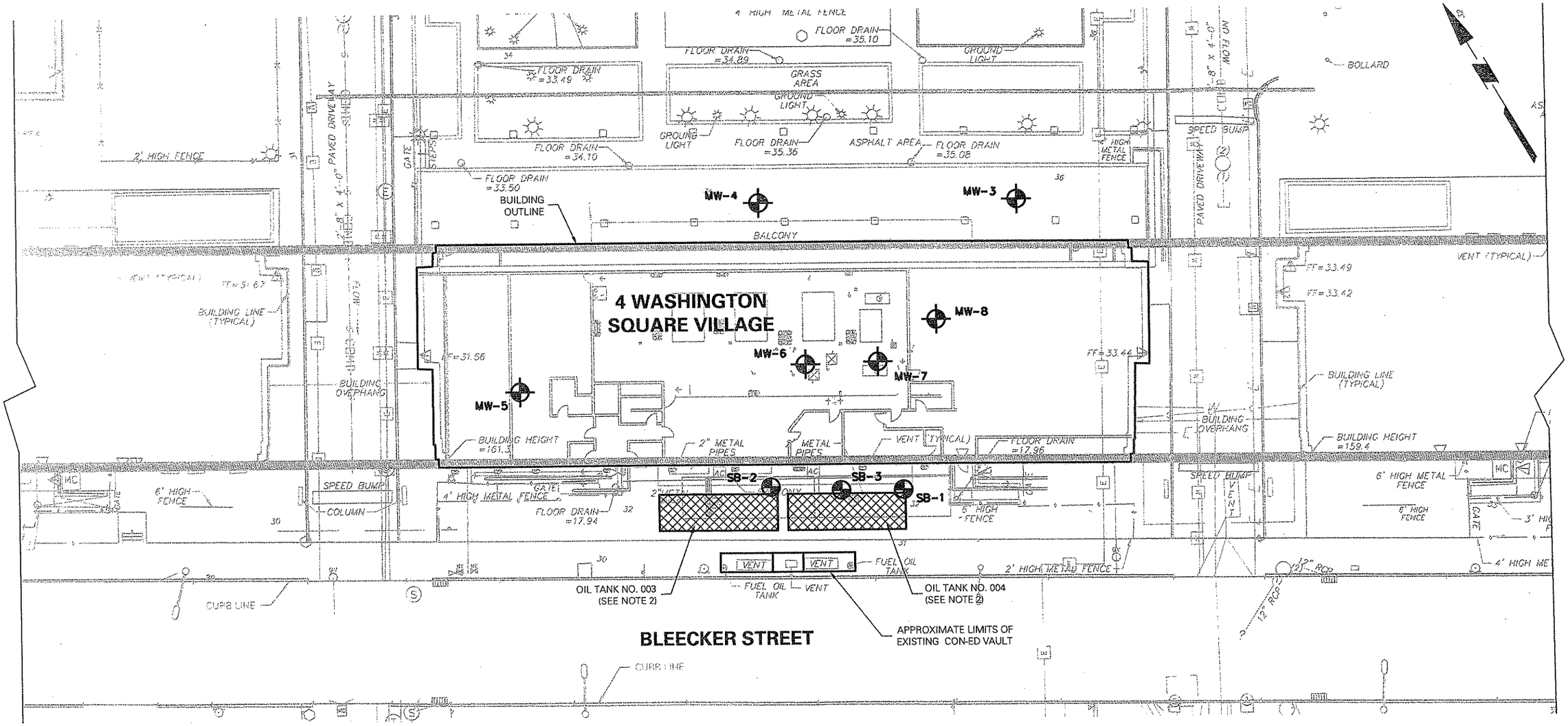
A Groundwater Monitoring Report will be provided to NYSDEC within 6 weeks of each monitoring event. Each Monitoring Report will summarize the groundwater sampling activities, findings, and conclusions, and will include laboratory analytical reports and a Site plan showing groundwater flow direction and sample results. After one complete year of quarterly monitoring, the sampling frequency will be re-evaluated and recommendations will be made to the NYSDEC if a change in the monitoring frequency is appropriate.

4.3.10 Closure Report

Upon completion of the remediation, NYU will submit a New York State Professional Engineer (P.E.)-certified Remedial Action Report to the NYSDEC. The report will document compliance with this RAWP and include a description of the remedial work performed. At a minimum, the Remedial Action Report will include a P.E. certification, a photographic log, documentation of all exported and imported soils, UST and soil disposal records, and as-built SVE System drawings.

4.3.11 Site Management Plan

A Site Management Plan (SMP) will be completed and submitted to the NYSDEC along with the Remedial Closure Report. The SMP will describe the (1) proposed operation, maintenance, and monitoring of the SVE System, (2) the proposed maintenance and monitoring of the passive/vacuum recovery methodology, and (3) quarterly groundwater monitoring and reporting requirements.



LEGEND:

- BUILDING OUTLINE
- MW-8 — GROUNDWATER MONITORING WELL LOCATION
- SB-1 — SOIL BORING LOCATION
- APPROXIMATE LOCATION OF UNDERGROUND STORAGE TANK

GENERAL NOTES:

1. BASE PLAN IS TAKEN FROM A TOPOGRAPHICAL AND UTILITY SURVEY BY LANGAN ENGINEERING, DATED 26 JANUARY 2010.
2. THE LIMITS OF OIL TANKS #3 AND #4 ARE APPROXIMATE, BASED ON DRAWING NO. A-001.0.0 TITLED "LOWER LEVEL GARAGE PLAN SECTION A-A" BY NAPACH ROTHENBERG ARCHITECTS, DATED 22 JANUARY 2010 AND THE SUBSURFACE GEOPHYSICAL INVESTIGATION CONDUCTED BY DIVERSIFIED GEOPHYSICS, INC. ON 9 APRIL 2010. CONTRACTOR TO VERIFY IN FIELD THE LOCATION AND LIMITS OF THE OIL TANKS.
3. THE INTERIOR BUILDING BASED ON DRAWING NO. A-001.0.0 TITLED "LOWER LEVEL GARAGE PLAN SECTION A-A" BY NAPACH ROTHENBERG ARCHITECTS, DATED 22 JANUARY 2010.

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SCALE IN FEET

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Project
SITE PLAN AND WELL SURVEY MAP
4 WASHINGTON SQUARE VILLAGE
NEW YORK NEW YORK

Project No.	Date	Scale	Dwg. No.
170107001	5/14/10	1" =30'	2

Filename: \\Langan.com\data\NY\data01\170107001\Cadd Data - 170107001\Dwg\RAP\Figure 2- Site Plan and Well Survey Map.dwg Date: 5/14/2010 Time: 10:17 User: vligioo Style Table: Langan.stb Layout: Site Plan