REMEDIAL INVESTIGATION WORK PLAN

for

42-11 9th Street
Long Island City, New York

Block 461, Lot 16
BCP Site No. C241237

Prepared For:

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Principal/Vice President

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Langan Project No. 170514702

LANGAN

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CERTIFICATION

I, Michael Burke, certify that I am currently a Qualified Environmental Professional as defined in 6 NYCRR Part 375 and that this Remedial Investigation Work Plan was prepared in accordance with all applicable statutes and regulations and in substantial conformance with the Division of Environmental Remediation (DER) Technical Guidance for Site Investigation and Remediation (DER-10).

Michael D. Burke, PG, CHMM
Principal/Vice President

1.0 INTRODUCTION

This Remedial Investigation Work Plan (RIWP) was prepared on behalf of RXR 42-11 9th Holdings LLC (the "Volunteer") for the property located at 42-11 9th Street in the Long Island City neighborhood of Queens, New York (the "site"). The Volunteer was accepted into the New York State Brownfield Cleanup Program (BCP) on August 23, 2019, and was assigned BCP Site No. C241237.

The objective of this Remedial Investigation (RI) is to investigate and characterize the nature and extent of contamination in soil, groundwater, and soil vapor at or emanating from the site; generate sufficient data to evaluate the remedial action alternatives; and generate sufficient data to evaluate the actual and potential threats to human health and the environment. This RIWP was developed in general accordance with the process identified in Title 6 of the Official Compilation of the New York Codes, Rules and Regulations (6 NYCRR) Part 375-3.8; the May 2010 New York State Department of Environmental Conservation (NYSDEC) Division of Environmental Remediation (DER) Technical Guidance for Site Investigation and Remediation (DER-10); and the October 2006 New York State Department of Health (NYSDOH) Guidance for Evaluating Soil Vapor Intrusion in the State of New York.

2.0 SITE BACKGROUND

2.1 Site Description

The site is located at 42-11 9th Street (Block 461, Lot 16) in the Long Island City neighborhood of Queens, New York. The about 49,400 square-foot (1.13 acres) site is located on the northern part of the city block bound by Queens Plaza South to the north, 10th Street to the east, 43rd Avenue to the south, and 9th Street to the west and is occupied by a one-story manufacturing/warehouse building with a partial second floor and partial basement on the southwestern portion of the site, and an asphalt-paved yard on the southwestern portion of the site. The building is used for a machine shop with a forge building and warehouse space.

The site is bordered by an organic compost waste site underneath the Ed Koch Queensboro Bridge to the north (across from Queens Plaza South); an industrial manufacturing building to the east (across 10th Street); industrial buildings to the south; and commercial buildings, including a hotel, to the west (beyond 9th Street). A Site Location Map is included as Figure 1.

2.2 Surrounding Property Land Use

The site is located in an urban setting characterized by commercial, industrial, and residential buildings. The following is a summary of surrounding property usage:

Direction	Block	Lot(s)	Adjoining Properties	Surrounding Properties
North	465	400	Queens Plaza South followed by an undeveloped lot used as a composting site beneath the Ed Koch Queensboro Bridge	Vehicle lots and multiple-family residential buildings
East	460	16	10th Street followed by a manufacturing building	11th Street followed by single-story industrial warehouses
South	461	13	3-story industrial building	Single and multiple-story industrial buildings and single-family residential buildings
West	462	53	9th Street followed by 9-story commercial/hotel building	Vernon Boulevard followed by vacant land and industrial-use lots
		161	9th Street followed by a parking garage	

Land use within a half mile of the site is primarily commercial, industrial, and residential, but also includes public park areas, and institutional buildings. The nearest ecological receptor is the East

River, which is located about 850 feet northwest of the site. Sensitive receptors, as defined in DER-10, located within a half-mile of the site include those listed in the following table.

Number	Name (Approximate distance from Site)	Address
1	PAL Western Queens Nursery School (approximately 0.2 miles north of the site)	10-26 41st Avenue Long Island City, NY 11101
2	The Floating Hospital (approximately 0.25 miles northeast of the site)	10-29 41st Avenue Long Island City, NY 11101
3	Busy Bee Playcare (approximately 0.33 miles south of the site)	10-21 44th Drive Long Island City, NY 11101
4	Queens Paideia School (approximately 0.35 miles southeast of the site)	44-02 23rd Street Long Island City, NY 11101
5	Information Technology High School (approximately 0.35 miles southeast of the site)	21-16 44th Road Long Island City, NY 11101
6	Long Island City School of Ballet (approximately 0.36 miles southeast of the site)	44-02 23rd Street Long Island City, NY 11101
7	NY Kids Club - Court Square (approximately 0.36 miles southeast of the site)	44-16 23rd Street Long Island City, NY 11101
8	Bridgeview School of Fine Arts (approximately 0.37 miles northeast of the site)	21-21 41st Avenue, #3B Long Island City, NY 11101
9	CUNY School of Law (approximately 0.45 miles southeast of the site)	2 Court Square West Long Island City, Queens, NY 11101
10	CityMD (approximately 0.47 miles east of the site)	42-10 27th Street Long Island City, NY 11101
11	Grand Central Atelier (approximately 0.5 miles south of the site)	46-06 11th Street Long Island City, NY 11101

2.3 Site Physical Conditions

2.3.1 Topography

The site is relatively flat with the general topography sloping slightly downwards to the west. According to the United States Geological Survey (USGS) Central Park and Brooklyn Quadrangle 7.5-minute Series Topographic Map, site grade is about elevation (el) +13 feet NAVD88. Groundwater is expected to flow west toward the East River.

2.3.2 Geology

New York City geology is generally characterized by layers of fill and native soil overburden above metamorphic bedrock. The native overburden was generally deposited during the last continental glaciation. Three formations of metamorphic rock, the Manhattan Schist, the Inwood Marble, and the Fordham Gneiss, are found in New York City. The formation of the Hudson and Harlem Rivers was mainly due to the late Pleistocene glaciation. As the glaciers melted, they deposited till (a mixture of boulders, gravel, clay, sand and silt) and outwash sands on top of the unweathered bedrock. A subsequent period of erosion in the Hudson River Valley resulted in the removal of the outwash sands and till from much of the river. Long Island City is situated near the southern end of the Manhattan Prong, which is one of two southwestward extensions of the New England Upland physiographic province of the Northern Appalachians. The underlying geology consists mainly of glacial till and outwash.

2.3.3 Site Geology

Langan conducted a geotechnical investigation between March 9 - 12, 2018, which included two borings on sidewalks east and west of the site. About 6 feet of historic fill material was observed overlying 6 to 13 feet of dense sand. Bedrock was observed at 15 to 19 feet below sidewalk grade. The site is underlain by fill material predominantly consisting of fine to medium sand with varying amounts of gravel, glass, brick, wood, concrete, coal ash, and slag. The historic fill material was observed from beneath the surface cover to about 13 feet below grade surface (bgs). Native soil encountered below historic fill consists of fine sand, silt, and clay.

2.3.4 Hydrogeology

Groundwater flow is typically topographically influenced, as shallow groundwater tends to originate in areas of topographic highs and flows toward areas of topographic lows, such as rivers, stream valleys, ponds, and wetlands. A broader, interconnected hydrogeologic network often governs groundwater flow at depth or in the bedrock aquifer. Groundwater depth and flow direction are also subject to hydrogeologic and anthropogenic variables such as precipitation, evaporation, extent of vegetation cover, and coverage by impervious surfaces. Other factors influencing groundwater include depth to bedrock, the presence of artificial fill, and variability in local geology and groundwater sources or sinks. Groundwater in the New York City area is not used as a potable water source. Potable water is provided to the site by the City of New York and is derived from surface impoundments in the Croton, Catskill, and Delaware watersheds.

Based on observations from the subsurface investigation performed in March 2018, groundwater is expected to flow west toward the East River. Groundwater level measurements collected by Langan during the subsurface investigation indicate that groundwater depth ranges from about 9 to 11 feet bgs.

2.3.5 Wetlands

Wetlands on or near the site were evaluated by reviewing the National Wetlands Inventory and NYSDEC regulated wetlands map. There are no wetlands on or adjacent to the site. The nearest wetland is the East River, about 850 feet northwest of the site.

2.4 Summary of Previous Environmental Investigations

Available environmental reports are included in Appendix A and summarized in chronological order below. Historical analytical data collected by Langan is included on Figures 2, 3, and 4.

Environmental reports prepared for the site include the following:

- Phase I Environmental Site Assessment (ESA), dated June 19, 1997, prepared for Bank of New York and New York City Industrial Development Agency by Environmental Planning & Management Inc.;
- Phase II Environmental Site Investigation (ESI), dated March 1998, prepared for Titan Machine Corporation, The Bank of New York, and New York City Industrial Development Agency by EEA, Inc.;
- Remedial Corrective Action Report, dated May 1998, prepared for Titan Machine Corporation by EEA, Inc.;
- Preliminary Geotechnical Engineering Memorandum, dated March 28, 2018, prepared for RXR Development Services by Langan Engineering, Environmental, Surveying, Landscape Architecture and Geology, D.P.C. (Langan);
- Phase I ESA, dated April 17, 2018, prepared for RXR Realty Investments, LLC by Langan; and
- Subsurface Investigation, performed in March 2019 for RXR Realty Investments, LLC by Langan.

A summary of relevant information from each report is presented below:

<u>Phase I ESA, prepared by Environmental Planning and Management and dated June 19, 1997</u>

The Phase I ESA was prepared by Environmental Planning and Management, Inc. of Lake Success, New York and identified the following Recognized Environmental Conditions (RECs):

- Potential subsurface impacts associated with the underground storage tanks (UST) that were closed in place and, according to the owner, were scheduled to be removed in June 1997;
- Presence of surficial staining and damaged drums; and
- Historical use of adjacent properties as chemical manufacturing.

The Phase I ESA also included the summary of the results of the asbestos containing materials (ACM) sampling. A total of 7,250 linear foot of ACM was identified in the samples collected from the boiler and pipe installation and transite roof panels.

The Phase I ESA recommended a Phase II ESI and abatement of the boiler and pipe insulation where ACM was identified.

<u>Phase II ESI, prepared by EEA and dated March 1998</u>

The Phase II ESI was conducted by EEA, Inc. of Garden City, New York, to investigate the former UST area, forge building, floor trenches (exact locations cannot be identified based on the information included in the report) that were open to the soil below the slab, and the surficial areas where staining was identified. The investigation findings are listed below:

- Floor Trenches: Five soil borings were installed in trenches that had soil bottom. Trenches were used for electrical wiring associated with heavy machinery, and metals shavings were observed in some of the trenches. One soil sample was collected from each of the trenches that had soil bottom. The samples were analyzed for volatile organic compounds (VOC), semivolatile organic compounds (SVOC), and RCRA metals. Metals including chromium, lead, and mercury were detected above the New York State Department of Environmental Conservation (NYSDEC) Technical and Administrative Guidance Manual (TAGM) guidelines, the applicable standard at the time. VOCs, including tetrachloroethene (PCE) and xylene, were detected below TAGM guidelines.
- Forge Building: Six soil borings were installed within buildings where surface staining was observed. One soil sample was collected from each boring and was analyzed for VOCs, SVOCs, and RCRA metals. The fill layer contained concrete, brick, coal ash, cinders, sand, and slag. Metals, including chromium, lead and mercury, and several SVOCs were detected at concentrations above TAGM guidelines.

- Surface Staining and Historical Use: Three soil borings were installed in areas where surface staining and damaged drums were observed. One soil sample was collected from each boring for VOCs, SVOCs, and RCRA metals. The areas where the staining and damaged drums were present were remediated prior to the Phase II ESI. The sample results did not indicate evidence of a release.
- Former UST Area: Four soil borings were installed within the former UST area and one soil sample was collected from each boring for VOC analysis. Based on field observations and the levels of the total petroleum hydrocarbon (TPH) concentrations (ranging from 1,100 parts per million [ppm] to 48,000 ppm) in the samples collected surrounding and below the former UST area, EEA recommended that a spill be reported to the NYSDEC.
- On April 7, 1998, Spill No. 9800302 was assigned, and corrective action was taken, as described in the Remedial Corrective Action Report, dated May 1998, summarized below.

Remedial Corrective Action Report, prepared by EEA and dated May 1998

The remediation included removal of about 300 tons of metals-impacted and petroleum-impacted (fuel oil #2) soil from the trenches and former UST areas.

- Metals, including chromium, lead, and mercury, were detected above the NYSDEC TAGM guidelines, the applicable standard at the time, in samples collected from trenches during the 1998 Phase II ESI (summarized above). Each trench area was excavated 3 to 4 feet below the bottom of the trench until no metals impacts were detectable using a portable mercury vapor detector and colorimetric field testing instrumentation. One confirmation endpoint sample was collected from each trench, and the samples were analyzed for chromium, lead, and mercury.
- The former UST area was excavated to a depth of about 18 feet below grade surface until no impacts were detectable with a portable organic vapor detector. Five confirmation endpoint samples were collected from the UST excavation, and were analyzed for VOCs and SVOCs.

Endpoint sample analytical results confirmed that concentrations of parameters analyzed were below TAGM guidelines. Excavated soil was disposed at TT Materials Corporation of Wingdale, New York, and the excavated areas were backfilled with clean fill material. Spill No. 9800302 was closed on July 23, 1998.

Preliminary Geotechnical Engineering Memorandum, prepared by Langan and dated March 28, 2018

Langan conducted a due diligence geotechnical evaluation in March 2018, which included two borings on sidewalks adjoining the BCP site to the east and west of the site building. About 6 feet of historic fill material was observed overlying 6 to 13 feet of dense sand. Bedrock was observed at 15 to 19 feet below sidewalk grade, and groundwater was encountered at about 9 to 10 feet below sidewalk grade. During the geotechnical borings, Langan collected two soil samples for Part 375 VOCs, SVOCs, metals, and polychlorinated biphenyls (PCB) analysis. SVOCs were detected at concentrations above the NYSDEC Title 6 of NYCRR Part 375 Unrestricted Use (UU) Soil Cleanup Objectives (SCO) and/or Restricted Use Commercial SCOs. Metals were detected above the UU SCOs but below the Restricted Use Commercial SCOs.

Phase I Environmental Site Assessment, prepared by Langan and dated April 17, 2018

Langan prepared a Phase I ESA on behalf of RXR Realty Investments, LLC in accordance with the ASTM E1527-13 standards and the United States Environmental Protection Agency's (EPA) All Appropriate Inquires (AAI) Rule. The Phase I ESA identified the historical and current use of the site, and historical use of the adjoining and surrounding properties RECs.

Historical uses of the site included a plastic hanger manufacturer (1970-1977) and a machine shop (circa 1998). Historical uses of adjoining and surrounding properties include a power sub-station (1915-1936) and a chemical manufacturer (1947-1950) at the southern adjoining property; an unspecified manufacturing facility (1997-2006) at the east adjoining property; a paint and lacquer mixing facility (1947-2006) approximately 75 feet south of the site; an unspecified manufacturing facility (1977-2006) approximately 160 feet east of the site; an auto repair facility (1970-1986) approximately 180 feet east/southeast of the site; drug manufacturing and cable manufacturing companies (1970) approximately 160 feet east of the site; and a dry cleaner (1990-present) approximately 500 feet east of the site.

The Phase I ESA also identified the closed spill, NYSDEC Spill No. 9800302, as a Historical Recognized Environmental Concern. Available documents pertaining to the closed spill indicate that petroleum-impacted soil was excavated and disposed of off-site and endpoint sample results indicate that applicable remediation objectives were met. The excavated area was backfilled and the spill was closed on July 23, 1998.

Additionally, historic fill and presence of several 55-gallon drums with recycled oil were identified as Business Environmental Risks. The presence of asbestos-containing material that was documented in the June 19, 1997 Phase I ESA and water infiltration in the basement of the forge building were noted. Isolated floor staining and equipment leaks that were observed throughout the building were identified as a de minimis condition.

Subsurface Investigation, performed by Langan and dated March 2019

A subsurface investigation was conducted in March 2019 to evaluate subsurface conditions. The investigation included a geophysical survey; completion of eight soil borings, three monitoring wells, and three soil vapor points; and collection and analysis of 22 soil samples, including two duplicate samples, four groundwater samples, including one duplicate sample, and four soil vapor samples, including one ambient air sample. Relevant findings and conclusions are summarized below:

- The geophysical survey did not identify any anomalies indicative of USTs.
- Historic fill consisting of fine-to-medium sand with varying amounts of gravel, glass, brick, wood, concrete, coal ash, and slag was encountered from beneath the surface cover to about 13 feet bgs. Native soil encountered below historic fill consists of fine sand, silt, and clay. Apparent bedrock refusal was encountered at depths ranging from 6.5 to 26.5 feet bgs[1].
- Grossly impacted material was not observed during the investigation. Photoionization detector (PID) readings in soil did not exceed background conditions. Chemical staining and odors were not apparent during soil sampling and no petroleum-like sheen was observed on groundwater. Soil/fill samples were compared to Part 375 UU SCOs and Restricted Use Commercial SCOs.
    - VOCs, including acetone (maximum of 0.11 milligrams per kilogram [mg/kg]) and tetrachloroethene (maximum of 1.4 mg/kg), were detected at concentrations above the Unrestricted Use SCOs but below the Restricted Use Commercial SCOs.
    - SVOCs, including benzo(a)anthracene (maximum of 5.3 mg/kg), benzo(k)fluoranthene (maximum of 1.3 mg/kg), chrysene (maximum of 5 mg/kg), and indeno(1,2,3-cd)pyrene (maximum of 3.3 mg/kg), were detected at concentrations above the UU SCOs in shallow soil samples but below the Restricted Use Commercial SCOs. SVOCs, including benzo(a)pyrene (maximum of 6.0 mg/kg), benzo(b)fluoranthene (maximum of 7.6 mg/kg, and dibenzo(a,h)anthracene (max concentration 1 mg/kg), were detected at concentrations above both the UU SCOs and the Restricted Use Commercial SCOs.
    - Metals, including cadmium (maximum of 6.79 mg/kg), lead (maximum of 843 mg/kg), mercury (maximum of 1.08 mg/kg), nickel (maximum of 34.5 mg/kg), silver (maximum of 2.54 mg/kg), trivalent chromium (35 mg/kg), and zinc (maximum of 3,200 mg/kg), were detected at concentrations above the UU SCOs but below the Restricted Use Commercial SCOs in soil. Copper was detected at concentrations (maximum 1,400 mg/kg) above both the UU SCO and the Restricted Use Commercial SCO.

[1] Based on the geotechnical investigation performed in March 2019.

  - Total PCBs (maximum of 0.464 mg/kg) were detected at concentrations above the UU SCOs in shallow soil samples from the southern portion of the site but below the Restricted Use Commercial SCOs
  - Pesticides and herbicides were detected at concentrations below the UU SCOs.
  - The historical site uses of environmental concern and placement of historic fill material with elevated concentrations of SVOCs occurred prior to the applicant's ownership. Copper in soil may be related to current and historical site use as a manufacturing and machine shop.

- Groundwater samples were compared to the Technical and Operational Guidance Series (TOGS) Ambient Water Quality Standards and Guidance Values (SGV). The results are summarized below:
  - Synoptic groundwater measurements were collected from environmental monitoring wells (MW-04, MW-06, MW-11, and MW-13). Depth to groundwater was measured at depths ranging between 8.85 feet to 10.90 feet below top-of-casing. Based on groundwater measurements and observations, groundwater is expected to flow west toward the East River.
  - VOCs, including 1,2-dichloroethane (maximum of 0.38 micrograms per liter (µg/l), acetone (maximum of 11 µg/l), chloroform (maximum of 2.4 µg//l), and trichloroethene (TCE – maximum of 0.29 µg/l), were detected at concentrations below the SGVs.
  - SVOCs, including benzo(a)anthracene (maximum of 0.06 µg/L), benzo(a)pyrene (maximum of 0.07 µg/L), benzo(b)fluoranthene (maximum of 0.06 µg/L), benzo(k)fluoranthene (maximum of 0.06 µg/L), chrysene (maximum of 0.07 µg/L), and indeno(1,2,3-c,d)pyrene (maximum of 0.05 µg/L), were detected at concentrations above the SGVs in groundwater within the southern portion of the site.
  - Total metals, including arsenic (maximum of 25.13 µg/L), barium (maximum of 1,298 µg/L), beryllium (maximum of 8.01 µg/L), trivalent chromium (maximum of 292.8 µg/L), copper (maximum of 470.4 µg/L), iron (maximum of 165,000 µg/L), lead (maximum of 1,639 µg/L), magnesium (maximum of 86,000 µg/L), manganese (maximum of 6,322 µg/L), mercury (maximum of 1.88 µg/L), nickel (maximum of 218.6 µg/L), selenium (maximum of 23.3 µg/L), sodium (maximum of 760,000 µg/L), and thallium (maximum of 1.28 µg/L), were detected at concentrations above the SGVs. Arsenic, barium, beryllium, chromium, trivalent chromium, copper, lead, mercury, nickel, selenium, and thallium were not detected in dissolved concentrations; therefore, these concentrations are likely associated with entrained sediments in groundwater.

    - Dissolved metals, including iron (maximum of 644 μg/L), magnesium (maximum of 43,000 μg/L), manganese (maximum of 3,216 μg/L), and sodium (maximum of 832,000 μg/L) were detected at concentrations above the SGVs. These compounds are likely associated with regional conditions.
    - Pesticides and herbicides were not detected above the SGVs in groundwater samples.
- Soil vapor samples were evaluated using the New York State Department of Health (NYSDOH) Final Guidance on Soil Vapor Intrusion (May 2017) Matrices A, B, and C.
    - Several petroleum-related and chlorinated VOCs were detected in soil vapor samples. The total VOC concentrations ranged from 254.8 to 582.6 micrograms per cubic meter.
    - VOCs, including PCE, TCE, methylene chloride, and carbon tetrachloride, were detected at concentrations below the minimum concentration at which mitigation is recommended.

2.5 Areas of Concern

Based on site observations, the site development history, and the findings of the previous environmental investigations, Areas of Concern (AOCs) that require further investigation include the following:

2.5.1 AOC 1: Former Floor Trenches

Trenches were historically used for electrical wiring associated with heavy machinery. During a Phase II investigation performed in March 1998, metals, including chromium, lead, and mercury, were detected above the NYSDEC TAGM guidelines, the applicable standard at the time. In addition, metal shavings were observed in the trenches. The 1998 Corrective Action included the excavation of metals-impacted soil from the trenches. Residual metals impacts may still be present within the former trench areas.

2.5.2 AOC 2: Approximate Location of Former No. 2 Fuel Oil Tank

A former UST was situated within the southwest corner of the site. A spill was reported in connection with the UST based on the levels of total petroleum hydrocarbon concentrations identified during the March 1998 Phase II ESI. Spill No. 9800302 was closed following the removal of petroleum-impacted soil from the former UST area. These historical impacts may have adversely impacted soil, soil vapor, and/or groundwater.

2.5.3 AOC 3: Site Use – Plastic Hanger Manufacturing (1970-1977) and Machine Shop (1998 – Present)

The site's current and historical use includes a plastic hanger manufacturer (1970-1977) and a machine shop (circa 1998 to present). Remediation in the machine shop is documented in the Remedial Corrective Action Report, dated May 1998. Endpoint samples were analyzed for chromium, lead, and mercury only. Accidental releases of other contaminants that may have been used during historical and current operations, including solvents, petroleum products, and/or other hazardous substances may have adversely impacted groundwater, soil, and/or soil vapor.

3.0 SCOPE OF WORK

The objective of this RI is to further investigate and characterize the nature and extent of the contamination in all media at or emanating from the site; generate sufficient data to evaluate the remedial action alternatives; and generate sufficient data to evaluate the actual and potential threats to human health and the environment The scope of work presented in this RIWP addresses potential contamination within the boundary of the site, per Environmental Conservation Law Article 27, Title 14 (Brownfield Legislation). The field investigation will include the listed tasks to supplement the data and findings of previous investigations. Tenant space is anticipated to be occupied during the remedial investigation. The rationale for each investigation point in relation to the AOCs is provided in Table 1. The proposed sample locations are shown on Figure 5. These tasks are discussed in more detail in the following sections.

<u>Soil Boring Advancement and Soil Sampling (Section 3.1)</u>

- 12 soil borings (SP-01 through SP-03, SP-05, SP-07, SP-08, SP-12, and SP-14 through SP-18) will be advanced to the top of bedrock (estimated at 20 feet below sidewalk grade).
- Up to four soil samples will be collected from each soil boring, plus quality assurance/quality control [QA/QC] samples.

<u>Monitoring Well Installation and Groundwater Sampling (Section 3.2)</u>

- Four permanent groundwater monitoring wells (MW-03, MW-05, MW-07, and MW-14) will be installed within the corresponding soil borings. One groundwater sample will be collected from each monitoring well, including the permanent wells that were installed during the March 2019 Subsurface Investigation, plus QA/QC samples.
- The monitoring wells will be surveyed and gauged to evaluate groundwater flow direction.

<u>Soil Vapor Sampling (Section 3.3)</u>

- Four sub-surface soil vapor sample points (SV-03, SV-05, SV-07, and SV-14) and four sub-slab soil vapor sample points (SV-02, SV-06, SV-08, and SV-12) will be installed within about 2 inches below the concrete slab and to the shallower of two feet above the groundwater table or two feet above bedrock, respectively.

Modifications to this scope of work may be required: 1) due to site operations, equipment, or restrictions; 2) in the event that unexpected contamination is detected and additional analytical data is needed; and 3) to confirm that impacts are adequately characterized and delineated in compliance with the Brownfield Law, regulations, and applicable investigation guidance documents (e.g., DER-10).

The field investigation will be completed in accordance with the procedures specified in Langan's Health and Safety Plan (HASP) and Quality Assurance Project Plan (QAPP) provided in Appendices B and C, respectively.

Names, contact information, and roles of the principal personnel who will participate in the investigation, including the project manager, contractor, and subcontractor contacts are listed below. Resumes for each person are provided in the QAPP (Appendix C).

Personnel	Investigation Role	Contact Information
Michael D. Burke, PG, CHMM Langan Engineering	Project Director	Phone – 212-479-5413 Email – mburke@langan.com
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Stuart Knoop, PG Langan Engineering	Qualified Environmental Professional	Phone – 212-479-5461 Email- sknoop@langan.com
Andrew Schweitzer, P.E. Langan Engineering	Project Manager	Phone – 212-479-5598 Email – aschweitzer@langan.com
Tony Moffa, CHMM Langan Engineering	Langan Health & Safety Officer	Phone – 215-491-6500 Email – tmoffa@langan.com
William Bohrer Langan Engineering	Field Safety Officer & Quality Assurance Manager	Phone – 410-984-3068 Email – wbohrer@langan.com
Sherief Saleh Langan Engineering	Field Team Leader	Phone – 212-479-5593 Email – ssaleh@langan.com
Emily Strake, CEP Langan Engineering	Data Validator	Phone – 215-491-6500 Email – estrake@langan.com

3.1 Soil Investigation

3.1.1 Soil Boring Drilling and Logging

An environmental drilling subcontractor will advance seven soil borings. The purpose of these borings is to further investigate the AOCs identified in Section 2.5. A plan showing the proposed boring locations is provided as Figure 5. Langan personnel will document the work, screen the soil samples for environmental impacts, and collect environmental samples for laboratory analyses. Work will comply with the safety guidelines outlined in the HASP (Appendix B).

The 12 soil borings (SP-01 through SP-03, SP-05, SP-07, SP-08, SP-12, and SP-14 through SP-18) will be advanced to the top of bedrock (estimated at 20 feet below sidewalk grade). Soil borings

SP-01 and SP-02 will be advanced in the approximate locations of former borings SP-01 and SP-02 (which were installed during the March 2019 Subsurface Investigation). Refusal was encountered at these locations between 2 to 3 feet bgs, so the new borings will aid in further delineating subsurface conditions at these locations. The soil boings will be advanced using direct-push (i.e., Geoprobe) drilling equipment. Sonic drilling equipment may be used if sub-surface conditions (e.g., boulders, concrete, or other obstructions) prevent direct-push advancement to target depths. Non-disposable, down-hole drilling and sampling equipment will be decontaminated between locations with Alconox® and water.

Soil will be screened continuously to the boring termination depth for organic vapors with a PID equipped with a 10.6 electron volt (eV) bulb, and for visual and olfactory indications of environmental impacts (i.e. staining and odor). Soil descriptions will be recorded in a field log by a qualified field engineer or scientist reporting to the Qualified Environmental Professional (QEP).

3.1.2 Soil Sampling

Up to four grab soil samples will be collected for laboratory analysis from each boring. Representative soil samples will be collected for laboratory analysis within the historic fill material and from the capillary fringe. If field evidence of a chemical or petroleum release is apparent, additional samples will be collected from the interval(s) exhibiting the greatest degree of impact based on visual observations, odors, and PID readings above background and from the first interval that is free of apparent impacts.

The samples will be collected into laboratory-supplied containers and will be sealed, labeled, and placed in a cooler containing ice (to maintain a temperature of about 4 degrees Celsius) for delivery to a New York State Department of Health (NYSDOH) Environmental Laboratory Approval Program (ELAP)-certified analytical laboratory. Soil samples will be analyzed for VOCs, SVOCs, PCBs, pesticides (historic fill interval only), herbicides (historic fill interval only), Target Analyte List (TAL) metals (including hexavalent chromium), 1,4-dioxane, and NYSDEC-list per and poly-fluoroalkyl substances (PFAS). Samples will also be analyzed for QA/QC procedures to be followed are described in the QAPP provided as Appendix C.

3.2 Groundwater Investigation

3.2.1 Installation of Monitoring Wells

Four soil borings will be converted into permanent groundwater monitoring wells (MW-03, MW-05, MW-07, and MW-14). The wells will be constructed to straddle the observed water table. The wells will be constructed using 2-inch diameter, schedule-40 polyvinyl chloride (PVC) riser pipe with 10 feet of schedule 40 0.02-inch slotted screens. Clean sand (Morie #2) will be used to fill the annulus around the each well screen to a height of at least one foot above the top of the screened interval followed by a 2-to-3-foot hydrated bentonite seal. The remaining annular space will be filled with soil cuttings that do not display any environmental impacts and/or clean sand to 0.5 ft bgs. The wells will be finished with a protective, flush-mount or stick-up, bolt-down well cover set into a concrete collar.

The wells will be developed using a surge block across the well screen to agitate and remove fines. The surge block will be moved within the well screen in 2- to 3-foot increments for about 2 minutes per increment. After surging, the well will be purged via pumping until the water becomes clear (having turbidity less than 50 Nephelometric Turbidity Units [NTU]). The well will then be allowed to sit for a minimum of one week prior to collecting groundwater samples.

3.2.2 Monitoring Well Survey

The location and elevation of the groundwater monitoring wells (top of casing elevations) will be surveyed. This data will be used with the groundwater well gauging data to prepare a groundwater contour map and document the direction of apparent groundwater flow. Vertical control will be established by surveying performed relative to the NAVD88 datum by a land surveyor licensed in New York State. Elevations of the top of monitoring well casings and protective well casings will be surveyed to the nearest 0.01 foot.

3.2.3 Groundwater Sampling

One groundwater sample will be collected from each of the three proposed wells and the existing wells installed by Langan during the 2019 Subsurface Investigation. Prior to sampling, each well will be gauged with an interface probe to record a depth to groundwater to the nearest 1/100 foot. The thickness of light non-aqueous phase liquid (LNAPL) or dense non-aqueous phase liquid (DNAPL), if applicable, will be measured. Wells will be purged until the physical and chemical parameters (e.g., temperature, dissolved oxygen, oxygen reduction potential, and turbidity) stabilize within the ranges specified in the USEPA's Low Stress Purging and Sampling Procedure for the Collection of Groundwater Samples From Monitoring Wells, Dated July 30, 1996 and Revised January 19, 2010 prior to sampling. Samples will be collected with a peristaltic pump and dedicated high-density polyethylene tubing. The submersible pump will be decontaminated with Alconox® and water between each sample location. Development and purge water will be containerized for off-site disposal.

Groundwater samples will be analyzed for VOCs, SVOCs, pesticides, herbicides, PCBs, TAL metals (total and dissolved, including hexavalent chromium), 1,4-dioxane, and NYSDEC-list PFAS. QA/QC procedures are described in the QAPP provided in Appendix C. If either LNAPL and/or DNAPL are observed, appropriate samples will be collected using a bailer for characterization and "fingerprint analysis".

3.3 Soil Vapor Investigation

Soil vapor samples will be collected in accordance with the October 2006 NYSDOH Final Guidance for Evaluating Soil Vapor Intrusion in the State of New York. Four sub-surface soil vapor sample points (SV-03, SV-05, SV-07, and SV-14) and four sub-slab soil vapor sample points (SV-02, SV-06, SV-08, and SV-12) will be installed throughout the site. Soil vapor points will be installed with a Geoprobe® to a depth of about two feet above the groundwater table. The sub-slab vapor points will be installed below the existing building slab using a concrete core or hammer drill to about 2 inches beneath the base of the slab. Conditions in the field may require adjustment of sampling locations. Each sub-surface sampling point will consist of a new, dedicated polyethylene implant connected to polyethylene or Teflon tubing extending to the target depth. Each sub-slab sampling point will consist of Teflon tubing extending below the concrete slab. A sand filter pack will be placed around the screen implant or Teflon tubing, and the remaining annular space will be backfilled to grade with hydrated bentonite.

A pre-sample tracer gas test will be performed using helium gas as a QA/QC measure to confirm the integrity of the implant seals by evaluating if surface outdoor air intrusion will impact the soil vapor sample (i.e., that no "short circuiting" has occurred). The helium will be introduced into a container over the surface of the sampling location being tested. The edges of the container will be sealed to the surface with hydrated bentonite to maintain a high concentration of helium within the container. The sample tubing from the implant will extend out of the probe hole through an air-tight fitting installed on the container, and into a real-time helium monitoring instrument. Air will be drawn using a MultiRAE multi-gas monitor at a rate of less than 0.2 liters per minute, for a time-period ensuring at least three times the volume of the tubing and screen setup has been purged. The outlet air will be monitored using a real-time helium-monitoring instrument. Soil vapor sampling will occur if the leak check confirms a competent seal.

Following purging, each soil vapor point will be sampled using a laboratory-provided, 6-liter air canister. The sub-slab samples will be collected into individually-certified canisters. Sub-slab soil vapor samples will be equipped with 2-hour sample interval flow controllers. A sample log sheet will be maintained by a qualified field scientist or engineer under the oversight of a QEP. The sheet will summarize sample identification, date and time of sample collection, sampling depth, identity of samplers, sampling methods and devices, soil vapor purge volumes, volume of the soil vapor extracted, vacuum of canisters before and after the samples are collected, apparent moisture content of the sampling zone, and chain-of-custody protocols. Soil vapor samples will be analyzed for VOCs by EPA Method TO-15. QA/QC procedures to be followed are described in the QAPP provided as Appendix C. Following sampling, soil vapor sample points will undergo another leak check using helium tracer gas.

An ambient air sample will be collected from an exterior location at a height above the ground to represent the breathing zone (about 3 to 5 feet). The air sample will be collected over an 8-hour sampling period (concurrently with the soil vapor samples) and analyzed for VOCs by USEPA TO-15 to evaluate potential outdoor air interferences with the sampling apparatus.

An indoor air sample will be co-located with each sub-slab vapor sample, as described in Table 1, and collected over a 2-hour sampling period (concurrently with the sub-slab vapor samples) to evaluate potential vapor intrusion. The samples will be analyzed for VOCs by USEPA TO-15.

3.4 Data Management and Validation

Laboratory analyses of soil, soil vapor, and groundwater samples will be conducted by an NYSDOH, ELAP-approved laboratory in accordance with USEPA SW-846 methods and NYSDEC Analytical Services Protocol (ASP) B deliverable format. Environmental data will be reported electronically using the database software application EQuIS in comportment with the NYSDEC Environmental Information Management System (EIMS).

Table 1 summarizes the anticipated samples and requested laboratory analysis. QA/QC procedures required by the NYSDEC ASP and SW-846 methods, including initial and continuing instrument calibrations, standard compound spikes, surrogate compound spikes, and analysis of other samples (blanks, laboratory control samples, and matrix spikes/matrix spike duplicates), will be followed. The laboratory will provide sample bottles, which have been pre-cleaned and preserved in accordance with the SW-846 methods. Where there are differences in the SW-846 and NYSDEC ASP requirements, the NYSDEC ASP shall take precedence.

Data validation will be performed in accordance with the USEPA validation guidelines for organic and inorganic data review. Validation will include the following:

- Verification of QC sample results (both qualitative and quantitative);
- Verification of sample results (both positive hits and non-detects);
- Recalculation of 10% of all investigative sample results; and
- Preparation of Data Usability Summary Report (DUSR).

The DUSR will be prepared and reviewed by the Program Quality Assurance Monitor (PQAM) before issuance. The DUSR will present the results of data validation, including a summary assessment of laboratory data packages, sample preservation and chain-of-custody procedures, and a summary assessment of precision, accuracy, representativeness, comparability, and completeness for each analytical method. A detailed assessment of each sample delivery group (SDG) will follow. Additional details on the DUSR are provided in the QAPP in Appendix C.

3.5 Management of Investigation-Derived Waste

Soil cuttings and groundwater investigation-derived wastes (IDW) will be containerized and disposed properly at an off-site facility. Soils to be disposed off-site will be placed in 55-gallon, United Nations (UN)/Department of Transportation (DOT) approved drums. Decontamination and well development/purging fluids will be placed in UN/DOT approved fluid drums with closed tops. Drums will be properly labeled, sealed, and characterized as necessary. The drums will be staged in a secure area onsite, pending disposal to an appropriate disposal facility upon receipt of analytical results.

3.6 Air Monitoring

Air monitoring will be conducted for site workers and the community (Community Air Monitoring Program). Air monitoring results will be recorded in a field log during the investigation activities. Fugitive particulate (dust) generation that could affect site workers or the public is not expected for the following reasons:

- The work area is paved with concrete.
- Intrusive work is limited to boring, well, and soil vapor probe installation, which generates minimal volumes of soil.

3.6.1 Worker Air Monitoring

Air monitoring will be performed within the breathing zone periodically during drilling and sampling activities to document health and safety protection for the work team. A portable PID will be used to monitor the work zone and for periodic monitoring for VOCs during activities such as soil and groundwater sampling, in accordance with the HASP (Appendix B). If air monitoring during intrusive operations identifies VOCs, the guidelines outlined in the HASP regarding action levels, permissible exposure, engineering controls, and personal protective equipment will be followed. If the VOC action level is exceeded, work will cease and the work location will be evacuated. Monitoring will be continued until the levels drop to safe limits. At that time, work can resume with continued monitoring. If high levels persist, field activities will be halted and the work relocated to another area. If dust emissions are observed, work will stop and dust suppression measures will be used.

3.6.2 Community Air Monitoring Plan

In addition to air monitoring in the worker breathing zone, community air monitoring will be performed in compliance with the NYSDOH Generic Community Air Monitoring Plan (CAMP) and the Special Requirements CAMP procedures. The CAMP is addressed in the HASP (Appendix B).

Periodic monitoring for VOCs will be conducted during non-intrusive activities, such as the collection of groundwater samples. Periodic monitoring may include obtaining measurements upon arrival at a location, when opening a monitoring well cap, when bailing/purging a well, as well as upon departure from the location. Monitoring for VOCs will also be conducted during ground intrusive activities (i.e., soil boring and monitoring well installation). Upwind concentrations will be measured at the start of each workday, and periodically thereafter, to establish background concentrations. VOCs at the downwind perimeter of the work zone, which will be established at a point on the site where the general public or site employees may be present, will be monitored. Monitoring will be conducted with a PID equipped with a 10.6 eV lamp. VOC community air monitoring requirements will be conducted until intrusive field activities are complete.

Dust emissions will be monitored using real-time monitoring equipment capable of measuring particulate matter less than 10 micrometers in size (PM-10) and capable of integrating over a period of 15 minutes (or less) for comparison to the airborne particulate action level (e.g., DustTrak). If fugitive dust emissions are observed or if respirable particulates are measured above the action levels defined in the CAMP, work will stop and dust suppression measures will be used.

In situations where adjacent occupied buildings are within 20 feet of exterior ground intrusive activities, the CAMP will include the following additional requirements to ensure that occupants of the adjacent building are not exposed to site-related contaminants during investigation activities:

- An additional monitoring station will be placed between the work area and the walls of the occupied structures.
- Engineering controls, such as vapor/dust barriers or special ventilation devices, will be deployed, as necessary.
- Special consideration will be given to scheduling ground intrusive activities at times when potentially exposed populations may not be occupying the building.
- If total VOC concentrations near the outside walls of occupied structures or next to intake vents are found to exceed 1 ppm, monitoring will occur within the occupied structure, as permitted by the building owner.
- If total particulate concentrations near the outside walls of occupied structures or next to intake vents exceed 150 $\mu g/m^3$, work activities will be suspended until controls are implemented.

3.7 Qualitative Human Health Exposure Assessment

A Qualitative Human Health Exposure Assessment will be conducted in accordance with Appendix 3B of the NYSDEC DER-10, Technical Guidance for Site Investigation and Remediation. The assessment will be submitted in the Remedial Investigation Report.

4.0 REMEDIAL INVESTIGATION REPORT

Following completion of the RI and receipt of analytical data, a Remedial Investigation Report (RIR) will be prepared. The report will include: 1) a summary of the site history and previous investigations; 2) description of site conditions and this RI; 3) evaluation of the results and findings; and 4) conclusions and recommendations. Additionally, the Standards, Criteria, and Guidance (SCGs) which pertain to the site location and contaminants, as well as potential remedial action objectives, will be identified in the report. The soil boring, monitoring well, and soil vapor point construction logs, sampling logs, and laboratory analytical reports will be appended to the report. Conclusions and recommendations will be provided that: 1) summarize the nature and extent of potential impact for each area of concern; 2) identify unacceptable exposure pathways (as determined through a Qualitative Human Health Exposure Assessment); and 3) recommend future work or remedial actions, as required.

The sampling results that exceed unrestricted use and restricted use commercial soil SCOs, the groundwater standards, or other applicable unrestricted SCGs, will be summarized in tables (organized by areas of concern). The tables will include sample location, media sampled, sample depth, field/laboratory identification numbers, analytical results, and the applicable unrestricted SCG for comparison. Scaled site maps will be used to show the boring, monitoring well, and soil vapor sample point locations, SCG exceedances, groundwater elevation contours, groundwater flow direction, and, if appropriate, groundwater contaminant concentration contours.

5.0 SCHEDULE

The table below presents an estimated schedule for the proposed remedial investigation and reporting. If the schedule changes, it will be updated and submitted to NYSDEC.

Schedule Milestone	Anticipated Start Date	Duration (weeks)
RI Mobilization and Field Work (drilling, well and probe installation, surveying, sampling)	September 2020	3
Laboratory Analysis	September 2020	3
RI Report Preparation	September-October 2020	8
RI Report Submittal	December 2020	-

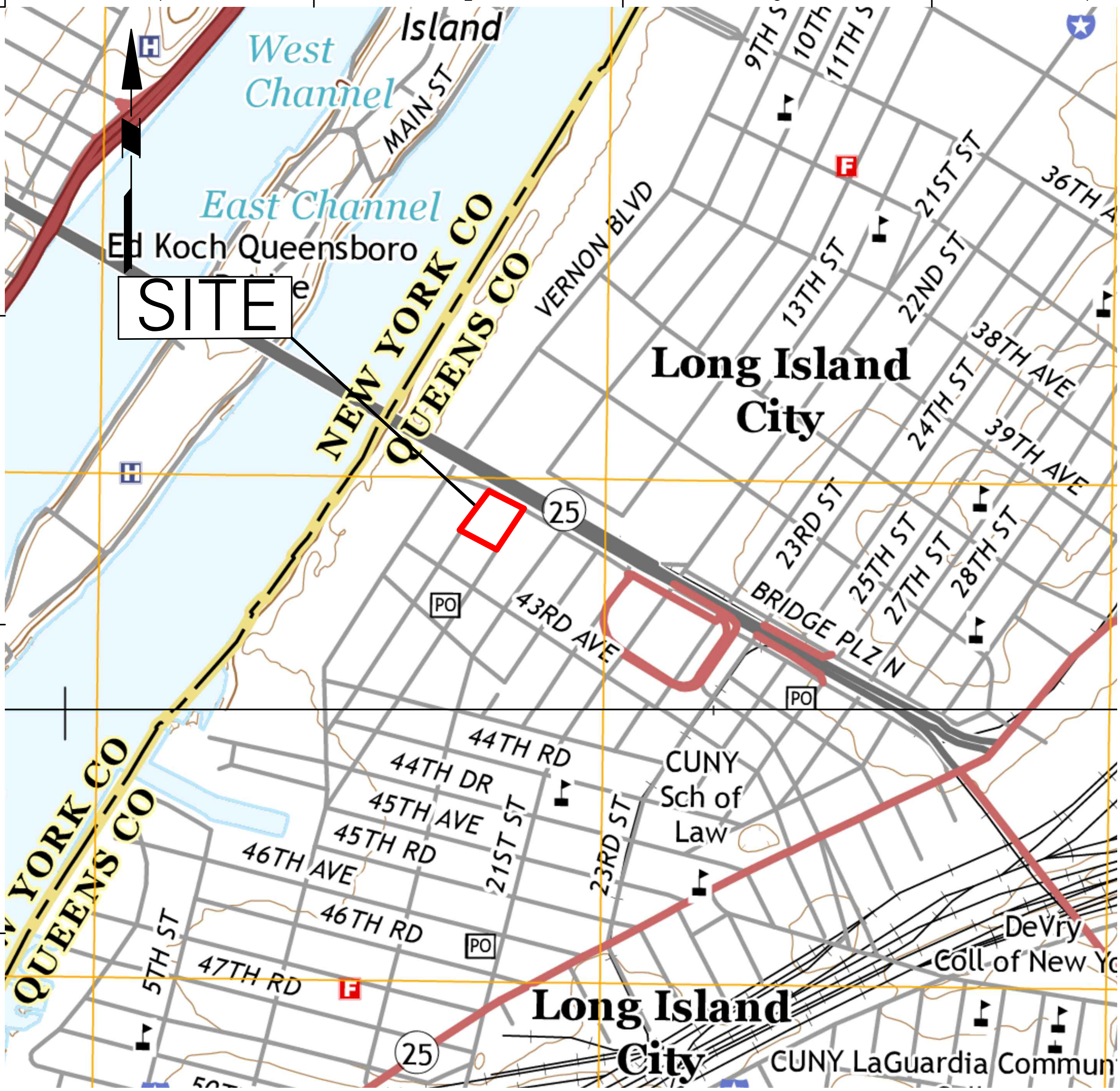
TABLES

Table 1 - Summary of Soil, Groundwater, and Soil Vapor Samples
42-11 9th Street
Long Island City, New York
Langan Project No. 170514701

No.	Sample Name	Sample Location	Sample Depth	Rationale	Analysis
SOIL					
1	SP-01_X-X	SP-01	Historic Fill	Investigate AOC 3	TCL VOCs, SVOCs, PCBs, pesticides (Historic Fill interval only), herbicides (Historic Fill interval only), TAL metals (including hexavalent chromium), 1,4-dioxane, and NYSDEC-list PFAS.
2	SP-01_X-X		Capillary Fringe		
3	SP-01_X-X		Greatest Impacts, if present		
4	SP-01_X-X		Below Impacts, if present		
5	SP-02_X-X	SP-02	Historic Fill	Investigate AOC 3	
6	SP-02_X-X		Capillary Fringe		
7	SP-02_X-X		Greatest Impacts, if present		
8	SP-02_X-X		Below Impacts, if present		
9	SP-03_X-X	SP-03	Historic Fill	Investigate AOC 3	
10	SP-03_X-X		Capillary Fringe		
11	SP-03_X-X		Greatest Impacts, if present		
12	SP-03_X-X		Below Impacts, if present		
13	SP-05_X-X	SP-05	Historic Fill	Investigate AOC 3	
14	SP-05_X-X		Capillary Fringe		
15	SP-05_X-X		Greatest Impacts, if present		
16	SP-05_X-X		Below Impacts, if present		
17	SP-07_X-X	SP-07	Historic Fill	Investigte AOC 1	
18	SP-07_X-X		Capillary Fringe		
19	SP-07_X-X		Greatest Impacts, if present		
20	SP-07_X-X		Below Impacts, if present		
21	SP-08_X-X	SP-08	Historic Fill	Investigate AOC 3	
22	SP-08_X-X		Capillary Fringe		
23	SP-08_X-X		Greatest Impacts, if present		
24	SP-08_X-X		Below Impacts, if present		
25	SP-12_X-X	SP-12	Historic Fill	Investigate AOC 3	
26	SP-12_X-X		Capillary Fringe		
27	SP-12_X-X		Greatest Impacts, if present		
28	SP-12_X-X		Below Impacts, if present		
29	SP-14_X-X	SP-14	Historic Fill	Investigate AOC 2	
30	SP-14_X-X		Capillary Fringe		
31	SP-14_X-X		Greatest Impacts, if present		
32	SP-14_X-X		Below Impacts, if present		
33	SP-15_X-X	SP-15	Historic Fill	Investigate AOC 1	
34	SP-15_X-X		Capillary Fringe		
35	SP-15_X-X		Greatest Impacts, if present		
36	SP-15_X-X		Below Impacts, if present		
37	SP-16_X-X	SP-16	Historic Fill	Investigate AOC 1	
38	SP-16_X-X		Capillary Fringe		
39	SP-16_X-X		Greatest Impacts, if present		
40	SP-16_X-X		Below Impacts, if present		
41	SP-17_X-X	SP-17	Historic Fill	Investigate AOC 1	
42	SP-17_X-X		Capillary Fringe		
43	SP-17_X-X		Greatest Impacts, if present		
44	SP-17_X-X		Below Impacts, if present		
45	SP-18_X-X	SP-18	Historic Fill	Investigate AOC 1	
46	SP-18_X-X		Capillary Fringe		
47	SP-18_X-X		Greatest Impacts, if present		
48	SP-18_X-X		Below Impacts, if present		
49	SODUP01_DATE	TBD	TBD	QA/QC	
50	SODUP02_DATE	TBD	TBD		
51	SODUP03_DATE	TBD	TBD		
52	MS/MSD-SO01_DATE	TBD	TBD		
53	MS/MSD-SO02_DATE	TBD	TBD		
54	MS/MSD-SO03_DATE	TBD	TBD		
55	FB01_DATE	NA	NA		
56	FB02_DATE				
57	TB01_DATE				TCL VOCs
58	TB02_DATE				
59	TB03_DATE				
60	TB04_DATE				
61	TB05_DATE				
GROUNDWATER					
1	MW-03_DATE	MW-03	Center of well screen	Investigate AOC 3	TCL VOCs, SVOCs, pesticides, herbicides, PCBs, TAL metals (total and dissolved, including hexavalent chromium), 1,4-dioxane, and NYSDEC-list PFAS.
2	MW-05_DATE	MW-05		Investigate AOC 3	
3	MW-07_DATE	MW-07		Investigate AOC 1	
4	MW-14_DATE	MW-14		Investigate AOC 2	
5	GWDUP01_DATE	TBD		QA/QC	
6	MS/MSD-GW01_DATE	TBD			
7	GWFB01_DATE	NA	NA		
8	GWTB01_DATE				TCL VOCs
SOIL VAPOR					
1	SV-02_DATE	SV-02	Two feet above the groundwater table	Investigate AOC 3	TO-15 VOCs
2	SV-03_DATE	SV-03		Investigate AOC3	
3	SV-05_DATE	SV-05		Investigate AOC 3	
4	SV-06_DATE	SV-06		Investigate AOC 1	
5	SV-07_DATE	SV-07		Investigate AOC 1	
6	SV-10_DATE	SV-10		Investigate AOC 3	
7	SV-14_DATE	SV-14		Investigate AOC 2	

Notes:
1. Soil samples analyzed for VOCs will be collected using Encore or Terra Core sampler kits.
2. VOCs- = Volatile Organic Compounds
5. SVOCs = Semivolatile Organic Compounds
6. PCBs = Polychlorinated Biphenyls
5. AOC = Area of Concern
7. TCL = Target Compound list
8. TAL = Target Analyte List
9. TBD = To Be Determined
10. QA/QC = Quality Assurance/Quality Control
11. NYSDEC = New York State Department of Environmental Conservation
12. PFAS = Per and poly-fluoroalkyl substances
13. NA = Not Applicable

FIGURES



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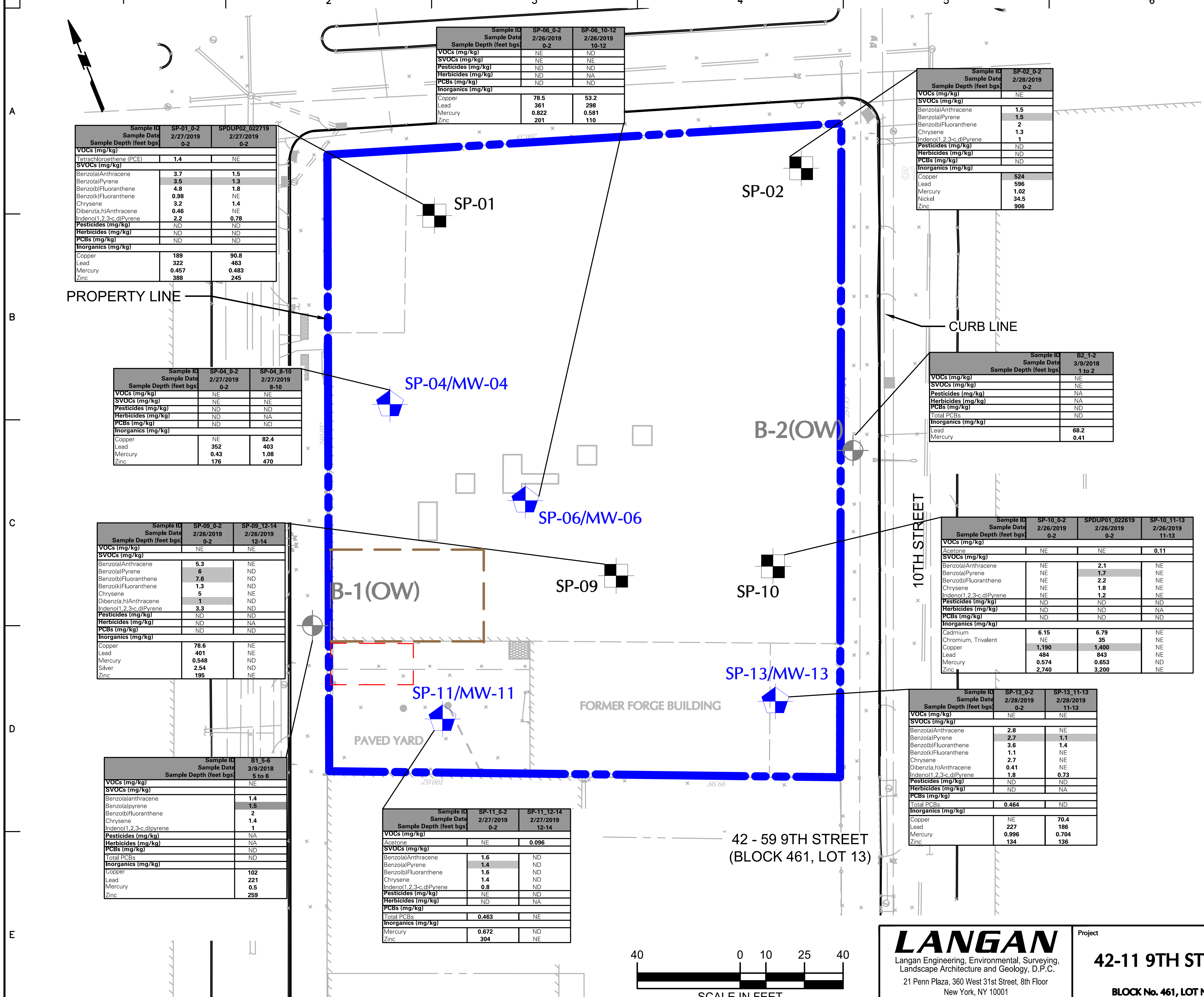
SCALE IN FEET

LANGAN	Project	Figure Title	Project No. 170514701	Figure No.
Langan Engineering, Environmental, Surveying, Landscape Architecture and Geology, D.P.C. 21 Penn Plaza, 360 West 31st Street, 8th Floor New York, NY 10001 T: 212.479.5400 F: 212.479.5444 www.langan.com	**42-11 9TH STREET** BLOCK No. 461, LOT No. 16 LONG ISLAND CITY QUEENS NEW YORK	**SITE LOCATION MAP**	Date 10/3/2019 Drawn By SS Checked By AS	**1** Figure 1 of 5

Filename: \\langan.com\data\NYC\data7\170514701\Project Data\CAD\01\SheetFiles\Environmental\CPP\Fig X - Ste Location.dwg Date: 10/9/2019 Time: 17:18 User: ruribe Style Table: Langan.stb Layout: ANSIA-BP



Sample ID / Sample Date / Sample Depth (feet bgs)	SP-06_0-2 / 2/26/2019 / 0-2	SP-06_10-12 / 2/26/2019 / 10-12
VOCs (mg/kg)	NE	ND
SVOCs (mg/kg)	NE	NE
Pesticides (mg/kg)	ND	ND
Herbicides (mg/kg)	ND	NA
PCBs (mg/kg)	ND	ND
Inorganics (mg/kg)		
Copper	**78.5**	**53.2**
Lead	**361**	**298**
Mercury	**0.822**	**0.581**
Zinc	**201**	**110**

Sample ID / Sample Date / Sample Depth (feet bgs)	SP-01_0-2 / 2/27/2019 / 0-2	SPDUP02_022719 / 2/27/2019 / 0-2
VOCs (mg/kg)		
Tetrachloroethene (PCE)	**1.4**	NE
SVOCs (mg/kg)		
Benzo(a)Anthracene	**3.7**	**1.5**
Benzo(a)Pyrene	**3.5**	**1.3**
Benzo(b)Fluoranthene	**4.8**	**1.8**
Benzo(k)Fluoranthene	**0.98**	NE
Chrysene	**3.2**	**1.4**
Dibenz(a,h)Anthracene	**0.46**	NE
Indeno(1,2,3-c,d)Pyrene	**2.2**	**0.78**
Pesticides (mg/kg)	ND	ND
Herbicides (mg/kg)	ND	ND
PCBs (mg/kg)	ND	ND
Inorganics (mg/kg)		
Copper	**189**	**90.8**
Lead	**322**	**463**
Mercury	**0.457**	**0.483**
Zinc	**388**	**245**

Sample ID / Sample Date / Sample Depth (feet bgs)	SP-02_0-2 / 2/28/2019 / 0-2
VOCs (mg/kg)	NE
SVOCs (mg/kg)	
Benzo(a)Anthracene	**1.5**
Benzo(a)Pyrene	**1.5**
Benzo(b)Fluoranthene	**2**
Chrysene	**1.3**
Indeno(1,2,3-c,d)Pyrene	**1**
Pesticides (mg/kg)	ND
Herbicides (mg/kg)	ND
PCBs (mg/kg)	ND
Inorganics (mg/kg)	
Copper	**524**
Lead	**596**
Mercury	**1.02**
Nickel	**34.5**
Zinc	**906**

Sample ID / Sample Date / Sample Depth (feet bgs)	B2_1-2 / 3/9/2018 / 1 to 2
VOCs (mg/kg)	NE
SVOCs (mg/kg)	NE
Pesticides (mg/kg)	NA
Herbicides (mg/kg)	NA
PCBs (mg/kg)	ND
Total PCBs	ND
Inorganics (mg/kg)	
Lead	**68.2**
Mercury	**0.41**

Sample ID / Sample Date / Sample Depth (feet bgs)	SP-04_0-2 / 2/27/2019 / 0-2	SP-04_8-10 / 2/27/2019 / 8-10
VOCs (mg/kg)	NE	NE
SVOCs (mg/kg)	NE	NE
Pesticides (mg/kg)	ND	ND
Herbicides (mg/kg)	ND	NA
PCBs (mg/kg)	ND	ND
Inorganics (mg/kg)		
Copper	NE	**82.4**
Lead	**352**	**403**
Mercury	**0.43**	**1.08**
Zinc	**176**	**470**

Sample ID / Sample Date / Sample Depth (feet bgs)	SP-09_0-2 / 2/26/2019 / 0-2	SP-09_12-14 / 2/26/2019 / 12-14
VOCs (mg/kg)	NE	NE
SVOCs (mg/kg)		
Benzo(a)Anthracene	**5.3**	NE
Benzo(a)Pyrene	**6**	ND
Benzo(b)Fluoranthene	**7.6**	ND
Benzo(k)Fluoranthene	**1.3**	ND
Chrysene	**5**	NE
Dibenz(a,h)Anthracene	**1**	ND
Indeno(1,2,3-c,d)Pyrene	**3.3**	ND
Pesticides (mg/kg)	ND	ND
Herbicides (mg/kg)	ND	NA
PCBs (mg/kg)	ND	ND
Inorganics (mg/kg)		
Copper	**78.6**	NE
Lead	**401**	NE
Mercury	**0.548**	ND
Silver	**2.54**	ND
Zinc	**195**	NE

Sample ID / Sample Date / Sample Depth (feet bgs)	SP-10_0-2 / 2/26/2019 / 0-2	SPDUP01_022619 / 2/26/2019 / 0-2	SP-10_11-13 / 2/26/2019 / 11-13
VOCs (mg/kg)			
Acetone	NE	NE	**0.11**
SVOCs (mg/kg)			
Benzo(a)Anthracene	NE	**2.1**	NE
Benzo(a)Pyrene	NE	**1.7**	NE
Benzo(b)Fluoranthene	NE	**2.2**	NE
Chrysene	NE	**1.8**	NE
Indeno(1,2,3-c,d)Pyrene	NE	**1.2**	NE
Pesticides (mg/kg)	ND	ND	ND
Herbicides (mg/kg)	ND	ND	NA
PCBs (mg/kg)	ND	ND	ND
Inorganics (mg/kg)			
Cadmium	**6.15**	**6.79**	NE
Chromium, Trivalent	NE	**35**	NE
Copper	**1,190**	**1,400**	NE
Lead	**484**	**843**	NE
Mercury	**0.574**	**0.653**	ND
Zinc	**2,740**	**3,200**	NE

Sample ID / Sample Date / Sample Depth (feet bgs)	SP-13_0-2 / 2/28/2019 / 0-2	SP-13_11-13 / 2/28/2019 / 11-13
VOCs (mg/kg)	NE	NE
SVOCs (mg/kg)		
Benzo(a)Anthracene	**2.8**	NE
Benzo(a)Pyrene	**2.7**	**1.1**
Benzo(b)Fluoranthene	**3.6**	**1.4**
Benzo(k)Fluoranthene	**1.1**	NE
Chrysene	**2.7**	NE
Dibenz(a,h)Anthracene	**0.41**	NE
Indeno(1,2,3-c,d)Pyrene	**1.8**	**0.73**
Pesticides (mg/kg)	ND	ND
Herbicides (mg/kg)	ND	NA
PCBs (mg/kg)		
Total PCBs	**0.464**	ND
Inorganics (mg/kg)		
Copper	NE	**70.4**
Lead	**227**	**186**
Mercury	**0.996**	**0.704**
Zinc	**134**	**136**

Sample ID / Sample Date / Sample Depth (feet bgs)	B1_5-6 / 3/9/2018 / 5 to 6
VOCs (mg/kg)	NE
SVOCs (mg/kg)	
Benzo(a)anthracene	**1.4**
Benzo(a)pyrene	**1.5**
Benzo(b)fluoranthene	**2**
Chrysene	**1.4**
Indeno(1,2,3-c,d)pyrene	**1**
Pesticides (mg/kg)	NA
Herbicides (mg/kg)	NA
PCBs (mg/kg)	ND
Total PCBs	ND
Inorganics (mg/kg)	
Copper	**102**
Lead	**221**
Mercury	**0.5**
Zinc	**259**

Sample ID / Sample Date / Sample Depth (feet bgs)	SP-11_0-2 / 2/27/2019 / 0-2	SP-11_12-14 / 2/27/2019 / 12-14
VOCs (mg/kg)		
Acetone	NE	**0.096**
SVOCs (mg/kg)		
Benzo(a)Anthracene	**1.6**	ND
Benzo(a)Pyrene	**1.4**	ND
Benzo(b)Fluoranthene	**1.6**	ND
Chrysene	**1.4**	ND
Indeno(1,2,3-c,d)Pyrene	**0.8**	ND
Pesticides (mg/kg)	NE	ND
Herbicides (mg/kg)	ND	NA
PCBs (mg/kg)		
Total PCBs	**0.463**	NE
Inorganics (mg/kg)		
Mercury	**0.672**	ND
Zinc	**304**	NE

LEGEND

SP-11 — 2019 SOIL BORING LOCATION

SP-12/MW-12 — 2019 SOIL BORING/MONITORING WELL LOCATION

B-1 — 2018 GEOTECHNICAL SOIL BORING

APPROXIMATE LOCATION OF FORMER UNDERGROUND STORAGE TANKS

APPROXIMATE LOCATION OF FORMER TRENCHES

APPROXIMATE EXTENTS OF EXISTING PARTIAL CELLAR

Analyte	CAS Number	NYSDEC Part 375 Unrestricted Use SCOs	NYSDEC Part 375 Restricted Use Commercial SCOs
VOCs (mg/kg)			
Acetone	67-64-1	0.05	500
Tetrachloroethene (PCE)	127-18-4	1.3	150
SVOCs (mg/kg)			
Benzo(a)Anthracene	56-55-3	1	5.6
Benzo(a)Pyrene	50-32-8	1	1
Benzo(b)Fluoranthene	205-99-2	1	5.6
Benzo(k)Fluoranthene	207-08-9	0.8	56
Chrysene	218-01-9	1	56
Dibenz(a,h)Anthracene	53-70-3	0.33	0.56
Indeno(1,2,3-c,d)Pyrene	193-39-5	0.5	5.6
PCBs (mg/kg)			
Total PCBs	1336-36-3	0.1	1
Inorganics (mg/kg)			
Cadmium	7440-43-9	2.5	9.3
Chromium, Trivalent	16065-83-1	30	1,500
Copper	7440-50-8	50	270
Lead	7439-92-1	63	1,000
Mercury	7439-97-6	0.18	2.8
Nickel	7440-02-0	30	310
Silver	7440-22-4	2	1,500
Zinc	7440-66-6	109	10,000

GENERAL NOTES

1. ELEVATIONS ARE RELATIVE TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88), WHICH IS 1.1 FT ABOVE MEAN SEA LEVEL AT SANDY HOOK, NJ, U.S.C. & G SURVEY-DATUM.
2. BASE PLAN TAKEN FROM THE BOUNDARY AND TOPOGRAPHICAL SURVEY FOR 42-11 9TH STREET PREPARED BY CONTROL POINT ASSOCIATES INC, DATED 14 MARCH 2018.
3. SOIL SAMPLE ANALYTICAL RESULTS ARE COMPARED TO THE NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION (NYSDEC) TITLE 6 OF THE OFFICIAL COMPILATION OF NEW YORK CODES, RULES, AND REGULATIONS (NYCRR) PART 375 UNRESTRICTED USE AND RESTRICTED USE COMMERCIAL SOIL CLEANUP OBJECTIVES (SCO).
4. ANALYTES DETECTED WITH CONCENTRATIONS ABOVE THE NYSDEC PART 375 UNRESTRICTED USE SCOS ARE SHOWN IN BOLD.
5. ANALYTES DETECTED WITH CONCENTRATIONS ABOVE THE RESTRICTED USE COMMERCIAL SCOS ARE SHADED.
6. mg/kg = MILLIGRAMS PER KILOGRAM
7. VOCS = VOLATILE ORGANIC COMPOUNDS
8. SVOCS = SEMIVOLATILE ORGANIC COMPOUNDS
9. PCBS = POLYCHLORINATED BIPHENYLS
10. ND = NOT DETECTED
11. NE = DETECTED AT CONCENTRATION(S) NOT EXCEEDING SCOS.
12. NA = NOT ANALYZED

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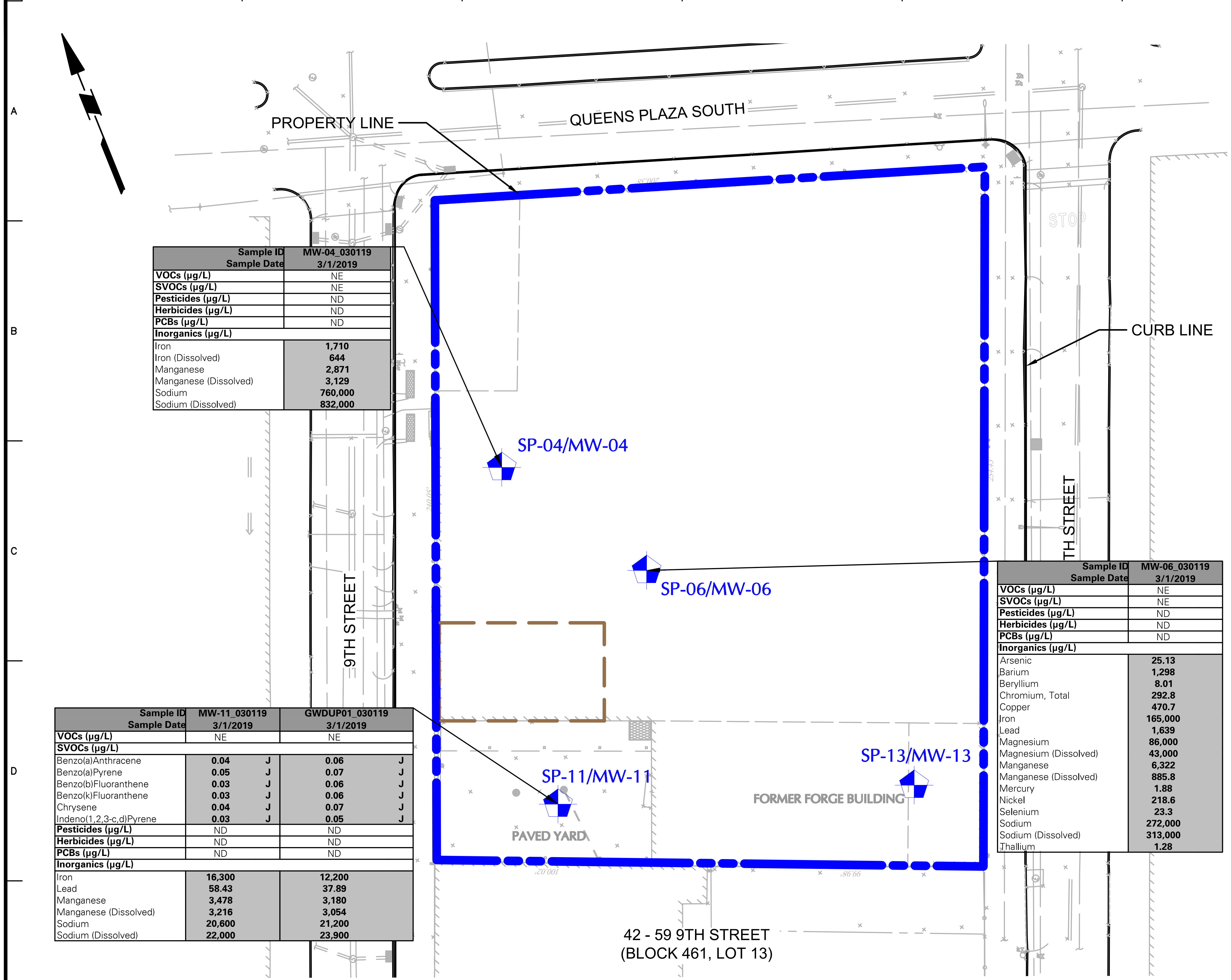
Project: 42-11 9TH STREET
BLOCK No. 461, LOT No.16
QUEENS NEW YORK

Figure Title: HISTORICAL SOIL SAMPLING RESULTS MAP

Project No. 170514701
Date 03/14/2019
Drawn By PS
Checked By TC

Figure No. 2

Filename: \\langan.com\data\NYC\data7\170514701\Project Data\CAD\01\SheetFiles\Environmental\BCP\Figure 2 - Historical Soil Sampling Results Map_3.24.2020.dwg Date: 3/25/2020 Time: 11:58 User: ksaxena Style Table: Langan.stb Layout: As-Built 3-1-19



Sample ID	MW-04_030119
Sample Date	3/1/2019
VOCs (µg/L)	NE
SVOCs (µg/L)	NE
Pesticides (µg/L)	ND
Herbicides (µg/L)	ND
PCBs (µg/L)	ND
Inorganics (µg/L)	
Iron	**1,710**
Iron (Dissolved)	**644**
Manganese	**2,871**
Manganese (Dissolved)	**3,129**
Sodium	**760,000**
Sodium (Dissolved)	**832,000**

Sample ID	MW-06_030119
Sample Date	3/1/2019
VOCs (µg/L)	NE
SVOCs (µg/L)	NE
Pesticides (µg/L)	ND
Herbicides (µg/L)	ND
PCBs (µg/L)	ND
Inorganics (µg/L)	
Arsenic	**25.13**
Barium	**1,298**
Beryllium	**8.01**
Chromium, Total	**292.8**
Copper	**470.7**
Iron	**165,000**
Lead	**1,639**
Magnesium	**86,000**
Magnesium (Dissolved)	**43,000**
Manganese	**6,322**
Manganese (Dissolved)	**885.8**
Mercury	**1.88**
Nickel	**218.6**
Selenium	**23.3**
Sodium	**272,000**
Sodium (Dissolved)	**313,000**
Thallium	**1.28**

Sample ID	MW-11_030119		GWDUP01_030119	
Sample Date	3/1/2019		3/1/2019	
VOCs (µg/L)	NE		NE	
SVOCs (µg/L)				
Benzo(a)Anthracene	**0.04**	**J**	**0.06**	**J**
Benzo(a)Pyrene	**0.05**	**J**	**0.07**	**J**
Benzo(b)Fluoranthene	**0.03**	**J**	**0.06**	**J**
Benzo(k)Fluoranthene	**0.03**	**J**	**0.06**	**J**
Chrysene	**0.04**	**J**	**0.07**	**J**
Indeno(1,2,3-c,d)Pyrene	**0.03**	**J**	**0.05**	**J**
Pesticides (µg/L)	ND		ND	
Herbicides (µg/L)	ND		ND	
PCBs (µg/L)	ND		ND	
Inorganics (µg/L)				
Iron	**16,300**		**12,200**	
Lead	**58.43**		**37.89**	
Manganese	**3,478**		**3,180**	
Manganese (Dissolved)	**3,216**		**3,054**	
Sodium	**20,600**		**21,200**	
Sodium (Dissolved)	**22,000**		**23,900**	

LEGEND

SP-12/MW-12 — 2019 SOIL BORING/MONITORING WELL LOCATION

APPROXIMATE EXTENTS OF EXISTING PARTIAL CELLAR

Analyte	CAS Number	NYSDEC SGVs
SVOCs (µg/L)		
Benzo(a)Anthracene	56-55-3	0.002
Benzo(a)Pyrene	50-32-8	0
Benzo(b)Fluoranthene	205-99-2	0.002
Benzo(k)Fluoranthene	207-08-9	0.002
Chrysene	218-01-9	0.002
Indeno(1,2,3-c,d)Pyrene	193-39-5	0.002
Inorganics (µg/L)		
Arsenic	7440-38-2	25
Barium	7440-39-3	1000
Beryllium	7440-41-7	3
Chromium, Total	7440-47-3	50
Copper	7440-50-8	200
Iron	7439-89-6	300
Lead	7439-92-1	25
Magnesium	7439-95-4	35000
Manganese	7439-96-5	300
Mercury	7439-97-6	0.7
Nickel	7440-02-0	100
Selenium	7782-49-2	10
Sodium	7440-23-5	20000
Thallium	7440-28-0	0.5

GENERAL NOTES

1. ELEVATIONS ARE RELATIVE TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88), WHICH IS 1.1 FT ABOVE MEAN SEA LEVEL AT SANDY HOOK, NJ, U.S.C. & G SURVEY-DATUM.
2. BASE PLAN TAKEN FROM THE BOUNDARY AND TOPOGRAPHICAL SURVEY FOR 42-11 9TH STREET PREPARED BY CONTROL POINT ASSOCIATES INC, DATED 14 MARCH 2018.
3. GROUNDWATER MONITORING WELLS WERE INSTALLED TO ABOUT 15 TO 20 FEET BELOW GRADE SURFACE (BGS). MONITORING WELLS CONSIST OF 2-INCH PVC SCREEN AND RISER PIPE.
4. GROUNDWATER SAMPLES WERE NOT COLLECTED FROM MW-13.
5. GROUNDWATER ANALYTICAL RESULTS WERE COMPARED TO NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION (NYSDEC) TITLE 6 OF THE OFFICIAL COMPLIATION OF NEW YOR CODES, RULES, AND REGULATIONS (NYCRR) PART 703.5 AND THE NYSDEC TECHNICAL AND OPERATIONAL GUIDANCE SERIES (TOGS) 1.1.1 AMBIENT WATER QUALITY STANDARDS AND GUIDANCE VALUES FOR CLASS GA WATER (NYSDEC SGVS).
6. ANALYTES DETECTED WITH CONCENTRATION ABOVE THE NYSDEC SGVS ARE BOLDED AND SHADED.
7. VOCS = VOLATILE ORGANIC COMPOUNDS
8. SVOCS = SEMIVOLATILE ORGANIC COMPOUNDS
9. PCBS = POLYCHLORINATED BIPHENYLS
10. µg/L = MICROGRAMS PER LITER
11. NE = DETECTED AT CONCENTRATION(S) NOT EXCEEDING THE TOGS 1.1.1 SGVS
12. ND = NOT DETECTED
13. J = THE ANALYTE WAS DETECTED ABOVE THE METHOD DETECTION LIMIT (MDL), BUT BELOW THE RL, THEREFORE, THE RESULT IS ESTIMATED

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Project
42-11 9TH STREET
BLOCK No. 461, LOT No.16
QUEENS NEW YORK

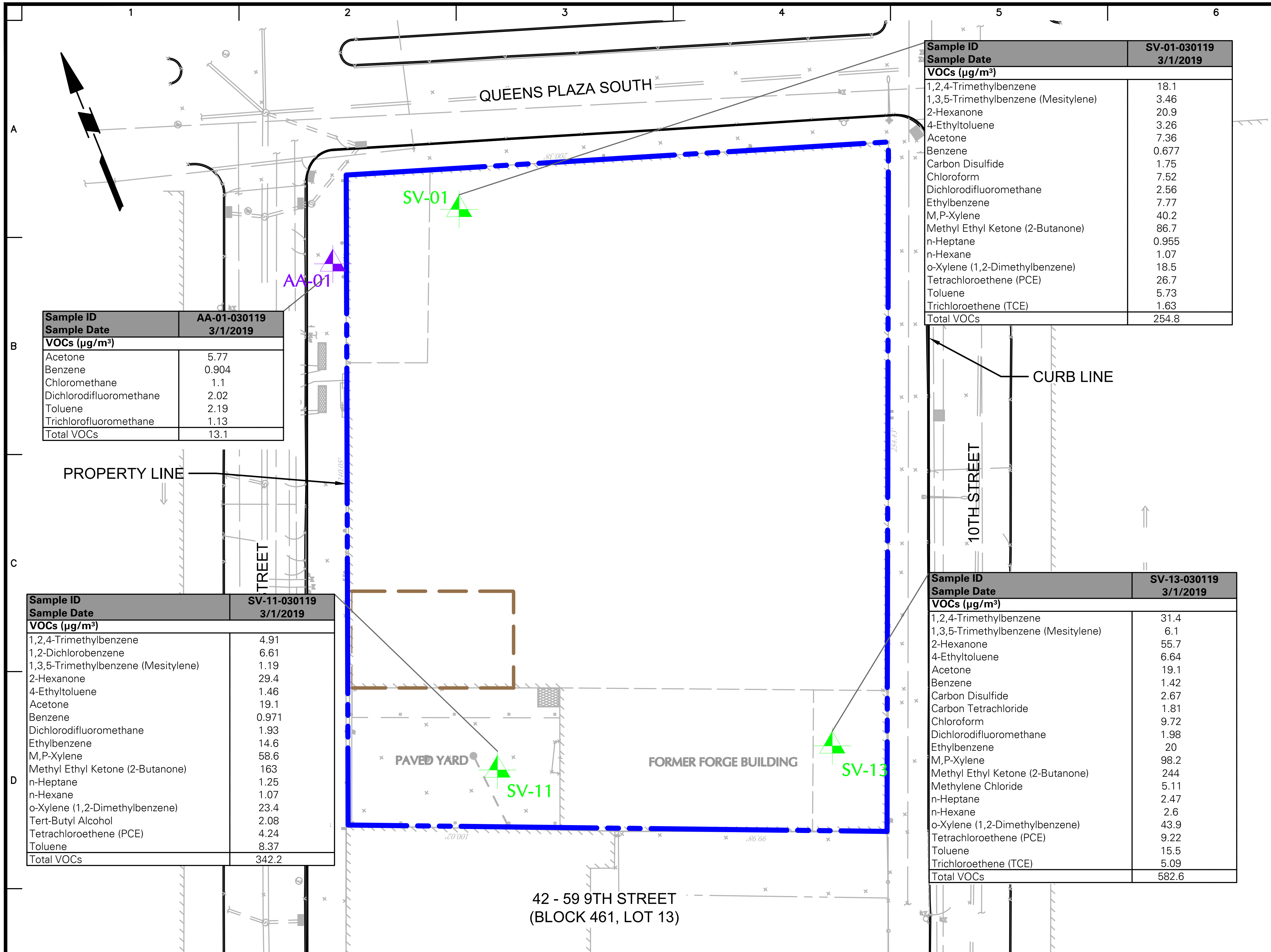
Figure Title
HISTORICAL GROUNDWATER SAMPLING RESULTS MAP

Project No. 170514701
Date 03/14/2019
Drawn By PS
Checked By TC

Figure No. 3

Figure 3 of 5

Filename: \\langan.com\data\NYC\data7\170514701\Project Data\CAD\01\SheetFiles\Environmental\BCP\Figure 3 - Historical Groundwater Sampling Results Map_ 3.24.2020.dwg Date: 3/25/2020 Time: 11:55 User: ksaxena Style Table: Langan.stb Layout: As-Built 3-1-19



Sample ID Sample Date	AA-01-030119 3/1/2019
VOCs (µg/m³)	
Acetone	5.77
Benzene	0.904
Chloromethane	1.1
Dichlorodifluoromethane	2.02
Toluene	2.19
Trichlorofluoromethane	1.13
Total VOCs	13.1

Sample ID Sample Date	SV-01-030119 3/1/2019
VOCs (µg/m³)	
1,2,4-Trimethylbenzene	18.1
1,3,5-Trimethylbenzene (Mesitylene)	3.46
2-Hexanone	20.9
4-Ethyltoluene	3.26
Acetone	7.36
Benzene	0.677
Carbon Disulfide	1.75
Chloroform	7.52
Dichlorodifluoromethane	2.56
Ethylbenzene	7.77
M,P-Xylene	40.2
Methyl Ethyl Ketone (2-Butanone)	86.7
n-Heptane	0.955
n-Hexane	1.07
o-Xylene (1,2-Dimethylbenzene)	18.5
Tetrachloroethene (PCE)	26.7
Toluene	5.73
Trichloroethene (TCE)	1.63
Total VOCs	254.8

Sample ID Sample Date	SV-11-030119 3/1/2019
VOCs (µg/m³)	
1,2,4-Trimethylbenzene	4.91
1,2-Dichlorobenzene	6.61
1,3,5-Trimethylbenzene (Mesitylene)	1.19
2-Hexanone	29.4
4-Ethyltoluene	1.46
Acetone	19.1
Benzene	0.971
Dichlorodifluoromethane	1.93
Ethylbenzene	14.6
M,P-Xylene	58.6
Methyl Ethyl Ketone (2-Butanone)	163
n-Heptane	1.25
n-Hexane	1.07
o-Xylene (1,2-Dimethylbenzene)	23.4
Tert-Butyl Alcohol	2.08
Tetrachloroethene (PCE)	4.24
Toluene	8.37
Total VOCs	342.2

Sample ID Sample Date	SV-13-030119 3/1/2019
VOCs (µg/m³)	
1,2,4-Trimethylbenzene	31.4
1,3,5-Trimethylbenzene (Mesitylene)	6.1
2-Hexanone	55.7
4-Ethyltoluene	6.64
Acetone	19.1
Benzene	1.42
Carbon Disulfide	2.67
Carbon Tetrachloride	1.81
Chloroform	9.72
Dichlorodifluoromethane	1.98
Ethylbenzene	20
M,P-Xylene	98.2
Methyl Ethyl Ketone (2-Butanone)	244
Methylene Chloride	5.11
n-Heptane	2.47
n-Hexane	2.6
o-Xylene (1,2-Dimethylbenzene)	43.9
Tetrachloroethene (PCE)	9.22
Toluene	15.5
Trichloroethene (TCE)	5.09
Total VOCs	582.6

LEGEND

SV-08 — 2019 SOIL VAPOR SAMPLE LOCATION

AA-01 — 2019 AMBIENT AIR SAMPLE LOCATION

APPROXIMATE EXTENTS OF EXISTING PARTIAL CELLAR

Analyte	CAS Number	NYSDOH Decision Matrix Minimum Concentration
VOCs (µg/m³)		
Carbon Tetrachloride	56-23-5	6
Methylene Chloride	75-09-2	100
Tetrachloroethene (PCE)	127-18-4	100
Trichloroethene (TCE)	79-01-6	6

GENERAL NOTES

1. ELEVATIONS ARE RELATIVE TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88), WHICH IS 1.1 FT ABOVE MEAN SEA LEVEL AT SANDY HOOK, NJ, U.S.C. & G SURVEY-DATUM.
2. BASE PLAN TAKEN FROM THE BOUNDARY AND TOPOGRAPHICAL SURVEY FOR 42-11 9TH STREET PREPARED BY CONTROL POINT ASSOCIATES INC, DATED 14 MARCH 2018.
3. SOIL VAPOR POINTS WERE INSTALLED BETWEEN ABOUT 6 AND 8 FEET BELOW GRADE SURFACE (BGS) USING A GEOPROBE® DIRECT PUSH RIG.
4. SOIL VAPOR ANALYTICAL RESULTS WERE COMPARED TO THE NEW YORK STATE DEPARTMENT OF HEALTH (NYSDOH) DECISION MATRICES MINIMUM SUB-SLAB VAPOR CONCENTRATION AT WHICH MITIGATION IS THE RECOMMENDED ACTION.
5. VOCS WERE NOT DETECTED IN SOIL VAPOR AT CONCENTRATIONS GREATER THAN THOSE VALUES AT WHICH NYSDOH RECOMMENDS MITIGATION.
6. VOCS = VOLATILE ORGANIC COMPOUNDS
7. µg/m3 = MICROGRAMS PER CUBIC METER
8. ND = NOT DETECTED

40 0 10 25 40
SCALE IN FEET

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Project
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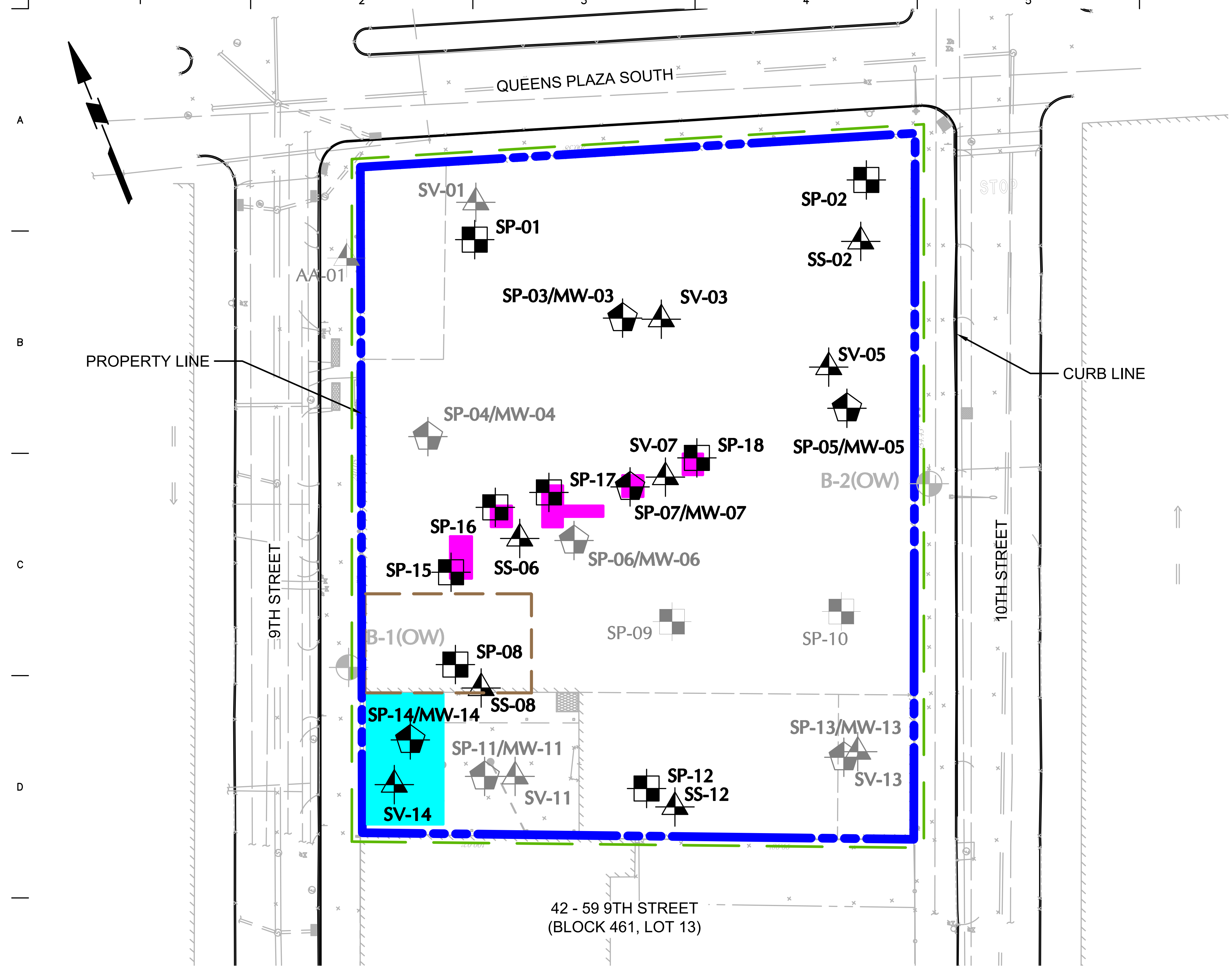
Figure Title
HISTORICAL SOIL VAPOR SAMPLING RESULTS MAP

Project No. 170514701
Date 03/14/2019
Drawn By PS
Checked By TC

Figure No. **4**

Figure 4 of 5



LEGEND

B-1	2018 COMPLETED GEOTECHNICAL BORING LOCATION
SP-11	2019 COMPLETED SOIL PROBE LOCATION
SP-12/MW-12	2019 COMPLETED SOIL PROBE/MONITORING WELL LOCATION
SV-08	2019 COMPLETED VAPOR SAMPLE LOCATION
AA-01	2019 COMPLETED AMBIENT AIR SAMPLE LOCATION
(OW)	OBSERVATION WELL
SP-01	PROPOSED SOIL BORING LOCATION
SV-05	PROPOSED SUB-SURFACE SOIL VAPOR SAMPLE LOCATION
SS-02	PROPOSED SUB-SLAB SOIL VAPOR SAMPLE LOCATION
SP-05/MW-05	PROPOSED BORING/MONITORING WELL LOCATION
	AOC 1: APPROXIMATE LOCATION OF PREVIOUSLY IDENTIFIED TRENCHES
	AOC 2: APPROXIMATE LOCATION OF FORMER NO.2 FUEL OIL TANK
	AOC 3: SITE - MACHINE SHOP (1998 - PRESENT), PLASTIC HANGER MANUFACTURING (1970 - 1977)
	APPROXIMATE EXTENTS OF EXISTING PARTIAL CELLAR

GENERAL NOTES

1. ELEVATIONS ARE RELATIVE TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88), WHICH IS 1.1 FT ABOVE MEAN SEA LEVEL AT SANDY HOOK, NJ, U.S.C. & G SURVEY-DATUM.
2. THE BASE PLAN TAKEN FROM THE BOUNDARY AND TOPOGRAPHICAL SURVEY FOR 4211 9TH STREET PREPARED BY CONTROL POINT ASSOCIATES INC DATED 14 MARCH 2018.
3. ALL LOCATIONS ARE APPROXIMATE.
4. SOIL BORINGS AND SAMPLING POINTS WILL BE BACKFILLED WITH SOIL CUTTINGS FOLLOWING COMPLETION.
5. A CO-LOCATED INDOOR AIR SAMPLE WILL BE COLLECTED WITH EACH SUB-SLAB SOIL VAPOR SAMPLE.
6. AOC = AREA OF CONCERN.

40 0 10 25 40
SCALE IN FEET

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Project: 42-11 9TH STREET BLOCK No. 461, LOT No.16 QUEENS NEW YORK	Figure Title: PROPOSED SAMPLE LOCATION PLAN	Project No. 170514701 Date 01/08/2018 Drawn By MP Checked By TC	Figure No. 5 Figure 5 of 5

Filename: \\Langan.com\data\NYC\data7\170514701\Project Data\CAD\01\SheetFiles\Environmental\Remedial Investigation\Figure 2 - Sample Location and AOC Map_3.24.2020.dwg Date: 3/25/2020 Time: 12:06 User: ksaxena Style Table: Langan.stb Layout: ANSIB-BL

APPENDIX A
PREVIOUS ENVIRONMENTAL REPORTS
(Included as a separate attachment)

APPENDIX B
HEALTH AND SAFETY PLAN

HEALTH AND SAFETY PLAN

for

42-11 9th Street
Long Island City, New York

Block 461, Lot 16
BCP Site No. C241237

Prepared For:

RXR 42-11 9th Holdings LLC
75 Rockefeller Plaza
Suite 13002
New York, New York 10019

Prepared By:

Langan Engineering, Environmental, Surveying, Landscape Architecture and Geology D.P.C.
21 Penn Plaza
360 West 31st Street, 8th Floor
New York, New York 10001

October 2019
Langan Project No. 170514702

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***** Items to be posted prominently on site, or made readily available to personnel.

1.0 INTRODUCTION

1.1 General

This HEALTH AND SAFETY PLAN (HASP) was developed to address disturbance of known and reasonably anticipated subsurface contaminants and comply with Occupational Safety and Health Administration (OSHA) Standard 29 CFR 1910.120(b)(4), *Hazardous Waste Operations and Emergency Response* during anticipated site work at 41-11 9th Street, in the borough of Queens, New York (Tax Map Block 461, Lot 16) ("the Site"). This HASP provides the minimum requirements for implementing site operations during future remedial measure activities. All contractors performing work on this site shall implement their own HASP that, at a minimum, adheres to this HASP. The contractor is responsible for their own health and safety and that of their subcontractors. Langan personnel will implement this HASP while onsite.

The management of the day-to-day site activities and implementation of this HASP in the field is the responsibility of the site Langan Field Team Leader (FTL). Assistance in the implementation of this HASP can also be obtained from the site Langan Health and Safety Officer (HSO) and the Langan Health and Safety Manager (HSM). Contractors operating on the site shall designate their own FTL, HSO and HSM. The content of this HASP may change or undergo revision based upon additional information made available to health and safety personnel, monitoring results, or changes in the work plan.

1.2 Site Location and Background

The site is located at 42-11 9th Street (Block 461, Lot 16) in the Long Island City neighborhood of Queens, New York. The about 49,400 square-foot (1.13 acres) site is located on the northern part of the city block bound by Queens Plaza South to the north, 10th Street to the east, 43rd Avenue to the south, and 9th Street to the west and is occupied by a one-story manufacturing/warehouse building with a partial second floor and partial basement on the southwestern portion of the site, and an asphalt-paved yard on the southwestern portion of the site. The building is used for a machine shop with a forge building and warehouse space.

The site is bordered by an organic compost waste site underneath the Ed Koch Queensboro Bridge to the north (across from Queens Plaza South); an industrial manufacturing building to the east (across 10th Street); industrial buildings to the south; and commercial buildings, including a hotel, to the west (beyond 9th Street). A Site Location Map is included as Figure 1.

1.3 Summary of Work Tasks

1.3.1 Geophysical Investigation

Prior to the commencement of intrusive field activities (i.e., soil borings); a geophysical consultant may conduct a geophysical survey using ground penetrating radar (GPR) and electromagnetic detection equipment. Langan personnel will coordinate the geophysical survey. The objective of the survey will be to identify any underground storage tank (UST) structures, drains, underground utilities, and other subsurface anomalies that may be encountered during the investigation. During this time Langan personnel will inspect the site and confirm sample locations.

1.3.2 Soil Investigation and Sampling

Langan will retain a drilling contractor to advance soil borings to a depth below grade surface (bgs) specified in the work plan. Borings will be installed at the approximate locations indicated in Langan's work plan, but may be moved in the field based on utility clearance and accessibility. The drilling contractor will contact the appropriate utility mark-out authority and make available to their drilling staff the verification number and effective dates. Langan will record the verification number and effective dates from the drillers. Langan will also note the location of marked out utilities on the site plan and scan the data into the project folder.

Langan personnel will screen soil for visual, olfactory, and instrumental indicators suggestive of a potential petroleum release. Instrument screening for the presence of VOCs may be performed with a calibrated photoionization detector (PID) equipped with a 10.6 electron volt (eV) bulb (or equivalent). Langan personnel will collect soil samples from the proposed soil boring locations following the sampling plan outlined in the work plan. The borings will be filled with clean soil cuttings or bentonite grout after samples are collected.

Soil samples will be submitted to a New York State Department of Health (NYSDOH) Environmental Laboratory Approval Program (ELAP)-certified laboratory and analyzed in accordance with work plan specifications.

1.3.3 Groundwater Investigation and Sampling

Selected soil borings will be converted into groundwater monitoring wells and sampled to evaluate groundwater quality. Groundwater samples will be collected from one or more of the new and if available, pre-existing monitoring wells in accordance with the Langan Low Flow Groundwater Sampling SOP (SOP #12). Groundwater samples will be submitted to an NYSDOH

ELAP-certified laboratory and analyzed for constituents as specified in the work plan. The monitoring wells will be eventually backfilled and abandoned in accordance with State and Local regulations.

1.3.4 Sub Slab or Soil Vapor Point Installation and Sampling

Langan will install one or more sub-slab or soil vapor points at selected locations. If installed, the sub-slab points will be set approximated 2-inches below the bottom of the slab in accordance with the work plan. The sub-slab points may be installed using an electric hammer drill to advance small diameter borings through the concrete (or equivalent) slab as defined in the work plan. The borings will terminate in and sample from the gravel substrate below the slab. If installed, the soil vapor points will be installed by the drilling contractor as specified in the work plan. Conditions in the field may require adjustment of sampling locations.

Vapor samples will be collected in accordance with the Final Guidance for Evaluating Soil Vapor Intrusion published by the NYSDOH in October 2006 and Langan's Sub-Slab Vapor Sampling SOP (SOP #14). The sub-slab vapor will be collected through an open tube (no implant) or similar method. The annulus around the tubing within the concrete slab is to be packed with bentonite to seal the sampling points. Once sampled, the boring will be backfilled to grade with patching material. The soil vapor samples will be collected using a stainless steel or polyethylene (or equivalent) soil vapor implant and tubing or similar method. The annulus around the probe and tubing will be filled with sand to two inches above the probe. Bentonite slurry will be applied to the top of the sand up to seal the sampling points.

Ambient air sample may be collected for use as a comparison sample. As part of the ambient air sampling program, Langan personnel may complete the NYSDOH building inventory inspection. The inspection may take place prior to the commencement of actual field sampling.

1.3.5 Equipment Decontamination

Before the start of the day's sampling and after sampling each run, sampling equipment will be decontaminated by the decontamination process outlined Attachment B - Decontamination Procedures. Decontamination wastes and purge water will be temporarily stored on site pending analytical results.

1.3.6 Management of Investigative-Derived Waste

The investigative-derived waste (IDW) generated during this investigation may be contained in DOT-approved 55-gallon drums. The drums will be temporarily stored on the site or as directed by the client representative. All drums will be filled to two-thirds full to allow easy maneuvering during drum pickup and disposal. Drum labels are to be provided by Langan (Environmental Closet). All drums will be labeled as "IDW Pending Analysis" until sample data are reported from the laboratory. Drum labels will include date filled and locations where waste was generated along with the standard information required by the labels in accordance with the Langan SOP09, Drum Labeling.

Closed top drums are to be used to store liquids. Debris, including plastic sheeting, polyethylene tubing, personal protection equipment (PPE), decontamination debris, etc. will be segregated from and disposed in large heavy duty garbage bags and disposed of at the site. Excess unused glassware should be returned to the lab along with the last day of collection samples.

1.3.7 Drum Sampling

Langan personnel may collect drum samples, as required, prior to off-site drum disposal. Samples will be placed into laboratory-supplied batch-certified clean glassware and submitted to a NYSDOH ELAP-certified laboratory.

1.3.8 Surveying

Surveying activities, if defined in the work plan, may be completed by Langan. Surveying will be conducted by licensed surveyors.

2.0 IDENTIFICATION OF KEY PERSONNEL/HEALTH AND SAFETY PERSONNEL

The following briefly describes the health and safety (H&S) designations and general responsibilities that may be employed for this site. The titles have been established to accommodate the project needs and requirements and ensure the safe conduct of site activities. The H&S personnel requirements for a given work location are based upon the proposed site activities.

2.1 Langan Project Manager

The Langan Environmental Project Manager (PM) is Andrew Schweitzer. His responsibilities include:

- Ensuring that this HASP is developed, current, and approved prior to on-site activities.
- Ensuring that all the tasks in the project are performed in a manner consistent with Langan's comprehensive *Health and Safety Program for Hazardous Waste Operations* and this HASP.

2.2 Langan Corporate Health and Safety Manager

The Langan Corporate Health and Safety Manager (HSM) is Tony Moffa. His responsibilities include:

- Updating the *Construction Health and Safety Program for Hazardous Waste Operations*.
- Assisting the site Health and Safety Officer (HSO) with development of the HASP, updating HASP as dictated by changing conditions, jobsite inspection results, etc. and approving changes to this HASP.
- Assisting the HSO in the implementation of this HASP and conducting Jobsite Safety Inspections and assisting with communication of results and correction of shortcomings found.
- Maintaining records on personnel (medical evaluation results, training and certifications, accident investigation results, etc.).

2.3 Langan Site Health & Safety Officer

The Langan site HSO is William Bohrer. His responsibilities include:

- Participating in the development and implementation of this HASP.
- When on-site, assisting the Langan Field Team Leader in conducting Tailgate Safety Meetings and Jobsite Safety Inspections and correcting any shortcomings in a timely manner.
- Ensuring that proper PPE is available, worn by employees, and properly stored and maintained.
- Controlling entry into and exit from the site contaminated areas or zones.
- Monitoring employees for signs of stress, such as heat stress, fatigue, and cold exposure.
- Monitoring site hazards and conditions.
- Knowing (and ensuring that all site personnel also know) emergency procedures, evacuation routes, and the telephone numbers of the ambulance, local hospital, poison control center, fire department, and police department.
- Resolving conflicts that may arise concerning safety requirements and working conditions.
- Reporting all incidents, injuries and near misses to the Langan Incident/Injury Hotline immediately and the client representative.

2.4 Langan Field Team Leader Responsibilities

The Langan Field Team Leader (FTL) is to be determined prior to the start of the start of field activities. The Field Team Leader's responsibilities include:

- The management of the day-to-day site activities and implementation of this HASP in the field.
- Participating in and/or conducting Tailgate Safety Meetings and Jobsite Safety Inspections and correcting any shortcomings in a timely manner.
- When a Community Air Monitoring Operating Program (CAMP) is part of the scope, the FTL will set up and maintaining community air monitoring activities and instructing the responsible contractor to implement organic vapor or dust mitigation when necessary.
- Overseeing the implementation of activities specified in the work plan.

2.5 Contractor Responsibilities

The contractor shall develop and implement their own HASP for their employees, lower-tier subcontractors, and consultants. The contractor is responsible for their own health and safety and that of their subcontractors. Contractors operating on the site shall designate their own FTL, HSO and HSM. The contractor's HASP will be at least as stringent as this Langan HASP. The contractor must be familiar with and abide by the requirements outlined in their own HASP. A contractor may elect to adopt Langan's HASP as its own provided that it has given written notification to Langan, but where Langan's HASP excludes provisions pertinent to the contractor’s work (i.e., confined space entry); the contractor must provide written addendums to this HASP. Additionally, the contractor must:

- Ensure their employees are trained in the use of all appropriate PPE for the tasks involved;
- Notify Langan of any hazardous material brought onto the job site or site related area, the hazards associated with the material, and must provide a material safety data sheet (MSDS) or safety data sheet (SDS) for the material;
- Have knowledge of, understand, and abide by all current federal, state, and local health and safety regulations pertinent to the work;
- Ensure their employees handling hazardous materials, if identified at the Site, have received current training in the appropriate levels of 29 CFR 1910.120, *Hazardous Waste Operations and Emergency Response* (HAZWOPER) if hazardous waste is identified at the Site;
- Ensure their employees handling hazardous materials, if identified at the Site, have been fit-tested within the year on the type respirator they will wear; and
- Ensure all air monitoring is in place pertaining to the health and safety of their employees as required by OSHA 1910.120; and
- All contractors must adherer to all federal, state, and local regulatory requirements.

3.0 TASK/OPERATION SAFETY AND HEALTH RISK ANALYSES

A Task-Hazard Analysis (Table 1) was completed for general construction hazards that may be encountered at the Site. The potential contaminants that might be encountered during the field activities and the exposure limits are listed in Table 2 complete inventory of MSDS/SDS for chemical products used on site is included as Attachment E.

3.1 Specific Task Safety Analysis

3.1.1 Geophysical Survey

Langan personnel are not permitted to operate or otherwise handle the geophysical equipment including any downhole geophysical equipment subsequently used to survey boreholes. When soil, groundwater or soil vapor point locations are surveyed with surface geophysical equipment, the locations of the point as well as possible utilities and other artifacts that may interfere with the subsurface investigation are to be marked with indelible paint, flags, or color tape (when marking indoor locations that the client has specifically requested not be marked with indelible paint). This information must also be added to the site map. When applying paint, proper PPE including at a minimum hand protections should be used.

3.1.2 Soil Investigation and Sampling

Sampling the soil requires the donning of chemical resistant gloves in addition to the standard PPE. Langan personnel are not to operate drilling or excavation equipment nor open sampling devices (acetate liners, sonic sample bags, etc.). These tasks are to be completed by the driller or excavation contractor.

3.1.3 Indoor Drilling and Excavation

The work scope may require indoor drilling or drilling in locations where there may not be adequate ventilation sufficient to safely operate any rig or excavation equipment powered by an internal combustion engine. Where possible, all such work should be done by equipment powered by electricity. If such equipment is used and must be directly wired to the buildings electrical system or to an independent system, this work must be completed by a licensed electrician in accordance with all electrical codes applicable to the work.

Indoor work which is to be completed with equipment powered by an internal combustion engine must incorporate air monitoring of carbon monoxide (CO) using calibrated air monitoring equipment (MultiRAE or equivalent). In addition, the work plan should incorporate mitigation for venting engine exhaust fumes directly to the outdoors and for circulating fresh air into the work area.

The OSHA Time Weighted Average (TWA) Permissible Exposure Limit (PEL) for CO from 50 to

35 parts per million (ppm). Langan will monitor CO with a suitable monitoring device. If CO levels exceed 5 ppm, Langan will instruct contractors to begin mitigation measures. These measures are at a minimum:

- Increase air circulation using industrial size fans to bring additional fresh air into the building or vent exhaust to the outside;
- Modify the passive exhaust method being used to increase venting circulation by using wider diameter tubing or sealing tubing connections; or
- Modify the work schedule where the rig is turned off to allow time for CO levels to fall back to background

All work must cease if CO levels reach 35 ppm. The Langan engineer is to report to the PM and H&S officer when an action level is reached.

3.1.4 Groundwater Investigation and Sampling

Sampling groundwater requires the donning of chemical resistant gloves in addition to the standard PPE and cut resistant gloves when cutting sampling-tubing to length. Langan personnel are not to operate drilling equipment nor assemble or install monitoring well equipment. These tasks are to be completed by the driller contractor.

3.1.5 Vapor Investigation and Sampling

Sampling vapor requires the donning of work gloves in addition to the standard PPE when assembling the Summa™ canister with the regulator and cut resistant gloves when cutting sampling- or silicone-tubing to length. Langan personnel are not to operate drilling equipment nor assemble or install soil vapor point equipment unless instructed by the work plan. When not instructed by the work plan, these tasks are to be completed by the contractor.

Langan personnel and contractors are not to move or opened any orphaned (unlabeled) drum found on the site without approval of the project manager.

3.1.6 Drum Sampling

Drilling fluid, rinse water, grossly-contaminated soil samples and cuttings will be containerized in 55-gallon drums for disposed off-site. Each drum must be labeled in accordance with the Langan Drum Labeling Standard Operating Procedure (SOP-#9). Sampling drums requires the donning of work gloves when opening the drums and chemical resistant gloves when sampling in addition to standard PPE.

Langan personnel and contractors are not to move or opened any orphaned (unlabeled) drum found on the site without approval of the project manager.

3.2 Radiation Hazards

No radiation hazards are known or expected at the site.

3.3 Physical Hazards

Physical hazards, which may be encountered during site operations for this project, are detailed in Table 1.

3.3.1 Explosion

No explosion hazards are expected for the scope of work at this site.

3.3.2 Heat Stress

The use of Level C protective equipment, or greater, may create heat stress. Monitoring of personnel wearing personal protective clothing should commence when the ambient temperature is 72^{O}F or above. Table 6 presents the suggested frequency for such monitoring. Monitoring frequency should increase as ambient temperature increases or as slow recovery rates are observed. Refer to the Table 7 to assist in assessing when the risk for heat related illness is likely. To use this table, the ambient temperature and relative humidity must be obtained (a regional weather report should suffice). Heat stress monitoring should be performed by the HSO or the FTL, who shall be able to recognize symptoms related to heat stress.

To monitor the workers, be familiar with the following heat-related disorders and their symptoms:

- **Heat Cramps:** Painful spasm of arm, leg or abdominal muscles, during or after work
- **Heat Exhaustion:** Headache, nausea, dizziness; cool, clammy, moist skin; heavy sweating; weak, fast pulse; shallow respiration, normal temperature
- **Heat Stroke**: Headache, nausea, weakness, hot dry skin, fever, rapid strong pulse, rapid deep respirations, loss of consciousness, convulsions, coma. *This is a life threatening condition*.

Do not permit a worker to wear a semi-permeable or impermeable garment when they are showing signs or symptoms of heat-related illness.

To monitor the worker, measure:

- **Heart rate:** Count the radial pulse during a 30-second period as early as possible in the rest period. If the heart rate exceeds 100 beats per minute at the beginning of the rest period, shorten the next work cycle by one-third and keep the rest period the same. If the heart rate still exceeds 100 beats per minute at the next rest period, shorten the following work cycle by one-third. A worker cannot return to work after a rest period until their heart rate is below 100 beats per minute.
- **Oral temperature:** Use a clinical thermometer (3 minutes under the tongue) or similar device to measure the oral temperature at the end of the work period (before drinking). If oral temperature exceeds 99.6°F (37.6°C), shorten the next work cycle by one-third without changing the rest period. A worker cannot return to work after a rest period until their oral temperature is below 99.6°F. If oral temperature still exceeds 99.6°F (37.6°C) at the beginning of the next rest period, shorten the following cycle by one-third. Do <u>not</u> permit a worker to wear a semi-permeable or impermeable garment when oral temperature exceeds 100.6°F (38.1°C).

<u>Prevention of Heat Stress</u> - Proper training and preventative measures will aid in averting loss of worker productivity and serious illness. Heat stress prevention is particularly important because once a person suffers from heat stroke or heat exhaustion, that person may be predisposed to additional heat related illness. To avoid heat stress the following steps should be taken:

- Adjust work schedules.
- Mandate work slowdowns as needed.
- Perform work during cooler hours of the day if possible or at night if adequate lighting can be provided.
- Provide shelter (air-conditioned, if possible) or shaded areas to protect personnel during rest periods.
- Maintain worker's body fluids at normal levels. This is necessary to ensure that the cardiovascular system functions adequately. Daily fluid intake must approximately equal the amount of water lost in sweat, id., eight fluid ounces (0.23 liters) of water must be ingested for approximately every eight ounces (0.23 kg) of weight lost. The normal thirst mechanism is not sensitive enough to ensure that enough water will be drunk to replace lost sweat. When heavy sweating occurs, encourage the worker to drink more. The following strategies may be useful:
  - Maintain water temperature 50° to 60°F (10° to 16.6°C).
  - Provide small disposal cups that hold about four ounces (0.1 liter).
  - Have workers drink 16 ounces (0.5 liters) of fluid (preferably water or dilute drinks) before beginning work.

- Urge workers to drink a cup or two every 15 to 20 minutes, or at each monitoring break. A total of 1 to 1.6 gallons (4 to 6 liters) of fluid per day are recommended, but more may be necessary to maintain body weight.
- Train workers to recognize the symptoms of heat related illness.

3.3.3 Cold-Related Illness

If work on this project begins in the winter months, thermal injury due to cold exposure can become a problem for field personnel. Systemic cold exposure is referred to as hypothermia. Local cold exposure is generally called frostbite.

- **Hypothermia -** Hypothermia is defined as a decrease in the patient core temperature below 96^{O}F. The body temperature is normally maintained by a combination of central (brain and spinal cord) and peripheral (skin and muscle) activity. Interference with any of these mechanisms can result in hypothermia, even in the absence of what normally is considered a "cold" ambient temperature. Symptoms of hypothermia include: shivering, apathy, listlessness, sleepiness, and unconsciousness.
- **Frostbite -** Frostbite is both a general and medical term given to areas of local cold injury. Unlike systemic hypothermia, frostbite rarely occurs unless the ambient temperatures are less than freezing and usually less than 20^{O}F. Symptoms of frostbite are: a sudden blanching or whitening of the skin; the skin has a waxy or white appearance and is firm to the touch; tissues are cold, pale, and solid.

Prevention of Cold-Related Illness - To prevent cold-related illness:

- Educate workers to recognize the symptoms of frostbite and hypothermia
- Identify and limit known risk factors:
- Assure the availability of enclosed, heated environment on or adjacent to the site.
- Assure the availability of dry changes of clothing.
- Assure the availability of warm drinks.
- Start (oral) temperature recording at the job site:
- At the FSO or Field Team Leader's discretion when suspicion is based on changes in a worker's performance or mental status.
- At a worker's request.
- As a screening measure, two times per shift, under unusually hazardous conditions (e.g., wind-chill less than 20^{O}F, or wind-chill less than 30^{O}F with precipitation).
- As a screening measure whenever anyone worker on the site develops hypothermia.

Any person developing moderate hypothermia (a core temperature of 92^{O}F) cannot return to work for 48 hours.

3.3.4 Noise

Work activities during the proposed activities may be conducted at locations with high noise levels from the operation of equipment. Hearing protection will be used as necessary.

3.3.5 Hand and Power Tools

The use of hand and power tools can present a variety of hazards, including physical harm from being struck by flying objects, being cut or struck by the tool, fire, and electrocution. All hand and power tools should be inspected for health and safety hazards prior to use. If deemed unserviceable/un-operable, notify supervisor and tag equipment out of service. Ground Fault Circuit Interrupters (GFCIs) are required for all power tools requiring direct electrical service.

3.3.6 Slips, Trips and Fall Hazards

Care should be exercised when walking at the site, especially when carrying equipment. The presence of surface debris, uneven surfaces, pits, facility equipment, and soil piles contribute to tripping hazards and fall hazards. To the extent possible, all hazards should be identified and marked on the site, with hazards communicated to all workers in the area.

3.3.7 Utilities (Electrocution and Fire Hazards)

3.3.7.1 Utility Clearance

The possibility of encountering underground utilities poses fire, explosion, and electrocution hazards. All excavation work will be preceded by review of available utility drawings and by notification of the subsurface work to the N.Y. One –Call–Center.

3.3.7.2 Lockout-Tagout

The potential adverse effects of electrical hazards include burns and electrocution, which could result in death. Therefore, there is a procedure that establishes the requirements for the lockout/tagout (LOTO) of energy isolating devices in accordance with the OSHA electrical lockout and tagging requirements as specified in 29 CFR 1926.417. This procedure will be used to ensure that all machines and equipment are isolated from potentially hazardous energy. If possible, equipment that could cause injury due to unexpected energizing, start-up, or release of stored energy will be locked/tagged, before field personnel perform work activities.

Depending upon the specific work task involved, Langan's SSC or FTL will serve as the authorized lockout/tagout coordinator, implement the lockout/tagout procedure and will be responsible to locate, lock and tag valves, switches, etc.

SPECIAL NOTE: Project personnel will assume that all electrical equipment at surface, subsurface and overhead locations is energized, until equipment has been designated and confirmed as de-energized by a utility company representative. Langan will notify the designated utility representative prior to working adjacent to this equipment and will verify that the equipment is energized or de-energized in the vicinity of the work location.

No project work shall be performed by Langan personnel or subcontractors on or near energized electrical lines or equipment unless hazard assessments are completed in writing, reviewed by Langan's SSHO, and clearly communicated to the field personnel.

The FTL shall conduct a survey to locate and identify all energy isolating devices. They shall be certain which switches, valves or other isolating devices apply to the equipment. The lockout/tagout procedure involves, but is not limited to, electricity, motors, steam, natural gas, compressed air, hydraulic systems, digesters, sewers, etc.

3.3.8 Physical Hazard Considerations for Material Handling

There are moderate to severe risks associated with moving heavy objects at the Site. The following physical hazards should be considered when handling materials at the Site:

- Heavy objects will be lifted and moved by mechanical devices rather than manual effort whenever possible.
- The mechanical devices will be appropriate for the lifting of moving task and will be operated only by trained and authorized personnel.
- Objects that require special handling or rigging will only be moved under the guidance of a person who has been specifically trained to move such objects.
- Lifting devices will be inspected, certified, and labeled to confirm their weight capacities. Defective equipment will be taken out of service immediately and repaired or destroyed.
- The wheels of any trucks being loaded or unloaded will be chocked to prevent movement. Outriggers will be fully extended on a flat, firm surface during operation.
- Personnel will not pass under a raised load, nor will a suspended load be left unattended.
- Personnel will not be carried on lifting equipment, unless it is specifically designed to carry passengers.
- All reciprocating, rotating, or other moving parts will be guarded at all times.
- Accessible fire extinguishers, currently (monthly) inspected, will be available in all mechanical lifting devices.
- Verify all loads/materials are secure before transportation.

Material handling tasks that are unusual or require specific guidance will need a written addendum to this HASP. The addendum must identify the lifting protocols before the tasks are performed. Upon approval, the plan must be reviewed with all affected employees and documented. Any deviation from a written plan will require approval by the Langan HSM.

3.3.9 Hearing Conservation

Under the construction industry standard, the maximum permissible occupational noise exposure is 90 dbA (8-hour TWA), and noise levels in excess of 90 dbA must be reduced through feasible administrative and engineering controls. (20 CFR 1926.52). Hearing protection is required when working within 15 feet of vacuum extraction equipment and drill rigs.

3.3.9 Open Water

Employees working over or near water, where the danger of drowning exists, shall be provided with U.S. Coast Guard-approved life jackets or buoyant work vests. Prior to and after each use, the buoyant work vests or life preservers shall be inspected for defects which would alter their strength or buoyancy. Defective units shall not be used.

And should a worker fall into the water, OSHA requires (29 CFR 1926.106(c)) that ring buoys with at least 90 feet of line shall be provided and readily available for emergency rescue operations. The distance between ring buoys shall not exceed 200 feet. Another remedial action required by OSHA (29 CFR 1926.106(d)) is the use of lifesaving skiffs.

OSHA requires that at least one lifesaving skiff shall be immediately available at locations where employees are working over or adjacent to water and must include the following provisions.

- The skiff must be in the water or capable of being quickly launched by one person.
- At least one person must be present and specifically designated to respond to water emergencies and operate the skiff at all times when there are employees above water.
- When the operator is on break another operator must be designated to provide requisite coverage when there are employees above water.
- The designated operator must either have the skiff staffed at all times or have someone remain in the immediate area such that the operator can quickly reach the skiff and perform rescue services.
- The skiff operator maybe assigned other tasks provided the tasks do not interfere with the operator’s ability to quickly reach the skiff.
- A communication system, such as a walkie-talkie, must be used to inform the skiff operator of an emergency and to inform the skiff operator where the skiff is needed.
- The skiff must be equipped with both a motor and oars.

With regard to the number of skiffs required and the appropriate maximum response time, the following factors must be evaluated:

- The number of work locations where there is a danger of falling into water;
- The distance to each of those locations;
- Water temperature and currents;
- Other hazards such as, but not limited to, rapids, dams, and water intakes;

Other regulations that present S&H practices and PPE for work on or near water include: 29 CFR 1910, Subpart T (401 – 440)

3.4 Biological Hazards

3.4.1 Animals

There is a possibility of encountering wildlife including reptiles, rodents and other small and medium size mammals. The Langan personnel is to avoid interacting with any wildlife.

3.4.2 Insects

Ticks and other biting or stinging insects may to be encountered during site operations. Langan personnel should take necessary precautions including donning long sleeve shirts and insecticide to prevent bites and stings. After field work, Langan personnel should perform a complete visual inspection of their clothing to insure they are not inadvertently harboring ticks. If they do observe a tick bite, they are to contact the HSM or HSO and report the event.

3.4.3 Plants

Poisonous plants may to be encountered during site operations. Langan personnel should take necessary precautions including donning long sleeve shirts and applying preventative poison Ivy/Sumac lotion to prevent or limit effects of exposure. If after field work, Langan employees do observe a reaction to poisonous plant exposure, they are to contact the HSM or HSO and report the event.

3.5 Additional Safety Analysis

3.5.1 Presence of Non-Aqueous Phase Liquids (NAPL)

There is potential for exposure to NAPL at this site. Special care and PPE should be considered when NAPL is observed as NAPL is a typically flammable fluid and releases VOCs known to be toxic and/or carcinogenic. If NAPL is present in a monitoring well, vapors from the well casing may contaminate the work area breathing zone with concentrations of VOCs potentially exceeding health and safety action levels. In addition, all equipment used to monitor or sample NAPL (or ground water from wells containing NAPL) must be intrinsically safe. Equipment that directly contacts NAPL must also be resistant to organic solvents.

At a minimum, a PID should be used to monitor for VOCs when NAPL is observed. If NAPL is expected to be observed in an excavation or enclosed area, air monitoring must be started using calibrated air monitoring equipment designed to sound an audio alarm when atmospheric concentrations of VOC are within 10% of the LEL. In normal atmospheric oxygen concentrations, the LEL monitoring may be done with a Wheatstone bridge/catalytic bead type sensor (i.e. MultiRAE). However in oxygen depleted atmospheres (confined space), only an LEL designed to work in low oxygen environments may be used. Best practices require that the LEL monitoring unit be equipped with a long sniffer tube to allow the LEL unit to remain outside the UST excavation.

When NAPL is present, Langan personnel are required to use disposable nitrile gloves at all times to prevent skin contact with contaminated materials. They should also consider having available a respirator and protective clothing (Tyvek® overalls), especially if NAPL is in abundance and there are high concentrations of VOCs.

All contaminated disposables including PPE and sampling equipment must be properly disposed of in labeled 55-gallong drums

3.6 Job Safety Analysis

A Job Safety Analysis (JSA) is a process to identify existing and potential hazards associated with each job or task so these hazards can be eliminated, controlled or minimized. A JSA will be performed at the beginning of each work day, and additionally whenever an employee begins a new task or moves to a new location. All JSAs must be developed and reviewed by all parties involved. A blank JSA form and documentation of completed JSAs are in Attachment G.

4.0 PERSONNEL TRAINING

4.1 Basic Training

Completion of an initial 40-hour HAZWOPER training program as detailed in OSHA's 29 CFR 1910.120(e) is required for all employees working on a site engaged in hazardous substance removal or other activities which expose or potentially expose workers to hazardous substances, health hazards, or safety hazards as defined by 29 CFR 1910.120(a). Annual 8-hour refresher training is also required to maintain competencies to ensure a safe work environment. In addition to these training requirements, all employees must complete the OSHA 10 hour Construction

Safety and Health training and supervisory personnel must also receive eight additional hours of specialized management training. Training records are maintained by the HSM.

4.2 Initial Site-Specific Training

Training will be provided to specifically address the activities, procedures, monitoring, and equipment for site operations at the beginning of each field mobilization and the beginning of each discrete phase of work. The training will include the site and facility layout, hazards, and emergency services at the site, and will detail all the provisions contained within this HASP. For a HAZWOPER operation, training on the site must be for a minimum of 3 days. Specific issues that will be addressed include the hazards described in Section 3.0.

4.3 Tailgate Safety Briefings

Before starting work each day or as needed, the Langan HSO will conduct a brief tailgate safety meeting to assist site personnel in conducting their activities safely. Tailgate meetings will be documented in Attachment H. Briefings will include the following:

- Work plan for the day;
- Review of safety information relevant to planned tasks and environmental conditions;
- New activities/task being conducted;
- Results of Jobsite Safety Inspection Checklist;
- Changes in work practices;
- Safe work practices; and
- Discussion and remedies for noted or observed deficiencies.

5.0 MEDICAL SURVEILLANCE

All personnel who will be performing field work involving potential exposure to toxic and hazardous substances (defined by 29 CFR 1910.120(a)) will be required to have passed an initial baseline medical examination, with follow-up medical exams thereafter, consistent with 29 CFR 1910.120(f). Medical evaluations will be performed by, or under the direction of, a physician board-certified in occupational medicine.

Additionally, personnel who may be required to perform work while wearing a respirator must receive medical clearance as required under CFR 1910.134(e), *Respiratory Protection*. Medical evaluations will be performed by, or under the direction of, a physician board-certified in occupational medicine. Results of medical evaluations are maintained by the HSM.

6.0 PERSONAL PROTECTIVE EQUIPMENT

6.1 Levels of Protection

Langan will provide PPE to Langan employees to protect them from the specific hazards they are likely to encounter on-site. Direct hired contractors will provide their employees with equivalent PPE to protect them from the specific hazards likely to be encountered on-site. Selection of the appropriate PPE must take into consideration: (1) identification of the hazards or suspected hazards; (2) potential exposure routes; and, (3) the performance of the PPE construction (materials and seams) in providing a barrier to these hazards.

Based on anticipated site conditions and the proposed work activities to be performed at the site, Level D protection will be used. The upgrading/downgrading of the level of protection will be based on continuous air monitoring results as described in Section 6.0 (when applicable). The decision to modify standard PPE will be made by the site HSO or FTL after conferring with the PM. The levels of protection are described below.

Level D Protection (as needed)

- Safety glasses with side shields or chemical splash goggles
- Safety boots/shoes
- Coveralls (Tyvek® or equivalent)
- Hard hat
- Long sleeve work shirt and work pants
- Nitrile gloves
- Hearing protection
- Reflective safety vest

Level D Protection (Modified, as needed)

- Safety glasses with sideshields or chemical splash goggles
- Safety boots/shoes (toe-protected)
- Disposable chemical-resistant boot covers
- Coveralls (polycoated Tyvek or equivalent to be worn when contact with wet contaminated soil, groundwater, or non-aqueous phase liquids is anticipated)
- Hard hat
- Long sleeve work shirt and work pants
- Nitrile gloves
- Hearing protection (as needed)
- Personal floatation device (for work within 5 ft of the water)

- Reflective traffic vest

Level C Protection (as needed)

- Full or Half face, air-purifying respirator, with NIOSH approved HEPA filter
- Inner (latex) and outer (nitrile) chemical-resistant gloves
- Safety glasses with side shields or chemical splash goggles
- Chemical-resistant safety boots/shoes
- Hard hat
- Long sleeve work shirt and work pants
- Coveralls (Tyvek® or equivalent)
- Hearing protection (as needed)
- Reflective safety vest

The action levels used in determining the necessary levels of respiratory protection and upgrading to Level C are summarized in Table 4. The written Respiratory Protection Program is maintained by the HSM and is available if needed. The monitoring procedures and equipment are outlined in Section 6.0 (when applicable).

6.2 Respirator Fit-Test

All Langan employees who may be exposed to hazardous substances at the work site are in possession of a full or half face-piece, air-purifying respirator and have been successfully fit-tested within the past year. Fit-test records are maintained by the HSM.

6.3 Respirator Cartridge Change-Out Schedule

Respiratory protection is required to be worn when certain action levels (table 2) are reached. A respirator cartridge change-out schedule has been developed in order to comply with 29 CFR 1910.134. The respirator cartridge change-out schedule for this project is as follows:

- Cartridges shall be removed and disposed of at the end of each shift, when cartridges become wet or wearer experiences breakthrough, whichever occurs first.
- If the humidity exceeds 85%, then cartridges shall be removed and disposed of after 4 hours of use.

Respirators shall not be stored at the end of the shift with contaminated cartridges left on. Cartridges shall not be worn on the second day, no matter how short the time period was the previous day they were used.

7.0 AIR QUALITY MONITORING AND ACTIONS LEVELS

7.1 Monitoring During Site Operations

Atmospheric air monitoring results may be collected and used to provide data to determine when exclusion zones need to be established and when certain levels of personal protective equipment are required. For all instruments there are Site-specific action level criteria which are used in making field health and safety determinations. Other data, such as the visible presence of contamination or the steady state nature of air contaminant concentration, are also used in making field health and safety decisions. Therefore, the HSO may establish an exclusion zone or require a person to wear a respirator even though atmospheric air contaminant concentrations are below established HASP action levels.

During site work involving disturbance of petroleum-impacted or fill material, real time air monitoring may be conducted for volatile organic compounds (VOCs). A photoionization detector (PID) and/or flame ionization detector (FID) will be used to monitor concentrations of VOCs at personnel breathing-zone height. Air monitoring will be the responsibility of the HSO or designee. Air monitoring may be conducted during intrusive activities associated with the completion of excavation, debris removal, and soil grading. All manufacturers' instructions for instrumentation and calibration will be available onsite.

Subcontractors' air monitoring plans must be equal or more stringent as the Langan plan.

An air monitoring calibration log is provided in Attachment D of this HASP.

7.1.1 Volatile Organic Compounds

Monitoring with a PID, such as a MiniRAE 2000 (10.6v) or equivalent may occur during intrusive work in the AOCs. Colormetric Indicator Tubes for benzene may be used as backup for the PID, if measurements remain above background monitor every 2 hours. The HSO will monitor the employee breathing zone <u>at least</u> every 30 minutes, or whenever there is any indication that concentrations may have changed (odors, visible gases, etc.) since the last measurement. If VOC levels are observed above 5 ppm for longer than 5 minutes or if the site PPE is upgraded to Level C, the HSO will begin monitoring the site perimeter at a location downwind of the AOC every 30 minutes in addition to the employee breathing zone. Instrument action levels for monitored gases are provided in Table 4.

7.1.2 Metals

Based upon the site historical fill, there is a potential for the soils to contain PAHs and metals. During invasive procedures which have the potential for creating airborne dust, such as excavation of dry soils, a real time airborne dust monitor such as a Mini-Ram may be used to monitor for air particulates. The HSO will monitor the employee breathing zone at least every 30 minutes, or whenever there is any indication that concentrations may have changed (appearance of visible dust) since the last measurement. If dust levels are observed to be greater than 0.100 mg/m^3 or visible dust is observed for longer than 15 minutes or if the site PPE is upgraded to Level C, the HSO will begin monitoring the site perimeter at a location downwind of the AOC every 30 minutes in addition to the employee breathing zone. Instrument action levels for dust monitoring are provided in Table 4.

7.2 Monitoring Equipment Calibration and Maintenance

Instrument calibration shall be documented and included in a dedicated safety and health logbook or on separate calibration pages of the field book. All instruments shall be calibrated before and after each shift. Calibration checks may be used during the day to confirm instrument accuracy. Duplicate readings may be taken to confirm individual instrument response.

All instruments shall be operated in accordance with the manufacturers' specifications. Manufacturers' literature, including an operations manual for each piece of monitoring equipment will be maintained on site by the HSO for reference.

7.3 Determination of Background Levels

Background (BKD) levels for VOCs and dust will be established prior to intrusive activities within the AOC at an upwind location. A notation of BKD levels will be referenced in the daily monitoring log. BKD levels are a function of prevailing conditions. BKD levels will be taken in an appropriate upwind location as determined by the HSO.

Table 4 lists the instrument action levels.

8.0 COMMUNITY AIR MONITORING PROGRAM

Community air monitoring may be conducted in compliance with the NYSDOH Generic CAMP outlined below:

Monitoring for dust and odors will be conducted during all ground intrusive activities by the FTL. Continuous monitoring on the perimeter of the work zones for odor, VOCs, and dust may be required for all ground intrusive activities such as soil excavation and handling activities. The work zone is defined as the general area in which machinery is operating in support of remediation activities. A portable PID will be used to monitor the work zone and for periodic monitoring for VOCs during activities such as soil and groundwater sampling and .soil excavation. The site perimeter will be monitored for fugitive dust emissions by visual observations as well as instrumentation measurements (if required). When required, particulate or dust will be monitored continuously with real-time field instrumentation that will meet, at a minimum, the performance standards from DER-10 Appendix 1B.

If VOC monitoring is required, the following actions will be taken based on VOC levels measured:

- If total VOC levels exceed 5 ppm above background for the 15-minute average at the perimeter, work activities will be temporarily halted and monitoring continued. If levels readily decrease (per instantaneous readings) below 5 ppm above background, work activities will resume with continued monitoring.
- If total VOC levels at the downwind perimeter of the hot zone persist at levels in excess of 5 ppm above background but less than 25 ppm, work activities will be halted, the source of vapors identified, corrective actions taken to abate emissions, and monitoring continued. After these steps work activities will resume provided that the total organic vapor level 200 feet downwind of the hot zone or half the distance to the nearest potential receptor or residential/commercial structure, whichever is less – but in no case less than 20 feet, is below 5 ppm above background for the 15-minute average.
- If the total VOC level is above 25 ppm at the perimeter of the hot zone, activities will be shut down.

If dust monitoring with field instrumentation is required, the following actions will be taken based on instrumentation measurements:

- If the downwind particulate level is 100 micrograms per cubic meter ($\mu g/m^3$) greater than background (upwind perimeter) for the 15-minute period or if airborne dust is observed leaving the work area, then dust suppression must be employed. Work may continue with dust suppression techniques provided that downwind PM10 levels do not exceed 150 $\mu g/m^3$ above the background level and provided that no visible dust is migrating from the work area.
- If, after implementation of dust suppression techniques, downwind PM10 levels are greater than 150 $\mu g/m^3$ above the background level, work must be stopped and a re-evaluation of activities initiated. Work can resume provided that dust suppression measures and other controls are successful in reducing the downwind PM10 concentration to within 150 $\mu g/m^3$ of the upwind level and in preventing visible dust migration.

8.1 Vapor Emission Response Plan

This section applies if VOC monitoring is required. If the ambient air concentration of organic vapors exceeds 5 ppm above background at the perimeter of the hot zone, boring and well installation, and excavation activities will be halted or odor controls will be employed, and monitoring continued. When work shut-down occurs, downwind air monitoring as directed by the HSO or FTL will be implemented to ensure that vapor emission does not impact the nearest residential or commercial structure at levels exceeding those specified in the Major Vapor Emission section.

If the organic vapor level decreases below 5 ppm above background, sampling and boring and well installation can resume, provided:

- The organic vapor level 200 feet downwind of the hot zone or half the distance to the nearest residential or commercial structure, whichever is less, is below 1 ppm over background, and
- More frequent intervals of monitoring, as directed by the HSO or FTL, are conducted.

8.2 Major Vapor Emission

This section applies if VOC monitoring is required. If any organic levels greater than 5 ppm over background are identified 200 feet downwind from the work site, or half the distance to the nearest residential or commercial property, whichever is less, all work activities must be halted or odor controls must be implemented.

If, following the cessation of the work activities, or as the result of an emergency, organic levels persist above 5 ppm above background 200 feet downwind or half the distance to the nearest residential or commercial property from the hot zone, then the air quality must be monitored within 20 feet of the perimeter of the nearest residential or commercial structure (20 Foot Zone).

If either of the following criteria is exceeded in the 20 Foot Zone, then the Major Vapor Emission Response Plan shall automatically be implemented.

- Sustained organic vapor levels approaching 5 ppm above background for a period of more than 30 minutes, or
- Organic vapor levels greater than 5 ppm above background for any time period.

8.3 Major Vapor Emission Response Plan

Upon activation, the following activities will be undertaken:

- The local police authorities will immediately be contacted by the HSO or FTL and advised of the situation;
- Frequent air monitoring will be conducted at 30-minute intervals within the 20 Foot Zone. If two successive readings below action levels are measured, air monitoring may be halted or modified by the HSO or FTL; and
- All Emergency contacts will go into effect as appropriate.

8.4 Dust Suppression Techniques

Preventative measures for dust generation may include wetting site fill and soil, construction of an engineered construction entrance with gravel pad, a truck wash area, covering soils with tarps, and limiting vehicle speeds to five miles per hour.

Work practices to minimize odors and vapors include limiting the time that the excavations remain open, minimizing stockpiling of contaminated-source soil, and minimizing the handling of contaminated material. Offending odor and organic vapor controls may include the application of foam suppressants or tarps over the odor or VOC source areas. Foam suppressants may include biodegradable foams applied over the source material for short-term control of the odor and VOCs.

If odors develop and cannot be otherwise controlled, additional means to eliminate odor nuisances will include: direct load-out of soils to trucks for off-site disposal; use of chemical odorants in spray or misting systems; and, use of staff to monitor odors in surrounding neighborhoods.

Where odor nuisances have developed during remedial work and cannot be corrected, or where the release of nuisance odors cannot otherwise be avoided due to on-site conditions or close proximity to sensitive receptors, odor control will be achieved by sheltering excavation and handling areas under tented containment structures equipped with appropriate air venting/filtering systems.

9.0 WORK ZONES AND DECONTAMINATION

9.1 Site Control

Work zones are intended to control the potential spread of contamination throughout the site and to assure that only authorized individuals are permitted into potentially hazardous areas.

Any person working in an area where the potential for exposure to site contaminants exists will only be allowed access after providing the HSO with proper training and medical documentation.

Exclusion Zone (EZ) - All activities which may involve exposure to site contaminants, hazardous materials and/or conditions should be considered an EZ. Decontamination of field equipment will also be conducted in the Contaminant Reduction Zone (CRZ) which will be located on the perimeter of the EZ. The EZ and the CRZ will be clearly delineated by cones, tapes or other means. The HSO may establish more than one EZ where different levels of protection may be employed or different hazards exist. The size of the EZ shall be determined by the HSO allowing adequate space for the activity to be completed, field members and emergency equipment.

9.2 Contamination Zone

9.2.1 Personnel Decontamination Station

Personal hygiene, coupled with diligent decontamination, will significantly reduce the potential for exposure.

9.2.2 Minimization of Contact with Contaminants

During completion of all site activities, personnel should attempt to minimize the chance of contact with contaminated materials. This involves a conscientious effort to keep "clean" during site activities. All personnel should minimize kneeling, splash generation, and other physical contact with contamination as PPE is intended to minimize accidental contact. This may ultimately minimize the degree of decontamination required and the generation of waste materials from site operations.

Field procedures will be developed to control over spray and runoff and to ensure that unprotected personnel working nearby are not affected.

9.2.3 Personnel Decontamination Sequence

Decontamination may be performed by removing all PPE used in EZ and placing it in drums/trash cans at the CRZ. Baby wipes should be available for wiping hands and face. Drums/trash cans-will be labeled by the field crews in accordance with all local, state, and federal requirements. Management plans for contaminated PPE, and tools are provided below.

9.2.4 Emergency Decontamination

If circumstances dictate that contaminated clothing cannot be readily removed, then remove gross contamination and wrap injured personnel with clean garments/blankets to avoid contaminating other personnel or transporting equipment. If the injured person can be moved, he/she will be decontaminated by site personnel as described above before emergency responders handle the victim. If the person cannot be moved because of the extent of the injury (a back or neck injury), provisions shall be made to ensure that emergency response personnel will be able to respond to the victim without being exposed to potentially hazardous atmospheric conditions. If the potential for inhalation hazards exist, such as with open excavation, this area will be covered with polyethylene sheeting to eliminate any potential inhalation hazards. All emergency personnel are to be immediately informed of the injured person's condition, potential contaminants, and provided with all pertinent data.

9.2.5 Hand-Held Equipment Decontamination

Hand-held equipment includes all monitoring instruments as stated earlier, samples, hand tools, and notebooks. The hand-held equipment is dropped at the first decontamination station to be decontaminated by one of the decontamination team members. These items must be decontaminated or discarded as waste prior to removal from the CRZ.

To aid in decontamination, monitoring instruments can be sealed in plastic bags or wrapped in polyethylene. This will also protect the instruments against contaminants. The instruments will be wiped clean using wipes or paper towels if contamination is visually evident. Sampling equipment, hand tools, etc. will be cleaned with non-phosphorous soap to remove any potentially contaminated soil, and rinsed with deionized water. All decontamination fluids will be containerized and stored on-site pending waste characterization sampling and appropriate off-site disposal.

9.2.6 Heavy Equipment Decontamination

All heavy equipment and vehicles arriving at the work site will be free from contamination from offsite sources. Any vehicles arriving to work that are suspected of being impacted will not be permitted on the work site. Potentially contaminated heavy equipment will not be permitted to leave the EZ unless it has been thoroughly decontaminated and visually inspected by the HSO or his designee.

9.3 Support Zone

The support zone or cold zone will include the remaining areas of the job site. Break areas and support facilities (include equipment storage and maintenance areas) will be located in this zone. No equipment or personnel will be permitted to enter the cold zone from the hot zone without passing through the decontamination station in the warm zone (if necessitated). Eating, smoking, and drinking will be allowed only in this area.

9.4 Communications

The following communications equipment will be utilized as appropriate.

- Telephones - A cellular telephone will be located with the HSO for communication with the HSM and emergency support services/facilities.
- Hand Signals - Hand signals shall be used by field teams, along with the buddy system. The entire field team shall know them before operations commence and their use covered during site-specific training. Typical hand signals are the following:

Hand Signal	Meaning
Hand gripping throat	Out of air; cannot breathe
Grip partners wrists or place both hands around waist	Leave immediately without debate
Hands on top of head	Need assistance
Thumbs up	OK; I'm alright; I understand
Thumbs down	No; negative
Simulated "stick" break with fists	Take a break; stop work

9.5 The Buddy System

When working in teams of two or more, workers will use the "buddy system" for all work activities to ensure that rapid assistance can be provided in the event of an emergency. This requires work groups to be organized such that workers can remain close together and maintain visual contact with one another. Workers using the "buddy system" have the following responsibilities:

- Provide his/her partner with assistance.
- Observe his/her partner for signs of chemical or heat exposure.
- Periodically check the integrity of his/her partner's PPE.
- Notify the HSO or other site personnel if emergency service is needed.

10.0 NEAREST MEDICAL ASSISTANCE

The address and telephone number of the nearest hospital:

Mount Sinai Hospital of Queens
25-10 30th Avenue
Long Island City, New York
718-932-1000

Map with directions to the hospital are shown in Figure 2. This information will either be posted prominently at the site or will be available to all personnel all of the time. Further, all field personnel, including the HSO & FTL, will know the directions to the hospital.

11.0 STANDING ORDERS/SAFE WORK PRACTICES

The standing orders, which consist of a description of safe work practices that must always be followed while on-site by Langan employees and contractors, are shown in Attachment A. The site HSO and FTL each have the responsibility for enforcing these practices. The standing orders will be posted prominently at the site, or are made available to all personnel at all times. Those who do not abide by these safe work practices will be removed from the site.

12.0 SITE SECURITY

No unauthorized personnel shall be permitted access to the work areas.

13.0 UNDERGROUND UTILITIES

As provided in Langan's Underground Utility Clearance Guidelines, the following safe work practices should be followed by Langan personnel and the contractor before and during subsurface work in accordance with federal, state and local regulations:

- Obtain available utility drawings from the property owner/client or operator.
- Provide utility drawings to the project team.
- In the field, mark the proposed area of subsurface disturbance (when possible).
- Ensure that the utility clearance system has been notified.
- Ensure that utilities are marked before beginning subsurface work.
- Discuss subsurface work locations with the owner/client and contractors.
- Obtain approval from the owner/client and operators for proposed subsurface work locations.
- Use safe digging procedures when applicable.
- Stay at least 10 feet from all equipment performing subsurface work.

14.0 SITE SAFETY INSPECTION

The Langan HSO or alternate will check the work area daily, at the beginning and end of each work shift or more frequently to ensure safe work conditions. The HSO or alternate must complete the Jobsite Safety Inspection Checklist, found in Attachment F. Any deficiencies shall be shared with the FTL, HSM and PM and will be discussed at the daily tailgate meeting.

15.0 HAND AND POWER TOOLS

All hand- and electric-power tools and similar equipment shall be maintained in a safe operating condition. All electric-power tools must be inspected before initial use. Damaged tools shall be removed immediately from service or repaired. Tools shall be used only for the purpose for which they were designed. All users must be properly trained in their safe operation.

16.0 EMERGENCY RESPONSE

16.1 General

This section establishes procedures and provides information for use during a project emergency. Emergencies happen unexpectedly and quickly, and require an immediate response; therefore, contingency planning and advanced training of staff is essential. Specific elements of emergency support procedures that are addressed in the following subsections include communications, local emergency support units, and preparation for medical emergencies, first aid for injuries incurred on site, record keeping, and emergency site evacuation procedures. In case of emergency, in addition to 911, call *Incident Intervention®* at 1-888-479-7787 to report their injuries. For all other communications, contact the Langan Incident Hotline at **(800) 9-LANGAN** (800-952-6426) extension 4699 as soon as possible.

Should outside assistance be needed for accidents, fire, or release of hazardous substances, the emergency numbers will be available and posted at the site (Table 5) where a readily accessible telephone is made available for emergency use.

Also, in the event of an incident where a team member becomes exposed or suffers from an acute symptom from contact with site materials and has to be taken to a hospital, a short medical data sheet (Attachment T) for that individual will be made available to the attending physician. The medical data sheet will include the following:

- Name, address, home phone
- Age, height, weight
- Name of person to be notified in case of an accident
- Allergies
- Particular sensitivities
- Does he/she wear contact lenses
- Short checklist of previous illness
- Name of personal physician and phone
- Name of company physician and phone
- Prescription and non-prescription medications currently used.

A sample medical data sheet is included in Attachment T.

16.2 Responsibilities

16.2.1 Health and Safety Officer (HSO)

The HSO is responsible for ensuring that all personnel are evacuated safely and that machinery and processes are shut down or stabilized in the event of a stop work order or evacuation. The HSO is responsible for ensuring the HSM are notified of all incidents, all injuries, near misses, fires, spills, releases or equipment damage. The HSO is required to immediately notify the HSM of any fatalities or catastrophes (three or more workers injured and hospitalized) so that the HSM can notify OSHA within the required time frame.

16.2.2 Emergency Coordinator

The HSO or their designated alternate will serve as the Emergency Coordinator. The Emergency Coordinator is responsible for ensuring that all personnel are evacuated safely and that machinery and processes are shut down or stabilized in the event of a stop work order or evacuation. They are also responsible for ensuring the HSM are notified of all incidents, all injuries, near misses, fires, spills, releases or equipment damage. The Emergency Coordinator is required to immediately notify the HSM of any fatalities or catastrophes (three or more workers injured and hospitalized.

The Emergency Coordinator shall locate emergency phone numbers and identify hospital routes prior to beginning work on the sites. The Emergency Coordinator shall make necessary arrangements to be prepared for any emergencies that could occur.

The Emergency Coordinator is responsible for implementing the Emergency Response Plan.

16.2.3 Site Personnel

Project site personnel are responsible for knowing the Emergency Response Plan and the procedures contained herein. Personnel are expected to notify the Emergency Coordinator of situations that could constitute a site emergency. Project site personnel, including all subcontractors will be trained in the Emergency Response Plan.

16.3 Communications

Once an emergency situation has been stabilized, or as soon as practically, the injured Langan personnel should contact *Incident Intervention®* at 1-888-479-7787 to report their injuries. For all other communications, contact the Langan Incident Hotline at **(800) 9-LANGAN** (800-952-6426) extension 4699 as soon as possible.

16.4 Local Emergency Support Units

In order to be able to deal with any emergency that might occur during investigative activities at the site, the Emergency Notification Numbers (Table 5) will be posted and provided to all personnel conducting work within the EZ.

Figure 2 shows the hospital route map. Outside emergency number 911 and local ambulance should be relied on for response to medical emergencies and transport to emergency rooms. Always contact first responders when there are serious or life threatening emergencies on the site. Project personnel are instructed not to drive injured personnel to the Hospital. In the event of an injury, provide first aid and keep the injured party calm and protected from the elements and treat for shock when necessary.

16.5 Pre-Emergency Planning

Langan will communicate directly with administrative personnel from the emergency room at the hospital in order to determine whether the hospital has the facilities and personnel needed to treat cases of trauma resulting from any of the contaminants expected to be found on the site. Instructions for finding the hospital will be posted conspicuously in the site office and in each site vehicle.

16.6 Emergency Medical Treatment

The procedures and rules in this HASP are designed to prevent employee injury. However, should an injury occur, no matter how slight, it will be reported to the HSO immediately. First-aid equipment will be available on site at the following locations:

- First Aid Kit: Contractor Vehicles
- Emergency Eye Wash: Contractor Vehicles

During the site safety briefing, project personnel will be informed of the location of the first aid station(s) that has been set up. Some injuries, such as severe cuts and lacerations or burns, may require immediate treatment. Any first aid instructions that can be obtained from doctors or paramedics, before an emergency-response squad arrives at the site or before the injured person can be transported to the hospital, will be followed closely.

16.7 Personnel with current first aid and CPR certification will be identified.

Only in non-emergency situations may an injured person be transported to an urgent care facility. Due to hazards that may be present at the site and the conditions under which operations are conducted, it is possible that an emergency situation may develop. Emergency situations can be characterized as injury or acute chemical exposure to personnel, fire or explosion, environmental release, or hazardous weather conditions.

16.8 Emergency Site Evacuation Routes and Procedures

All project personnel will be instructed on proper emergency response procedures and locations of emergency telephone numbers during the initial site safety meeting. If an emergency occurs as a result of the site investigation activities, including but not limited to fire, explosion or significant release of toxic gas into the atmosphere, the Langan Project Manager will be verbally notified immediately. All heavy equipment will be shut down and all personnel will evacuate the work areas and assemble at the nearest intersection to be accounted for and to receive further instructions.

In the event that an emergency situation arises, the FTL will implement an immediate evacuation of all project personnel due to immediate or impending danger. The FTL will also immediately communicate with the contractor to coordinate any needed evacuation of the property.

The FTL or Site Supervisor will give necessary instructions until the Designated Incident Commander (IC) assumes control. After the emergency has been resolved, the FTL or Site Supervisor will coordinate with the IC and indicate when staff should resume their normal duties. If dangers are present for those at the designated assembly point, another designated location of assembly will be established.

It will be the responsibility of the FTL or Site Supervisor to report a fire or emergency, assess the seriousness of the situation, and initiate emergency measures until the arrival of the local fire fighters or other first responders, should they be necessary. The FTL, working with emergency responders, may also order the closure of the Site for an indefinite period as long as it is deemed necessary.

Under no circumstances will incoming visitors be allowed to proceed to the area of concern, once an emergency evacuation has been implemented. Visitors or other persons present in the area of the emergency shall be instructed to evacuate the area. The FTL will ensure that access roads are not obstructed and will remain on-site to provide stand-by assistance upon arrival of emergency personnel.

If it is necessary to temporarily control traffic in the event of an emergency, those persons controlling traffic will wear proper reflection warning vests until the arrival of police or fire personnel.

16.8.1 Designated Assembly Locations

All personnel will evacuate the site and assemble at a designated assembly location. The assembly location will be designated by Langan personnel and discussed during each shift's pre-job safety briefing.

16.8.2 Accounting for Personnel

All contractor and subcontractor supervisors are responsible for the accounting of all personnel assembled at the designed assembly area. The Designated Incident Commander shall be notified if personnel are not found.

16.9 Fire Prevention and Protection

In the event of a fire or explosion, procedures will include immediately evacuating the site and notification of the Langan Project Manager of the investigation activities. Portable fire extinguishers will be provided at the work zone. The extinguishers located in the various locations should also be identified prior to the start of work. No personnel will fight a fire beyond the stage where it can be put out with a portable extinguisher (incipient stage).

16.9.1 Fire Prevention

Fires will be prevented by adhering to the following precautions:

- Good housekeeping and storage of materials.
  - Storage of flammable liquids and gases away from oxidizers.
  - Shutting off engines to refuel.
  - Grounding and bonding metal containers during transfer of flammable liquids.
  - Use of UL approved flammable storage cans.
  - Fire extinguishers rated at least 10 pounds ABC located on all heavy equipment, in all trailers and near all hot work activities.

The person responsible for the control of fuel source hazards and the maintenance of fire prevention and/or control equipment is the HSO.

16.10 Significant Vapor Release

Based on the proposed tasks, the potential for a significant vapor release is low. However, if a release occurs, the following steps will be taken:

- Move all personnel to an upwind location. All non-essential personnel shall evacuate.
- Upgrade to Level C Respiratory Protection.

- Downwind perimeter locations shall be monitored for volatile organics.
- If the release poses a potential threat to human health or the environment in the community, the Emergency Coordinator shall notify the Langan Project Manager.
- Local emergency response coordinators will be notified.

16.11 Overt Chemical Exposure

The following are standard procedures to treat chemical exposures. Other, specific procedures detailed on the Material Safety Data Sheet (MSDS) will be followed, when necessary.

SKIN AND EYE: Use copious amounts of soap and water from eye-wash kits and portable hand wash stations.

CONTACT: Wash/rinse affected areas thoroughly, then provide appropriate medical attention. Skin shall also be rinsed for 15 minutes if contact with caustics, acids or hydrogen peroxide occurs. Affected items of clothing shall also be removed from contact with skin.

Providing wash water and soap will be the responsibility of each individual contractor or subcontractor on-site.

16.12 Decontamination during Medical Emergencies

If emergency life-saving first aid and/or medical treatment is required, normal decontamination procedures may need to be abbreviated or omitted. The HSO or designee will accompany contaminated victims to the medical facility to advice on matters involving decontamination when necessary. The outer garments can be removed if they do not cause delays, interfere with treatment or aggravate the problem. Respiratory equipment must always be removed. Protective clothing can be cut away. If the outer contaminated garments cannot be safely removed on site, a plastic barrier placed between the injured individual and clean surfaces should be used to help prevent contamination of the inside of ambulances and/or medical personnel. Outer garments may then be removed at the medical facility. No attempt will be made to wash or rinse the victim if his/her injuries are life threatening, unless it is known that the individual has been contaminated with an extremely toxic or corrosive material which could also cause severe injury or loss of life to emergency response personnel. For minor medical problems or injuries, the normal decontamination procedures will be followed.

16.13 Adverse Weather Conditions

In the event of adverse weather conditions, the HSO will determine if work will continue without potentially risking the safety of all field workers. Some of the items to be considered prior to determining if work should continue are:

- Potential for heat stress and heat-related injuries.
- Potential for cold stress and cold-related injuries.
- Treacherous weather-related working conditions (hail, rain, snow, ice, high winds).
- Limited visibility (fog).
- Potential for electrical storms.
- Earthquakes.
- Other major incidents.

Site activities will be limited to daylight hours, or when suitable artificial light is provided, and acceptable weather conditions prevail. The HSO will determine the need to cease field operations or observe daily weather reports and evacuate, if necessary, in case of severe inclement weather conditions.

16.14 Spill Control and Response

All small spills/environmental releases shall be contained as close to the source as possible. Whenever possible, the MSDS will be consulted to assist in determining proper waste characterization and the best means of containment and cleanup. For small spills, sorbent materials such as sand, sawdust or commercial sorbents should be placed directly on the substance to contain the spill and aid recovery. Any acid spills should be diluted or neutralized carefully prior to attempting recovery. Berms of earthen or sorbent materials can be used to contain the leading edge of the spills. All spill containment materials will be properly disposed. An exclusion zone of 50 to 100 feet around the spill area should be established depending on the size of the spill.

All contractor vehicles shall have spill kits on them with enough material to contain and absorb the worst-case spill from that vehicle. All vehicles and equipment shall be inspected prior to be admitted on site. Any vehicle or piece of equipment that develops a leak will be taken out of service and removed from the job site.

The following seven steps shall be taken by the Emergency Coordinator:

1. Determine the nature, identity and amounts of major spills.
2. Make sure all unnecessary persons are removed from the spill area.
3. Notify the HSO immediately.
4. Use proper PPE in consultation with the HSO.
5. If a flammable liquid, gas or vapor is involved, remove all ignition sources and use non-sparking and/or explosion-proof equipment to contain or clean up the spill (diesel-only vehicles, air-operated pumps, etc.)

6. If possible, try to stop the leak with appropriate material.
7. Remove all surrounding materials that can react or compound with the spill.

In addition to the spill control and response procedures described in this HASP, Langan personnel will coordinate with the designated project manager relative to spill response and control actions. Notification to the Project Manager must be immediate and, to the extent possible, include the following information:

- Time and location of the spill.
- Type and nature of the material spilled.
- Amount spilled.
- Whether the spill has affected or has a potential to affect a waterway or sewer.
- A brief description of affected areas/equipment.
- Whether the spill has been contained.
- Expected time of cleanup completion. If spill cleanup cannot be handled by Langan's on-site personnel alone, such fact must be conveyed to the Project Manager immediately.

Langan shall not make any notification of spills to outside agencies. The client will notify regulatory agencies as per their reporting procedures.

16.15 Emergency Equipment

The following minimum emergency equipment shall be kept and maintained on site:

- Industrial first aid kit.
- Fire extinguishers (one per site).

16.16 Restoration and Salvage

After an emergency, prompt restoration of utilities, fire protection equipment, medical supplies and other equipment will reduce the possibility of further losses. Some of the items that may need to be addressed are:

- Refilling fire extinguishers.
- Refilling medical supplies.
- Recharging eyewashes and/or showers.
- Replenishing spill control supplies.

16.17 Documentation

Immediately following an incident or near miss, unless emergency medical treatment is required, either the employee or a coworker must contact the Langan Incident/Injury Hotline at 1-(800)-9-

LANGAN (ext. #4699) and the client representative to report the incident or near miss. For emergencies involving personnel injury and/or exposure, the HSO and affected employee will complete and submit an Employee Exposure/Injury Incident Report (Attachment C) to the Langan Corporate Health and Safety Manager as soon as possible following the incident.

17.0 SPECIAL CONDITIONS

This guideline contains information and requirements for special conditions that may not be routinely encountered.

17.1 Scope

The guideline applies to the specific projects identified within this document. Additional provisions will be addressed in each Site-Specific HEALTH AND SAFETY PLAn (HASP), as needed.

17.2 Responsibilities

Site Personnel - All site personnel must be alert to safety hazards on work sites and take action to minimize such hazards. Personnel must utilize the buddy system, watch for inappropriate behavior, and be alert to changes in site conditions.

Health and Safety Officer (HSO) - The HSO is responsible for considering these procedures in the development of site specific HASPs. The HSO shall schedule frequent "tail gate" safety briefings to enhance safety awareness and discuss potential problems.

17.3 Procedures

The procedures outlined below shall be followed when such conditions are encountered.

17.3.1 Ladders

Langan safety procedures shall be used to ensure employee safety when using ladders in the office or work sites. All ladders shall be coated or repaired to prevent injury to the employee from punctures or lacerations and to prevent snagging or clothing. Any wood ladders used must have an opaque covering except for identification or warning labels, which may be placed on one face only of a side rail.

17.3.1.1 Ladder Use

Employees shall only use ladders for the purposes, which they were designed and shall not be used as scaffolding. Ladders will be maintained and inspected prior to use for slip hazards including oil and grease. Employees shall use ladders only on stable and level surfaces unless the ladder is secured to prevent possible displacement. Ladders should not be used on slippery surfaces unless secured or provided with slip resistant feet to prevent accidental displacement. Ladders should not be used in locations where they could be displaced by workplace activities or traffic. Ladder rungs, cleats and steps shall be parallel, level and uniformly spaced when the ladder is in the use position.

Employees should not be carrying anything including equipment that could cause injury if there was a fall while utilizing the ladder. The top and bottom of the ladder area must remain clear while in use. When ascending and descending the ladder, employees must face the ladder.

Ladders shall not be loaded beyond the maximum intended load for which they were built or the manufacturer's rated capacity.

17.3.1.2 Portable Ladders

Rungs, cleats and steps for portable ladders and fixed ladders shall be spaced not less than 10 inches apart, nor more than 14 inches apart, as measured between center lines of the rungs, cleats and steps. When used to access an upper landing surface, the ladder side rails must extend at least three feet above the upper landing surface to which the ladder is used to gain access. If this is not possible, due to the ladders length, then the top of the ladder shall be secured at its top to a rigid support.

17.3.1.3 Step Stools

Rungs, cleats and steps of step stools shall not be less than 8 inches apart, nor more than 12 inches apart, as measured between center lines of the rungs, cleats and steps.

17.3.1.4 Extension Ladders

Rungs, cleats and steps of the base section of extension trestle ladders shall be spaced not less than 8 inches apart, nor more than 18 inches apart, as measured between center lines of the rungs, cleats and steps. The rung spacing on the extension section of the extension trestle ladder shall not be less than 6 inches nor more than 12 inches, as measured between center lines of the rungs, cleats and steps. Ladders shall be used at an angle such that the horizontal distance from the top support to the foot of the ladder is approximately one-quarter of the working length of the ladder (the distance along the ladder between the foot and the top support).

17.3.1.5 Inspection

Ladders will be inspected for visible detects periodically, prior to utilization or after any occurrence that could have negatively affected the ladder. Portable ladders with defects including broken or missing rungs, cleats, or steps, broken or split rails, corroded components or other faulty or defective components shall not be used. The ladder will be immediately marked as defective, tagged as "Do Not Use" or blocked from being used and removed from service until repaired.

17.3.2 First Aid/Cardiopulmonary Resuscitation (CPR)

Langan field and office personnel will be encouraged to be trained in First Aid and Cardiopulmonary Resuscitation (CPR). Training will be provided free of charge by Langan to all employees. Employees will receive a training certificate that will be kept on file with the Health & Safety Coordinator (HSC). Training and certification will be provided by a credited provider such as American Red Cross or equivalent.

17.3.2.1 Emergency Procedures

Prior to work at sites the Langan employees certified in first aid and CPR will be identified in the site specific HASP. Langan will endear to have at least one employee at a job site trained and able to render first aid and CPR. The site specific HASP will contain first aid information on both potential chemical and physical hazards. Emergency procedures to be followed are in case of injury or illnesses are provided in the HASP. The HASP will include emergency contact information including local police and fire departments, hospital emergency rooms, ambulance services, on-site medical personnel and physicians. The HASP will also include directions and contact information to the nearest emergency facility in case immediate medical attention is required. The emergency contact information will be conspicuously posted at the worksite. Employees that are injured and require immediate medical attention shall call either 911 or the local posted emergency contacts. Employees should use ambulatory services to transport injured workers to the nearest facility for emergency medical care. In areas where 911 is not available, the telephone numbers of the physicians, hospitals, or ambulances shall be conspicuously posted.

17.3.2.2 First Aid Supplies

First aid supplies are readily available to all Langan employees when required. First aid kits are located in each Langan office. Portable first aid kits are available for employees to use at work sites. First aid kits should consist of items needed to treat employees for potential chemical and physical injuries. At a minimum, first aid kits should contain items to allow basic first aid to be rendered. Where the eyes or body of an employee may be exposed to corrosive materials, suitable facilities for quick drenching or flushing of the eyes and body shall be provided within the work area for immediate emergency use including eye wash.

First aid kits will be weatherproof with individual sealed packages of each item. All portable first aid kits shall be inspected by Langan employees before and after use to ensure all used items are replaced. When out in the field, employees shall check first aid kits weekly to ensure used items are replaced.

17.3.3 Hydrogen Sulfide

Langan employees with the potential to be exposed to hydrogen sulfide while at work sites shall have training in hydrogen sulfide awareness. The training will include identification of areas where employees could be exposed to hydrogen sulfide, health effects, permissible exposure limits, first aid procedures and personnel protective equipment. Langan employees could be exposed to hydrogen sulfide while at job sites including petroleum refineries, hazardous waste treatment, storage and disposal facilities, uncontrolled hazardous waste sites and remediation projects.

17.3.3.1 Characteristics

Hydrogen sulfide is a colorless gas with a strong odor of rotten eggs that is soluble in water. Hydrogen sulfide is used to test and make other chemicals. It is also found as a by-product of chemical reactions, such as in sewer treatment. It is a highly flammable gas and a dangerous fire hazard. Poisonous gases are produced in fires including sulfur oxides. Hydrogen sulfide is not listed as a carcinogen.

17.3.3.2 Health Effects

Hydrogen Sulfide can affect employees if inhaled or through contact with skin or eyes. Acute (or short term) health effects of hydrogen sulfide exposure include irritation of the nose and throat, dizziness, confusion, headache and trouble sleeping. Inhalation of hydrogen sulfide can irritate the lungs causing coughing and/or shortness of breath. Higher levels of exposure can cause build-up of fluid in the lungs (pulmonary edema), a medical emergency, with severe shortness of breath.

Chronic (or long term) health effects of low levels of exposure to hydrogen sulfide can cause pain and redness of the eyes with blurred vision. Repeated exposure may cause bronchitis with cough, phlegm and shortness of breath.

17.3.3.3 Protective Clothing and Equipment

Respirators are required for those operations in which employees will be exposed to hydrogen sulfide above OSHA permissible exposure level. The maximum OSHA permissible exposure limit (PEL) for hydrogen sulfide is 20 parts of hydrogen sulfide vapor per million parts of air (20 ppm) for an 8-hour workday and the maximum short-term exposure limit (STEL) is 10 ppm for any 10-minute period.

Where employees are exposed to levels up to 100 parts of hydrogen sulfide vapor per million parts of air (100 ppm), the following types of respiratory protection are allowed:

- Any powered, air purifying respirator with cartridge(s);
- Any air purifying, full-facepiece respirator (gas mask) with a chin style, front- or back-mounted canister;
- Any supplied air system with escape self-contained breathing apparatus, if applicable; and,
- Any self-contained breathing apparatus with a full facepiece.

Respirators used by employees must have joint Mine Safety and Health Administration and the National Institute for Occupational Safety and Health (NIOSH) seal of approval. Cartridges or canisters must be replaced before the end of their service life, or the end of the shift, whichever occurs first. Langan employees that have the potential to be exposed to hydrogen sulfide will be trained in the proper use of respirators. Respirator training is discussed under– Langan's Respiratory Protection Program.

Employees with potential exposure to hydrogen sulfide, or when required by the client, will wear a portable hydrogen sulfide gas detector. The detector should have an audible, visual and vibrating alarm. The detector may also provide detection for carbon monoxide, sulfur dioxide and oxygen deficient atmospheres. The hydrogen sulfide monitor will, at a minimum, be calibrated to detect hydrogen sulfide at a level of 20 parts of hydrogen sulfide vapor per million parts of air (20 ppm). Many portable gas detectors will have factory defaults with a low level alarm at 10 ppm and a high level alarm at 15 ppm. Langan employees shall consult clients to determine if any site specific threshold levels exist.

If the hydrogen sulfide gas detector sounds and employees are not wearing appropriate respiratory protection, employees must immediately vacate the area and meet at the assigned emergency location. Langan employees may not re- enter the site without proper respiratory protection and approval from the client or property owner, if needed.

Employees shall wear PPE to prevent eye and skin contact with hydrogen sulfide. Employees must wear appropriate protective clothing including boots, gloves, sleeves and aprons, over any parts of their body that could be exposed to hydrogen sulfide. Non-vented, impact resistant goggles should be worn when working with or exposed to hydrogen sulfide.

17.3.3.4 Emergency and First Aid Procedures

Eye and Face Exposure

If hydrogen sulfide comes in contact with eyes, it should be washed out immediately with large amounts of water for 30 minutes, occasionally lifting the lower and upper eye lids. Seek medical attention immediately.

Skin Exposure

If hydrogen sulfide contaminates clothing or skin, remove the contaminated clothing immediately and wash the exposed skin with large amounts of water and soap. Seek medical attention immediately. Contaminated clothing should either be disposed of or washed before wearing again.

Breathing

If a Langan employee or other personnel breathe in hydrogen sulfide, immediately get the exposed person to fresh air. If breathing has stopped, artificial respiration should be started. Call for medical assistance or a doctor as soon as possible.

Safety Precautions

Hydrogen sulfide is a highly flammable gas and a dangerous fire hazard. Containers of hydrogen sulfide may explode in a fire situation. Poisonous gases are produced during fires.

Langan employees should contact property owners and operators prior to conducting work onsite to be aware of any site specific contingency plans, identify where hydrogen sulfide is used at the facility and be informed about additional safety rules or procedures.

19.3.4 Fire Protection/Extinguishers

Langan field personnel that have been provided with portable fire extinguishers for use at worksites will be trained to familiarize employees with general principles of fire extinguisher use and hazards associated with the incipient stage of firefighting. Training will be provided prior to initial assignment for field work and annually thereafter.

Portable fire extinguishers shall be visually inspected monthly and subjected to an annual maintenance check. Langan shall retain records of the annual maintenance date.

17.3.5 Overhead lines

When field work is performed near overhead lines, the lines shall be deenergized and grounded, or other protective measures shall be provided before the work shall commence. If overhead lines are to be deenergized, arrangements shall be made with the client, property owner or organization that operates or controls the electric circuits involved to deenergize and ground them. If protective measures, such as guarding, isolating, or insulating, are provided, these precautions shall prevent employees from contacting such lines directly with any part of their body or indirectly through conductive materials, tools, or equipment.

When unqualified Langan personnel are working in an elevated position near overhead lines, the location shall be such that the person and the longest conductive object they may contact cannot come closer to any unguarded, energized overhead line than the following distances:

1. For voltages to ground 50kV or below - 10 feet; and
2. For voltages to ground over 50kV - 10 feet, plus 4 inches for every 10kV over 50kV.

As previously indicated, Langan does not retain qualified employees to perform work on energized equipment.

17.3.5.1 Vehicle and Equipment Clearance

Any vehicle or mechanical equipment capable of having parts of its structure elevated near energized overhead lines shall be operated so that a clearance of 10 feet is maintained. If the voltage of the overhead lines is higher than 50kV, the clearance shall be increased 4 inches for every 10kV over that voltage.

If any of the following discussed conditions occur, the clearance may be reduced.

- If the vehicle is in transit with its structure lowered, the clearance may be reduced to 4 ft. If the voltage is higher than 50kV, the clearance shall be increased 4 in. for every 10 kV over that voltage.
- If insulating barriers are installed to prevent contact with the lines, and if the barriers are rated for the voltage of the line being guarded and are not a part of or an attachment to the vehicle or its raised structure, the clearance may be reduced to a distance within the designed working dimensions of the insulating barrier.

Employees standing on the ground may not contact the vehicle or mechanical equipment or any of its attachments, unless the employee is using protective equipment rated for the voltage; or the equipment is located so that no uninsulated part of its structure (that portion of the structure that provides a conductive path to employees on the ground) can come closer to the overhead line than permitted.

If any vehicle or mechanical equipment capable of having parts of its structure elevated near energized overhead lines is intentionally grounded, employees working on the ground near the point of grounding may not stand at the grounding location whenever there is a possibility of overhead line contact. Additional precautions, such as the use of barricades or insulation, shall be taken to protect employees from hazardous ground potentials, depending on earth resistivity and fault currents, which can develop within the first few feet or more outward from the grounding point.

17.3.6 Trade Secret

Langan employees could potentially be provided trade secret information by the client or property owner when site specific information is provided about highly hazardous chemicals. Trade secret means any confidential formula, pattern, process, device, information or compilation of information that is used in an employer's business, and that gives the employer an opportunity to obtain an advantage over competitors who do not know or use it. Langan employees understand that this information should be kept confident and if required, may enter into a confidentially agreement with the client.

17.3.7 Bloodborne Pathogens

Langan employees that can reasonably anticipate exposure to blood or other potentially infectious material while at work sites shall have training in bloodborne pathogens. Applicable employees would include those trained in first aid and serving a designated role as an emergency medical care provider. Bloodborne pathogens are pathogenic microorganisms that are present in human blood and can cause disease in humans. These pathogens include, but are not limited to, hepatitis B virus and human immunodeficiency virus.

17.3.7.1 Training

Langan employees with potential occupational exposure to blood or other potentially infectious material must participate in a training program. Training must be conducted prior to initial assignment where there would be potential for exposure and annually thereafter within one year of previous training. The training program will be provided to Langan employees at no cost to them and during working hours.

Langan will ensure the training program shall consist of the following:

- An accessible copy of the regulatory text of 29 CFR 1910.1030 and an explanation of its contents;
- A general explanation of the epidemiology and symptoms of bloodborne diseases;
- An explanation of the modes of transmission of bloodborne pathogens;
- An explanation of Langan's exposure control plan and the means by which the employee can obtain a copy of the written plan;
- An explanation of the appropriate methods for recognizing tasks and other activities that may involve exposure to blood and other potentially infectious materials;
- An explanation of the use and limitations of personal protective
    - equipment (PPE) to prevent and reduce exposure;
    - Information on the types, proper use, location, removal, handling and disposal of PPE;
    - An explanation of the basis for selection of PPE;
    - Information on the hepatitis B vaccine, including information on its efficacy, safety, method of administration, the benefits of being vaccinated, and that the vaccine and vaccination will be offered free of charge;
    - Information on the appropriate actions to take and persons to contact in an emergency involving blood or other potentially infectious materials;
    - An explanation of the procedure to follow if an exposure incident occurs, including the method of reporting the incident and the medical follow-up that will be made available;
    - Information on the post-exposure evaluation and follow-up that the
    - employer is required to provide for the employee following an exposure incident;
    - An explanation of the signs and labels and/or color coding required by paragraph 29 CFR 1910.1030(g)(1); and
    - An opportunity for interactive questions and answers with the person conducting the training session.

Langan will develop and implement a written Exposure Control Plan, which will be designed to eliminate or minimize employee exposure to bloodborne pathogens. The Exposure Control Plan will contain the following elements:

- An exposure determination for employees;
- The schedule and method of implementation for Methods of Compliance (29 CFR 191.1030(d)), Hepatitis B Vaccination and Post-Exposure Evaluation and Follow-up (29 CFR 1910.1030(f)), Communication of Hazards to Employees (29 CFR 1910.1030(g)) and (h) Recordkeeping (29 CFR 1910.1030(h));
- The procedure for the evaluation of circumstances surrounding exposure incidents;
- Ensure a copy of the Exposure Control Plan will be accessible to employees; and,
- The Exposure Control Plan shall be reviewed and updated at least annually.

Langan employees with occupational exposure to bloodborne pathogens include any employees trained in first aid that would be expected to provide emergency medical care. This determination is made without regards to the use of PPE, which could eliminate or minimize exposure.

Universal precautions shall be observed to prevent contact with blood or other potentially infectious materials. According to the concept of Universal Precautions, all human blood and certain human body fluids are treated as if known to be infectious for bloodborne pathogens. Under circumstances in which differentiation between body fluid types is difficult or impossible, all body fluids shall be considered potentially infectious materials.

Work practice controls shall be used to eliminate or minimize employee exposure, if applicable. Since Langan employees will have occupational exposure only during rendering of first aid, personnel protective equipment will be utilized to reduce or minimize exposure. PPE that could be available to Langan personnel when administering first aid includes safety glasses, gloves, and Tyvek suits or sleeves. PPE and first aid kits will be provided to employees at no cost to them.

Langan employees that render first aid in office areas will have access to hand washing facilities or restrooms. For first aid rendered at field locations, first aid kits will contain an appropriate antiseptic hand cleanser and clean cloth/paper towels or antiseptic towelettes. After using antiseptic hand cleansers or towelettes, employees shall wash their hands with soap and running water as soon as feasible.

After administering first aid, potentially infectious materials, including towels, personnel protective equipment, clothes and bandages, shall be placed in a container, which prevents leakage during collection, handling, processing, storage, transport, or shipping. All PPE will be dispose of after use. Any equipment or working surfaces which was been exposed to blood or potentially infectious materials due to an injury, will be decontaminated prior to reuse.

Langan will make available the hepatitis B vaccine and vaccination series to all employees who have occupational exposure, and post-exposure evaluation and follow-up to all employees who have had an exposure incident. These services will be available to the employee at no cost to them through a medical provider.

17.3.7.2 Recordkeeping

Langan will maintain training and medical records for each employee with occupational exposure to blood or potentially infectious materials. Medical and training records will be maintained by Langan’s H&S Department.

Training records will include the following:

- Dates of the training sessions;
- Contents or a summary of the training sessions;
- Names and qualifications of persons conducting the training; and
- Names and job titles of all persons attending the training sessions.

Training records shall be maintained for 3 years from the date on which the training occurred. Medical records will be will be preserved and maintained for the duration of employment plus 30 years.

All records will be made available upon request to employees, the Assistant Secretary of Labor for Occupational Safety and Health, and Director of National Institute for Occupational Safety and Health Director of OSHA for examination and copying. Medical records must have written consent from employee before releasing.

If Langan ceases to do business, all records shall be transferred to the successor employer. The successor employer shall receive and maintain these records.

If there will not be a successor, Langan will notify current employees of their rights to access records at least three months prior to the cessation of business.

18.0 RECORDKEEPING

The following is a summary of required health and safety logs, reports and recordkeeping.

18.1 Field Change Authorization Request

Any changes to the work to be performed that is not included in the HASP will require an addendum that is approved by the Langan project manager and Langan HSM to be prepared. Approved changes will be reviewed with all field personnel at a safety briefing.

18.2 Medical and Training Records

Copies or verification of training (40-hour, 8-hour, supervisor, site-specific training, documentation of three-day OJT, and respirator fit-test records) and medical clearance for site work and respirator use will be maintained in the office and available upon request. Records for all subcontractor employees must also be available upon request. All employee medical records will be maintained by the HSM.

18.3 Onsite Log

A log of personnel on site each day will be kept by the HSO or designee.

18.4 Daily Safety Meetings ("Tailgate Talks")

Completed safety briefing forms will be maintained by the HSO.

18.5 Exposure Records

All personal monitoring results, laboratory reports, calculations and air sampling data sheets are part of an employee exposure record. These records will be maintained by the HSO during site work. At the end of the project they will be maintained according to 29 CFR 1910.1020.

18.6 Hazard Communication Program/MSDS-SDS

Material safety data sheets (MSDS) of Safety Data Sheets (SDS) have been obtained for applicable substances and are included in this HASP (Attachment D). Langan's written hazard communication program, in compliance with 29 CFR 1910.1200, is maintained by the HSM.

18.7 Documentation

Immediately following an incident or near miss, unless emergency medical treatment is required, either the employee or a coworker must contact the Langan incident/injury hotline at 1-800-952-6426, extension 4699 and the Project Manager to report the incident or near miss. The Project Manager will contact the client or client representative. A written report must be completed and submitted HSM within 24 hours of the incident. For emergencies involving personnel injury and/or exposure, employee will complete and submit the Langan incident/injury report to the Langan corporate health and safety manager as soon as possible following the incident. Accidents will be investigated in-depth to identify all causes and to recommend hazard control measures.

18.7.1 Accident and Injury Report Forms

18.7.1.1 Accident/Incident Report

All injuries, no matter how slight, shall be reported to the FTL and the PM immediately. The accident/incident report forms, attached in Attachment U and Attachment V will be filled out on all accidents by the applicable contractor supervision personnel, the FTL, or the HSO. Copies of all accident/incident reports shall be kept on-site and available for review. Project personnel will be instructed on the location of the first aid station, hospital, and doctor and ambulance service near the job. The emergency telephone numbers will be conspicuously posted in site vehicles near the work zone. First aid supplies will be centrally located and conspicuously posted between restricted and non-restricted areas to be readily accessible to all on the site.

18.7.1.2 First Aid Treatment Record

The forms in will be used for recording all non-lost time injuries treated by the project first-aid attendant, the local physician or hospital will be entered in detail on this record. "Minor" treatment of scratches, cuts, etc. will receive the same recording attention as treatment of more severe injuries.

18.7.1.3 OSHA Form 300

An OSHA Form 300 will be kept at the Langan Corporate Office in Parsippany, New Jersey. All recordable injuries or illnesses will be recorded on this form. Subcontractor employers must also meet the requirements of maintaining an OSHA 300 form. The Incident Report form used to capture the details of work-related injuries/illnesses meets the requirements of the OSHA Form 301 (supplemental record) and must be maintained with the OSHA Form 300 for all recordable injuries or illnesses. Forms for recording OSHA work-related injuries and illnesses are included in Attachment U and Attachment V.

19.0 CONFINED SPACE ENTRY

Confined spaces are not anticipated at the Site during planned construction activities. If confined spaces are identified, the contractor must implement their own confined space program that all applicable federal, state and local regulations. Confined spaces **<u>will not</u>** be entered by Langan personnel.

20.0 HASP ACKNOWLEDGEMENT FORM

All Langan personnel and contractors will sign this HASP Compliance Agreement indicating that they have become familiar with this HASP and that they understand it and agree to abide by it.

Printed Name	Signature	Company	Date

TABLES

TABLE 1
TASK HAZARD ANALYSES

Task	Hazard	Description	Control Measures	First Aid
1.3.1 – 1.3.8	Contaminated Soil or Groundwater-Dermal Contact	Contaminated water spills on skin, splashes in eyes; contact with contaminated soil/fill during construction activities or sampling.	Wear proper PPE; follow safe practices, maintain safe distance from construction activities	See Table 2, seek medical attention as required
1.3.1 – 1.3.8	Lacerations, abrasions, punctures	Cutting bailer twine, pump tubing, acetate liners, etc. with knife; cuts from sharp site objects or previously cut piles, tanks, etc.; Using tools in tight spaces	Wear proper PPE; follow safe practices	Clean wound, apply pressure and/or bandages; seek medical attention as required.
1.3.1 – 1.3.8	Contaminated Media Inhalation	Opening drums, tanks, wells; vapors for non-aqueous phase liquids or other contaminated site media; dust inhalation during excavation; vapor accumulation in excavation	Follow air monitoring plan; have quick access to respirator, do not move or open unlabeled drums found at the site, maintain safe distance from construction activities	See Table 2, seek medical attention as required
1.3.1 – 1.3.8	Lifting	Improper lifting/carrying of equipment and materials causing strains	Follow safe lifting techniques; Langan employees are not to carry contractor equipment or materials	Rest, ice, compression, elevation; seek medical attention as required
1.3.1 – 1.3.8	Slips, trips, and falls	Slips, trips and falls due to uneven surfaces, cords, steep slopes, debris and equipment in work areas	Good housekeeping at site; constant awareness and focus on the task; avoid climbing on stockpiles; maintain safe distance from construction activities and excavations; avoid elevated areas over six feet unless fully accredited in fall protection and wearing an approved fall protection safety apparatus	Rest, ice, compression, elevation; seek medical attention as required
1.3.1 – 1.3.8	Noise	Excavation equipment, hand tools, drilling equipment.	Wear hearing protection; maintain safe distance from construction activities	Seek medical attention as required
1.3.1 – 1.3.8	Falling objects	Soil material, tools, etc. dropping from drill rigs, front-end loaders, etc.	Hard hats to be worn at all times while in work zones; maintain safe distance from construction activities and excavations	Seek medical attention as required
1.3.1 – 1.3.8	Underground/ overhead utilities	Excavation equipment, drill rig auger makes contact with underground object; boom touches overhead utility	"One Call" before dig; follow safe practices; confirm utility locations with contractor; wear proper PPE; maintain safe distance from construction activities and excavations	Seek medical attention as required
1.3.1 – 1.3.8	Insects (bees, wasps, hornet, mosquitoes, and spider)	Sings, bites	Insect Repellent; wear proper protective clothing (work boots, socks and light colored pants);field personnel who may have insect allergies (e.g., bee sting) should provide this information to the HSO or FSO prior to commencing work, and will have allergy medication on site.	Seek medical attention as required
1.3.1 – 1.3.8	Vehicle traffic / Heavy Equipment Operation	Vehicles unable to see workers on site, operation of heavy equipment in tight spaces, equipment failure, malfunctioning alarms	Wear proper PPE, especially visibility vest; use a buddy system to look for traffic; rope off area of work with cones and caution tape or devices at points of hazard, maintain safe distance from construction activities and equipment	Seek medical attention as required

TABLE 2
CONTAMINANT HAZARDS OF CONCERN

Task	Contaminant	CAS Number	Monitoring Device	PEL/ IDLH	Source of Concentration on Site	Route of Exposure	Symptoms	First Aid
1.3.1 – 1.3.8	1,1′-Biphenyl 1,1-Biphenyl Biphenyl Phenyl benzene Diphenyl	92-52-4	None	1 mg/m^3 100 mg/m^3	Soil Vapor	inhalation, skin absorption, ingestion, skin and/or eye contact	irritation to the eyes, throat; headache, nausea, lassitude (weakness, exhaustion), numb limbs; liver damage	Eye: Irrigate immediately Skin: Water flush immediately Breathing: Respiratory support Swallow: Medical attention immediately
1.3.1 – 1.3.8	1,2,4-Trimethylbenzene	95-63-6	PID	None None	Groundwater Soil Vapor	inhalation, ingestion, skin and/or eye contact	irritation to the eyes, skin, nose, throat, respiratory system; bronchitis; hypochromic anemia; headache, drowsiness, lassitude (weakness, exhaustion), dizziness, nausea, incoordination; vomiting, confusion; chemical pneumonitis (aspiration liquid)	Eye: Irrigate immediately Skin: Soap wash Breathing: Respiratory support Swallow: Medical attention immediately
1.3.1 – 1.3.8	1,2-Dichlorobenzene	95-50-1	PID	50 ppm 200 ppm	Groundwater Soil Vapor	inhalation, skin absorption, ingestion, skin and/or eye contact	irritation to the eye, swelling periorbital (situated around the eye); profuse rhinitis; headache, anorexia, nausea, vomiting; weight loss, jaundice, cirrhosis; in animals: liver, kidney injury; [potential occupational carcinogen]	Eye: Irrigate immediately Skin: Soap wash Breathing: Respiratory support Swallow: Medical attention immediately

Task	Contaminant	CAS Number	Monitoring Device	PEL/ IDLH	Source of Concentration on Site	Route of Exposure	Symptoms	First Aid
1.3.1 – 1.3.8	1,2-Dichloroethane Ethylene dichloride 1,2-DCA DCE[1] Ethane dichloride Dutch liquid, Dutch oil Freon 150 Glycol dichloride	107-06-2	PID	1 ppm 50 ppm	Groundwater Soil Vapor	inhalation, ingestion, skin absorption, skin and/or eye contact	irritation to the eyes, corneal opacity; central nervous system depression; nausea, vomiting; dermatitis; liver, kidney, cardiovascular system damage; [potential occupational carcinogen]	Eye: Irrigate immediately Skin: Soap wash promptly Breathing: Respiratory support Swallow: Medical attention immediately
1.3.1 – 1.3.8	1,3,5-Trimethylbenzene Mesitylene sym-Trimethylbenzene	108-67-8	PID	None None	Groundwater Soil Vapor	inhalation, ingestion, skin and/or eye contact	irritation to the eyes, skin, nose, throat, respiratory system; bronchitis; hypochromic anemia; headache, drowsiness, lassitude (weakness, exhaustion), dizziness, nausea, incoordination; vomiting, confusion; chemical pneumonitis (aspiration liquid)	Eye: Irrigate immediately Skin: Soap wash Breathing: Respiratory support Swallow: Medical attention immediately
1.3.1 – 1.3.8	2,4-Dimethylphenol 2,4-Xylenol m-Xylenol 1-Hydroxy-2,4-dimethylbenzene 2,4-Dimethylphenol 4-Hydroxy-1,3-dimethylbenzene 4,6-Dimethylphenol 1,3-Dimethyl-4-hydroxybenze	105-67-9	None	NA NA	Groundwater Soil Vapor	inhalation, ingestion, skin and/or eye contact	irritation to the eyes, skin, mucous membrane; headache, narcosis, coma; dermatitis; in animals: liver, kidney damage	Eye: Irrigate immediately Skin: Water flush promptly Breathing: Respiratory support Swallow: Medical attention immediately
1.3.1 – 1.3.8	2-Butanone Ethyl methyl ketone MEK Methyl acetone Methyl ethyl ketone	78-93-3	PID	200 ppm 3000 ppm	Soil Groundwater Vapor	inhalation, ingestion, skin and/or eye contact	irritation to the eyes, skin, nose; headache; dizziness; vomiting; dermatitis	Eye: Irrigate immediately Skin: Water wash immediately Breathing: Fresh air Swallow: Medical attention immediately

Task	Contaminant	CAS Number	Monitoring Device	PEL/ IDLH	Source of Concentration on Site	Route of Exposure	Symptoms	First Aid
1.3.1 – 1.3.8	2-Hexanone Butyl methyl ketone MBK Methyl butyl ketone Methyl n-butyl ketone	591-78-6	PID	100 ppm 1600 ppm	Groundwater Soil Vapor	inhalation, skin absorption, ingestion, skin and/or eye contact	irritation to the eyes, nose; peripheral neuropathy: lassitude (weakness, exhaustion), paresthesia; dermatitis; headache, drowsiness	Eye: Irrigate immediately Skin: Soap wash immediately Breathing: Respiratory support Swallow: Medical attention immediately
1.3.1 – 1.3.8	2-Methylnaphthalene β-methylnaphthalene	91-57-6	PID	NA NA	Groundwater Soil Vapor	inhalation, ingestion or skin absorption, eye contact	irritation to the skin, eyes, mucous membranes and upper respiratory tract. It may also cause headaches, nausea, vomiting, diarrhea, anemia, jaundice, euphoria, dermatitis, visual disturbances, convulsions and comatose	Eye: Irrigate immediately Skin: Water flush promptly Breathing: Respiratory support Swallow: Medical attention immediately
1.3.1 – 1.3.8	Acenaphthene 1,2-Dihydroacenaphthylene 1,8-Ethylenenaphthalene peri-Ethylenenaphthalene Naphthyleneethylene Tricyclododecapentaene	83-32-9	PID	NA NA	Soil	inhalation, ingestion, skin and/or eye contact,	irritation to the skin, eyes, mucous membranes and upper respiratory tract; If ingested, it can cause vomiting	Eye: Irrigate immediately Skin: Soap wash immediately, if redness or irritation develop, seek medical attention immediately Breathing: Move to fresh air Swallow: do not induce vomiting, seek medical attention immediately

Task	Contaminant	CAS Number	Monitoring Device	PEL/ IDLH	Source of Concentration on Site	Route of Exposure	Symptoms	First Aid
1.3.1 – 1.3.8	Acenaphthylene Cycopental(de)naphthalene, Acenaphthalene	208-96-8	PID	NA NA	Soil	inhalation, ingestion, skin and/or eye contact	irritation to the skin, eyes, mucous membranes and upper respiratory tract	Eye: Irrigate immediately, seek medical attention immediately, Skin: Soap wash immediately, if redness or irritation develop, seek medical attention immediately Breathing: Move to fresh air Swallow: do not induce vomiting, seek medical attention immediately
1.3.1 – 1.3.8	Acetone Dimethyl ketone Ketone propane 2-Propanone	67-64-1	PID	1000 ppm 2500 ppm	Groundwater Soil	inhalation, ingestion, skin and/or eye contact	irritation to the eyes, nose, throat; headache, dizziness, central nervous system depression; dermatitis	Eye: Irrigate immediately Skin: Soap wash immediately Breathing: Respiratory support Swallow: Medical attention immediately

Task	Contaminant	CAS Number	Monitoring Device	PEL/ IDLH	Source of Concentration on Site	Route of Exposure	Symptoms	First Aid
1.3.1 – 1.3.8	Acetophenone 1-phenylethanone Methyl phenyl ketone Phenylethanone	98-86-2	None	NA NA	Groundwater Soil	inhalation, ingestion, skin and/or eye contact	irritation to the skin, eyes, mucous membranes and upper respiratory tract	Eye: Irrigate immediately, seek medical attention immediately, Skin: Soap wash immediately, if redness or irritation develop, seek medical attention immediately Breathing: Move to fresh air Swallow: do not induce vomiting, seek medical attention immediately
1.3.1 – 1.3.8	Aluminum	7429-90-5	None	0.5 mg/m3 50 mg/m3	Soil	inhalation, skin and/or eye contact	irritation to the eyes, skin, respiratory system	Eye: Irrigate immediately Breathing: Fresh air
1.3.1 – 1.3.8	Anthracene	120-12-7	PID	0.2 mg/m^3 80 mg/m^3 (Coal Pitch Tar)	Soil	inhalation, skin or eye contact, ingestion	irritation to the skin, eyes, mucous membranes and upper respiratory tract, abdominal pain if ingested.	Eye: Irrigate immediately, seek medical attention immediately, Skin: Soap wash immediately, Breathing: Move to fresh air, refer to medical attention; Swallow: refer to medical attention

Task	Contaminant	CAS Number	Monitoring Device	PEL/ IDLH	Source of Concentration on Site	Route of Exposure	Symptoms	First Aid
1.3.1 – 1.3.8	Antimony	7440-36-0	None	0.5 mg/m^3 50 mg/m^3	Groundwater Soil	inhalation, ingestion, skin and/or eye contact	irritation skin, possible dermatitis; resp distress; diarrhea; muscle tremor, convulsions; possible gastrointestinal tract	Eye: Irrigate immediately Skin: Soap wash immediately Breathing: Respiratory support Swallow: Medical attention immediately
1.3.1 – 1.3.8	Aroclor 1254	11097-69-1	None	0.5 mg/m^3 5 mg/m^3	Groundwater Soil	inhalation, skin absorption, ingestion, skin and/or eye contact	irritation to the eyes, chloracne	Eye: Irrigate immediately Skin: Soap wash immediately Breathing: Respiratory support Swallow: Medical attention immediately
1.3.1 – 1.3.8	Aroclor 1260	11096-82-5	None	0.5 mg/m^3 5 mg/m^3	Groundwater Soil	inhalation, skin absorption, ingestion, skin and/or eye contact	irritation to the eyes, chloracne	Eye: Irrigate immediately Skin: Soap wash immediately Breathing: Respiratory support Swallow: Medical attention immediately
1.3.1 – 1.3.8	Arsenic	NA	None	0.5 mg/m^3 NA	Groundwater Soil	inhalation, ingestion, skin and/or eye contact	irritation skin, possible dermatitis; resp distress; diarrhea; muscle tremor, convulsions; possible gastrointestinal tract	Eye: Irrigate immediately Skin: Soap wash immediately Breathing: Respiratory support Swallow: Medical attention immediately

Task	Contaminant	CAS Number	Monitoring Device	PEL/ IDLH	Source of Concentration on Site	Route of Exposure	Symptoms	First Aid
1.3.1 – 1.3.8	Barium	10022-31-8	None	0.5 mg/m^3 50 mg/m^3	Groundwater Soil	inhalation, ingestion, skin and/or eye contact	irritation to the eyes, skin, upper respiratory system; skin burns; gastroenteritis; muscle spasm; slow pulse	Eye: Irrigate immediately Skin: Water flush immediately Breathing: Respiratory support Swallow: Medical attention immediately
1.3.1 – 1.3.8	Benzene Benzol Phenyl hydride	71-43-2	PID	3.19 mg/m^3 1,595 mg/mg^3	Groundwater Soil Vapor	inhalation, skin absorption, ingestion, skin and/or eye contact	irritation to the eyes, skin, nose, respiratory system; dizziness; headache, nausea, staggered gait; lassitude (weakness, exhaustion) [potential occupational carcinogen]	Eye: Irrigate immediately Skin: Soap wash immediately Breathing: Respiratory support Swallow: Medical attention immediately
1.3.1 – 1.3.8	Benzo(a)anthracene Benzanthracene Benzanthrene 1,2-Benzanthracene Benzo[b]phenanthrene Tetraphene	56-55-3	PID	0.2 mg/m^3 80 mg/m^3 (Coal Pitch Tar)	Groundwater Soil	inhalation, skin or eye contact, ingestion	dermatitis, bronchitis, [potential occupational carcinogen]	Eye: Irrigate immediately Skin: Soap wash immediately Breathing: Respiratory support Swallow: Medical attention immediately

Task	Contaminant	CAS Number	Monitoring Device	PEL/ IDLH	Source of Concentration on Site	Route of Exposure	Symptoms	First Aid
1.3.1 – 1.3.8	Benzo(a)pyrene	50-32-8	PID	0.2 mg/m^3 80 mg/m^3 (Coal Pitch Tar)	Soil	inhalation, skin or eye contact, ingestion	dermatitis, bronchitis, [potential occupational carcinogen]	Eye: Irrigate immediately, seek medical attention Skin: Soap wash immediately; Breathing: move to fresh air; Swallow: Induce vomiting if conscious, seek medical attention immediately
1.3.1 – 1.3.8	Benzo(b)fluoranthene	205-99-2	PID	0.2 mg/m^3 80 mg/m^3 (Coal Pitch Tar)	Soil	inhalation, skin or eye contact, ingestion	irritation to eyes and skin, respiratory irritation(dizziness, weakness, fatigue, nausea, headache)	Eye: Irrigate immediately, refer to medical attention Skin: Soap wash immediately Breathing: move to fresh air Swallow: Medical attention immediately
1.3.1 – 1.3.8	Benzo(g,h,i)perylene Benzo(ghi)perylene	191-24-2	PID	0.2 mg/m^3 80 mg/m^3 (Coal Pitch Tar)	Soil	inhalation, skin or eye contact, ingestion	NA	Eye: Irrigate immediately, refer to medical attention Skin: Soap wash immediately Breathing: move to fresh air Swallow: Medical attention immediately

Task	Contaminant	CAS Number	Monitoring Device	PEL/ IDLH	Source of Concentration on Site	Route of Exposure	Symptoms	First Aid
1.3.1 – 1.3.8	Benzo(k)fluoranthene	207-08-9	PID	0.2 mg/m^3 80 mg/m^3 (Coal Pitch Tar)	Soil	inhalation, skin or eye contact, ingestion	irritation to eyes and skin, respiratory irritation (dizziness, weakness, fatigue, nausea, headache)	Eye: Irrigate immediately, refer to medical attention Skin: Soap wash immediately Breathing: move to fresh air Swallow: Medical attention immediately
1.3.1 – 1.3.8	Beryllium	7440-41-7	None	0.002 mg/m^3 4 mg/m^3	Soil	inhalation, skin and/or eye contact	berylliosis (chronic exposure): anorexia, weight loss, lassitude (weakness, exhaustion), chest pain, cough, clubbing of fingers, cyanosis, pulmonary insufficiency; irritation to the eyes; dermatitis; [potential occupational carcinogen]	Eye: Irrigate immediately Breathing: Fresh air
1.3.1 – 1.3.8	Bis(2-ethylhexyl)phthalate Bis(2-Ethylhexyl) Phthalate Di-sec octyl phthalate DEHP Di(2-ethylhexyl)phthalate Octyl phthalate bis(2-ethylexyl)phthalate Bis(2-Ethylhexyl) Phthalate	117-81-7	None	5 mg/m^3 5000 mg/m^3	Groundwater Soil Vapor	inhalation, ingestion, skin and/or eye contact	irritation to the eyes, mucous membrane; in animals: liver damage; teratogenic effects; [potential occupational carcinogen	Eye: Irrigate immediately Breathing: Respiratory support Swallow: Medical attention immediately

Task	Contaminant	CAS Number	Monitoring Device	PEL/ IDLH	Source of Concentration on Site	Route of Exposure	Symptoms	First Aid
1.3.1 – 1.3.8	Cadmium	7440-43-9	None	0.005 mg/m^3 9 mg/m^3	Soil	inhalation, ingestion	pulmonary edema, dyspnea (breathing difficulty), cough, chest tightness, substernal (occurring beneath the sternum) pain; headache; chills, muscle aches; nausea, vomiting, diarrhea; anosmia (loss of the sense of smell), emphysema, proteinuria, mild anemia; [potential occupational carcinogen]	Eye: Irrigate immediately Skin: Soap wash Breathing: Respiratory support Swallow: Medical attention immediately
1.3.1 – 1.3.8	Calcium	7440-70-2	None	NA	Groundwater Soil	inhalation, ingestion, skin and/or eye contact	irritation to the eyes, skin, upper resp tract; ulcer, perforation nasal septum; pneumonitis; dermatitis	Eye: Irrigate immediately Skin: Water flush immediately Breathing: Respiratory support Swallow: Medical attention immediately
1.3.1 – 1.3.8	Carbazole 9-azafluorene Dibenzopyrrole Diphenylenimine diphenyleneimide	86-74-8	None	NA NA	Soil	inhalation, skin absorption (liquid), skin and/or eye contact	irritation to eyes and skin, respiratory irritation	Eye: Irrigate immediately, refer to medical attention Skin: Soap wash immediately Breathing: move to fresh air Swallow: Medical attention immediately

Task	Contaminant	CAS Number	Monitoring Device	PEL/ IDLH	Source of Concentration on Site	Route of Exposure	Symptoms	First Aid
1.3.1 – 1.3.8	Carbon disulfide	75-15-0	PID	20 ppm 500 ppm	Soil Groundwater Vapor	inhalation, skin or eye contact, ingestion	irritation to the eyes, skin, respiratory system	Eye: Irrigate immediately (liquid) Skin: Water flush immediately (liquid) Breathing: Respiratory support
1.3.1 – 1.3.8	Carbon tetrachloride Carbon chloride Carbon tet Freon® 10 Halon® 104 Tetrachloromethane	56-23-5	PID	10 ppm 200 ppm	Groundwater Soil Vapor	inhalation, skin absorption, ingestion, skin and/or eye contact	irritation to the eyes, skin; central nervous system depression; nausea, vomiting; liver, kidney injury; drowsiness, dizziness, incoordination; [potential occupational carcinogen]	Eye: Irrigate immediately Skin: Soap wash immediately Breathing: Respiratory support Swallow: Medical attention immediately
1.3.1 – 1.3.8	Chloroform Methane trichloride Trichloromethane Chloro-3-methyl phenol	67-66-3	None	50 ppm 500 ppm	Groundwater Soil	inhalation, skin absorption, ingestion, skin and/or eye contact	irritation to the eyes, skin; dizziness, mental dullness, nausea, confusion; headache, lassitude (weakness, exhaustion); anesthesia; enlarged liver; [potential occupational carcinogen]	Eye: Irrigate immediately Skin: Soap wash promptly Breathing: Respiratory support Swallow: Medical attention immediately
1.3.1 – 1.3.8	Chromium Total Chromium Chromium, Total	7440-47-3	None	1.0 mg/m^3 250 mg/m^3	Groundwater Soil	inhalation absorption ingestion	irritation to eye, skin, and respiratory	Eye: Irrigate immediately Skin: Soap wash Breathing: Respiratory support Swallow: Medical attention immediately

Task	Contaminant	CAS Number	Monitoring Device	PEL/ IDLH	Source of Concentration on Site	Route of Exposure	Symptoms	First Aid
1.3.1 – 1.3.8	Chrysene Benzo[a]phenanthrene 1,2-Benzphenanthrene	218-01-9	PID	0.2 mg/m³ 80 mg/m³ (Coal Pitch Tar)	Groundwater Soil	inhalation, absorption, ingestion, consumption	irritation to eye, skin, and respiratory, gastrointestinal irritation nausea, vomit, diarrhea [potential occupational carcinogen]	Eyes: Irrigate immediately Skin: Soap wash promptly. Breath: Respiratory support Swallow: Medical attention immediately
1.3.1 – 1.3.8	Cobalt	7440-48-4	None	0.1mg/m³ 20 mg/m³	Soil	inhalation, ingestion, skin and/or eye contact	Cough, dyspnea (breathing difficulty), wheezing, decreased pulmonary function; weight loss; dermatitis; diffuse nodular fibrosis; resp hypersensitivity, asthma	Eye: Irrigate immediately Skin: Soap wash Breathing: Respiratory support Swallow: Medical attention immediately
1.3.1 – 1.3.8	Copper	7440-50-8	None	1.0 mg/m³ 100 mg/m³	Groundwater Soil	inhalation, ingestion, skin and/or eye contact	irritation to the eyes, nose, metallic taste; dermatitis; anemia	Eye: Irrigate immediately Skin: Soap wash promptly Breathing: Respiratory support Swallow: Medical attention immediately

Task	Contaminant	CAS Number	Monitoring Device	PEL/ IDLH	Source of Concentration on Site	Route of Exposure	Symptoms	First Aid
1.3.1 – 1.3.8	Cyanide	57-12-5	None	5 mg/m^3 25 mg/m^3	Groundwater Soil	inhalation, ingestion, skin and/or eye contact	Exposure to cyanide can cause weakness, headaches, confusion, dizziness, fatigue, anxiety, sleepiness, nausea and vomiting. Breathing can speed up then become slow and gasping. Coma and convulsions also occur. If large amounts of cyanide have been absorbed by the body, the person usually collapses and death can occur very quickly. Long-term exposure to lower levels of cyanide can cause skin and nose irritation, itching, rashes and thyroid changes.	Eye: Irrigate immediately Skin: Soap wash Breathing: Respiratory support Swallow: Medical attention immediately
1.3.1 – 1.3.8	Dibenz(a,h)anthracene Dibenzo(a,h)anthracene	53-70-3	PID	0.2 mg/m^3 80 mg/m^3 (Coal Pitch Tar)	Groundwater Soil	inhalation, absorption, ingestion, consumption	irritation to eyes, skin, respiratory, and digestion [potential occupational carcinogen]	Eyes: Irrigate immediately Skin: Soap wash promptly. Breath: Respiratory support PID Swallow: Medical attention immediately
1.3.1 – 1.3.8	Dibenzofuran	132-64-9	None	NA NA	Soil	inhalation, absorption	irritation to eyes, and skin	Eyes: Irrigate immediately Skin: Soap wash promptly.

Task	Contaminant	CAS Number	Monitoring Device	PEL/ IDLH	Source of Concentration on Site	Route of Exposure	Symptoms	First Aid
1.3.1 – 1.3.8	Dibutyl phthalate Di-n-butyl phthalate Butyl phthalate n-Butyl phthalate 1,2-Benzenedicarboxylic acid dibutyl ester o-Benzenedicarboxylic acid dibutyl ester DBP Palatinol C, Elaol Dibutyl-1,2-benzene-dicarboxylate Di-n-butylphthalate	84-74-2	None	5 mg/m^3 4000 mg/m^3	Groundwater Soil Vapor	inhalation, ingestion, skin and/or eye contact	irritation to the eyes, upper respiratory system, stomach	Eye: Irrigate immediately Skin: Wash regularly Breathing: Respiratory support Swallow: Medical attention immediately
1.3.1 – 1.3.8	Dichlorodifluoromethane Difluorodichloromethane, Fluorocarbon 12 Freon 12 Freon® 12 Genetron® 12 Halon® 122 Propellant 12 Refrigerant 12 Dichlorodifluromethane	75-71-8	None	1000 pp, 15,000 ppm	Groundwater Soil Vapor	inhalation, skin and/or eye contact (liquid)	dizziness, tremor, asphyxia, unconsciousness, cardiac arrhythmias, cardiac arrest; liquid: frostbite	Eye: Frostbite Skin: Frostbite Breathing: Respiratory support
1.3.1 – 1.3.8	Dieldrin HEOD 1,2,3,4,10,10-Hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4-endo exo-5,8-dimethanonaphthalene	60-57-1	PID	0.25 mg/m^3 50 mg/m^3	Groundwater Soil Water	inhalation, skin absorption, ingestion, skin and/or eye contact	headache, dizziness; nausea, vomiting, malaise (vague feeling of discomfort), sweating; myoclonic limb jerks; clonic, tonic convulsions; coma; [potential occupational carcinogen]; in animals: liver, kidney damage	Eye: Irrigate immediately Skin: Soap wash immediately Breathing: Respiratory support Swallow: Medical attention immediately

Task	Contaminant	CAS Number	Monitoring Device	PEL/ IDLH	Source of Concentration on Site	Route of Exposure	Symptoms	First Aid
1.3.1 – 1.3.8	Diesel Fuel automotive diesel fuel oil No. 2 distillate diesoline diesel oil diesel oil light diesel oil No. 1-D summer diesel	68334-30-5	PID	NA NA	Groundwater Soil Vapor	inhalation, ingestion, skin and/or eye contact	irritation to the eyes, skin, nose, throat; burning sensation in chest; headache, nausea, lassitude (weakness, exhaustion), restlessness, incoordination, confusion, drowsiness; vomiting, diarrhea; dermatitis; chemical pneumonitis (aspiration liquid)	Eye: Irrigate immediately Skin: Soap flush immediately Breathing: Respiratory support Swallow: Medical attention immediately
1.3.1 – 1.3.8	Ethyl benzene Ethylbenzene Ethylbenzol Phenylethane	100-40-4	PID	435 mg/m^3 3,472 mg/m^3	Groundwater Soil Vapor	inhalation, ingestion, skin and/or eye contact	irritation to the eyes, skin, mucous membrane; headache; dermatitis; narcosis, coma	Eye: Irrigate immediately Skin: Water flush promptly Breathing: Respiratory support Swallow: Medical attention immediately
1.3.1 – 1.3.8	Fluoranthene Benzo(j, k)fluorene	206-44-0	PID	0.2 mg/m^3 80 mg/m^3 (Coal Pitch Tar)	Groundwater Soil	inhalation, skin or eye contact, ingestion	irritation to eyes and skin, respiratory irritation(dizziness, weakness, fatigue, nausea, headache)	Eye: Irrigate immediately, refer to medical attention Skin: Soap wash immediately Breathing: move to fresh air Swallow: Medical attention immediately

Task	Contaminant	CAS Number	Monitoring Device	PEL/ IDLH	Source of Concentration on Site	Route of Exposure	Symptoms	First Aid
1.3.1 – 1.3.8	Fluorene	86-73-7	PID	0.2 mg/m^3 80 mg/m^3 (Coal Pitch Tar)	Soil	inhalation, skin or eye contact, ingestion	irritation to eyes and skin, respiratory irritation(dizziness, weakness, fatigue, nausea, headache)	Eye: Irrigate immediately, refer to medical attention Skin: Soap wash immediately Breathing: move to fresh air Swallow: Medical attenti
1.3.1 – 1.3.8	Fuel Oil No. 2	68476-30-2	PID	NA NA	Groundwater Soil Vapor	inhalation, ingestion, skin and/or eye contact	irritation to the eyes, skin, nose, throat; burning sensation in chest; headache, nausea, lassitude (weakness, exhaustion), restlessness, incoordination, confusion, drowsiness; vomiting, diarrhea; dermatitis; chemical pneumonitis (aspiration liquid)	Eye: Irrigate immediately Skin: Soap flush immediately Breathing: Respiratory support Swallow: Medical attention immediately
1.3.1 – 1.3.8	Gasoline	8006-61-9	PID	NA NA	Groundwater Soil Vapor	inhalation, skin absorption, ingestion, skin and/or eye contact	irritation to the eyes, skin, mucous membrane; dermatitis; headache, lassitude (weakness, exhaustion), blurred vision, dizziness, slurred speech, confusion, convulsions; chemical pneumonitis (aspiration liquid)	Eye: Irrigate immediately Skin: Soap flush immediately Breathing: Respiratory support Swallow: Medical attention immediately
1.3.1 – 1.3.8	Helium	7440-59-7	Helium Detector	NA NA	NA	inhalation	dizziness, headache, and nausea	Breathing: Respiratory support

Task	Contaminant	CAS Number	Monitoring Device	PEL/ IDLH	Source of Concentration on Site	Route of Exposure	Symptoms	First Aid
1.3.1 – 1.3.8	Heptane n-Heptane	142-82-5	PID	500 ppm 750 ppm	Goundwater Soil Vapor	inhalation, ingestion, skin and/or eye contact	dizziness, stupor, incoordination; loss of appetite, nausea; dermatitis; chemical pneumonitis (aspiration liquid); unconsciousness	Eye: Irrigate immediately Skin: Soap wash promptly Breathing: Respiratory support Swallow: Medical attention immediately
1.3.1 – 1.3.8	Hexavalent Chromium Chromium VI Chromium, Hexavalent	18540-29-9	None	1.0 mg/m^3 250 mg/m^3	Groundwater Soil	inhalation absorption ingestion	irritation to eye, skin, and respiratory	Eye: Irrigate immediately Skin: Soap wash Breathing: Respiratory support Swallow: Medical attention immediately
1.3.1 – 1.3.8	Indeno(1,2,3-cd)pyrene Indeno(1,2,3-c,d)Pyrene Indeno(1,2,3-cd)Pyrene	193-39-5	None	0.2 mg/m^3 80 mg/m^3 (Coal Pitch Tar)	Groundwater Soil	inhalation, absorption, ingestion, consumption	irritation to eyes, skin, respiratory, and digestion [potential occupational carcinogen]	Eyes: Irrigate immediately Skin: Soap wash promptly. Breath: Respiratory support Swallow: Medical attention immediately, wash mouth with water
1.3.1 – 1.3.8	Iron	7439-89-6	None	10 mg/m^3 NA	Groundwater Soil	inhalation, ingestion, skin and/or eye contact	irritation to the eyes, skin, mucous membrane; abdominal pain, diarrhea, vomiting	Eye: Irrigate immediately Skin: Soap wash Breathing: Respiratory support Swallow: Medical attention immediately

Task	Contaminant	CAS Number	Monitoring Device	PEL/ IDLH	Source of Concentration on Site	Route of Exposure	Symptoms	First Aid
1.3.1 – 1.3.8	Lead	7439-92-1	None	0.050 mg/m^3 100 mg/m^3	Groundwater Soil	inhalation, ingestion, skin and/or eye contact	lassitude (weakness, exhaustion), insomnia; facial pallor; anorexia, weight loss, malnutrition; constipation, abdominal pain, colic; anemia; gingival lead line; tremor; paralysis wrist, ankles; encephalopathy; kidney disease; irritation to the eyes; hypertension	Eye: Irrigate immediately Skin: Soap flush promptly Breathing: Respiratory support Swallow: Medical attention immediately
1.3.1 – 1.3.8	Magnesium	7439-95-4	None	15 mg/m^3 NA	Soil	inhalation, skin and/or eye contact	irritation to the eyes, skin, respiratory system; cough	Eye: Irrigate immediately Breathing: Fresh air
1.3.1 – 1.3.8	Manganese	7439-96-5	None	5 mg/m^3 500 mg/m^3	Groundwater Soil	inhalation, ingestion	aerosol is irritating to the respiratory tract	Eye: Irrigate immediately Skin: Soap flush promptly Breathing: Respiratory support Swallow: Medical attention immediately
1.3.1 – 1.3.8	m-Cresol meta-Cresol 3-Cresol m-Cresylic acid 1-Hydroxy-3-methylbenzene 3-Hydroxytoluene 3-Methylphenol	108-39-4	PID	5 ppm 250 ppm	Groundwater Soil Vapor	inhalation, skin absorption, ingestion, skin and/or eye contact	irritation to the eyes, skin, mucous membrane; central nervous system effects: confusion, depression, resp failure; dyspnea (breathing difficulty), irreg rapid resp, weak pulse; eye, skin burns; dermatitis; lung, liver, kidney, pancreas damage	Eye: Irrigate immediately Skin: Soap wash immediately Breathing: Respiratory support Swallow: Medical attention immediately

Task	Contaminant	CAS Number	Monitoring Device	PEL/ IDLH	Source of Concentration on Site	Route of Exposure	Symptoms	First Aid
1.3.1 – 1.3.8	Mercury	7439-97-6	None	0.1 mg/m^3 10 mg/m^3	Groundwater Soil	inhalation, skin absorption, ingestion, skin and/or eye contact	irritation to the eyes, skin; cough, chest pain, dyspnea (breathing difficulty), bronchitis, pneumonitis; tremor, insomnia, irritability, headache, lassitude (weakness, exhaustion); stomatitis, salivation; gastrointestinal disturbance, anorexia, weight loss; proteinuria	Eye: Irrigate immediately Skin: Soap wash promptly Breathing: Respiratory support Swallow: Medical attention immediately
1.3.1 – 1.3.8	Methyl Bromide Bromomethane Monobromomethane	74-83-9	PID	20 ppm 250 ppm	Soil Groundwater Vapor	inhalation, skin absorption (liquid), skin and/or eye contact (liquid)	irritation to the eyes, skin, respiratory system; muscle weak, incoordination, visual disturbance, dizziness; nausea, vomiting, headache; malaise (vague feeling of discomfort); hand tremor; convulsions; dyspnea (breathing difficulty); skin vesiculation; liquid: frostbite; [potential occupational carcinogen]	Eye: Irrigate immediately (liquid) Skin: Water flush immediately (liquid) Breathing: Respiratory support
1.3.1 – 1.3.8	Methyl Chloride Chloromethane Monochloromethane Refrigerant-40 R-40	74-87-3	NA	100 ppm 2000 ppm	Groundwater Soil	inhalation, skin and/or eye contact	dizziness, nausea, vomiting; visual disturbance, stagger, slurred speech, convulsions, coma; liver, kidney damage; liquid: frostbite; reproductive, teratogenic effects; [potential occupational carcinogen]	Eye: Frostbite Skin: Frostbite Breathing: Respiratory support

Task	Contaminant	CAS Number	Monitoring Device	PEL/ IDLH	Source of Concentration on Site	Route of Exposure	Symptoms	First Aid
1.3.1 – 1.3.8	Methylene Chloride Dichloromethane Methylene dichloride	75-09-2	PID	25 ppm 2300 ppm	Groundwater Soil Vapor	inhalation, skin absorption, ingestion, skin and/or eye contact	irritation to the eyes, skin; lassitude (weakness, exhaustion), drowsiness, dizziness; numb, tingle limbs; nausea; [potential occupational carcinogen]	Eye: Irrigate immediately Skin: Soap wash promptly Breathing: Respiratory support Swallow: Medical attention immediately
1.3.1 – 1.3.8	m-Xylenes 1,3-Dimethylbenzene m-Xylol Metaxylene	108-38-3	PID	100 ppm 900 ppm	Groundwater Soil Vapor	inhalation, skin absorption, ingestion, skin and/or eye contact	irritation to the eyes, skin, nose, throat; dizziness, excitement, drowsiness, incoordination, staggering gait; corneal vacuolization; nausea, vomiting, abdominal pain; dermatitis	Eye: Irrigate immediately Skin: Soap flush immediately Breathing: Respiratory support Swallow: Medical attention immediately
1.3.1 – 1.3.8	Naphthalene Naphthalin Tar camphor White tar	91-20-3	PID	50 mg/m^3 250 ppm	Groundwater Soil Vapor	inhalation, skin absorption, ingestion, skin and/or eye contact	irritation to the eyes; headache, confusion, excitement, malaise (vague feeling of discomfort); nausea, vomiting, abdominal pain; irritation bladder; profuse sweating; hematuria (blood in the urine); dermatitis, optical neuritis	Eye: Irrigate immediately Skin: Molten flush immediately/solid-liquid soap wash promptly Breathing: Respiratory support Swallow: Medical attention immediately

Task	Contaminant	CAS Number	Monitoring Device	PEL/ IDLH	Source of Concentration on Site	Route of Exposure	Symptoms	First Aid
1.3.1 – 1.3.8	n-Hexane Hexane, Hexyl hydride, normal-Hexane	110-54-3	PID	500 ppm 1100 ppm	Groundwater Soil Vapor	inhalation, ingestion, skin and/or eye contact	irritation to the eyes, nose; nausea, headache; peripheral neuropathy: numb extremities, muscle weak; dermatitis; dizziness; chemical pneumonitis (aspiration liquid)	Eye: Irrigate immediately Skin: Soap wash immediately Breathing: Respiratory support Swallow: Medical attention immediately
1.3.1 – 1.3.8	Nickel	7440-02-0	None	NA 10 mg/m^3	Groundwater Soil	ion, ingestion, skin and/or eye contact	sensitization dermatitis, allergic asthma, pneumonitis; [potential occupational carcinogen]	Skin: Water flush immediately Breathing: Respiratory support Swallow: Medical attention immediately
1.3.1 – 1.3.8	Non-Flammable Gas Mixture CALGAS (Equipment Calibration Gas : Oxygen Methane Hydrogen Sulfide Carbon Monoxide Nitrogen	 7782-44-7 74-82-8 7783-08-4 830-08-0 7727-37-9	Multi-Gas PID	 NA/NA NA/NA 10/100 ppm 50/1200 ppm NA/NA	NA	inhalation	dizziness, headache, and nausea	Breathing: Respiratory support
1.3.1 – 1.3.8	Non-Flammable Gas Mixture CALGAS (Equipment Calibration Gas : Oxygen Isobutylene Nitrogen	 7782-44-7 115-11-7 7727-37-9	PID	 NA/NA NA/NA NA/NA	NA	inhalation	dizziness, headache, and nausea	Breathing: Respiratory support

Task	Contaminant	CAS Number	Monitoring Device	PEL/ IDLH	Source of Concentration on Site	Route of Exposure	Symptoms	First Aid
1.3.1 – 1.3.8	o-Cresol ortho-Cresol 2-Cresol o-Cresylic acid 1-Hydroxy-2-methylbenzene 2-Hydroxytoluene 2-Methyl phenol 2-Methylphenol 2-Metyhlphenol	95-48-7	PID	5 ppm 250 ppm	Groundwater Soil Vapor	inhalation, skin absorption, ingestion, skin and/or eye contact	irritation to the eyes, skin, mucous membrane; central nervous system effects: confusion, depression, resp failure; dyspnea (breathing difficulty), irreg rapid resp, weak pulse; eye, skin burns; dermatitis; lung, liver, kidney, pancreas damage	Eye: Irrigate immediately Skin: Soap wash immediately Breathing: Respiratory support Swallow: Medical attention immediatelyethylphhhhhhhhhh
1.3.1 – 1.3.8	o-Xylenes 1,2-Dimethylbenzene ortho-Xylene o-Xylol	95-47-6	PID	100 ppm 900 ppm	Groundwater Soil Vapor	inhalation, skin absorption, ingestion, skin and/or eye contact	irritation to the eyes, skin, nose, throat; dizziness, excitement, drowsiness, incoordination, staggering gait; corneal vacuolization; nausea, vomiting, abdominal pain; dermatitis	Eye: Irrigate immediately Skin: Soap flush immediately Breathing: Respiratory support Swallow: Medical attention immediately
1.3.1 – 1.3.8	p-Cresol para-Cresol 4-Cresol p-Cresylic acid 1-Hydroxy-4-methylbenzene 4-Hydroxytoluene 4-Methylphenol	106-44-5	PID	5 ppm 250 ppm	Groundwater Soil Vapor	inhalation, skin absorption, ingestion, skin and/or eye contact	irritation to the eyes, skin, mucous membrane; central nervous system effects: confusion, depression, resp failure; dyspnea (breathing difficulty), irreg rapid resp, weak pulse; eye, skin burns; dermatitis; lung, liver, kidney, pancreas damage	Eye: Irrigate immediately Skin: Soap wash immediately Breathing: Respiratory support Swallow: Medical attention immediately

Task	Contaminant	CAS Number	Monitoring Device	PEL/ IDLH	Source of Concentration on Site	Route of Exposure	Symptoms	First Aid
1.3.1 – 1.3.8	p-Ethyltoluene 4-Ethyltoluene 1-ethyl-4-methyl-benzene 1-methyl-4-ethylbenzene	622-96-8	NA	NA NA	Soil	ingestion, skin and/or eye contact	irritation to the eyes, skin, mucous membrane; headache; dermatitis; narcosis, coma	Eye: Irrigate immediately Skin: Water flush promptly Breathing: Respiratory support Swallow: Medical attention immediately
1.3.1 – 1.3.8	Phenanthrene	85-01-8	PID	0.2 mg/m^3 80 mg/m^3 (Coal Pitch Tar)	Groundwater Soil	inhalation, skin or eye contact, ingestion	irritation to eyes and skin, respiratory irritation(dizziness, weakness, fatigue, nausea, headache)	Eye: Irrigate immediately, refer to medical attention Skin: Soap wash immediately Breathing: move to fresh air Swallow: Medical attention immediately
1.3.1 – 1.3.8	Phenol Carbolic acid Hydroxybenzene, Monohydroxybenzene Phenyl alcohol Phenyl hydroxide	108-95-2	PID	5 ppm 250 ppm	Groundwater Soil	inhalation, skin absorption, ingestion, skin and/or eye contact	irritation to the eyes, nose, throat; anorexia, weight loss; lassitude (weakness, exhaustion), muscle ache, pain; dark urine, skin burns; dermatitis; tremor, convulsions, twitching	Eye: Irrigate immediately Skin: Soap wash immediately Breathing: Respiratory support Swallow: Medical attention immediately

Task	Contaminant	CAS Number	Monitoring Device	PEL/ IDLH	Source of Concentration on Site	Route of Exposure	Symptoms	First Aid
1.3.1 – 1.3.8	Potassium	7440-09-7	None	NA NA	Soil	inhalation, skin absorption, ingestion, skin and/or eye contact inhalation, ingestion, skin and/or eye contact	eye: Causes eye burns. Skin: Causes skin burns. Reacts with moisture in the skin to form potassium hydroxide and hydrogen with much heat. ingestion: Causes gastrointestinal tract burns. inhalation: May cause irritation of the respiratory tract with burning pain in the nose and throat, coughing, wheezing, shortness of breath and pulmonary edema. Causes chemical burns to the respiratory tract. inhalation may be fatal as a result of spasm, inflammation, edema of the larynx and bronchi, chemical pneumonitis and pulmonary edema.	Eyes: Get medical aid immediately Skin: Get medical aid immediately. Immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Ingestion: If victim is conscious and alert, give 2-4 full cups of milk or water. Get medical aid immediately. inhalation: Get medical aid immediately.
1.3.1 – 1.3.8	p-Xylenes 1,4-Dimethylbenzene para-Xylene p-Xylol	106-42-3	PID	100 ppm 900 ppm	Groundwater Soil Vapor	inhalation, skin absorption, ingestion, skin and/or eye contact	irritation to the eyes, skin, nose, throat; dizziness, excitement, drowsiness, incoordination, staggering gait; corneal vacuolization; nausea, vomiting, abdominal pain; dermatitis	Eye: Irrigate immediately Skin: Soap flush immediately Breathing: Respiratory support Swallow: Medical attention immediately

Task	Contaminant	CAS Number	Monitoring Device	PEL/ IDLH	Source of Concentration on Site	Route of Exposure	Symptoms	First Aid
1.3.1 – 1.3.8	Pyrene benzo[def]phenanthrene	129-00-0	PID	0.2 mg/m³ 80 mg/m³ (Coal Pitch Tar)	Groundwater Soil	inhalation, skin or eye contact, ingestion	irritation to eyes and skin, respiratory irritation(dizziness, weakness, fatigue, nausea, headache)	Eye: Irrigate immediately, refer to medical attention Skin: Soap wash immediately Breathing: move to fresh air Swallow: Medical attention immediately
1.3.1 – 1.3.8	Selenium	7782-49-2	None	1 mg/m³ 0.2 mg/m³	Soil	inhalation, ingestion, skin and/or eye contact	irritation to the eyes, skin, nose, throat; visual disturbance; headache; chills, fever; dyspnea (breathing difficulty), bronchitis; metallic taste, garlic breath, gastrointestinal disturbance; dermatitis; eye, skin burns; in animals: anemia; liver necrosis, cirrhosis; kidney, spleen damage	Eye: Irrigate immediately Skin: Soap wash immediately Breathing: Respiratory support Swallow: Medical attention immediately
1.3.1 – 1.3.8	Silver	7440-22-4	None	0.01mg/m³ 10 mg/m³	Soil	inhalation, ingestion, skin and/or eye contact	blue-gray eyes, nasal septum, throat, skin; irritation, ulceration skin; gastrointestinal disturbance	Eye: Irrigate immediately Skin: Water flush Breathing: Respiratory support Swallow: Medical attention immediately
1.3.1 – 1.3.8	Sodium	7440-23-5	None	NA NA	Groundwater Soil	ion, ingestion, skin and/or eye contact	sensitization dermatitis, allergic asthma, pneumonitis; [potential occupational carcinogen]	Skin: Water flush immediately Breathing: Respiratory support Swallow: Medical attention immediately

Task	Contaminant	CAS Number	Monitoring Device	PEL/ IDLH	Source of Concentration on Site	Route of Exposure	Symptoms	First Aid
1.3.1 – 1.3.8	Tert-Butyl Alcohol Tertiary Butyl Alcohol Tert-Butanol Butyl alcohol 2-Methyl-2-propanol Trimethyl carbinol TBA	75-65-0	PID	100 ppm 1600 ppm	Groundwater Soil Vapor	inhalation, ingestion, skin and/or eye contact	irritation to the eyes, skin, nose, throat; drowsiness, narcosis	Eye: Irrigate immediately Skin: Water flush promptly Breathing: Respiratory support Swallow: Medical attention immediately
1.3.1 – 1.3.8	Tetrachloroethylene Perchlorethylene Perchloroethylene PCE Perk Tetrachlorethylene Tetrachloroethene	127-18-4	PID	100 ppm 150 ppm	Groundwater Soil Vapor	inhalation, skin absorption, ingestion, skin and/or eye contact	irritation to the eyes, skin, nose, throat, respiratory system; nausea; flush face, neck; dizziness, incoordination; headache, drowsiness; skin erythema (skin redness); liver damage; [potential occupational carcinogen]	Eye: Irrigate immediately Skin: Soap wash promptly Breathing: Respiratory support Swallow: Medical attention immediately
1.3.1 – 1.3.8	Thallium	7440-28-0	None	0.1 mg/m^3 15 mg/m^3	Groundwater Soil	inhalation, skin absorption, ingestion, skin and/or eye contact	nausea, diarrhea, abdominal pain, vomiting; ptosis, strabismus; peri neuritis, tremor; retrosternal (occurring behind the sternum) tightness, chest pain, pulmonary edema; convulsions, chorea, psychosis; liver, kidney damage; alopecia; paresthesia legs	Eye: Irrigate immediately Skin: Water flush promptly Breathing: Respiratory support Swallow: Medical attention immediately

Task	Contaminant	CAS Number	Monitoring Device	PEL/ IDLH	Source of Concentration on Site	Route of Exposure	Symptoms	First Aid
1.3.1 – 1.3.8	Total PCBs Chlorodiphenyl (42% chlorine) Aroclor® 1242 PCB Polychlorinated biphenyl	53469-21-9	None	0.5 mg/m^3 5 mg/m^3	Groundwater Soil	inhalation, skin absorption, ingestion, skin and/or eye contact	irritation to the eyes, chloracne	Eye: Irrigate immediately Skin: Soap wash immediately Breathing: Respiratory support Swallow: Medical attention immediately
1.3.1 – 1.3.8	Total Xylenes Dimethylbenzene Xylol	1330-20-7	PID	100 ppm 900 ppm	Groundwater Soil Vapor	inhalation, skin absorption, ingestion, skin and/or eye contact	irritation to the eyes, skin, nose, throat; dizziness, excitement, drowsiness, incoordination, staggering gait; corneal vacuolization; nausea, vomiting, abdominal pain; dermatitis	Eye: Irrigate immediately Skin: Soap flush immediately Breathing: Respiratory support Swallow: Medical attention immediately
1.3.1 – 1.3.8	Trichloroethylene Ethylene trichloride TCE Trichloroethene Trilene	79-01-6	PID	100 ppm 1000 ppm	Groundwater Soil Vapor	inhalation, skin absorption, ingestion, skin and/or eye contact	irritation to the eyes, skin; headache, visual disturbance, lassitude (weakness, exhaustion), dizziness, tremor, drowsiness, nausea, vomiting; dermatitis; cardiac arrhythmias, paresthesia; liver injury; [potential occupational carcinogen]	Eye: Irrigate immediately Skin: Soap wash promptly Breathing: Respiratory support Swallow: Medical attention immediately

Task	Contaminant	CAS Number	Monitoring Device	PEL/ IDLH	Source of Concentration on Site	Route of Exposure	Symptoms	First Aid
1.3.1 – 1.3.8	Trichlorofluoromethane Fluorotrichloromethane Freon® 11 Monofluorotrichloromethane Refrigerant 11 Trichloromonofluoromethane	75-69-4	PID	1000 ppm 2000 ppm	Groundwater Soil Vapor	inhalation, ingestion, skin and/or eye contact	incoordination, tremor; dermatitis; cardiac arrhythmias, cardiac arrest; asphyxia; liquid: frostbite	Eye: Irrigate immediately Skin: Water flush immediately Breathing: Respiratory support Swallow: Medical attention immediately
1.3.1 – 1.3.8	Trivalent Chromium Chromium III Chromium, Trivalent	NA	None	1.0 mg/m^3 250 mg/m^3	Groundwater Soil	inhalation absorption ingestion	irritation to eye, skin, and respiratory	Eye: Irrigate immediately Skin: Soap wash Breathing: Respiratory support Swallow: Medical attention immediately
1.3.1 – 1.3.8	Vanadium	7440-62-2	None	0.1 mg/m3 15 mg/m3	Groundwater Soil	inhalation, skin absorption, ingestion, skin and/or eye contact	nausea, diarrhea, abdominal pain, vomiting; ptosis, strabismus; peri neuritis, tremor; retrosternal (occurring behind the sternum) tightness, chest pain, pulmonary edema; convulsions, chorea, psychosis; liver, kidney damage; alopecia; paresthesia legs	Eye: Irrigate immediately Skin: Water flush promptly Breathing: Respiratory support Swallow: Medical attention immediately

Task	Contaminant	CAS Number	Monitoring Device	PEL/ IDLH	Source of Concentration on Site	Route of Exposure	Symptoms	First Aid
1.3.1 – 1.3.8	Zinc	7440-62-2	None	15 mg/m³ 500 mg/m³	Groundwater Soil	inhalation	chills, muscle ache, nausea, fever, dry throat, cough; lassitude (weakness, exhaustion); metallic taste; headache; blurred vision; low back pain; vomiting; malaise (vague feeling of discomfort); chest tightness; dyspnea (breathing difficulty), rales, decreased pulmonary function	Breathing: Respiratory support`

EXPLANATION OF ABBREVIATIONS

PID = Photoionization Detector
PEL = Permissible Exposure Limit (8-hour Time Weighted Average)
IDLH = Immediately Dangerous to Life and Health
ppm = part per million
mg/m^3 = milligrams per cubic meter
500 mg/m^3

TABLE 3
Summary of Monitoring Equipment

Instrument	Operation Parameters
Photoionization Detector (PID)	**Hazard Monitored:** Many organic and some inorganic gases and vapors. **Application:** Detects total concentration of many organic and some inorganic gases and vapors. Some identification of compounds is possible if more than one probe is measured. **Detection Method:** Ionizes molecules using UV radiation; produces a current that is proportional to the number of ions. **General Care/Maintenance:** Recharge or replace battery. Regularly clean lamp window. Regularly clean and maintain the instrument and accessories. **Typical Operating Time:** 10 hours. 5 hours with strip chart recorder.
Oxygen Meter	**Hazard Monitored:** Oxygen (O_2). **Application:** Measures the percentage of O_2 in the air. **Detection Method:** Uses an electrochemical sensor to measure the partial pressure of O_2 in the air, and converts the reading to O_2 concentration. **General Care/Maintenance:** Replace detector cell according to manufacturer's recommendations. Recharge or replace batteries prior to explanation of the specified interval. If the ambient air is less than 0.5% C O_2, replace the detector cell frequently. **Typical Operating Time:** 8 – 12 hours.
Additional equipment (if needed, based on site conditions)	
Combustible Gas Indicator (CGI)	**Hazard Monitored:** Combustible gases and vapors. **Application:** Measures the concentration of combustible gas or vapor. **Detection Method:** A filament, usually made of platinum, is heated by burning the combustible gas or vapor. The increase in heat is measured. Gases and vapors are ionized in a flame. A current is produced in proportion to the number of carbon atoms present. **General Care/Maintenance:** Recharge or replace battery. Calibrate immediately before use. **Typical Operating Time:** Can be used for as long as the battery lasts, or for the recommended interval between calibrations, whichever is less.
Flame Ionization Detector (FID) with Gas Chromatography Option *(i.e., Foxboro Organic Vapor Analyzer (OVA))*	**Hazard Monitored:** Many organic gases and vapors (approved areas only). **Application:** In survey mode, detects the concentration of many organic gases and vapors. In gas chromatography (GC) mode, identifies and measures specific compounds. In survey mode, all the organic compounds are ionized and detected at the same time. In GC mode, volatile species are separated. **General Care/Maintenance:** Recharge or replace battery. Monitor fuel and/or combustion air supply gauges. Perform routine maintenance as described in the manual. Check for leaks. **Typical Operating Time:** 8 hours; 3 hours with strip chart recorder.
Potable Infrared (IR) Spectrophotometer	**Hazard Monitored:** Many gases and vapors. **Application:** Measures concentration of many gases and vapors in air. Designed to quantify one or two component mixtures. **Detection Method:** Passes different frequencies of IR through the sample. The frequencies absorbed are specific for each compound. **General Care/Maintenance:** As specified by the manufacturer.

Instrument	Operation Parameters
Direct Reading Colorimetric Indicator Tube	**Hazard Monitored:** Specific gas and vapors. **Application:** Measures concentration of specific gases and vapors. **Detection Method:** The compound reacts with the indicator chemical in the tube, producing a stain whose length or color change is proportional to the compound's concentration. **General Care/Maintenance:** Do not use a previously opened tube even if the indicator chemical is not stained. Check pump for leaks before and after use. Refrigerate before use to maintain a shelf life of about 2 years. Check expiration dates of tubes. Calibrate pump volume at least quarterly. Avoid rough handling which may cause channeling.
Aerosol Monitor	**Hazard Monitored:** Airborne particulate (dust, mist, fume) concentrations **Application:** Measures total concentration of semi-volatile organic compounds, PCBs, and metals. **Detection Method:** Based on light-scattering properties of particulate matter. Using an internal pump, air sample is drawn into the sensing volume where near infrared light scattering is used to detect particles. **General Care/Maintenance:** As specified by the mfr. Also, the instrument must be calibrated with particulates of a size and refractive index similar to those to be measured in the ambient air.
Monitox	**Hazard Monitored:** Gases and vapors. **Application:** Measures specific gases and vapors. **Detection Method:** Electrochemical sensor relatively specific for the chemical species in question. **General Care/Maintenance:** Moisten sponge before use; check the function switch; change the battery when needed.
Gamma Radiation Survey Instrument	**Hazard Monitored:** Gamma Radiation. **Application:** Environmental radiation monitor. **Detection Method:** Scintillation detector. **General Care/Maintenance:** Must be calibrated annually at a specialized facility. **Typical Operating Time:** Can be used for as long as the battery lasts, or for the recommended interval between calibrations, whichever is less.

TABLE 4
INSTRUMENTATION ACTION LEVELS

Photoionization Detector Action Levels	Action Required
Background to 5 ppm	No respirator; no further action required
> 1 ppm but < 5 ppm for > 5 minutes	1. Temporarily discontinue all activities and evaluate potential causes of the excessive readings. If these levels persist and cannot be mitigated (i.e., by slowing drilling or excavation activities), contact HSO to review conditions and determine source and appropriate response action. 2. If PID readings remain above 1 ppm, temporarily discontinue work and upgrade to Level C protection. 3. If sustained PID readings fall below 1 ppm, downgrading to Level D protection may be permitted.
> 5 ppm but < 150 ppm for > 5 minutes	1. Discontinue all work; all workers shall move to an area upwind of the jobsite. 2. Evaluate potential causes of the excessive readings and allow work area to vent until VOC concentrations fall below 5 ppm. 3. Level C protection will continue to be used until PID readings fall below 1 ppm.
> 150 ppm	Evacuate the work area

Notes:
1. 1 ppm level based on OSHA Permissible Exposure Limit (PEL) for benzene.
2. 5 ppm level based on OSHA Short Term Exposure Limit (STEL) maximum exposure for benzene for any 15 minute period.
3. 150 ppm level based on NIOSH Immediately Dangerous to Life and Health (IDLH) for tetrachloroethylene.

TABLE 5
EMERGENCY NOTIFICATION LIST

ORGANIZATION	CONTACT	TELEPHONE
Local Police Department	NYPD	911
Local Fire Department	NYFD	911
Ambulance/Rescue Squad	NYFD	911
Hospital	Mount Sinai Hospital of Queens	911 or 718-932-1000
Langan Incident Hotline		800-952-6426 ex 4699
Medical Treatment Hotline	Incident Intervention	888-449-7787
Langan Environmental Project Manager	Andrew Schweitzer	516-458-3820
Langan Health and Safety Manager (HSM)	Tony Moffa	215-756-2523 (cell)
Langan Health & Safety Officer (HSO)	William Bohrer	410-984-3068 (cell)
Langan Field Team Leader (FTL)	To Be Determined	
Client's Representative	Rose Tilley	516-874-2960
National Response Center (NRC)		800-424-8802
Chemical Transportation Emergency Center (Chemtrec)		800-424-9300
Center for Disease Control (CDC)		404-639-3534
EPA (RCRA Superfund Hotline)		800-424-9346
TSCA Hotline		202-554-1404
Poison Control Center		800-222-1222

Immediately following an injury, unless immediate emergency medical treatment is required, the injured employee must contact Incident Intervention® at 888-449-7787.

For all other incidents or near misses, unless emergency response is required, either the employee or a coworker must contact the Langan Incident Hotline at 1-(800)-9-LANGAN (ext. #4699).

TABLE 6
SUGGESTED FREQUENCY OF PHYSIOLOGICAL MONITORING FOR FIT AND ACCLIMATED WORKERS[A]

Adjusted Temperature[b]	Normal Work Ensemble[c]	Impermeable Ensemble
90°F or above (32.2°C) or above	After each 45 min. of work	After each 15 min. of work
87.5°F (30.8°-32.2°C)	After each 60 min. of work	After each 30 min. of work
82.5°-87.5°F (28.1°-30.8°C)	After each 90 min. of work	After each 60 min. of work
77.5°-82.5°F (25.3°-28.1°C)	After each 120 min. of work	After each 90 min. of work
72.5°-77.5°F (22.5°-25.3°C)	After each 150 min. of work	After each 120 min. of work

a For work levels of 250 kilocalories/hour.

b Calculate the adjusted air temperature (ta adj) by using this equation: ta adj ^{o}F = ta ^{o}F + (13 x % sunshine). Measure air temperature (ta) with a standard mercury-in-glass thermometer, with the bulb shielded from radiant heat. Estimate percent sunshine by judging what percent time the sun is not covered by clouds that are thick enough to produce a shadow. (100 percent sunshine = no cloud cover and a sharp, distinct shadow; 0 percent sunshine = no shadows.)

c A normal work ensemble consists of cotton coveralls or other cotton clothing with long sleeves and pants.

TABLE 7

HEAT INDEX

RELATIVE HUMIDITY	ENVIRONMENTAL TEMPERATURE (Fahrenheit) 70	75	80	85	90	95	100	105	110	115	120
	APPARENT TEMPERATURE*										
0%	64	69	73	78	83	87	91	95	99	103	107
10%	65	70	75	80	85	90	95	100	105	111	116
20%	66	72	77	82	87	93	99	105	112	120	**130**
30%	67	73	78	84	90	96	104	113	123	**135**	**148**
40%	68	74	79	86	93	101	110	123	**137**	**151**	
50%	69	75	81	88	96	107	120	**135**	**150**		
60%	70	76	82	90	100	114	**132**	**149**			
70%	70	77	85	93	106	124	**144**				
80%	71	78	86	97	113	**136**					
90%	71	79	88	102	122						
100%	72	80	91	108							

*Combined Index of Heat and Humidity...what it "feels like" to the body
Source: National Oceanic and Atmospheric Administration

How to use Heat Index:
1. Across top locate Environmental Temperature
2. Down left side locate Relative Humidity
3. Follow across and down to find Apparent Temperature
4. Determine Heat Stress Risk on chart at right

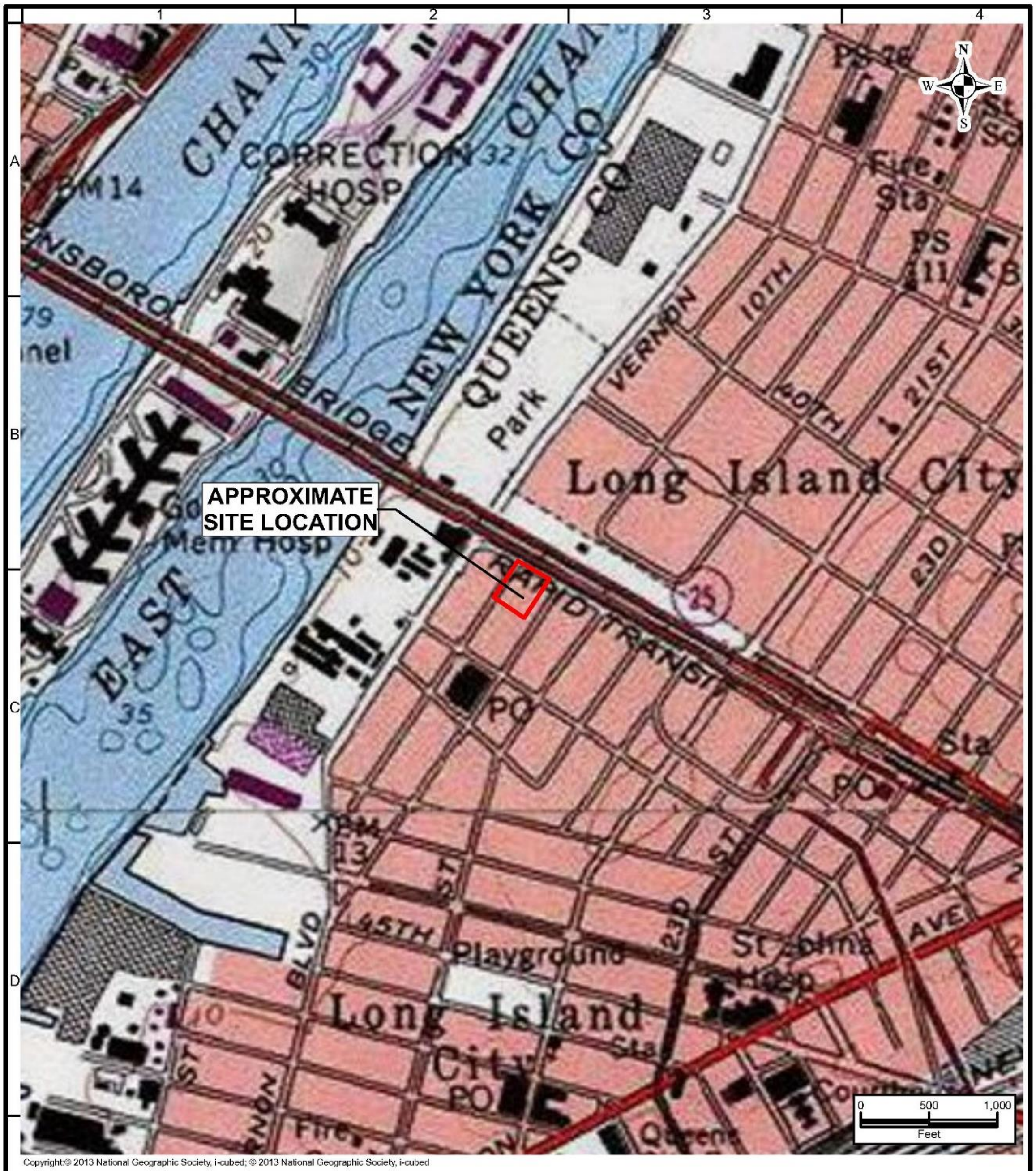
Note: Exposure to full sunshine can increase Heat Index values by up to 15 degrees F.

Apparent Temperature	Heat Stress Risk with Physical Activity and/or Prolonged Exposure
90-105	Heat Cramps or Heat Exhaustion Possible
105-130	Heat Cramps or Heat Exhaustion Likely, Heat Stroke Possible
>130	Heatstroke Highly Likely

FIGURES

FIGURE 1

Site Location Map



LANGAN 21 Penn Plaza, 360 West 31st Street, 8th Floor New York, NY 10001-2727 T: 212.479.5400 F: 212.479.5444 www.langan.com Langan Engineering & Environmental Services, Inc. Langan Engineering, Environmental, Surveying, Landscape Architecture and Geology, D.P.C. Langan International Collectively known as Langan	Project **42-11 9th Street, LIC, NY** LONG ISLAND CITY QUEENS COUNTY NEW YORK	**SITE LOCATION** Spatial Reference: WGS 1984 Web Mercator Auxiliary Sphere Projection: Mercator Auxiliary Sphere	Project No. 170514701 Date 2/26/2019 Scale 1:1,000 Drawn By Site Analyzer Submission Date 02/26/2019	Figure 1 Sheet 1 of 1

Disclaimer: This information is produced by an automated system and may not be complete. The absence of a feature is not a confirmation that the feature is not present at the subject location.

FIGURE 2

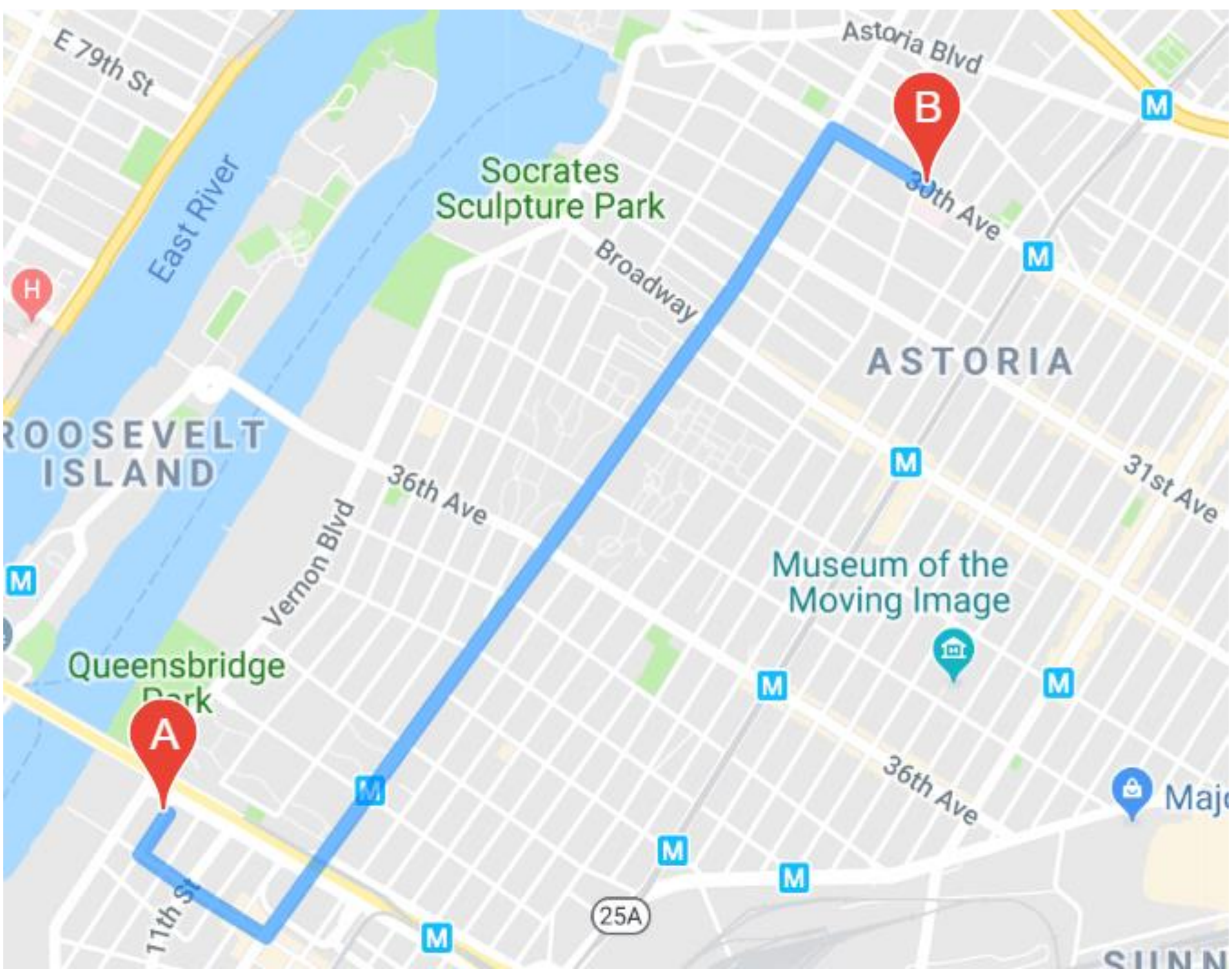
HOSPITAL ROUTE PLAN

Hospital Location: **Mount Sinai Hospital of Queens**
25-10 30th Avenue
Long Island City, New York
718-932-1000

START: 42-11 9th Street, LIC, NY

1. Head southwest on 9th Street toward 43rd Avenue
2. Turn left at the 1st cross street onto 43rd Avenue
3. Turn left onto 21st Street
4. Turn right onto 30th Avenue, destination will be on the right.

END: Mount Sinai Hospital of Queens, 25-10 20th Avenue, LIC, NY



ATTACHMENT A

STANDING ORDERS

STANDING ORDERS

GENERAL

- No smoking, eating, or drinking in this work zone.
- Upon leaving the work zone, personnel will thoroughly wash their hands and face.
- Minimize contact with contaminated materials through proper planning of work areas and decontamination areas, and by following proper procedures. Do not place equipment on the ground. Do not sit on contaminated materials.
- No open flames in the work zone.
- Only properly trained and equipped personnel are permitted to work in potentially contaminated areas.
- Always use the appropriate level of personal protective equipment (PPE).
- Maintain close contact with your buddy in the work zone
- Contaminated material will be contained in the Exclusion Zone (EZ).
- Report any unusual conditions.
- Work areas will be kept clear and uncluttered. Debris and other slip, trip, and fall hazards will be removed as frequently as possible.
- The number of personnel and equipment in the work zone will be kept to an essential minimum.
- Be alert to the symptoms of fatigue and heat/cold stress, and their effects on the normal caution and judgment of personnel.
- Conflicting situations which may arise concerning safety requirements and working conditions must be addressed and resolved quickly by the site HSO.

TOOLS AND HEAVY EQUIPMENT

- Do not, under any circumstances, enter or ride in or on any backhoe bucket, materials hoist, or any other device not specifically designed to carrying passengers.
- Loose-fitting clothing or loose long hair is prohibited around moving machinery.
- Ensure that heavy equipment operators and all other personnel in the work zone are using the same hand signals to communicate.
- Drilling/excavating within 10 feet in any direction of overhead power lines is prohibited.
- The locations of all underground utilities must be identified and marked out prior to initiating any subsurface activities.
- Check to insure that the equipment operator has lowered all blades and buckets to the ground before shutting off the vehicle.
- If the equipment has an emergency stop device, have the operator show all personnel its location and how to activate it.
- Help the operator ensure adequate clearances when the equipment must negotiate in tight quarters; serve as a signalman to direct backing as necessary.
- Ensure that all heavy equipment that is used in the Exclusion Zone is kept in that zone until the job is done, and that such equipment is completely decontaminated before moving it into the clean area of the work zone.
- Samplers must not reach into or get near rotating equipment such as the drill rig. If personnel must work near any tools that could rotate, the equipment operator must completely shut down the rig prior to initiating such work. It may be necessary to use a remote sampling device.

ATTACHMENT B

DECONTAMINATION PROCEDURES

PERSONNEL DECONTAMINATION

LEVEL C DECONTAMINATION

Station 1:	Equipment Drop	1. Deposit equipment used on-site (tools, sampling devices and containers, monitoring instruments, radios, clipboards, etc.) on plastic drop cloths. Segregation at the drop reduces the probability of cross contamination. During hot weather operations, cool down stations may be set up within this area.
Station 2:	Outer Garment, Boots, and Gloves Wash and Rinse	2. Scrub outer boots, outer gloves and chemical-resistant splash suit with decon solution or detergent and water. Rinse off using copious amounts of water.
Station 3:	Outer Boot and Glove Removal	3. Remove outer boots and gloves. Deposit in container with plastic liner.
Station 4:	Canister or Mask Change	4. If worker leaves Exclusion Zone to change canister (or mask), this is the last step in the decontamination procedure. Worker's canister is exchanged, new outer gloves and boot covers donned, joints taped, and worker returns to duty.
Station 5:	Boot, Gloves and Outer Garment Removal	5. Boots, chemical-resistant splash suit, inner gloves removed and deposited in separate containers lined with plastic.
Station 6:	Face piece Removal	6. Face piece is removed (avoid touching face with fingers). Face piece deposited on plastic sheets.
Station 7:	Field Wash	7. Hands and face are thoroughly washed. Shower as soon as possible.

LEVEL D DECONTAMINATION

Station 1:	Equipment Drop	1. Deposit equipment used on-site (tools, sampling devices and containers, monitoring instruments, radios, clipboards, etc.) on plastic drop cloths. Segregation at the drop reduces the probability of cross contamination. During hot weather operations, cool down stations may be set up within this area.
Station 2:	Outer Garment, Boots, and Gloves Wash and Rinse	2. Scrub outer boots, outer gloves and chemical-resistant splash suit with decon solution or detergent and water. Rinse off using copious amounts of water.
Station 3:	Outer Boot and Glove Removal	3. Remove outer boots and gloves. Deposit in container with plastic liner.
Station 4:	Boot, Gloves and Outer Garment Removal	4. Boots, chemical-resistant splash suit, inner gloves removed and deposited in separate containers lined with plastic.
Station 5:	Field Wash	5. Hands and face are thoroughly washed. Shower as soon as possible.

EQUIPMENT DECONTAMINATION

GENERAL:

Equipment to be decontaminated during the project may include tools, monitoring equipment, respirators, sampling containers, laboratory equipment and drilling equipment.

All decontamination will be done by personnel in protective gear, appropriate for the level of decontamination, as determined by the site HSO. The decontamination work tasks will be split or rotated among support and work crews.

Depending on site conditions, backhoe and pumps may be decontaminated over a portable decontamination pad to contain wash water; or, wash water may be allowed to run off into a storm sewer system. Equipment needed may include a steam generator with high-pressure water, empty drums, screens, screen support structures, and shovels. Drums will be used to hold contaminated wash water pumped from the lined pit. These drums will be labeled as such.

Miscellaneous tools and equipment will be dropped into a plastic pail, tub, or other container. They will be brushed off and rinsed with a detergent solution, and finally rinsed with clean water.

MONITORING EQUIPMENT:

Monitoring equipment will be protected as much as possible from contamination by draping, masking, or otherwise covering as much of the instruments as possible with plastic without hindering the operation of the unit. The PID, HNu or OVA meter, for example, can be placed in a clear plastic bag, which allows reading of the scale and operation of knobs. The probes can be partially wrapped keeping the sensor tip and discharge port clear.

The contaminated equipment will be taken from the drop area and the protective coverings removed and disposed in the appropriate containers. Any dirt or obvious contamination will be brushed or wiped with a disposable paper wipe.

RESPIRATORS:

Respirators will be cleaned and disinfected after every use. Taken from the drop area, the masks (with the cartridges removed and disposed of with other used disposable gear) will be immersed in a cleaning solution and scrubbed gently with a soft brush, followed by a rinse in plain warm water, and then allowed to air dry. In the morning, new cartridges will be installed. Personnel will inspect their own masks for serviceability prior to donning them. And, once the mask is on, the wearer will check the respirator for leakage using the negative and positive pressure fit check techniques.

ATTACHMENT C

EMPLOYEE EXPOSURE/
INJURY INCIDENT REPORT

EMPLOYEE INCIDENT/INJURY REPORT
LANGAN ENGINEERING & ENVIRONMENTAL SERVICES

(Complete and return to Tony Moffa in the Doylestown Office)

Affected Employee Name: ______________________________ Date: ______________________________

Incident type: ☐ Injury ☐ Report Only/No Injury

☐ Near Miss ☐ Other: ______________________________ ______

EMPLOYEE INFORMATION (Person completing Form)

Employee Name: ______________________________ Employee No: ______________________________

Title: ______________________________ Office Location: ______________________________

Length of time employed or date of hire: ______________________________

Mailing address: ______________________________

____

Sex: M ☐ F ☐ Birth date: ______________

Business phone & extension: ______________ Residence/cell phone: ______________________________

ACCIDENT INFORMATION

Project: ______________________________ Project #: ______________________________

Date & time of incident: ______________ Time work started & ended: ______________________________

Site location: ______________________________

Incident Type: Possible Exposure ☐ Exposure ☐ Physical Injury ☐

Names of person(s) who witnessed the incident:____

Exact location incident occurred:

Describe work being done:__________________________________

Describe what affected employee was doing prior to the incident occurring:

Describe in detail how the incident occurred:

Nature of the incident (List the parts of the body affected):

Person(s) to whom incident was reported (Time and Date):

List the names of other persons affected during this incident:

Possible causes of the incident (equipment, unsafe work practices, lack of PPE, etc.):

Weather conditions during incident:

MEDICAL CARE INFORMATION

Did affected employee receive medical care? Yes ☐ No ☐

If Yes, when and where was medical care received:

Provide name of facility (hospital, clinic, etc.):

Length of stay at the facility?

Did the employee miss any work time? Yes ☐ No ☐ Undetermined ☐

Date employee last worked: Date employee returned to work:

Has the employee returned to work? Yes ☐ No ☐

Does the employee have any work limitations or restrictions from the injury? : Yes ☐ No ☐

If Yes, please describe:

Did the exposure/injury result in permanent disability? Yes ☐ No ☐ Unknown ☐

If Yes, please describe:

HEALTH & SAFETY INFORMATION

Was the operation being conducted under an established site specific CONSTRUCTION HEALTH AND SAFETY PLAN?
Yes ☐ No ☐ Not Applicable: ☐

Describe protective equipment and clothing used by the employee:

____

____

____

Did any limitations in safety equipment or protective clothing contribute to or affect exposure / injury? If so, explain:

____

____

____

____

Employee Signature Date

____

Langan Representative Date

ATTACHMENT D

CALIBRATION LOG

DATE:________________ PROJECT:____________________

CALIBRATION LOG

Date & Time	Inst Type	Inst #	Media	Initial Reading	Span #	Calibrat. Reading	Performed By:

ATTACHMENT E

MATERIAL SAFETY DATA SHEETS

SAFETY DATA SHEETS

All Langan Field Personnel Completing This Work Plan Are To Have Real Time Accessibility To Material Safety Data Sheet (MSDs) or Safety Data Sheet (SDSs) Through Their Smart Phone.

The link is http://www.msds.com/
The login name is "drapehead"
The password is "2angan987"

If You Are Unable To Use the Smart Phone App, You Are To Bring Printed Copies of the MSDs/SDSs to the Site

ATTACHMENT F

JOBSITE SAFETY INSPECTION CHECKLIST

Jobsite Safety Inspection Checklist

Date: ______________________ **Inspected By:** ______________________

Location: ______________________ **Project #:** ______________________

Check one of the following: **A:** Acceptable **NA**: Not Applicable **D**: Deficiency

	A	NA	D	Remark
1. HASP available onsite for inspection?				
2. Health & Safety Compliance agreement (in HASP) appropriately signed by Langan employees and contractors?				
3. Hospital route map with directions posted on site?				
4. Emergency Notification List posted on site?				
5. First Aid kit available and properly stocked?				
6. Personnel trained in CPR/First Aid on site?				
7. MSDSs readily available, and all workers knowledgeable about the specific chemicals and compounds to which they may be exposed?				
8 Appropriate PPE being worn by Langan employees and contractors?				
9. Project site safe practices ("Standing Orders") posted?				
10. Project staff have 40-hr./8-hr./Supervisor HAZWOPER training?				
11. Project staff medically cleared to work in hazardous waste sites and fit-tested to wear respirators, if needed?				
12. Respiratory protection readily available?				
13. Health & Safety Incident Report forms available?				
14. Air monitoring instruments calibrated daily and results recorded on the Daily Instrument Calibration check sheet?				
15. Air monitoring readings recorded on the air monitoring data sheet/field log book?				
16. Subcontract workers have received 40-hr./8-hr./Spvsr. HAZWOPER training, as appropriate?				
17. Subcontract workers medically cleared to work on site, and fit-tested for respirator wear?				
18. Subcontract workers have respirators readily available?				
19. Mark outs of underground utilities done prior to initiating any subsurface activities?				
20. Decontamination procedures being followed as outlined in HASP?				
21. Are tools in good condition and properly used?				
22. Drilling performed in areas free from underground objects including utilities?				

23. Adequate size/type fire extinguisher supplied?				
24. Equipment at least 20 feet from overhead powerlines?				
25. Evidence that drilling operator is responsible for the safety of his rig.				
26. Trench sides shored, layer back, or boxed?				
27. Underground utilities located and authorities contacted before digging?				
28. Ladders in trench (25-foot spacing)?				
29. Excavated material placed more than 2 feet away from excavation edge?				
30. Public protected from exposure to open excavation?				
31. People entering the excavation regarding it as a permit-required confined space and following appropriate procedures?				
32. Confined space entry permit is completed and posted?				
33. All persons knowledgeable about the conditions and characteristics of the confined space?				
34. All persons engaged in confined space operations have been trained in safe entry and rescue (non-entry)?				
35. Full body harnesses, lifelines, and hoisting apparatus available for rescue needs?				
36. Attendant and/or supervisor certified in basic first aid and CPR?				
37. Confined space atmosphere checked before entry and continuously while the work is going on?				
38. Results of confined space atmosphere testing recorded?				
39. Evidence of coordination with off-site rescue services to perform entry rescue, if needed?				
40. Are extension cords rated for this work being used and are they properly maintained?				
41. Are GFCIs provided and being used?				

Unsafe Acts: ______________________________

____

____

____

Notes: ______________________________

____

____

____

ATTACHMENT G

JOB SAFETY ANALYSIS FORM

LANGAN	Job Safety Analysis (JSA) Health and Safety
JSA TITLE: **JSA NUMBER:**	**DATE CREATED:** **CREATED BY:** **REVISION DATE:** **REVISED BY:**

Langan employees must review and revise the Job Safety Analysis (JSA) as needed to address the any site specific hazards not identified. Employees must provide their signatures on the last page of the JSA indicating they have review the JSA and are aware the potential hazards associated with this work and will follow the provided preventive or corrective measures.

PERSONAL PROTECTIVE EQUIPMENT REQUIRED: (PPE): ■ Required	☒ As Needed	
☐ Steel-toed boots	☐ Nitrile gloves	☐ Dermal Protection (Specify)
☐ Long-sleeved shirt	☐ Leather/ Cut-resistant gloves	☐ High visibility vest/clothing
☐ Safety glasses	☐Face Shield	☐ Hard hat
ADDITIONAL PERSONAL PROTECTIVE EQUIPMENT NEEDED (Provide specific type(s) or descriptions)		
☐ Air Monitoring:	☐ Respirators:	☐ Other:

JOB STEPS	POTENTIAL HAZARDS	PREVENTATIVE OR CORRECTIVE ACTION
1.	1. 2.	1a. 1b. 2a. 2b.
2.	1.	1
Additional items identified in the field.		
Additional Items.		

If additional items are identified during daily work activities, please notify all relevant personnel about the change and document on this JSA.

LANGAN

Job Safety Analysis (JSA)
Health and Safety

JSA Title: **Subsurface Investigation**

JSA Number: **JSA030-01**

A Job Safety Analysis (JSA) must identify all job steps required to complete the task, the potential hazards employees could be exposed to while performing the job step and the preventative/corrective actions required to reduce/mitigate the identified potential hazards. Employees must certify that they have either prepared the JSA or have reviewed the JSA and are aware of the potential hazards associated with this task and will follow the provided preventive/corrective actions.

PERSONAL PROTECTIVE EQUIPMENT (Required or to be worn as needed):				
☒ Safety Shoes	☒ Long Sleeves	☒ Safety Vest (Class 2)	☒ Hard Hat	☒ Hearing Protection
☒ Safety Glasses	☒ Safety Goggles	☐ Face Shield	☐ Nitrile Gloves	☐ PVC Gloves
☒ Leather Gloves	☒ Cut Resist. Gloves	☐ Fall Protection	☐ Fire Resistant Clothing	☐ Rubber Boots
☐ Insect/Animal Repellent	☐ Ivy Blocker/Cleaner	☐ Traffic Cones/Signs	☐ Life Vest/Jacket	
☒ Other: Dielectric Overshoes, Sun Block				

JOB STEPS	POTENTIAL HAZARDS	PREVENTATIVE / CORRECTIVE ACTION
1. Transport equipment to work area	1. Back/strain 2. Slip/Trip/Falls 3. Traffic 4. Cuts/abrasions/contusions from equipment 5. Accidents due to vehicle operations	1. Use proper lifting techniques/Use wheeled transport 2. Minimize distance to work area/unobstructed path to work area/follow good housekeeping procedures 3. Wear proper PPE (high visibility vest or clothing) 4. Wear proper PPE (leather gloves, long sleeves, Langan approved safety shoes) 5. Observe posted speed limits/ Wear seat belts at all times
2. Traffic	1. Hit by moving vehicle	1. Use traffic cones and signage/ Use High visibility traffic vests and clothing/ Caution tape when working near active roadways.
3. Field Work (drilling, resistivity testing, and inspection)	1. Biological Hazards: insects, rats, snakes, poisonous plants, and other animals 2. Heat stress/injuries 3. Cold Stress/injuries 4. High Energy Transmission Lines 5. Underground Utilities 6. Electrical (soil resistivity testing)	1. Inspect work area to identify biological hazards. Wear light colored long sleeve shirt and long pants/ Use insect repellant as necessary/ Beware of tall grass, bushes, woods and other areas where ticks may live/ Avoid leaving garbage on site to prevent attracting animals/ Identify and avoid contact with poisonous plants/Beware of rats, snakes, or stray animals. 2. Wear proper clothing (light colored)/ drink plenty of water/ take regular breaks/use sun block 3. Wear proper clothing/ dress in layers/ take regular breaks. 4. Avoid direct contact with high energy transmission lines/ position equipment at least 15 feet or as required by PSE&G from the transmission lines/ wear proper PPE (dielectric overshoes 15 kV minimum rating). 5. Call one-call service before performing intrusive field work/ Review utility mark-outs and available utility drawings (with respect to proposed work locations)/ Follow Underground Utility Guidelines 6. See AGI Sting R1 operating manual for specific concerns during operating instrument

JOB STEPS	POTENTIAL HAZARDS	PREVENTATIVE / CORRECTIVE ACTION
4. All activities	1. Slips/ Trips/ Falls 2. Hand injuries, cuts or lacerations during manual handling of materials 3. Foot injuries 4. Back injuries 5. Traffic 6. Wildlife: Stray dogs, Mice/rats, Vectors (i.e. mosquitoes, bees, etc.) 7. High Noise levels 8. Overhead hazards 9. Heat Stress/ Cold Stress 10. Eye Injuries	7. Be aware of potential trip hazards / Follow good housekeeping procedures/ Mark significant hazards 8. Inspect for jagged/sharp edges, and rough or slippery surfaces / Keep fingers away from pinch points / Wipe off greasy, wet, slippery or dirty objects before handling / Wear leather/ cut-resistant gloves 9. Wear Langan approved safety shoes 10. Use proper lifting techniques / Consider load location, task repetition, and load weigh when evaluating what is safe or unsafe to lift / Obtain assistance when possible 11. Wear high visibility clothing & vest / Use cones or signs to designate work area 12. Be aware of surroundings at all times, including the presence of wildlife/ Do not approach stray dogs / Carry/use dog/animal repellant / Use bug spray when needed 13. Wear proper hearing protection 14. Wear hard hat / Avoid areas were overhead hazards exist. 15. Wear proper attire for weather conditions (sunscreen or protective clothing in sunlight, layers for cold weather) / Drink plenty of fluids to avoid dehydration / Takes breaks as necessary to avoid heat/cold stress 16. Wear safety glasses
Additional items.		
Additional Items identified while in the field. (Delete row if not needed.)		

Print Name	**Sign Name**	**Date**
Prepared by:		
Reviewed by:		

LANGAN	Job Safety Analysis (JSA) Health and Safety

JSA Title: Field Sampling

JSA Number: JSA022-01

A Job Safety Analysis (JSA) must identify all job steps required to complete the task, the potential hazards employees could be exposed to while performing the job step and the preventative/corrective actions required to reduce/mitigate the identified potential hazards. Employees must certify that they have either prepared the JSA or have reviewed the JSA and are aware of the potential hazards associated with this task and will follow the provided preventive/corrective actions.

PERSONAL PROTECTIVE EQUIPMENT (Required or to be worn as needed):

☒ Safety Shoes	☒ Long Sleeves	☐ Safety Vest (Class 2)	☒ Hard Hat	☒ Hearing Protection
☒ Safety Glasses	☐ Safety Goggles	☐ Face Shield	☒ Nitrile Gloves	☐ PVC Gloves
☒ Leather Gloves	☐ Cut Resist. Gloves	☐ Fall Protection	☐ Fire Resistant Clothing	☐ Rubber Boots
☐ Insect/Animal Repellent	☐ Ivy Blocker/Cleaner	☒ Traffic Cones/Signs	☐ Life Vest/Jacket	
☐ Other:				

JOB STEPS	POTENTIAL HAZARDS	PREVENTATIVE / CORRECTIVE ACTION
5. Unpack/Transport equipment to work area.	6. Back Strains 7. Slip/Trips/Falls 8. Cuts/Abrasions from equipment 9. Contusions from dropped equipment	6. Use proper lifting techniques/Use wheeled transport 7. Minimize distance to work area/Unobstructed path to work area/follow good housekeeping procedures. Mark slip/trip/fall hazards with orange safety cones. 8. Wear proper PPE (leather gloves, long sleeves). 9. Wear proper PPE (Langan approved safety shoes).
6. Initial Site Arrival-Site Assessment	1. Traffic	1. Situational awareness (be alert of your surroundings). Secure area from through traffic.
7. Surface Water Sampling	1. Contaminated media. Skin/eye contact with biological agents and/or chemicals.	1. Wear appropriate PPE (Safety glasses, appropriate gloves). Review (M)SDS for all chemicals being.
8. Sampling from bridges	1. Struck by vehicles	1. Wear appropriate PPE (Safety Vest). Use buddy system and orange safety cones.
9. Icing of Samples/ Transporting coolers/equipment from work area.	11. Back Strains 12. Slips/Trips/Falls 13. Cuts/Abrasions from equipment 14. Pinch/Crushing Hazards.	17. Drain coolers of water. Use proper lifting techniques. Use wheeled transport. 18. Have unobstructed path from work area. Aware of surroundings. 19. Wear proper PPE (Leather gloves, long sleeves) 20. Wear proper PPE (Leather gloves, long sleeves)
10. Site Departure	1. Contaminated PPE/Vehicle	1. Contaminated PPE should be disposed of on-site. Remove boots and soiled clothing for secure storage in trunk. Wash hands promptly.
11. All activities	1. Slips/ Trips/ Falls 2. Hand injuries, cuts or lacerations during manual handling of materials	1. Be aware of potential trip hazards / Follow good housekeeping procedures/ Mark significant hazards

JOB STEPS	POTENTIAL HAZARDS	PREVENTATIVE / CORRECTIVE ACTION
	3. Foot injuries 4. Back injuries 15. Traffic 16. Wildlife: Stray dogs, Mice/rats, Vectors (i.e. mosquitoes, bees, etc.) 17. High Noise levels 18. Overhead hazards 19. Heat Stress/ Cold Stress 20. Eye Injuries	2. Inspect for jagged/sharp edges, and rough or slippery surfaces / Keep fingers away from pinch points / Wipe off greasy, wet, slippery or dirty objects before handling / Wear leather/ cut-resistant gloves 3. Wear Langan approved safety shoes 4. Use proper lifting techniques / Consider load location, task repetition, and load weigh when evaluating what is safe or unsafe to lift / Obtain assistance when possible 21. Wear high visibility clothing & vest / Use cones or signs to designate work area 22. Be aware of surroundings at all times, including the presence of wildlife/ Do not approach stray dogs / Carry/use dog/animal repellant / Use bug spray when needed 23. Wear hearing protection 24. Wear hard hat / Avoid areas were overhead hazards exist. 25. Wear proper attire for weather conditions (sunscreen or protective clothing in sunlight, layers for cold weather) / Drink plenty of fluids to avoid dehydration / Takes breaks as necessary to avoid heat/cold stress 26. Wear safety glasses
Additional items.		
Additional Items identified while in the field. (Delete row if not needed.)		

Print Name	**Sign Name**	**Date**
Prepared by:		
Reviewed by:		

LANGAN	Job Safety Analysis (JSA) Health and Safety

JSA Title: **Equipment Transportation and Set-Up**

JSA Number: **JSA012-01**

A Job Safety Analysis (JSA) must identify all job steps required to complete the task, the potential hazards employees could be exposed to while performing the job step and the preventative/corrective actions required to reduce/mitigate the identified potential hazards. Employees must certify that they have either prepared the JSA or have reviewed the JSA and are aware of the potential hazards associated with this task and will follow the provided preventive/corrective actions.

PERSONAL PROTECTIVE EQUIPMENT (Required or to be worn as needed):

☒ Safety Shoes	☒ Long Sleeves	☒ Safety Vest (Class 2)	☒ Hard Hat	☒ Hearing Protection
☒ Safety Glasses	☐ Safety Goggles	☐ Face Shield	☐ Nitrile Gloves	☐ PVC Gloves
☒ Leather Gloves	☐ Cut Resist. Gloves	☐ Fall Protection	☐ Fire Resistant Clothing	☐ Rubber Boots
☐ Insect/Animal Repellent	☐ Ivy Blocker/Cleaner	☐ Traffic Cones/Signs	☐ Life Vest/Jacket	
☐ Other:				

JOB STEPS	POTENTIAL HAZARDS	PREVENTATIVE / CORRECTIVE ACTION
12.Transport equipment to work area	10.Back Strain 11.Slips/ Trips/ Falls 12.Traffic 13.Cuts/abrasions from equipment 14.Contusions from dropped equipment	1. Use proper lifting techniques / Use wheeled transport 2. Minimize distance to work area / Have unobstructed path to work area / Follow good housekeeping procedures 3. Wear proper PPE (high visibility vest or clothing) 4. Wear proper PPE (leather gloves, long sleeves) 5. Wear proper PPE (safety shoes)
13.Moving equipment to its planned location	2. Pinch Hazard 3. Slips/ Trips/ Falls	1. Wear proper PPE (leather gloves) 2. Be aware of potential trip hazards / Practice good housekeeping procedures / Mark significant below-grade hazards (i.e. holes, trenches) with safety cones or spray paint
14.Equipment Set-up	2. Pinch Hazard 3. Cuts/abrasions to knuckles/hands 4. Back Strain	1. Wear proper PPE (leather gloves) 2. Wear proper PPE (leather gloves) 3. Use proper lifting techniques / Use wheeled transport
15. All activities	21. Slips/ Trips/ Falls 22. Hand injuries, cuts or lacerations during manual handling of materials 23. Foot injuries 24. Back injuries 25. Traffic 26. Wildlife: Stray dogs, Mice/rats, Vectors (i.e. mosquitoes, bees, etc.) 27. High Noise levels 28. Overhead hazards 29. Heat Stress/ Cold Stress 30. Eye Injuries	27. Be aware of potential trip hazards / Follow good housekeeping procedures/ Mark significant hazards 28. Inspect for jagged/sharp edges, and rough or slippery surfaces / Keep fingers away from pinch points / Wipe off greasy, wet, slippery or dirty objects before handling / Wear leather/ cut-resistant gloves 29. Wear Langan approved safety shoes 30. Use proper lifting techniques / Consider load location, task repetition, and load weigh when evaluating what is safe or unsafe to lift / Obtain assistance when possible 31. Wear high visibility clothing & vest / Use cones or signs to designate work area

JOB STEPS	POTENTIAL HAZARDS	PREVENTATIVE / CORRECTIVE ACTION
4. All activities (cont'd)		32. Be aware of surroundings at all times, including the presence of wildlife/ Do not approach stray dogs / Carry/use dog/animal repellant / Use bug spray when needed 33. Wear hearing protection 34. Wear hard hat / Avoid areas were overhead hazards exist. 35. Wear proper attire for weather conditions (sunscreen or protective clothing in sunlight, layers for cold weather) / Drink plenty of fluids to avoid dehydration / Takes breaks as necessary to avoid heat/cold stress 36. Wear safety glasses
Additional items.		
Additional Items identified while in the field. (Delete row if not needed.)		

Print Name	**Sign Name**	**Date**
Prepared by:		
Reviewed by:		

LANGAN	Job Safety Analysis (JSA) Health and Safety

JSA Title: 55-gallon Drum Sampling

JSA Number: JSA043-01

A Job Safety Analysis (JSA) must identify all job steps required to complete the task, the potential hazards employees could be exposed to while performing the job step and the preventative/corrective actions required to reduce/mitigate the identified potential hazards. Employees must certify that they have either prepared the JSA or have reviewed the JSA and are aware of the potential hazards associated with this task and will follow the provided preventive/corrective actions.

PERSONAL PROTECTIVE EQUIPMENT (Required or to be worn as needed):

☒ Safety Shoes	☒ Long Sleeves	☒ Safety Vest (Class 2)	☒ Hard Hat	☐ Hearing Protection
☒ Safety Glasses	☒ Safety Goggles	☒ Face Shield	☒ Nitrile Gloves	☒ PVC Gloves
☒ Leather Gloves	☐ Cut Resist. Gloves	☐ Fall Protection	☐ Fire Resistant Clothing	☐ Rubber Boots
☐ Insect/Animal Repellent	☐ Ivy Blocker/Cleaner	☐ Traffic Cones/Signs	☐ Life Vest/Jacket	

☒ Other: All Drums are required to be labeled. Langan employees do not open or move undocumented drums or unlabeled drums without proper project manager authorization.

JOB STEPS	POTENTIAL HAZARDS	PREVENTATIVE / CORRECTIVE ACTION
16. Unpack/Transport equipment to work area.	15. Back Strains 16. Slip/Trips/Falls 17. Cuts/Abrasions from equipment 4. Contusions from dropped equipment	10. Use proper lifting techniques/Use wheeled transport 11. Minimize distance to work area/Unobstructed path to work area/follow good housekeeping procedures. Mark slip/trip/fall hazards with orange safety cones. 12. Wear proper PPE (leather gloves, long sleeves). 4. Wear proper PPE (Langan approved safety shoes).
17. Open Drums	1. Hand Injuries, cuts or lacerations when untightening drum locking bolt, removing drum lid strap, or removing lid. 2. Pressure from drums.	1. Inspect for jagged/sharp edges, and rough or slippery surfaces / Keep fingers away from pinch points / Wipe off greasy, wet, slippery or dirty objects before handling / Wear leather/ cut-resistant gloves. Use non-metallic mallet and non-sparking tools/wrenches. 2. Open drum slowly to relieve pressure. Wear proper PPE: face shield and goggles; correct gloves; and over garments.
18. Collecting Soil/Fluid Sample	4. Irritation to eye from vapor, soil dust, or splashing 5. Irritation to exposed skin	2. Wear proper eye protection including safety glasses/ face shield/googles and when necessary, splash guard. If dust or vapor phase is present, wear appropriate safety breathing gear (1/2 mask or full face mask with correct filter) 3. Wear proper skin protection including nitrile gloves.
19. Closing Drums	1. Hand Injuries, cuts or lacerations when untightening drum locking bolt, removing drum lid strap, or removing lid.	2. Inspect for jagged/sharp edges, and rough or slippery surfaces / Keep fingers away from pinch points / Wipe off greasy, wet, slippery or dirty objects before handling / Wear leather/ cut-resistant gloves. Use non-metallic mallet and non-sparking tools/wrenches.
20. Moving Drums	2. Hand Injuries, cuts or lacerations when untightening drum locking bolt, removing drum lid strap, or removing lid. 3. Back Strains	2. Inspect for jagged/sharp edges, and rough or slippery surfaces / Keep fingers away from pinch points / Wipe off greasy, wet, slippery or dirty objects before handling / Wear leather/ cut-resistant gloves. Use non-metallic mallet and non-sparking tools/wrenches. 3. Use proper lifting techniques/Use wheeled transport

JOB STEPS	POTENTIAL HAZARDS	PREVENTATIVE / CORRECTIVE ACTION
21. All activities	31. Slips/ Trips/ Falls 32. Hand injuries, cuts or lacerations during manual handling of materials 33. Foot injuries 34. Back injuries 35. Traffic 36. Wildlife: Stray dogs, Mice/rats, Vectors (i.e. mosquitoes, bees, etc.) 37. High Noise levels 38. Overhead hazards 39. Heat Stress/ Cold Stress 40. Eye Injuries	37. Be aware of potential trip hazards / Follow good housekeeping procedures/ Mark significant hazards 38. Inspect for jagged/sharp edges, and rough or slippery surfaces / Keep fingers away from pinch points / Wipe off greasy, wet, slippery or dirty objects before handling / Wear leather/ cut-resistant gloves 39. Wear Langan approved safety shoes 40. Use proper lifting techniques / Consider load location, task repetition, and load weigh when evaluating what is safe or unsafe to lift / Obtain assistance when possible 41. Wear high visibility clothing & vest / Use cones or signs to designate work area 42. Be aware of surroundings at all times, including the presence of wildlife/ Do not approach stray dogs / Carry/use dog/animal repellant / Use bug spray when needed 43. Wear hearing protection 44. Wear hard hat / Avoid areas were overhead hazards exist. 45. Wear proper attire for weather conditions (sunscreen or protective clothing in sunlight, layers for cold weather) / Drink plenty of fluids to avoid dehydration / Takes breaks as necessary to avoid heat/cold stress 46. Wear safety glasses
Additional items.		
Additional Items identified while in the field. (Delete row if not needed.)		

Print Name	**Sign Name**	**Date**
Prepared by:		
Reviewed by:		

LANGAN	Job Safety Analysis (JSA) Health and Safety

JSA Title: **Direct-Push Soil Borings**
JSA Number: **JSA004-01**

A Job Safety Analysis (JSA) must identify all job steps required to complete the task, the potential hazards employees could be exposed to while performing the job step and the preventative/corrective actions required to reduce/mitigate the identified potential hazards. Employees must certify that they have either prepared the JSA or have reviewed the JSA and are aware of the potential hazards associated with this task and will follow the provided preventive/corrective actions.

PERSONAL PROTECTIVE EQUIPMENT REQUIRED:				
☒ Safety Shoes	☒ Long Sleeves	☒ Safety Vest (Class 2)	☒ Hard Hat	☒ Hearing Protection
☒ Safety Glasses	☐ Safety Goggles	☐ Face Shield	☒ Nitrile Gloves	☐ PVC Gloves
☒ Leather Gloves	☒ Cut Resist. Gloves	☐ Fall Protection	☐ Fire Resistant Clothing	☐ Rubber Boots
☐ Insect/Animal Repellent	☐ Ivy Blocker/Cleaner	☐ Traffic Cones/Signs	☐ Life Vest/Jacket	
☒ Other: Half-face respirator, dust cartridges, PID (if applicable)				

JOB STEPS	POTENTIAL HAZARDS	PREVENTATIVE / CORRECTIVE ACTION
22.Move equipment to work site	18.Back strain when lifting equipment 19.Slips/ Trips/ Falls while moving equipment 20.Traffic (if applicable) 21.Pinched fingers or running over toes during geoprobe set-up 22.Overturn drilling rig while transporting to loading dock on flat-bed tow truck	13. Use proper lifting technique (use legs for bending and lifting and not the back)/ Use wheeled transport for heavy equipment / Get assistance when handling loads greater than 50 lbs. / Minimize distance to vehicle 14. Use proper lifting technique (use legs for bending and lifting and not the back) / Use wheeled transport for heavy equipment / Get assistance when handling loads greater than 50 lbs. / Minimize distance to vehicle / Have unobstructed path to vehicle or collection point / Do not lift/walk with boxes that are heavy/difficult to lift 15. Wear high visibility safety vests or clothing / Exercise caution 16. Wear proper PPE (cut-resistant gloves) / Stay alert, be aware of geoprobe rig at all times 17. Drill rig should be parked in center of flat-bed tow truck / Emergency brake shall be used at all times during transport on the flat-bed truck/ All unnecessary personnel should stay away from the flat-bed truck during moving activities
23.Calibration of monitoring equipment	6. Skin or eye contact with calibration chemicals 7. Pinch fingers in monitoring equipment	4. Wear proper PPE (safety glasses/ goggles) 5. Wear proper PPE (leather gloves)
24.Set-up geoprobe rig	5. Geoprobe rig movement	3. All field personnel should stay clear of the geoprobe rig while moving / Use a spotter when backing up the geoprobe
25.Advance geoprobe rods below ground surface to desired depth	4. Underground utilities 5. High noise levels	4. Clean all subsurface soil borings to a minimum of 5 feet below grade 5. Wear proper PPE (hearing protection)
26. Remove and open acetate liner	41. Pinched fingers while removing macrocore 42. Cuts/lacerations when cutting acetate liner open 43. Exposure to hazardous vapors	1. Wear proper PPE (nitrile gloves, cut-resistant or leather gloves 2. Wear proper PPE (cut-resistant or leather gloves) 3. Do not place face over acetate liner when opening / Monitor hazardous vapors in air with PID / Upgrade PPE as necessary based on levels contained in the Health and Safety Plan

JOB STEPS	POTENTIAL HAZARDS	PREVENTATIVE / CORRECTIVE ACTION
5. Remove and open acetate liner (cont'd)	44. Skin contact with contaminated soil	4. Wear proper PPE (nitrile gloves)
27. Sample Collections a) Monitor parameters b) Prepare sample containers and labels	1. Contact with potentially contaminated soil 2. Lacerations from broken sample bottles 3. Back strain while transporting full coolers 4. Internal exposure to contaminants and metals through inhalation of dust 5. Slips/ Trips/ Falls	1. Use monitoring devices / Wear proper PPE (safety glasses, nitrile gloves) 2. Do not over-tighten bottle caps / Handle bottles safely to prevent breakage 6. Use proper lifting techniques / Do not lift heavy loads without assistance 7. Avoid creating dust / If necessary, wear a half mask respirator with applicable dust cartridge / Inspect respirator for damage and cleanliness prior to use / Clean respirator after each use and store in a clean, secure location 8. Be alert / Follow good housekeeping procedures
28. Remove excess soil from acetate liner and place in 55-gallon drum (IF NOT PERFORMED BY LANGAN, REMOVE!)	1. Cuts/lacerations from acetate liner 2. Pinched fingers/hand while opening/closing drum 3. Skin contact with contaminated soil 4. Soil debris in eyes	1. Wear proper PPE (cut-resistant or leather gloves) 2. Wear proper PPE (cut-resistant or leather gloves) 3. Wear proper PPE (nitrile gloves) 4. Wear proper PPE (safety glasses)
8. Transport drums to central staging location (IF NOT PERFORMED BY LANGAN, REMOVE!)	1. Back, arm or shoulder strain from moving drums 2. Pinch fingers/hand in drum cart when moving drums 3. Pinch fingers/hand when operating lift-gate on vehicle 4. Contact with potentially contaminated groundwater when moving improperly sealed drums 5. Slips when moving drums 6. Drop drum on feet/toes	47. Use drum cart for moving drums / Use proper lifting techniques / Do not lift heavy loads without assistance 48. Wear proper PPE (cut-resistant or leather gloves) 49. Wear proper PPE (cut-resistant or leather gloves) 50. Wear proper PPE (nitrile gloves underneath work gloves) 51. Follow good housekeeping procedures / Ensure route to move drum and storage space is free from obstructions 52. Wear proper PPE (safety shoes) / Work in a safe manner to prevent dropped drum
9. All activities	1. Slips/ Trips/ Falls 2. Hand injuries, cuts or lacerations during manual handling of materials 3. Foot injuries 4. Back injuries 5. Traffic 6. Wildlife: Stray dogs, Mice/rats, Vectors (i.e. mosquitoes, bees, etc.) 7. High Noise levels 8. Overhead hazards 9. Heat Stress/ Cold Stress	1. Be aware of potential trip hazards / Follow good housekeeping procedures/ Mark significant hazards 2. Inspect for jagged/sharp edges, and rough or slippery surfaces / Keep fingers away from pinch points / Wipe off greasy, wet, slippery or dirty objects before handling / Wear leather/ cut-resistant gloves 3. Wear Langan approved safety shoes 4. Use proper lifting techniques / Consider load location, task repetition, and load weigh when evaluating what is safe or unsafe to lift / Obtain assistance when possible 5. Wear high visibility clothing & vest / Use cones or signs to designate work area 6. Be aware of surroundings at all times, including the presence of wildlife/ Do not approach stray dogs / Carry/use dog/animal repellant / Use bug spray when needed 7. Wear hearing protection 8. Wear hard hat / Avoid areas were overhead hazards exist. 9. Wear proper attire for weather conditions (sunscreen or protective clothing in sunlight, layers for cold weather) / Drink plenty of fluids to avoid dehydration / Takes breaks as necessary to avoid heat/cold stress

JOB STEPS	POTENTIAL HAZARDS	PREVENTATIVE / CORRECTIVE ACTION
9. All activities (cont'd)	10. Eye Injuries	10. Wear safety glasses
Additional items.		
Additional Items identified while in the field. (Delete row if not needed.)		

Print Name	**Sign Name**	**Date**
Prepared by:		
Reviewed by:		

LANGAN	Job Safety Analysis (JSA) Health and Safety

JSA Title: **Monitoring Well Development**

JSA Number: **JSA026-01**

A Job Safety Analysis (JSA) must identify all job steps required to complete the task, the potential hazards employees could be exposed to while performing the job step and the preventative/corrective actions required to reduce/mitigate the identified potential hazards. Employees must certify that they have either prepared the JSA or have reviewed the JSA and are aware of the potential hazards associated with this task and will follow the provided preventive/corrective actions.

PERSONAL PROTECTIVE EQUIPMENT (Required or to be worn as needed):				
☒ Safety Shoes	☒ Long Sleeves	☒ Safety Vest (Class 2)	☒ Hard Hat	☐ Hearing Protection
☒ Safety Glasses	☐ Safety Goggles	☒ Face Shield	☒ Nitrile Gloves	☐ PVC Gloves
☒ Leather Gloves	☒ Cut Resist. Gloves	☐ Fall Protection	☐ Fire Resistant Clothing	☐ Rubber Boots
☐ Insect/Animal Repellent	☐ Ivy Blocker/Cleaner	☐ Traffic Cones/Signs	☐ Life Vest/Jacket	
☒ Other: Tyvek Sleeves				

JOB STEPS	POTENTIAL HAZARDS	PREVENTATIVE / CORRECTIVE ACTION
29. Transport equipment to work area	23. Back Strains 24. Slips/Trips/Falls 25. Traffic 26. Cuts/Abrasions/Contusions from equipment	18. Use proper lifting techniques/ Use wheeled transport/ use buddy system when lifting equipment. 19. Minimize distance from work area/ unobstructed path to collection points and vehicle/ Follow good housekeeping procedures. 20. Wear high-visibility vest or clothing/Exercise caution/ Use traffic cones or signage if needed. 21. Wear proper PPE (leather gloves, long sleeves, Langan approved safety shoes).
30. Measure depth of water	8. Exposure to hazardous substances 9. Pinched fingers	6. Wear proper PPE (Nitrile gloves, Safety glasses/Face shield). 7. Wear proper PPE (cut-resistant gloves).
31. Install Tremie pipe in the monitoring well and connect to water source.	6. Hand injuries during installation (pinched fingers/hands). 7. Back strain from holding Tremie pipe. 8. High pressure water spray.	4. Wear proper PPE (Nitrile gloves/cut-resistant gloves). 5. Use proper lifting techniques/ Use two personnel when lowering pump greater than 80 feet. 6. Ensure all hose connections are tight and secure/ Use proper PPE (face shield and safety glasses).
32. Install pump in to well a. Connect pump to sample tubing. b. Lower pump to desired depth in well. c. Connect sample tubing to flow cell d. Connect pump to power source (generator)	6. Hand injuries during pump installation and sample tubing cutting. 7. Back strain 8. Electric shock 9. Exhaust gases from generator 10. Burns from hot equipment	9. Wear proper PPE when installing pump and cutting sample tubing (Nitrile and cut-resistant gloves)/ Use tubing cutter. 10. Proper lifting techniques/ Two personnel when installing pump at depths greater than 80 feet/ Use buddy when lifting heavy loads (pump, generator)/Use wheeled transport. 11. Ensure equipment is (LO/TO: locked out/tagged out) prior to preforming any electrical connections/ Inspect wires for frays or cuts/Ensure generator is properly grounded prior to starting. 12. Position generator so that exhaust is flowing away from work area.

JOB STEPS	POTENTIAL HAZARDS	PREVENTATIVE / CORRECTIVE ACTION
e. Turn on power source (generator)		13. Do not touch exhaust or any hot part of generator/ Allow equipment time to cool down prior to carrying/ Use proper PPE (long sleeves, leather gloves)
33. Develop monitoring well a. Jet water into well using Tremie pipe b. Turn pump on and adjust to desired flow rate. c. Surge pump up and down well to remove sediment from screen d. Containerize all purge water from well.	45. Hand injuries 46. Face injuries 47. Contaminated spray from water	53. Wear proper PPE (cut-resistant gloves and nitrile gloves). 54. Wear proper PPE (face shield and safety glasses)/do not stand over well opening. 55. Wear proper PPE (Face shield and safety goggles)/Tyvek over garments/ Ensure all connections are secure and tight/ Tubing outlet is contained in an overflow container.
34. Drum staging area.	1. Back, Arm, and shoulder strain. 2. Pinch points 3. Cross contamination 4. Slip/Trips/Falls	1. Use proper lifting techniques/ Use drum carts when moving drums/ use buddy system for moving of drums if needed/Move drums shortest distance needed. 2. Keep fingers and feet away from pinch points/ Use proper PPE (cut-resistant gloves, Langan approved safety shoes) 3. Use proper PPE (Nitrile gloves, Tyvek sleeves) 4. Ensure pathway is clear prior to moving equipment/ Mark all hazards/ Use additional person as a spotter if needed.
35. Equipment pack-up	1. Back Strains 2. Slips/Trips/Falls 3. Traffic 4. Cuts/Abrasions/Contusions from equipment.	1. Use proper lifting techniques/ Use wheeled transport/ use buddy system when lifting equipment. 2. Minimize distance from work area/ Unobstructed path to collection points and vehicle/ Follow good housekeeping procedures. 3. Wear high-visibility vest or clothing/Exercise caution/ Use traffic cones or signage if needed. 56. Wear proper PPE (leather gloves, long sleeves, Langan approved safety shoes).
36. All activities	1. Slips/ Trips/ Falls 2. Hand injuries, cuts or lacerations during manual handling of materials 3. Foot injuries 48. Back injuries 49. Traffic 50. Wildlife: Stray dogs, Mice/rats, Vectors (i.e. mosquitoes, bees, etc.) 51. High Noise levels 52. Overhead hazards 53. Heat Stress/ Cold Stress 54. Eye Injuries	1. Be aware of potential trip hazards / Follow good housekeeping procedures/ Mark significant hazards 2. Inspect for jagged/sharp edges, and rough or slippery surfaces / Keep fingers away from pinch points / Wipe off greasy, wet, slippery or dirty objects before handling / Wear leather/ cut-resistant gloves 3. Wear Langan approved safety shoes 4. Use proper lifting techniques / Consider load location, task repetition, and load weigh when evaluating what is safe or unsafe to lift / Obtain assistance when possible 5. Wear high visibility clothing & vest / Use cones or signs to designate work area 6. Be aware of surroundings at all times, including the presence of wildlife/ Do not approach stray dogs / Carry/use dog/animal repellant / Use bug spray when needed 7. Wear hearing protection 8. Wear hard hat / Avoid areas were overhead hazards exist.

JOB STEPS	POTENTIAL HAZARDS	PREVENTATIVE / CORRECTIVE ACTION
		9. Wear proper attire for weather conditions (sunscreen or protective clothing in sunlight, layers for cold weather) / Drink plenty of fluids to avoid dehydration / Takes breaks as necessary to avoid heat/cold stress 10. Wear safety glasses.
Additional items.		
Additional Items identified while in the field. (Delete row if not needed.)		

Print Name	**Sign Name**	**Date**
Prepared by:		
Reviewed by:		

LANGAN	Job Safety Analysis (JSA) Health and Safety

JSA Title: Groundwater Sampling

JSA Number: JSA008-01

A Job Safety Analysis (JSA) must identify all job steps required to complete the task, the potential hazards employees could be exposed to while performing the job step and the preventative/corrective actions required to reduce/mitigate the identified potential hazards. Employees must certify that they have either prepared the JSA or have reviewed the JSA and are aware of the potential hazards associated with this task and will follow the provided preventive/corrective actions.

PERSONAL PROTECTIVE EQUIPMENT (Required or to be worn as needed):

☒ Safety Shoes	☒ Long Sleeves	☒ Safety Vest (Class 2)	☒ Hard Hat	☒ Hearing Protection
☒ Safety Glasses	☐ Safety Goggles	☐ Face Shield	☒ Nitrile Gloves	☐ PVC Gloves
☒ Leather Gloves	☐ Cut Resist. Gloves	☒ Fall Protection	☐ Fire Resistant Clothing	☐ Rubber Boots
☐ Insect/Animal Repellent	☐ Ivy Blocker/Cleaner	☐ Traffic Cones/Signs	☐ Life Vest/Jacket	
☒ Other: Tyvek sleeves, Dermal Protection, PID				

JOB STEPS	POTENTIAL HAZARDS	PREVENTATIVE / CORRECTIVE ACTION
37.Transport equipment to work area	1. Back Strain 2. Slips/ Trips/ Falls 3. Traffic 4. Cuts/abrasions from equipment 5. Contusions from dropped equipment	1. Use proper lifting techniques / Use wheeled transport 2. Minimize distance to work area / Have unobstructed path to work area / Follow good housekeeping procedures 3. Wear proper PPE (high visibility vest or clothing) 4. Wear proper PPE (leather gloves, long sleeves) 5. Wear proper PPE (safety shoes)
38. Remove well cover	10.Scrape knuckles/hand 11.Strain wrist/bruise palm 12.Pinch fingers or hand	3. Wear proper PPE (leather gloves) 4. Using a hammer, tap the end of the wrench to loosen grip of bolts 5. Wear proper PPE (leather gloves)
39. Remove well cap and lock	9. Well can pops from pressure 10. Exposure to hazardous substances through inhalation or dermal exposure 11. Scrape knuckles/hand 12. Strain write/bruise palm	5. Remove cap slowly to relieve pressure / Do not place face over well when opening / Wear proper PPE (safety glasses) 6. Use direct air monitoring/reading instrument (i.e. PID) / Be familiar with and follow actions prescribed in the HASP / Wear proper PPE (nitrile gloves) 7. Wear proper PPE (leather gloves) 8. Using hammer, tap the end of the wrench to loosen grip
40. Measure head-space vapor levels	1. Exposure to hazardous substances through inhalation	1. Do not place face over well when collecting measurement
41. Remove dedicated tubing (if necessary)	1. Exposure to hazardous substances through inhalation or dermal exposure 2. Tubing swings around after removal	1. Wear proper PPE (nitrile gloves, Tyvek sleeves) 2. Wear proper PPE (safety glasses)
42. Set-up plastic sheeting for work site around the well	1. Lacerations when cutting plastic sheeting	1. Use scissors to cut plastic sheeting / Cut motions should always be away from body and body parts
43. Measure depth to water	1. Exposure to hazardous substances through inhalation or dermal exposure 2. Pinch fingers or hand in water level instrument	1. Wear proper PPE (nitrile gloves) 2. Wear proper PPE (leather gloves)

JOB STEPS	POTENTIAL HAZARDS	PREVENTATIVE / CORRECTIVE ACTION
44. Calibrate monitoring equipment	1. Skin or eye contact with calibration chemicals 2. Pinch fingers or hand in monitoring equipment	1. Wear proper PPE (safety glasses, nitrile gloves) 2. Wear proper PPE (leather gloves) / Avoid pinch points
45. Install sampling pump in well	1. Hand injuries during installation of pump 2. Lacerations when cutting tubing 3. Back strain during installation of pump 4. Physical hazards associated with manual lifting of heavy equipment 5. Back strain from starting generator 6. Burns from hot exhaust from generator 7. Electrical shock from improper use of generator and pump 8. Contaminated water spray from loose connections	1. Wear proper PPE (leather gloves, nitrile gloves) 2. Use safety tubing cutter 3. Use proper lifting techniques 4. Use proper lifting techniques / Use wheeled transport for heavy equipment 5. Use arm when starting generator / Do not over-strain if generator does not start 6. Do not touch generator near exhaust / Use proper handle to carry / Allow generator to cool down before moving 7. Properly plug in pump to generator / Do not allow the pump or generator to contact water / Check for breaks in the cord 8. Check all tubing connections to ensure they are tight and secure
10. Purge water	1. Contact with potentially contaminated groundwater 2. Back strain from lifting buckets of water 3. Tripping potential on sample discharge lines and pump electric line	1. Wear proper PPE (safety glasses, nitrile gloves) 2. Use proper lifting techniques / Use wheeled transport 3. Organize discharge of electric line to keep out of way as much as possible / Mark potential tripping hazards with caution tape or safety cones
11. Sample water collection	1. Contact with potentially contaminated groundwater through dermal exposure 2. Contact with and burns from acid used for sample preservation 3. Tripping potential on sample discharge lines and pump electric line 4. Lacerations from broken sample bottles 5. Back strain when transporting coolers full of collected samples 6. Slips/ Trips/ Falls	1. Wear proper PPE (safety glasses, nitrile gloves) 2. Wear proper PPE (safety glasses, nitrile gloves) / Ensure sample bottle lids are secure before use and after sample collection 3. Organize line to keep out of the way as much as possible / Mark potential tripping hazards with caution tape or safety cones 4. Do not over-tighten bottle caps / Handle bottles safely to prevent breakage / Wrap glass bottles in bubble wrap, if possible 5. Use proper lifting techniques / Use wheeled transport / Seek assistance if coolers weight exceeds 50lbs. / Minimize distance to vehicle 6. Have unobstructed path to vehicle or collection point / Follow good housekeeping procedures / Do not lift/walk with coolers that are too heavy/difficult to lift
12. Remove pump and pack up equipment	1. Back strain when removing pump or lifting heavy equipment	1. Use proper lifting technique / Use wheeled transport for heavy equipment
13. Replace well cap and lock	1. Scrape fingers/hand 2. Strain wrist/bruise palm	1. Wear proper PPE (leather gloves) 2. Using hammer, tap the end of the well cap to tighten grip
14. Replace well cover	1. Scrape knuckles/hand 2. Strain write/bruise palm 3. Pinch fingers or hand	1. Wear proper PPE (leather gloves) 2. Using hammer, tap the end of the wrench to tighten the grip of the bolts 3. Wear proper PPE (leather gloves)
15. Transport drums to disposal staging location	1. Back, arm or shoulder strain from moving drums 2. Pinch hazard 3. Contact with potentially contaminated groundwater when moving improperly sealed drums 4. Slips/ Trips/ Falls when moving drum 5. Drop drum on feet/toes	1. Use drum cart for moving drums / Use proper lifting techniques / Obtain assistance, if needed 2. Wear proper PPE (leather gloves) 3. Wear proper PPE (nitrile gloves under leather gloves) / Properly seal drum to prevent leak 4. Ensure route to move drum to storage space is dry and free from obstructions 5. Wear proper PPE (safety shoes)

JOB STEPS	POTENTIAL HAZARDS	PREVENTATIVE / CORRECTIVE ACTION
16. Place used PPE in designated disposal drum	1. Pressure build-up inside drum 2. Pinch hazard	1. Remove cap from bung hole in drum to relieve pressure 2. Wear proper PPE (leather gloves)
17. Decontaminate equipment	1. Splashing water/soap from decontamination 2. Contact with potentially contaminated groundwater through dermal exposure 3. Electrical shock from broken electric cords	1. Wear proper PPE (safety glasses) 2. Wear proper PPE (safety glasses, dermal protection) 3. Properly plug in pump to generator / Do not allow the pump or generator to contact water / Check for breaks in the cord
18. All activities	55. Slips/ Trips/ Falls 56. Hand injuries, cuts or lacerations during manual handling of materials 57. Foot injuries 58. Back injuries 59. Traffic 60. Wildlife: Stray dogs, Mice/rats, Vectors (i.e. mosquitoes, bees, etc.) 61. High Noise levels 62. Overhead hazards 63. Heat Stress/ Cold Stress 64. Eye Injuries	57. Be aware of potential trip hazards / Follow good housekeeping procedures/ Mark significant hazards 58. Inspect for jagged/sharp edges, and rough or slippery surfaces / Keep fingers away from pinch points / Wipe off greasy, wet, slippery or dirty objects before handling / Wear leather/ cut-resistant gloves 59. Wear Langan approved safety shoes 60. Use proper lifting techniques / Consider load location, task repetition, and load weigh when evaluating what is safe or unsafe to lift / Obtain assistance when possible 61. Wear high visibility clothing & vest / Use cones or signs to designate work area 62. Be aware of surroundings at all times, including the presence of wildlife/ Do not approach stray dogs / Carry/use dog/animal repellant / Use bug spray when needed 63. Wear hearing protection 64. Wear hard hat / Avoid areas were overhead hazards exist. 65. Wear proper attire for weather conditions (sunscreen or protective clothing in sunlight, layers for cold weather) / Drink plenty of fluids to avoid dehydration / Takes breaks as necessary to avoid heat/cold stress 66. Wear safety glasses
Additional items.		
Additional Items identified while in the field. (Delete row if not needed.)		

Print Name	**Sign Name**	**Date**
Prepared by:		
Reviewed by:		

LANGAN

Job Safety Analysis (JSA)
Health and Safety

JSA Title: **Environmental Sampling**
JSA Number: **JSA021-01**

A Job Safety Analysis (JSA) must identify all job steps required to complete the task, the potential hazards employees could be exposed to while performing the job step and the preventative/corrective actions required to reduce/mitigate the identified potential hazards. Employees must certify that they have either prepared the JSA or have reviewed the JSA and are aware of the potential hazards associated with this task and will follow the provided preventive/corrective actions. Prior to the start of any work "TAKE 5" and conduct a Last Minute Risk Assessment.

S – ***Stop,*** *what has changed?*
T – ***Think*** *about the task*
E – ***Evaluate*** *potential hazards*
P – ***Plan*** *safe approach*
S - ***Start*** *task /* ***Stop*** *& regroup*

PERSONAL PROTECTIVE EQUIPMENT (Required or to be worn as needed):				
☒ Safety Shoes	☒ Long Sleeves	☒ Safety Vest (Class 2)	☒ Hard Hat	☐ Hearing Protection
☒ Safety Glasses	☐ Safety Goggles	☐ Face Shield	☒ Nitrile Gloves	☐ PVC Gloves
☐ Leather Gloves	☐ Cut Resist. Gloves	☐ Fall Protection	☒ Fire Resistant Clothing	☐ Rubber Boots
☒ Insect/Animal Repellent	☒ Ivy Blocker/Cleaner	☐ Traffic Cones/Signs	☐ Life Vest/Jacket	
☒ Other: Tyvek Sleeves				

JOB STEPS	POTENTIAL HAZARDS	PREVENTATIVE / CORRECTIVE ACTION
46. Drive to sample location	27. Rough/Off Road terrain	1. Pay attention to road conditions such as road erosion, unprotected embankments, and soft road conditions.
47. Sample Collection (Walking)	13. Slip/Trips/Falls 14. Back strains 15. Wildlife (Insects, Stray animals, rodents) 16. Poisonous vegetation	8. Minimize distance to sample area/ Plan route and check surface prior to carrying heavy equipment/ Locate safest access point/ Follow good housekeeping procedures/ Mark significant below grade hazards (holes, trenches) with spray paint or cones/ Wear foot protection with ankle support and gripping soles. 9. Use proper lifting techniques/ Use wheeled transport/ Obtain assistance where and when needed/ Consider load weight when evaluating what is safe and unsafe to carry. 10. Be aware of surroundings for the presence of wildlife/ Do not approach stray animals/ Carry and use animal repellant when needed/ Use bug spray when needed. 11. Keep skin covered/ Identify and avoid poisonous vegetation/ Clean areas after contact with suspected vegetation.
48. Sample Collection (Water)	13. Drowning Hazards 14. Chemical burns (when adding acid preservative to sample) 15. Back Strains 16. Ergonomic issues 17. Slip/Trips/Falls	7. Use buddy system/ Wear flotation vest if water is deeper than 2 feet or swift moving/ Select working area with stable footing/ Do not attempt to cross or stand in swift moving water. 8. Wear proper PPE (Nitrile gloves, Tyvek Sleeves) 9. Use proper lifting techniques/ Use wheeled transport/ Obtain assistance where and when needed/ Consider load weight when evaluating what is safe or unsafe to carry. 10. When possible avoid bending over for long periods of time/ Use a small stool for sitting or knee pad for kneeling.

JOB STEPS	POTENTIAL HAZARDS	PREVENTATIVE / CORRECTIVE ACTION
		11. Minimize distance to sample area/ Plan route and check surface prior to carrying heavy equipment/ Locate safest access point/ Follow good housekeeping procedures/ Mark significant below grade hazards (holes, trenches) with spray paint or cones/ Wear foot protection with ankle support and gripping soles/ Avoid standing water or slippery terrain.
49. All activities	1. Slips/ Trips/ Falls 2. Hand injuries, cuts or lacerations during manual handling of materials 3. Foot injuries 4. Back injuries 5. Traffic 6. Wildlife: Stray dogs, Mice/rats, Vectors (i.e. mosquitoes, bees, etc.) 7. High Noise levels 8. Overhead hazards 9. Heat Stress/ Cold Stress 10. Eye Injuries	1. Be aware of potential trip hazards / Follow good housekeeping procedures/ Mark significant hazards 2. Inspect for jagged/sharp edges, and rough or slippery surfaces / Keep fingers away from pinch points / Wipe off greasy, wet, slippery or dirty objects before handling / Wear leather/ cut-resistant gloves 3. Wear Langan approved safety shoes 4. Use proper lifting techniques / Consider load location, task repetition, and load weigh when evaluating what is safe or unsafe to lift / Obtain assistance when possible 5. Wear high visibility clothing & vest / Use cones or signs to designate work area 6. Be aware of surroundings at all times, including the presence of wildlife/ Do not approach stray dogs / Carry/use dog/animal repellant / Use bug spray when needed 7. Wear hearing protection 8. Wear hard hat / Avoid areas were overhead hazards exist. 9. Wear proper attire for weather conditions (sunscreen or protective clothing in sunlight, layers for cold weather) / Drink plenty of fluids to avoid dehydration / Takes breaks as necessary to avoid heat/cold stress 10. Wear safety glasses
Additional items.		
Additional Items identified while in the field. (Delete row if not needed.)		

Print Name	**Sign Name**	**Date**
Prepared by:		
Reviewed by:		

LANGAN	**Job Safety Analysis (JSA)** **Health and Safety**
JSA Title: **Geophysical Investigation** **JSA Number:** **JSA023-01**	TAKE 5
A Job Safety Analysis (JSA) must identify all job steps required to complete the task, the potential hazards employees could be exposed to while performing the job step and the preventative/corrective actions required to reduce/mitigate the identified potential hazards. Employees must certify that they have either prepared the JSA or have reviewed the JSA and are aware of the potential hazards associated with this task and will follow the provided preventive/corrective actions. Prior to the start of any work "TAKE 5" and conduct a Last Minute Risk Assessment.	**S** – ***Stop,*** *what has changed?* **T** – ***Think*** *about the task* **E** – ***Evaluate*** *potential hazards* **P** – ***Plan*** *safe approach* **S** - ***Start*** *task /* ***Stop*** *& regroup*

PERSONAL PROTECTIVE EQUIPMENT (Required or to be worn as needed):				
☒ Safety Shoes	☒ Long Sleeves	☒ Safety Vest (Class 2)	☒ Hard Hat	☒ Hearing Protection
☒ Safety Glasses	☐ Safety Goggles	☐ Face Shield	☒ Nitrile Gloves	☐ PVC Gloves
☒ Leather Gloves	☒ Cut Resist. Gloves	☐ Fall Protection	☐ Fire Resistant Clothing	☐ Rubber Boots
☐ Insect/Animal Repellent	☐ Ivy Blocker/Cleaner	☐ Traffic Cones/Signs	☐ Life Vest/Jacket	
☐ Other:				

JOB STEPS	POTENTIAL HAZARDS	PREVENTATIVE / CORRECTIVE ACTION
50. Transport equipment to work area	28. Back/strain 29. Slip/Trip/Falls 30. Traffic 31. Cuts/abrasions/contusions from equipment	22. Use proper lifting techniques/Use wheeled transport 23. Minimize distance to work area/unobstructed path to work area/follow good housekeeping procedures 24. Wear proper PPE (high visibility vest or clothing) 25. Wear proper PPE (leather gloves, long sleeves, Langan approved safety shoes)
51. Supervision of subcontractor and all other activities	17. Slip/Trips/Falls 18. Hand injuries 19. Foot injuries 20. Back injuries/Strains 21. Traffic 22. Wildlife a. Wildlife b. Mice/rats c. Vectors (i.e. mosquitoes, bees, etc.) 7. Heat/Cold Stress	12. Be aware of potential trip hazards/follow good housekeeping procedures/mark significant below-grade hazards (i.e. holes, trenches, wires, ropes) with safety cones or spray paint. 13. Wear proper PPE (leather gloves)/watch wear you place your hands/inspect material or equipment for jagged, rough or slippery surfaces/ watch for pinch points/ wipe off slippery, wet, or dirty items prior to handling. 14. Wear proper PPE (Langan approved safety shoes)/ Be aware of uneven terrain) 15. Use proper lifting techniques/ Buddy system when lifting/ use wheeled transport. 16. Wear proper PPE (high-visibility shirts and vests)/ use cones if appropriate/ notify equipment operators of work area. 17. Be aware of surroundings at all times for the presence of wildlife. a. Do not approach stray animals b. Carry animal repellant/ use if situation arrises. c. Use bug spray when needed. 7. Wear proper attire for weather conditions (sunscreen, protective clothing in

JOB STEPS	POTENTIAL HAZARDS	PREVENTATIVE / CORRECTIVE ACTION
		sunlight or layer clothing in cold weather)/ drink plenty of fluids/ take regular breaks.
52. All actvities	65. Slips/ Trips/ Falls 66. Hand injuries, cuts or lacerations during manual handling of materials 67. Foot injuries 68. Back injuries 69. Traffic 70. Wildlife: Stray dogs, Mice/rats, Vectors (i.e. mosquitoes, bees, etc.) 71. High Noise levels 72. Overhead hazards 73. Heat Stress/ Cold Stress 74. Eye Injuries	67. Be aware of potential trip hazards / Follow good housekeeping procedures/ Mark significant hazards 68. Inspect for jagged/sharp edges, and rough or slippery surfaces / Keep fingers away from pinch points / Wipe off greasy, wet, slippery or dirty objects before handling / Wear leather/ cut-resistant gloves 69. Wear Langan approved safety shoes 70. Use proper lifting techniques / Consider load location, task repetition, and load weigh when evaluating what is safe or unsafe to lift / Obtain assistance when possible 71. Wear high visibility clothing & vest / Use cones or signs to designate work area 72. Be aware of surroundings at all times, including the presence of wildlife/ Do not approach stray dogs / Carry/use dog/animal repellant / Use bug spray when needed 73. Wear proper hearing protection 74. Wear hard hat / Avoid areas were overhead hazards exist. 75. Wear proper attire for weather conditions (sunscreen or protective clothing in sunlight, layers for cold weather) / Drink plenty of fluids to avoid dehydration / Takes breaks as necessary to avoid heat/cold stress 76. Wear safety glasses
Additional items.		
Additional Items identified while in the field. (Delete row if not needed.)		

Print Name	**Sign Name**	**Date**
Prepared by:		
Reviewed by:		

LANGAN

Job Safety Analysis (JSA)
Health and Safety

JSA Title: Indoor Air Sampling
JSA Number: JSA007-01

A Job Safety Analysis (JSA) must identify all job steps required to complete the task, the potential hazards employees could be exposed to while performing the job step and the preventative/corrective actions required to reduce/mitigate the identified potential hazards. Employees must certify that they have either prepared the JSA or have reviewed the JSA and are aware of the potential hazards associated with this task and will follow the provided preventive/corrective actions. Prior to the start of any work "TAKE 5" and conduct a Last Minute Risk Assessment.

S – ***Stop,*** *what has changed?*
T – ***Think*** *about the task*
E – ***Evaluate*** *potential hazards*
P – ***Plan*** *safe approach*
S - ***Start*** *task /* ***Stop*** *& regroup*

PERSONAL PROTECTIVE EQUIPMENT (Required or to be worn as needed):				
☒ Safety Shoes	☒ Long Sleeves	☒ Safety Vest (Class 2)	☒ Hard Hat	☒ Hearing Protection
☒ Safety Glasses	☐ Safety Goggles	☐ Face Shield	☒ Nitrile Gloves	☐ PVC Gloves
☒ Leather Gloves	☐ Cut Resist. Gloves	☐ Fall Protection	☐ Fire Resistant Clothing	☐ Rubber Boots
☐ Insect/Animal Repellent	☐ Ivy Blocker/Cleaner	☒ Traffic Cones/Signs	☐ Life Vest/Jacket	
☒ Other: PID, Respiratory Protection (if necessary)				

JOB STEPS	POTENTIAL HAZARDS	PREVENTATIVE / CORRECTIVE ACTION
53.Buidling walkthrough and background contaminant removal	32.Slips / Trips/ Falls 33.Exposure to substances/vapors during removal	6. Be aware of potential trip hazards / Follow good housekeeping procedures / Mark significant below-grade hazards (i.e. holes, trenches) with safety cones or spray paint 7. Monitor indoor air concentrations with a PID / Wear proper PPE (nitrile gloves) / Wear proper respiratory protection if necessary
54.Transport equipment to work area	6. Back Strain 7. Slips/ Trips/ Falls 8. Traffic 9. Cuts/abrasions from equipment 10. Contusions from dropped equipment	6. Use proper lifting techniuqes / Use wheeled transport 7. Minimize distance to work area / Have unobstructed path to work area / Follow good housekeeping procedures 8. Wear proper PPE (high visibility vest or clothing) 9. Wear proper PPE (leather gloves, long sleeves) 10. Wear proper PPE (safety shoes)
55. Mark out areas for indoor air sampling	23. Slips/ Trips/ Falls	6. Be aware of potential trip hazards / Follow good housekeeping procedures / Mark significant below-grade hazards (i.e. holes, trenches) with safety cones or spray paint
56. Set-up canisters and begin indoor air sampling	18. Dropping crates or canisters 19. Pinch hazard	9. Exercise caution when moving crates and canisters / Use proper housekeeping of materials during sample events / Do not carry too many items at one time / Perform several trips, if necessary 10. Wear proper PPE (leather gloves)
57. Sample collection	2. Droping crates or canisters 3. Pinched fingers from opening valves	2. Exercise caution when moving crates and canisters / Use proper housekeeping of materials during sample events / Do not carry too many items at one time / Perform several trips, if necessary 3. Wear proper PPE (leather gloves) / Keep fingers away from pinch points
58. Pack up equipment	3. Back strain	3. Use proper lifting techniques / Use wheeled transport

JOB STEPS	POTENTIAL HAZARDS	PREVENTATIVE / CORRECTIVE ACTION
	4. Slips/ Trips/ Falls 5. Traffic	4. Be aware of potential trip hazards / Follow good housekeeping procedures / Minimize distance to vehicle 5. Wear proper PPE (safety vest)
59. All activities	75. Slips/ Trips/ Falls 76. Hand injuries, cuts or lacerations during manual handling of materials 77. Foot injuries 78. Back injuries 79. Traffic 80. Wildlife: Stray dogs, Mice/rats, Vectors (i.e. mosquitoes, bees, etc.) 81. High Noise levels 82. Overhead hazards 83. Heat Stress/ Cold Stress 84. Eye Injuries	77. Be aware of potential trip hazards / Follow good housekeeping procedures/ Mark significant hazards 78. Inspect for jagged/sharp edges, and rough or slippery surfaces / Keep fingers away from pinch points / Wipe off greasy, wet, slippery or dirty objects before handling / Wear leather/ cut-resistant gloves 79. Wear Langan approved safety shoes 80. Use proper lifting techniques / Consider load location, task repetition, and load weigh when evaluating what is safe or unsafe to lift / Obtain assistance when possible 81. Wear high visibility clothing & vest / Use cones or signs to designate work area 82. Be aware of surroundings at all times, including the presence of wildlife/ Do not approach stray dogs / Carry/use dog/animal repellant / Use bug spray when needed 83. Wear hearing protection 84. Wear hard hat / Avoid areas were overhead hazards exist. 85. Wear proper attire for weather conditions (sunscreen or protective clothing in sunlight, layers for cold weather) / Drink plenty of fluids to avoid dehydration / Takes breaks as necessary to avoid heat/cold stress 86. Wear safety glasses
Additional items.		
Additional Items identified while in the field. (Delete row if not needed.)		

Print Name	Sign Name	Date
Prepared by:		
Reviewed by:		

LANGAN	Job Safety Analysis (JSA) Health and Safety
JSA Title: **Sub-slab soil gas temporary point installation and sampling** **JSA Number: JSA037-01**	
A Job Safety Analysis (JSA) must identify all job steps required to complete the task, the potential hazards employees could be exposed to while performing the job step and the preventative/corrective actions required to reduce/mitigate the identified potential hazards. Employees must certify that they have either prepared the JSA or have reviewed the JSA and are aware of the potential hazards associated with this task and will follow the provided preventive/corrective actions. Prior to the start of any work "TAKE 5" and conduct a Last Minute Risk Assessment.	S – ***Stop,*** *what has changed?* T – ***Think*** *about the task* E – ***Evaluate*** *potential hazards* P – ***Plan*** *safe approach* S - ***Start*** *task /* ***Stop*** *& regroup*

PERSONAL PROTECTIVE EQUIPMENT (Required or to be worn as needed):				
☒ Safety Shoes	☒ Long Sleeves	☒ Safety Vest (Class 2)	☒ Hard Hat	☐ Hearing Protection
☒ Safety Glasses	☒ Safety Goggles	☐ Face Shield	☒ Nitrile Gloves	☐ PVC Gloves
☒ Leather Gloves	☐ Cut Resist. Gloves	☐ Fall Protection	☐ Fire Resistant Clothing	☐ Rubber Boots
☒ Insect/Animal Repellent	☐ Ivy Blocker/Cleaner	☒ Traffic Cones/Signs	☐ Life Vest/Jacket	
☒ Other: Tyvek Sleeves				

JOB STEPS	POTENTIAL HAZARDS	PREVENTATIVE / CORRECTIVE ACTION
60. Transport equipment to work site	34. Back injuries 35. Slips/Trips/Falls 36. Traffic 37. Hand injuries	26. Use proper lifting techniques/ Use wheeled transport/ Get assistance when need with moving equipment/ Minimize distance from vehicle 27. Minimize distance from vehicle/ Have unobstructed pathway to vehicle and collection points/ Mark tripping hazards with spray paint, cones, or caution tape/ Observe good housekeeping procedures. 28. Wear proper PPE (High Visibility vest and clothing)/ Exercise caution (stay alert-stay alive) 29. Wear proper PPE (leather gloves)/ Keep finger and hands clear of pinch points.
61.Mark area for drilling	24.Slips/Trips/Falls	18. Minimize distance from vehicle/ Have unobstructed pathway to vehicle and collection points/ Mark tripping hazards with spray paint, cones, or caution tape/ Observe good housekeeping procedures
62.Drill sampling points with hammer drill	20. Eye injuries 21. Dust exposure 22. Hand injuries 23. Catch items (clothing) 24. Electric shock 25. Chemical atmosphere hazard (vapor) 26. Slips/Trips/Falls	12. Wear proper PPE (safety glasses) 13. Wear proper PPE (dust mask) 14. Wear proper PPE (leather gloves)/ Keep hands and fingers out of pinch points/ Avoid drill catching on ground and twisting wrist or hand/ Release drill grip if drill becomes caught/ Ensure drill is unplugged prior to inserting bit. 15. Tie up or tuck-in all loose clothing/ Maintain distance from drill 16. Inspect power cable for cuts or nicks before use/ Use GFCI outlet on power cord/ Do not use in wet conditions 17. Monitor air, vapors with Photo-ionization detector (PID)

JOB STEPS	POTENTIAL HAZARDS	PREVENTATIVE / CORRECTIVE ACTION
		18. Minimize distance from vehicle/ Have unobstructed pathway to vehicle and collection points/ Mark tripping hazards with spray paint, cones, or caution tape/ Observe good housekeeping procedures
63. Measure vapor content and depth to bottom of hole	1. Chemical atmosphere hazard (vapors)	1. Monitor air, vapors with Photo-ionization detector (PID)/ Keep face away from opening of hole while collecting measurements
64. Set-up of shroud and sampling canister system	1. Hand injuries 2. Chemical atmosphere hazard (vapors) 3. Slips/Trips/Falls	1. Wear proper PPE (leather gloves, nitrile gloves)/ Keep fingers away from pinch points when installing pump/ Do not use open blades, use tubing cutter 2. Monitor air, vapors with Photo-ionization detector (PID)/ Keep face away from opening of hole while collecting measurements 3. Minimize distance from vehicle/ Have unobstructed pathway to vehicle and collection points/ Mark tripping hazards with spray paint, cones, or caution tape/ Observe good housekeeping procedures
65. Purge soil gas	1. Chemical atmosphere hazard (vapors)	1. Monitor air, vapors with Photo-ionization detector (PID)/ Keep face away from exhaust port of pump
66. Sample collection (opening and closing valves)	1. Hand injuries	1. Wear proper PPE (leather gloves)/ Keep fingers away from pinch points
67. Sealing sampling holes	1. Back injuries 2. Concrete dust 3. Eye injuries	1. Use proper lifting techniques for lifting of cement bags 2. Wear proper PPE (dust mask) 3. Wear proper PPE (safety glasses)
68. All activities	85. Slips/ Trips/ Falls 86. Hand injuries, cuts or lacerations during manual handling of materials 87. Foot injuries 88. Back injuries 89. Traffic 90. Wildlife: Stray animals, Mice/rats, Vectors (i.e. mosquitoes, bees, etc.) 91. High Noise levels 92. Overhead hazards 93. Heat or cold injuries 94. Eye Injuries	87. Be aware of potential trip hazards/ Follow good housekeeping procedures/ Mark significant hazards 88. Inspect for jagged/sharp edges, and rough or slippery surfaces/ Keep fingers away from pinch points/ Wipe off greasy, wet, slippery or dirty objects before handling/ Wear leather/ cut-resistant gloves Wear proper PPE (Langan approved safety shoes) 89. Use proper lifting techniques/ Consider load location, task repetition, and load weigh when evaluating what is safe or unsafe to lift/ Obtain assistance when possible 90. Wear high visibility clothing & vest/ Use cones or signs to designate work area 91. Be aware of surroundings at all times, including the presence of wildlife/ Do not approach stray animals/ Carry and use animal repellant when needed/ Use bug spray when needed 92. Wear hearing protection 93. Wear hard hat/ Avoid areas were overhead hazards exist. 94. Wear proper attire for weather conditions (sunscreen or protective clothing in sunlight, layers for cold weather)/ Drink plenty of fluids to avoid dehydration/ Takes breaks as necessary to avoid heat/cold stress 95. Wear safety glasses

JOB STEPS	POTENTIAL HAZARDS	PREVENTATIVE / CORRECTIVE ACTION
Additional items.		
Additional Items identified while in the field. (Delete row if not needed.)		

Print Name	**Sign Name**	**Date**
Prepared by:		
Reviewed by:		

ATTACHMENT H

TAILGATE SAFETY BRIEFING FORM

LANGAN TAILGATE SAFETY BRIEFING

Date:____________________ Time: ____________________

Leader:____________________ Location:____________________

Work Task:

SAFETY TOPICS (*provide some detail of discussion points*)

Chemical Exposure Hazards and Control:

Physical Hazards and Control:

Air Monitoring:

PPE:

Communications:

Safe Work Practices:

Emergency Response:

Hospital/Medical Center Location:

Phone Nos.:

Other:

FOR FOLLOW-UP (the issues, responsibilities, due dates, etc.)

ATTENDEES

PRINT NAME	COMPANY	SIGNATURE

QUALITY ASSURANCE PROJECT PLAN

for

42-11 9th Street
Long Island City, New York

Block 461, Lot 16
BCP Site No. C241237

Prepared For:

RXR 42-11 9th Holdings LLC
75 Rockefeller Plaza
Suite 13002
New York, New York 10019

Prepared By:

Langan Engineering, Environmental, Surveying, Landscape Architecture and Geology D.P.C.
21 Penn Plaza
360 West 31st Street, 8th Floor
New York, New York 10001

March 23, 2020
Langan Project No. 170514702

LANGAN

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1.0 PROJECT DESCRIPTION

1.1 INTRODUCTION

This Quality Assurance Project Plan (QAPP) is for the property located at 42-11 9th Street, Queens, New York (the "site"). The site is located in the Long Island City neighborhood of Queens, New York, and occupies the entirety of New York City Tax Block 461 (Lot 16). The about 49,400 square-foot (1.13 acres) site is located on the northern part of the city block bound by Queens Plaza South to the north, 10th Street to the east, 43rd Avenue to the south, and 9th Street to the west and is occupied by a one-story manufacturing/warehouse building with a partial second floor and partial basement on the southwestern portion of the site, and an asphalt-paved yard on the southwestern portion of the site. The building is used for a machine shop with a forge building and warehouse space.

This QAPP specifies analytical methods to be used to ensure that data collected during Site management are precise, accurate, representative, comparable, complete, and meet the sensitivity requirements of the project.

1.2 PROJECT OBJECTIVES

The objective of the RIWP is to investigate and characterize the nature and extent of environmental impacts on the site associated with areas of concern (AOC), and provide sufficient information to evaluate remedial actions, as required.

1.3 SCOPE OF WORK

Implementation of the RIWP will include the collection of soil, groundwater and soil vapor samples. The scope of work is described in detail in the RIWP. A dust, odor, and organic vapor control and monitoring plan will be implemented during ground intrusive activities.

The following samples will be collected as part of the RIWP:

<u>Soil Boring Advancement and Soil Sampling</u>

- 12 soil borings (SP-01 through SP-03, SP-05, SP-07, SP-08, SP-12, and SP-14 through SP-18) will be advanced to the top of bedrock (estimated at 20 feet below sidewalk grade).

- Up to four soil samples will be collected from each soil boring, plus quality assurance/quality control [QA/QC] samples.

Monitoring Well Installation and Groundwater Sampling

- Four permanent groundwater monitoring wells (MW-03, MW-05, MW-07, and MW-14) will be installed within the corresponding soil borings. One groundwater sample will be collected from each monitoring well, including the permanent wells that were installed during the March 2019 Subsurface Investigation, plus QA/QC samples.
- The monitoring wells will be surveyed and gauged to evaluate groundwater flow direction.

Soil Vapor Sampling

- Four sub-surface soil vapor sample points (SV-03, SV-05, SV-07, and SV-14) and four sub-slab soil vapor sample points (SV-02, SV-06, SV-08, and SV-12) will be installed within about 2 inches below the concrete slab and to the shallower of two feet above the groundwater table or two feet above bedrock, respectively.

Modifications to this scope of work may occur: 1) due to site operations and equipment accessibility; 2) if unexpected contamination is detected and additional analytical data is needed to characterize the nature and extent of contamination at the site; and 3) to confirm that impacts are adequately characterized and delineated in compliance with the Brownfield Law, regulations, and applicable investigation guidance documents (e.g., DER-10). NYSDEC and NYSDOH will be contacted to obtain approval for these modifications. A Proposed Sample Location Plan is included as Figure 1.

2.0 DATA QUALITY OBJECTIVES AND PROCESS

Data Quality Objectives (DQOs) are qualitative and quantitative statements to help ensure that data of known and appropriate quality are obtained during the project. The overall objective is to investigate and characterize the nature and extent of contamination in soil, groundwater, and soil vapor at or emanating from the site; generate sufficient data to evaluate the remedial action alternatives; and generate sufficient data to evaluate the actual and potential threats to human health and the environment. DQOs for sampling activities are determined by evaluating five factors:

- Data needs and uses: The types of data required and how the data will be used after it is obtained.
- Parameters of Interest: The types of chemical or physical parameters required for the intended use.
- Level of Concern: Levels of constituents, which may require remedial actions or further investigations.
- Required Analytical Level: The level of data quality, data precision, and QA/QC documentation required for chemical analysis.
- Required Detection Limits: The detection limits necessary based on the above information.

The quality assurance and quality control objectives for all measurement data include:

- **Precision** – an expression of the reproducibility of measurements of the same parameter under a given set of conditions. Field sampling precision will be determined by analyzing coded duplicate samples and analytical precision will be determined by analyzing internal QC duplicates and/or matrix spike duplicates.
- **Accuracy** – a measure of the degree of agreement of a measured value with the true or expected value of the quantity of concern. For soil and groundwater samples, accuracy will be determined through the assessment of the analytical results of field blanks, equipment blanks, and trip blanks for each sample set. Analytical accuracy will be assessed by examining the percent recoveries of surrogate compounds that are added to each sample (organic analyses only), internal standards, laboratory method blanks, instrument calibration, and the percent recoveries of matrix spike compounds added to selected samples and laboratory blanks.

For soil vapor or air samples, analytical accuracy will be assessed by examining the percent recoveries that are added to each sample, internal standards, laboratory method blanks, and instrument calibration.

- **Representativeness** – expresses the degree to which sample data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, or an environmental condition. Representativeness is dependent upon the adequate design of the sampling program and will be satisfied by ensuring that the scope of work is followed and that specified sampling and analysis techniques are used. Representativeness in the laboratory is ensured by compliance to nationally-recognized analytical methods, meeting sample holding times, and maintaining sample integrity while the samples are in the laboratory's possession. This is accomplished by following all applicable methods, laboratory-issued standard operating procedures (SOPs), the laboratory's Quality Assurance Manual, and this QAPP. The laboratory is required to be properly certified and accredited.
- **Completeness** – the percentage of measurements made which are judged to be valid. Completeness will be assessed through data validation. The QC objective for completeness is generation of valid data for at least 90 percent of the analyses requested.
- **Comparability** – expresses the degree of confidence with which one data set can be compared to another. The comparability of all data collected for this project will be ensured using several procedures, including standard methods for sampling and analysis as documented in the QAPP, using standard reporting units and reporting formats, and data validation.
- **Sensitivity** – the ability of the instrument or method to detect target analytes at the levels of interest. The project manager will select, with input from the laboratory and QA personnel, sampling and analytical procedures that achieve the required levels of detection.

3.0 PROJECT ORGANIZATION

Any future remedial activities and investigations will be overseen by Langan or another environmental consultant for the Volunteer or a future owner. The environmental consultant will also arrange data analysis and reporting tasks. The analytical services will be performed by an ELAP-certified laboratory. Data validation services will be performed by approved data validation contractor(s).

For the required sampling as stated in the RIWP, sampling will be conducted by Langan, the analytical services (except mercury speciation) will be performed by Alpha Analytical Laboratories, Inc. (Alpha) of Mansfield, MA, New York State Department of Health (NYSDOH) ELAP certification number 11148. Mercury speciation will be performed by Eurofins Frontier Global Sciences, Inc. (Eurofins) of Bothell, WA, New York State Department of Health (NYSDOH) ELAP certification number 11662

Data validation services will be performed by Emily Strake; résumé attached (Attachment A).

Key contacts for this project are as follows:

Personnel	Investigation Role	Contact Information
Michael Burke, PG, CHMM Langan	Project Leader/ Quality Assurance Officer	Phone – 212-479-5400 Email – mburke@langan.com
Andrew Schweitzer, P.E. Langan	Project Manager	Phone – 212-479-5400 Email – aschweitzer@langan.com
Stuart Knoop Langan	Qualified Environmental Professional	Phone – 212-479-5400 Email – sknoop@langan.com
Jason Hayes, P.E. Langan	Project Engineer	Phone – 212-479-5400 Email – jhayes@langan.com
Tony Moffa, CHMM, CSP Langan	Langan Health & Safety Officer	Phone – 215-491-6500 Email – tmoffa@langan.com
William Bohrer, PG Langan	Field Safety Officer	Phone – 212-479-5400 Email – wbohrer@langan.com
Sherief Saleh Langan	Field Team Leader	Phone – 212-479-5400 Email – ssaleh@langan.com
Lidya Gulizia York Analytical	Laboratory Contractor	Phone – 203-461-2986 Email – LGulizia@yorklab.com
Emily Strake, CEP Langan	Data Validator	Phone – 215-491-6526 Email – estrake@langan.com

4.0 QUALITY ASSURANCE OBJECTIVES FOR COLLECTION OF DATA

The overall quality assurance objective is to develop and implement procedures for sampling, laboratory analysis, field measurements, and reporting that will provide data of sufficient quality to evaluate the engineering controls on the site. The sample set, chemical analysis results, and interpretations must be based on data that meet or exceed quality assurance objectives established for the site. Quality assurance objectives are usually expressed in terms of accuracy or bias, sensitivity, completeness, representativeness, comparability, and sensitivity of analysis. Variances from the quality assurance objectives at any stage of the investigation will result in the implementation of appropriate corrective measures and an assessment of the impact of corrective measures on the usability of the data.

4.1 PRECISION

Precision is a measure of the degree to which two or more measurements are in agreement. Field precision is assessed through the collection and measurement of field duplicates. Laboratory precision and sample heterogeneity also contribute to the uncertainty of field duplicate measurements. This uncertainty is taken into account during the data assessment process. For field duplicates, results less than 2x the reporting limit (RL) meet the precision criteria if the absolute difference is less than ±2x the RL and acceptable based on professional judgment. For results greater than 2x the RL, the acceptance criteria is a relative percent difference (RPD) of ≤50% (soil and air), <30% (water). RLs and method detection limits (MDL) are provided in Attachment B.

4.2 ACCURACY

Accuracy is the measurement of the reproducibility of the sampling and analytical methodology. It should be noted that precise data may not be accurate data. For the purpose of this QAPP, bias is defined as the constant or systematic distortion of a measurement process, which manifests itself as a persistent positive or negative deviation from the known or true value. This may be due to (but not limited to) improper sample collection, sample matrix, poorly calibrated analytical or sampling equipment, or limitations or errors in analytical methods and techniques.

Accuracy in the field is assessed through the use of field and equipment blanks and through compliance to all sample handling, preservation, and holding time requirements. All field blanks should be non-detect when analyzed by the laboratory. Any contaminant detected in an associated field or equipment blank will be evaluated against laboratory blanks (preparation or method) and evaluated against field samples collected on the same day to determine potential for bias. Trip blanks are not required for non-aqueous matrices but are planned for non-aqueous matrices where high concentrations of VOCs are anticipated.

Laboratory accuracy is assessed by evaluating the percent recoveries of matrix spike/matrix spike duplicate (MS/MSD) samples, laboratory control samples (LCS), surrogate compound recoveries, and the results of method preparation blanks. MS/MSD, LCS, and surrogate percent recoveries will be compared to either method-specific control limits or laboratory-derived control limits. Sample volume permitting, samples displaying outliers should be reanalyzed. All associated method blanks should be non-detect when analyzed by the laboratory.

4.3 COMPLETENESS

Laboratory completeness is the ratio of total number of samples analyzed and verified as acceptable compared to the number of samples submitted to the fixed-base laboratory for analysis, expressed as a percent. Three measures of completeness are defined:

- Sampling completeness, defined as the number of valid samples collected relative to the number of samples planned for collection;
- Analytical completeness, defined as the number of valid sample measurements relative to the number of valid samples collected; and
- Overall completeness, defined as the number of valid sample measurements relative to the number of samples planned for collection.

Air, soil vapor, soil, and groundwater data will meet a 90% completeness criterion. If the criterion is not met, sample results will be evaluated for trends in rejected and unusable data. The effect of unusable data required for a determination of compliance will also be evaluated.

4.4 REPRESENTATIVENESS

Representativeness expresses the degree to which data accurately and precisely represents a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition within a defined spatial and/or temporal boundary. Representativeness is dependent upon the adequate design of the sampling program and will be satisfied by ensuring that the scope of work is followed and that specified sampling and analysis techniques are used. This is performed by following applicable SOPs and this QAPP. All field technicians will be given copies of appropriate documents prior to sampling events and are required to read, understand, and follow each document as it pertains to the tasks at hand.

Representativeness in the laboratory is ensured by compliance to nationally-recognized analytical methods, meeting sample holding times, and maintaining sample integrity while the samples are in the laboratory's possession. This is performed by following all applicable EPA methods, laboratory-issued SOPs, the laboratory’s Quality Assurance Manual, and this QAPP. The laboratory is required to be properly certified and accredited.

4.5 COMPARABILITY

Comparability is an expression of the confidence with which one data set can be compared to another. Comparability is dependent upon the proper design of the sampling program and will be satisfied by ensuring that the sampling plan is followed and that sampling is performed according to the SOPs or other project-specific procedures. Analytical data will be comparable when similar sampling and analytical methods are used as documented in the QAPP. Comparability will be controlled by requiring the use of specific nationally-recognized analytical methods and requiring consistent method performance criteria. Comparability is also dependent on similar quality assurance objectives. Previously collected data will be evaluated to determine whether they may be combined with contemporary data sets.

4.6 SENSITIVITY

Sensitivity is the ability of the instrument or method to detect target analytes at the levels of interest. The project director will select, with input from the laboratory and QA personnel, sampling and analytical procedures that achieve the required levels of detection and QC acceptance limits that meet established performance criteria. Concurrently, the project director will select the level of data assessment to ensure that only data meeting the project DQOs are used in decision-making.

Field equipment will be used that can achieve the required levels of detection for analytical measurements in the field. In addition, the field sampling staff will collect and submit full volumes of samples as required by the laboratory for analysis, whenever possible. Full volume aliquots will help ensure achievement of the required limits of detection and allow for reanalysis if necessary. The concentration of the lowest level check standard in a multi-point calibration curve will represent the reporting limit.

Analytical methods and quality assurance parameters associated with the sampling program are presented in Attachment C. The frequency of associated field blanks and duplicate samples will be based on the recommendations listed in DER-10, and as described in Section 5.3.

Site-specific MS and MSD samples will be prepared and analyzed by the analytical laboratory by spiking an aliquot of submitted sample volume with analytes of interest. Additional sample volume is not required by the laboratory for this purpose. An MS/MSD analysis will be analyzed at a rate of 1 out of every 20 samples, or one per analytical batch. MS/MSD samples are only required for soil and groundwater samples.

5.0 SAMPLE COLLECTION AND FIELD DATA ACQUISITION PROCEDURES

Soil sampling will be conducted in accordance with the established NYSDEC protocols contained in DER-10/Technical Guidance for Site Investigation and Remediation (May 2010). The following sections describe procedures to be followed for specific tasks.

5.1 FIELD DOCUMENTATION PROCEDURES

Field documentation procedures will include summarizing field data in field books and proper sample labeling. These procedures are described in the following sections.

5.1.1 Field Data and Notes

Field notebooks contain the documentary evidence regarding procedures conducted by field personnel. Hard cover, bound field notebooks will be used because of their compact size, durability, and secure page binding. The pages of the notebook will not be removed.

Entries will be made in waterproof, permanent blue or black ink. No erasures will be allowed. If an incorrect entry is made, the information will be crossed out with a single strike mark and the change initialed and dated by the team member making the change. Each entry will be dated. Entries will be legible and contain accurate and complete documentation of the individual or sampling team's activities or observations made. The level of detail will be sufficient to explain and reconstruct the activity conducted. Each entry will be signed by the person(s) making the entry.

The following types of information will be provided for each sampling task, as appropriate:

- Project name and number
- Reasons for being on-site or taking the sample
- Date and time of activity
- Sample identification numbers
- Geographical location of sampling points with references to the site, other facilities or a map coordinate system. Sketches will be made in the field logbook when appropriate
- Physical location of sampling locations such as depth below ground surface

- Description of the method of sampling including procedures followed, equipment used and any departure from the specified procedures
- Description of the sample including physical characteristics, odor, etc.
- Readings obtained from health and safety equipment
- Weather conditions at the time of sampling and previous meteorological events that may affect the representative nature of a sample
- Photographic information including a brief description of what was photographed, the date and time, the compass direction of the picture and the number of the picture on the camera
- Other pertinent observations such as the presence of other persons on the site, actions by others that may affect performance of site tasks, etc.
- Names of sampling personnel and signature of persons making entries

Field records will also be collected on field data sheets including boring logs, which will be used for geologic and drilling data during soil boring activities. Field data sheets will include the project-specific number and stored in the field project files when not in use. At the completion of the field activities, the field data sheets will be maintained in the central project file.

5.1.2 Sample Labeling

Each sample collected will be assigned a unique identification number in accordance with the sample nomenclature guidance included in Attachment D, and placed in an appropriate sample container. Each sample container will have a sample label affixed to the outside with the date and time of sample collection and project name. In addition, the label will contain the sample identification number, analysis required and chemical preservatives added, if any. All documentation will be completed in waterproof ink.

5.2 EQUIPMENT CALIBRATION AND PREVENTATIVE MAINTENANCE

A PID will be used during the sampling activities to evaluate work zone action levels and screen soil samples. Field calibration and/or field checking of the PID will be the responsibility of the field team leader and the site HSO, and will be accomplished by following the procedures outlined in the operating manual for the instrument. At a minimum, field calibration and/or field equipment checking will be performed once daily, prior to use. Field calibration will be documented in the field notebook. Entries made into the logbook regarding the status of field equipment will include the following information:

- Date and time of calibration
- Type of equipment serviced and identification number (such as serial number)
- Reference standard used for calibration
- Calibration and/or maintenance procedure used
- Other pertinent information

Equipment that fails calibration or becomes inoperable during use will be removed from service and segregated to prevent inadvertent utilization. The equipment will be properly tagged to indicate that it is out of calibration. Such equipment will be repaired and recalibrated to the manufacturer's specifications by qualified personnel. Equipment that cannot be repaired will be replaced.

Off-site calibration and maintenance of field instruments will be conducted as appropriate throughout the duration of project activities. All field instrumentation, sampling equipment and accessories will be maintained in accordance with the manufacturer's recommendations and specifications and established field equipment practice. Off-site calibration and maintenance will be performed by qualified personnel. A logbook will be kept to document that established calibration and maintenance procedures have been followed. Documentation will include both scheduled and unscheduled maintenance.

5.3 SAMPLE COLLECTION

Soil Samples

Soil samples will be visually classified and field screened using a PID to assess potential impacts from VOCs and for health and safety monitoring. Soil samples collected for analysis of VOCs will be collected using either EnCore® or Terra Core® sampling equipment. For analysis of non-volatile parameters, samples will be homogenized and placed into glass jars.

Soil sampling for PFAS will be conducted in accordance with EPA Method 537 Field Sampling Guidelines. PFAS samples will be collected first in High Density Polyethylene (HDPE)/polypropylene containers using sampling equipment either made with stainless steel, HDPE, or polypropylene. Food and beverages will be prohibited near the sampling equipment. Additionally, no cosmetics, moisturizers, hand cream, sun screen or clothing materials containing Gore-Tex™ or Tyvek® will be worn during sampling.

All soil samples being run for full Part 375/TCL parameters will be analyzed for PFAS by USEPA Method 537 Modified and 1,4-dioxane by USEPA Method 8270. Both methods listed above will be able to meet the reporting limits for PFAS (1 microgram per kilogram [μg/kg]) and 1,4-Dioxane (0.1 milligram per kilogram [mg/kg]) in soil.

After collection, all sample jars will be capped and securely tightened, and placed in iced coolers and maintained at 4°C ±2°C until they are transferred to the laboratory for analysis, in accordance with the procedures outlined in Section 5.4. Analysis and/or extraction and digestion of collected soil samples will meet the holding times required for each analyte as specified in Attachment C. In addition, analysis of collected soil sample will meet all quality assurance criteria set forth by this QAPP and DER-10.

Groundwater Samples

Groundwater sampling will be conducted using low-flow sampling procedures following USEPA guidance ("Low Stress [low flow] Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells", EQASOP-GW 004, January 19, 2017).

During purging, field parameters should be measured, including: water level drawdown, purge rate, pH, specific conductance, temperature, dissolved oxygen, turbidity and oxidation-reduction-potential (ORP), every five minutes using a water quality meter (Horiba U-52 or similar) and a depth-to-water interface probe that should be decontaminated between wells. Samples should generally not be collected until the field parameters have stabilized. Field parameters will be considered stable once three sets of measurements are within ±0.1 standard units for pH, ±3% for conductivity and temperature, ±10 millivolts for ORP, and ±10% for turbidity and dissolved oxygen. Purge rates should be adjusted to keep the drawdown in the well to less than 0.3 feet, as practical. Additionally, an attempt should be made to achieve a stable turbidity reading of less than 10 Nephelometric Turbidity Units (NTU) prior to sampling. If the turbidity reading does not stabilize at reading of less than 10 NTU for a given well, then both filtered and unfiltered samples should be collected from that well. If necessary, field filtration should be performed using a 0.45 micron disposable in-line filter. Groundwater samples should be collected after parameters have stabilized as noted above or the readings are within the precision of the meter. Deviations from the stabilization and drawdown criteria, if any, should be noted on the sampling logs.

Groundwater sampling for PFAS and 1,4-dioxane will be performed in accordance with the NYSDEC-approved Groundwater Monitoring Plan, dated August 27, 2004, which specifies purging three to five well volumes prior to sample collection. The pump will be decontaminated with Alconox and water. Field personnel will wear nitrile gloves while collecting and handing groundwater samples.

Groundwater sampling for PFAS will be conducted in accordance with EPA Method 537 Field Sampling Guidelines. PFAS samples will be collected first in High Density Polyethylene (HDPE)/polypropylene containers using sampling equipment either made with stainless steel, HDPE, or polypropylene. Food and beverages will be prohibited near the sampling equipment. Additionally, no cosmetics, moisturizers, hand cream, sun screen or clothing materials containing Gore-Tex™ or Tyvek® will be worn during sampling.

Groundwater samples will analyzed for PFAS by USEPA Method 537 Modified and 1,4-dioxane by USEPA Method 8270 SIM. Both methods listed above will be able to meet the reporting limits for PFAS (2 nanograms per liter [ng/L]) and 1,4-Dioxane (0.35 micrograms per liter [µg/L]) in groundwater.

Samples should be collected directly into laboratory-supplied jars. After collection, all sample jars will be capped and securely tightened, and placed in iced coolers and maintained at 4°C ±2°C until they are transferred to the laboratory for analysis, in accordance with the procedures outlined in Section 5.4. Analysis and/or extraction and digestion of collected groundwater samples will meet the holding times required for each analyte as specified in Attachment C. In addition, analysis of collected groundwater sample will meet all quality assurance criteria set forth by this QAPP and DER-10.

A list of the PFCS is provided in Attachment B. Groundwater samples collected for analysis of per- and polyfluoroalkyl substances (PFAS) will be collected in accordance with the specialized protocol outlined in Attachment E.

Air Samples

Prior to sample collection, a pre-sampling inspection will be conducted to document chemicals and potential subsurface pathways at the Site. The pre-sampling inspection will assess the potential for interference from chemical storage nearby or within the building. Air samples will be collected into laboratory-supplied, batch certified-clean 6-L Summa® canisters calibrated for a sampling rate of two hours. The pressure gauges on each calibrated flow controller should be monitored throughout sample collection. Sample collection should be stopped when the pressure reading reaches -4 mmHg.

Sample Field Blanks, Equipment Blanks, and Duplicates

Field blanks will be collected for quality assurance purposes at a rate of one per 20 soil and groundwater investigation samples per analysis. Field blanks will be obtained by pouring laboratory-demonstrated analyte-free water on or through a decontaminated sampling device following use and implementation of decontamination protocols. The water will be collected off of the sampling device into a laboratory-provided sample container for analysis. Field blank samples will be analyzed for the complete list of analytes on the day of sampling. Trip blanks will be collected at a rate of one per day if soil samples are analyzed for VOCs during that day.

Equipment blanks will be collected for quality assurance purposes when soil and groundwater samples are being collected for PFAS at a rate of one per day per media. Equipment blanks will be obtained by pouring laboratory-demonstrated PFA-free water on or through a decontaminated field equipment following use and implementation of decontamination protocols. The water will be collected off of the sampling device into a laboratory-provided sample container for analysis. Equipment blank samples will be analyzed for the NYSDEC list PFAS.

Duplicate soil and groundwater samples will be collected and analyzed for quality assurance purposes. Duplicate samples will be collected at a frequency of 1 per 20 investigative soil samples per analysis and will be submitted to the laboratory as "blind" samples. If less than 20 samples are collected during a particular sampling event, one duplicate sample will be collected.

5.4 SAMPLE CONTAINERS AND HANDLING

Certified, commercially clean sample containers will be obtained from the analytical laboratory. If soil or groundwater samples are being collected, the laboratory will also prepare and supply the required trip blanks, equipment blanks, and field blank sample containers and reagent preservatives. Sample bottle containers, including the field and equipment blank containers, will be placed into plastic coolers by the laboratory. These coolers will be received by the field sampling team within 24 hours of their preparation in the laboratory. Prior to the commencement of field work, Langan field personnel will fill the plastic coolers with ice in Ziploc® bags (or equivalent) to maintain a temperature of 4° ±2° C.

Soil, groundwater and soil vapor samples collected in the field for laboratory analysis will be placed directly into the laboratory-supplied sample containers. Soil and groundwater samples will then be placed and stored on-ice in laboratory provided coolers until shipment to the laboratory. Blue ice will not be used to cool PFAS samples. The temperature in the coolers containing samples and associated field and equipment blanks will be maintained at a temperature of 4°±2°C while on-site and during sample shipment to the analytical laboratory.

Possession of samples collected in the field will be traceable from the time of collection until they are analyzed by the analytical laboratory or are properly disposed. Chain-of-custody procedures, described in Section 5.9, will be followed to maintain and document sample possession. Samples will be packaged and shipped as described in Section 5.6.

5.5 SPECIAL CONSIDERATIONS FOR PFAS SAMPLE COLLECTION

The following special considerations apply to the collection of groundwater samples for PFAS analysis to prevent cross-contamination:

- Field equipment will not contain Teflon®
- All sampling material will be made from stainless steel, HDPE, acetate, silicon, or polypropylene
- No waterproof field books will be used
- No plastic clipboards, binders, or spiral hard cover notebooks will be used
- No adhesives will be used

- No sharpies or permanent markers will be used; ball point pens are acceptable
- Aluminum foil will not be used
- PFAS samples will be kept in a separate cooler from other sampling containers
- Coolers will be filled only with regular ice

PFAS compound sampling protocol and the laboratories SOP for PFAS analysis are provided in Attachment E.

5.6 SAMPLE PRESERVATION

Sample preservation measures will be used in an attempt to prevent sample decomposition by contamination, degradation, biological transformation, chemical interactions and other factors during the time between sample collection and analysis. Preservation will commence at the time of sample collection and will continue until analyses are performed. Should chemical preservation be required, the analytical laboratory will add the preservatives to the appropriate sample containers before shipment to the office or field. Samples will be preserved according to the requirements of the specific analytical method selected, as shown in Attachment C.

5.6 SAMPLE SHIPMENT

5.6.1 Packaging

Soil sample containers will be placed in plastic coolers. Ice in Ziploc® bags (or equivalent) will be placed around sample containers. Cushioning material will be added around the sample containers if necessary. Chains-of-custody and other paperwork will be placed in a Ziploc® bag (or equivalent) and placed inside the cooler. The cooler will be taped closed and custody seals will be affixed to one side of the cooler at a minimum. If the samples are being shipped by an express delivery company (e.g. FedEx) then laboratory address labels will be placed on top of the cooler.

5.6.2 Shipping

Standard procedures to be followed for shipping environmental samples to the analytical laboratory are outlined below.

- All environmental samples will be transported to the laboratory by a laboratory-provided courier under the chain-of-custody protocols described in Section 5.9.

- Prior notice will be provided to the laboratory regarding when to expect shipped samples. If the number, type or date of shipment changes due to site constraints or program changes, the laboratory will be informed.

5.7 DECONTAMINATION PROCEDURES

Decontamination procedures will be used for non-dedicated sampling equipment. Decontamination of field personnel is discussed in the site-specific HASP included in Appendix B of the RIWP. Field sampling equipment that is to be reused will be decontaminated in the field in accordance with the following procedures:

1. Laboratory-grade glassware detergent and tap water scrub to remove visual contamination
2. Generous tap water rinse
3. Distilled/de-ionized water rinse

Any field sampling equipment that is to be reused for PFAS sampling will be decontaminated in the field in accordance with the following procedures:

1. Alconox detergent and "PFAS-free" water scrub to remove visual contamination
2. Generous PFAS-free" water rinse

5.8 RESIDUALS MANAGEMENT

Debris (e.g., paper, plastic and disposable PPE) will be collected in plastic garbage bags and disposed of as non-hazardous industrial waste. Debris is expected to be transported to a local municipal landfill for disposal. If applicable, residual solids (e.g., leftover soil cuttings) will be placed back in the borehole from which it was sampled. If gross contamination is observed, soil will be collected and stored in Department of Transportation (DOT)-approved 55-gallon drums in a designated storage area at the Site. The residual materials stored in a designated storage area at the site for further characterization, treatment or disposal.

Residual fluids (such as purge water) will be collected and stored in DOT-approved (or equivalent) 55-gallon drums in a designated storage area at the site. The residual fluids will be transported to the on-site wastewater treatment plant or analyzed, characterized and disposed off-site in accordance with applicable federal and state regulations. Residual fluids such as decontamination water may be discharged to the ground surface, however, if gross contamination is observed, the residual fluids will be collected, stored, and transported similar purge water or other residual fluids.

5.9 CHAIN OF CUSTODY PROCEDURES

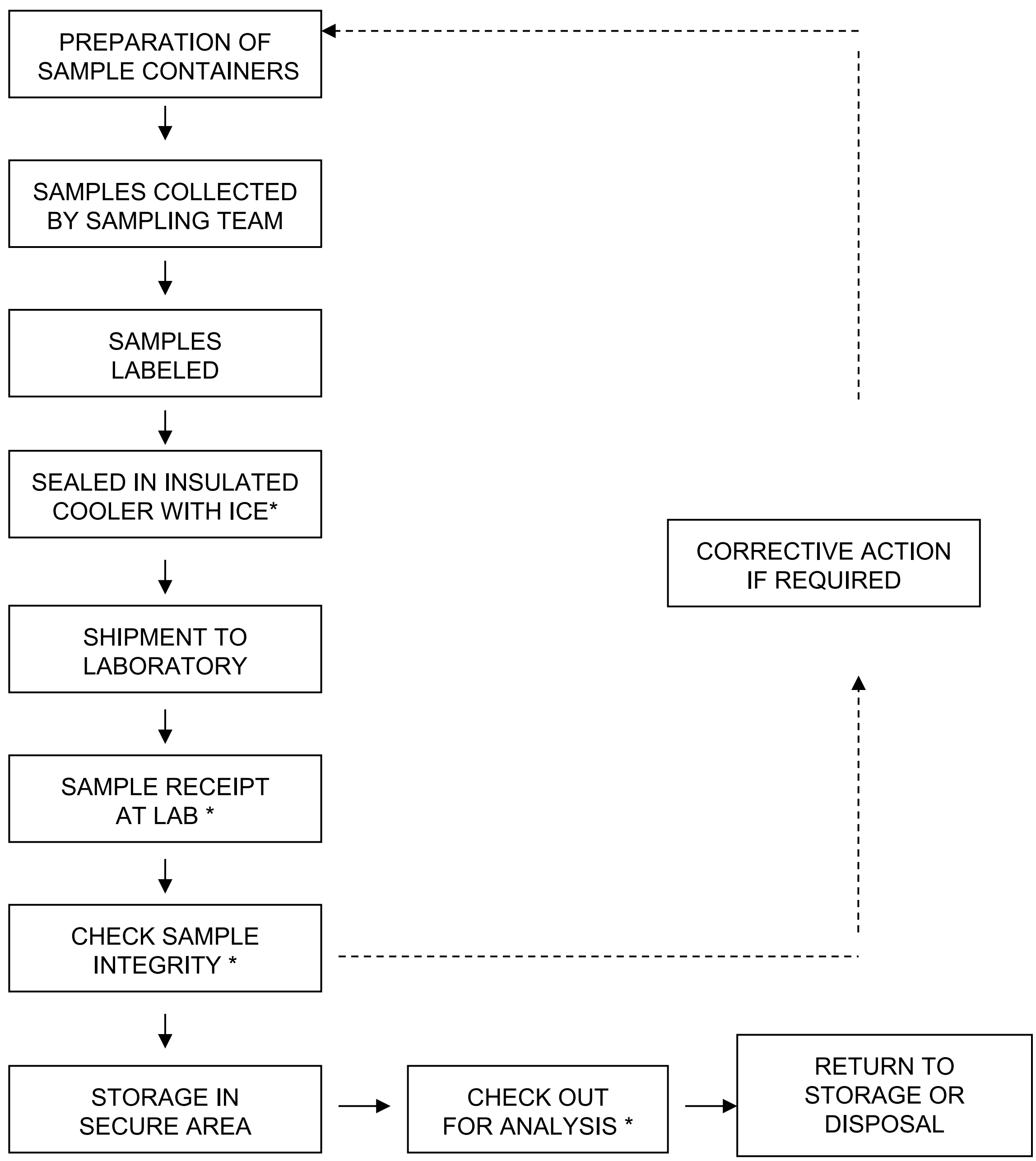
A chain-of-custody protocol has been established for collected samples that will be followed during sample handling activities in both field and laboratory operations. The primary purpose of the chain-of-custody procedures is to document the possession of the samples from collection through shipping, storage and analysis to data reporting and disposal. Chain-of-custody refers to actual possession of the samples. Samples are considered to be in custody if they are within sight of the individual responsible for their security or locked in a secure location. Each person who takes possession of the samples, except the shipping courier, is responsible for sample integrity and safe keeping. Chain-of-custody procedures are provided below:

- Chain-of-custody will be initiated by the laboratory supplying the pre-cleaned and prepared sample containers. Chain-of-custody forms will accompany the sample containers.
- Following sample collection, the chain-of-custody form will be completed for the sample collected. The sample identification number, date and time of sample collection, analysis requested and other pertinent information (e.g., preservatives) will be recorded on the form. All entries will be made in waterproof, permanent blue or black ink.
- Langan field personnel will be responsible for the care and custody of the samples collected until the samples are transferred to another party, dispatched to the laboratory, or disposed. The sampling team leader will be responsible for enforcing chain-of-custody procedures during field work.
- When the form is full or when all samples have been collected that will fit in a single cooler, the sampling team leader will check the form for possible errors and sign the chain-of-custody form. Any necessary corrections will be made to the record with a single strike mark, dated, and initialed.

Sample coolers will be accompanied by the chain-of-custody form, sealed in a Ziploc® bag (or equivalent) and placed on top of the samples or taped to the inside of the cooler lid. If applicable, a shipping bill will be completed for each cooler and the shipping bill number recorded on the chain-of-custody form.

Samples will be packaged for shipment to the laboratory with the appropriate chain-of-custody form. A copy of the form will be retained by the sampling team for the project file and the original will be sent to the laboratory with the samples. Bills of lading will also be retained as part of the documentation for the chain-of-custody records, if applicable. When transferring custody of the samples, the individuals relinquishing and receiving custody of the samples will verify sample numbers and condition and will document the sample acquisition and transfer by signing and dating the chain-of-custody form. This process documents sample custody transfer from the sampler to the analytical laboratory. A flow chart showing a sample custody process is included as Figure 5.1, and chain-of-custody forms from Alpha are included as Figures 5.2 and 5.3.

Figure 5.1 Sample Custody



* REQUIRES SIGN-OFF ON CHAIN-OF-CUSTODY FORM

Figure 5.2 Sample Chain-of-Custody Form – Air Sample

AIR ANALYSIS PAGE_____ OF _____

ALPHA ANALYTICAL **CHAIN OF CUSTODY**

320 Forbes Blvd, Mansfield, MA 02048
TEL: 508-822-9300 FAX: 508-822-3288

Client Information

Client:
Address:
Phone:
Fax:
Email:
❑ These samples have been previously analyzed by Alpha

Project Information

Project Name:
Project Location:
Project #:
Project Manager:
ALPHA Quote #:

Turn-Around Time

❑ Standard ❑ RUSH (only confirmed if pre-approved!)

Date Due: Time:

Date Rec'd in Lab:

Report Information - Data Deliverables

❑ FAX
❑ ADEx
Criteria Checker: ________
(Default based on Regulatory Criteria Indicated)
Other Formats: ________
❑ EMAIL (standard pdf report)
❑ Additional Deliverables:
Report to: (if different than Project Manager)

ALPHA Job #:

Billing Information

❑ Same as Client info | PO #:

Regulatory Requirements/Report Limits

State/Fed	Program	Res / Comm

Other Project Specific Requirements/Comments:

Project-Specific Target Compound List: ❑

All Columns Below Must Be Filled Out

ALPHA Lab ID (Lab Use Only)	Sample ID	COLLECTION End Date	Start Time	End Time	Initial Vacuum	Final Vacuum	Sample Matrix*	Sampler's Initials	Can Size	I D Can	I D - Flow Controller	TO-15	TO-15 SIM	APH	Fixed Gases	Sulfides & Mercaptans by TO-15		Sample Comments (i.e. PID)

*SAMPLE MATRIX CODES
AA = Ambient Air (Indoor/Outdoor)
SV = Soil Vapor/Landfill Gas/SVE
Other = Please Specify

Container Type

Relinquished By:	Date/Time	Received By:	Date/Time:

Please print clearly, legibly and completely. Samples can not be logged in and turnaround time clock will not start until any ambiguities are resolved. All samples submitted are subject to Alpha's Terms and Conditions.
See reverse side.

Form No: 101-02 Rev: (25-Sep-15)

Figure 5.3 Sample Chain-of-Custody Form – Soil and Groundwater

NEW YORK CHAIN OF CUSTODY

Westborough, MA 01581
8 Walkup Dr.
TEL: 508-898-9220
FAX: 508-898-9193

Mansfield, MA 02048
320 Forbes Blvd
TEL: 508-822-9300
FAX: 508-822-3288

Service Centers
Mahwah, NJ 07430: 35 Whitney Rd, Suite 5
Albany, NY 12205: 14 Walker Way
Tonawanda, NY 14150: 275 Cooper Ave, Suite 105

Page ___ of ___

Date Rec'd in Lab

ALPHA Job #

Client Information
Client:
Address:
Phone:
Fax:
Email:

Project Information
Project Name:
Project Location:
Project #
(Use Project name as Project #) ☐
Project Manager:
ALPHAQuote #:

Turn-Around Time
Standard ☐ Due Date:
Rush (only if pre approved) ☐ # of Days:

Deliverables
☐ ASP-A ☐ ASP-B
☐ EQuIS (1 File) ☐ EQuIS (4 File)
☐ Other

Billing Information
☐ Same as Client Info
PO #

Regulatory Requirement
☐ NY TOGS ☐ NY Part 375
☐ AWQ Standards ☐ NY CP-51
☐ NY Restricted Use ☐ Other
☐ NY Unrestricted Use
☐ NYC Sewer Discharge

Disposal Site Information
Please identify below location of applicable disposal facilities.
Disposal Facility:
☐ NJ ☐ NY
☐ Other:

These samples have been previously analyzed by Alpha ☐

Other project specific requirements/comments:

Please specify Metals or TAL.

ANALYSIS

Sample Filtration
☐ **Done**
☐ **Lab to do**
Preservation
☐ **Lab to do**

(Please Specify below)

ALPHA Lab ID (Lab Use Only)	Sample ID	Collection Date	Collection Time	Sample Matrix	Sampler's Initials									Sample Specific Comments	Total Bottle

Preservative Code:
A = None
B = HCl
C = HNO_3
D = H_2SO_4
E = NaOH
F = MeOH
G = $NaHSO_4$
H = $Na_2S_2O_3$
K/E = Zn Ac/NaOH
O = Other

Container Code
P = Plastic
A = Amber Glass
V = Vial
G = Glass
B = Bacteria Cup
C = Cube
O = Other
E = Encore
D = BOD Bottle

Westboro: Certification No: MA935
Mansfield: Certification No: MA015

Container Type
Preservative

Relinquished By:	Date/Time	Received By:	Date/Time

Please print clearly, legibly and completely. Samples can not be logged in and turnaround time clock will not start until any ambiguities are resolved. BY EXECUTING THIS COC, THE CLIENT HAS READ AND AGREES TO BE BOUND BY ALPHA'S TERMS & CONDITIONS. (See reverse side.)

Form No: 01-25 HC (rev. 30-Sept-2013)

Laboratory chain-of-custody will be maintained throughout the analytical processes as described in the laboratory's Quality Assurance (QA) Manual. The analytical laboratory will provide a copy of the chain-of-custody in the analytical data deliverable package. The chain-of-custody becomes the permanent record of sample handling and shipment.

5.10 LABORATORY SAMPLE STORAGE PROCEDURES

The subcontracted laboratory will use a laboratory information management system (LIMS) to track and schedule samples upon receipt by the analytical laboratories. Any sample anomalies identified during sample log-in must be evaluated on individual merit for the impact upon the results and the data quality objectives of the project. When irregularities do exist, the environmental consultant must be notified to discuss recommended courses of action and documentation of the issue must be included in the project file.

For samples requiring thermal preservation, the temperature of each cooler will be immediately recorded. Each sample and container will be will be assigned a unique laboratory identification number and secured within the custody room walk-in coolers designated for new samples. Samples will be, as soon as practical, disbursed in a manner that is functional for the operational team. The temperature of all coolers and freezers will be monitored and recorded using a certified temperature sensor. Any temperature excursions outside of acceptance criteria (i.e., below 2°C or above 6°C) will initiate an investigation to determine whether any samples may have been affected. Samples for VOCs will be maintained in satellite storage areas within the VOC laboratory. Following analysis, the laboratory's specific procedures for retention and disposal will be followed as specified in the laboratory's SOPs and/or QA manual.

5.11 SPECIAL CONSIDERATIONS FOR PFAS SAMPLE COLLECTION

Groundwater samples collected for analysis of PFAS will be collected in accordance with the specialized protocol outlined in this section. Groundwater samples collected from select wells will be analyzed for 1,4-dioxane with a detection limit no higher than 0.35 micrograms per liter, and for PFAS with a detection limit no higher than 2 nanograms per liter in accordance with the procedure outlined in Attachment E.

The following special considerations apply to the collection of groundwater samples for PFAS analysis to prevent cross-contamination:

- Field equipment will not contain Teflon®

- All sampling material will be made from stainless steel, HDPE, acetate, silicon, or polypropylene
- No waterproof field books will be used
- No plastic clipboards, binders, or spiral hard cover notebooks will be used
- No adhesives will be used
- No sharpies or permanent markers will be used; ball point pens are acceptable
- Aluminum foil will not be used
- PFAS samples will be kept in a separate cooler from other sampling containers
- Coolers will be filled only with regular ice

PFAS compound sampling protocol is provided in Attachment E.

5.12 PFAS TARGET ANALYTE LIST

DER has developed a PFAS target analyte list. At minimum, the laboratory will report the following PFAS target compounds:

Group	Analyte Name	Abbreviation	CAS #
Perfluoroalkyl carboxylates	Perfluorobutanoic acid	PFBA	375-22-4
	Perfluoropentanoic acid	PFPeA	2706-90-3
	Perfluorohexanoic acid	PFHxA	307-24-4
	Perfluoroheptanoic acid	PFHpA	375-85-9
	Perfluorooctanoic acid	PFOA	335-67-1
	Perfluorononanoic acid	PFNA	375-95-1
	Perfluorodecanoic acid	PFDA	335-76-2
	Perfluoroundecanoic acid	PFUA/PFUdA	2058-94-8
	Perfluorododecanoic acid	PFDoA	307-55-1
	Perfluorotridecanoic acid	PFTriA/PFTrDA	72629-94-8
	Perfluorotetradecanoic acid	PFTA/PFTeDA	376-06-7
Perfluoroalkyl sulfonates	Perfluorobutanesulfonic acid	PFBS	375-73-5
	Perfluorohexanesulfonic acid	PFHxS	355-46-4
	Perfluoroheptanesulfonic acid	PFHpS	375-92-8
	Perfluorooctanessulfonic acid	PFOS	1763-23-1
	Perfluorodecanesulfonic acid	PFDS	335-77-3

Fluorinated Telomer Sulfonates	6:2 Fluorotelomer sulfonate	6:2 FTS	27619-97-2
	8:2 Fluorotelomer sulfonate	8:2 FTS	39108-34-4
Perfluorooctane-sulfonamides	Perfluroroctanesulfonamide	FOSA	754-91-6
Perfluorooctane-sulfonamidoacetic acids	N-methyl perfluorooctanesulfonamidoacetic acid	N-MeFOSAA	2355-31-9
	N-ethyl perfluorooctanesulfonamidoacetic acid	N-EtFOSAA	2991-50-6

Attachment E contains the PFAS sampling protocol and laboratory SOPs for PFAS analysis.

6.0 DATA REDUCTION, VALIDATION, AND REPORTING

6.1 INTRODUCTION

Data collected during the field investigation will be reduced and reviewed by the laboratory QA personnel, and a report on the findings will be tabulated in a standard format. The criteria used to identify and quantify the analytes will be those specified for the applicable methods in the USEPA SW-846 and subsequent updates. The data package provided by the laboratory will contain all items specified in the USEPA SW-846 appropriate for the analyses to be performed, and be reported in standard format.

The completed copies of the chain-of-custody records (both external and internal) accompanying each sample from time of initial bottle preparation to completion of analysis shall be attached to the analytical reports.

6.2 DATA REDUCTION

The Analytical Services Protocol (ASP) Category B data packages and an electronic data deliverable (EDD) will be provided by the laboratory after receipt of a complete sample delivery group. The Project Manager will immediately arrange for archiving the results and preparation of result tables. These tables will form the database for assessment of the site contamination condition.

Each EDD deliverable must be formatted using a Microsoft Windows operating system and the NYSDEC data deliverable format for EQuIS. To avoid transcription errors, data will be loaded directly into the ASCII format from the laboratory information management system (LIMS). If this cannot be accomplished, the consultant should be notified via letter of transmittal indicating that manual entry of data is required for a particular method of analysis. All EDDs must also undergo a QC check by the laboratory before delivery. The original data, tabulations, and electronic media are stored in a secure and retrievable fashion.

The Project Manager or Task Manager will maintain close contact with the QA reviewer to ensure all non-conformance issues are acted upon prior to data manipulation and assessment routines. Once the QA review has been completed, the Project Manager may direct the Team Leaders or others to initiate and finalize the analytical data assessment.

6.3 DATA VALIDATION

Data validation will be performed in accordance with the USEPA validation guidelines for organic and inorganic data review. Validation will include the following:

- Verification of the QC sample results,
- Verification of the identification of sample results (both positive hits and non-detects),
- Recalculation of 10% of all investigative sample results, and
- Preparation of Data Usability Summary Reports (DUSR).

A DUSR will be prepared and reviewed by the QAO before issuance. The DUSR will present the results of data validation, including a summary assessment of laboratory data packages, sample preservation and COC procedures, and a summary assessment of precision, accuracy, representativeness, comparability, and completeness for each analytical method. A detailed assessment of each SDG will follow. For each of the organic analytical methods, the following will be assessed:

- Holding times;
- Instrument tuning;
- Instrument calibrations;
- Blank results;
- System monitoring compounds or surrogate recovery compounds (as applicable);
- Internal standard recovery results;
- MS and MSD results;
- Target compound identification;
- Chromatogram quality;
- Pesticide cleanup (if applicable);
- Compound quantitation and reported detection limits;
- System performance; and
- Results verification.

For each of the inorganic compounds, the following will be assessed:

- Holding times;
- Calibrations;
- Blank results;
- Interference check sample;
- Laboratory check samples;
- Duplicates;
- Matrix Spike;
- Furnace atomic absorption analysis QC;
- ICP serial dilutions; and
- Results verification and reported detection limits.

Based on the results of data validation, the validated analytical results reported by the laboratory will be assigned one of the following usability flags:

- "U" - Not detected. The associated number indicates the approximate sample concentration necessary to be detected significantly greater than the level of the highest associated blank;
- "UJ" - Not detected. Quantitation limit may be inaccurate or imprecise;
- "J" - Analyte is present. Reported value may be associated with a higher level of uncertainty than is normally expected with the analytical method
- "N" – Tentative identification. Analyte is considered present in the sample;
- "R" – Unreliable result; data is rejected or unusable. Analyte may or may not be present in the sample; and
- No Flag - Result accepted without qualification.

7.0 QUALITY ASSURANCE PERFORMANCE AUDITS AND SYSTEM AUDITS

7.1 INTRODUCTION

Quality assurance audits may be performed by the project quality assurance group under the direction and approval of the QAO. These audits will be implemented to evaluate the capability and performance of project and subcontractor personnel, items, activities, and documentation of the measurement system(s). Functioning as an independent body and reporting directly to corporate quality assurance management, the QAO may plan, schedule, and approve system and performance audits based upon procedures customized to the project requirements. At times, the QAO may request additional personnel with specific expertise from company and/or project groups to assist in conducting performance audits. However, these personnel will not have responsibility for the project work associated with the performance audit.

7.2 SYSTEM AUDITS

System audits may be performed by the QAO or designated auditors, and encompass a qualitative evaluation of measurement system components to ascertain their appropriate selection and application. In addition, field and laboratory quality control procedures and associated documentation may be system audited. These audits may be performed once during the performance of the project. However, if conditions adverse to quality are detected or if the Project Manager requests, additional audits may occur.

7.3 PERFORMANCE AUDITS

The laboratory may be required to conduct an analysis of Performance Evaluation samples or provide proof that Performance Evaluation samples submitted by USEPA or a state agency have been analyzed within the past twelve months.

7.4 FORMAL AUDITS

Formal audits refer to any system or performance audit that is documented and implemented by the QA group. These audits encompass documented activities performed by qualified lead auditors to a written procedure or checklists to objectively verify that quality assurance requirements have been developed, documented, and instituted in accordance with contractual and project criteria. Formal audits may be performed on project and subcontractor work at various locations.

Audit reports will be written by auditors who have performed the site audit after gathering and evaluating all data. Items, activities, and documents determined by lead auditors to be in noncompliance shall be identified at exit interviews conducted with the involved management. Non-compliances will be logged, and documented through audit findings, which are attached to and are a part of the integral audit report. These audit-finding forms are directed to management to satisfactorily resolve the noncompliance in a specified and timely manner.

The Project Manager has overall responsibility to ensure that all corrective actions necessary to resolve audit findings are acted upon promptly and satisfactorily. Audit reports must be submitted to the Project Manager within fifteen days of completion of the audit. Serious deficiencies will be reported to the Project Manager within 24 hours. All audit checklists, audit reports, audit findings, and acceptable resolutions are approved by the QAO prior to issue. Verification of acceptable resolutions may be determined by re-audit or documented surveillance of the item or activity. Upon verification acceptance, the QAO will close out the audit report and findings.

8.0 CORRECTIVE ACTION

8.1 INTRODUCTION

The following procedures have been established to ensure that conditions adverse to quality, such as malfunctions, deficiencies, deviations, and errors, are promptly investigated, documented, evaluated, and corrected.

8.2 PROCEDURE DESCRIPTION

When a significant condition adverse to quality is noted at site, laboratory, or subcontractor location, the cause of the condition will be determined and corrective action will be taken to preclude repetition. Condition identification, cause, reference documents, and corrective action planned to be taken will be documented and reported to the QAO, Project Manager, Field Team Leader and involved contractor management, at a minimum. Implementation of corrective action is verified by documented follow-up action.

All project personnel have the responsibility, as part of the normal work duties, to promptly identify, solicit approved correction, and report conditions adverse to quality. Corrective actions will be initiated as follows:

- When predetermined acceptance standards are not attained;
- When procedure or data compiled are determined to be deficient;
- When equipment or instrumentation is found to be faulty;
- When samples and analytical test results are not clearly traceable;
- When quality assurance requirements have been violated;
- When designated approvals have been circumvented;
- As a result of system and performance audits;
- As a result of a management assessment;
- As a result of laboratory/field comparison studies; and
- As required by USEPA SW-846, and subsequent updates, or by the NYSDEC ASP.

Project management and staff, such as field investigation teams, remedial response planning personnel, and laboratory groups, monitor on-going work performance in the normal course of daily responsibilities. Work may be audited at the sites, laboratories, or contractor locations. Activities, or documents ascertained to be noncompliant with quality assurance requirements will be documented. Corrective actions will be mandated through audit finding sheets attached to the audit report. Audit findings are logged, maintained, and controlled by the Task Manager.

Personnel assigned to quality assurance functions will have the responsibility to issue and control Corrective Action Request (CAR) Forms (Figure 12.1 or similar). The CAR identifies the out-of-compliance condition, reference document(s), and recommended corrective action(s) to be administered. The CAR is issued to the personnel responsible for the affected item or activity. A copy is also submitted to the Project Manager. The individual to whom the CAR is addressed returns the requested response promptly to the QA personnel, affixing his/her signature and date to the corrective action block, after stating the cause of the conditions and corrective action to be taken. The QA personnel maintain the log for status of CARs, confirms the adequacy of the intended corrective action, and verifies its implementation. CARs will be retained in the project file for the records.

Any project personnel may identify noncompliance issues; however, the designated QA personnel are responsible for documenting, numbering, logging, and verifying the close out action. The Project Manager will be responsible for ensuring that all recommended corrective actions are implemented, documented, and approved.

FIGURE 8.1

CORRECTIVE ACTION REQUEST

Number: ____________________________ Date: _____________

TO: ____

You are hereby requested to take corrective actions indicated below and as otherwise determined by you to (a) resolve the noted condition and (b) to prevent it from recurring. Your written response is to be returned to the project quality assurance manager by ________________

CONDITION:

REFERENCE DOCUMENTS:

RECOMMENDED CORRECTIVE ACTIONS:

___________	_______	___________	_________	____________	_________
Originator	Date	Approval	Date	Approval	Date

RESPONSE

CAUSE OF CONDITION

CORRECTIVE ACTION

(A) RESOLUTION

(B) PREVENTION

(C) AFFECTED DOCUMENTS

C.A. FOLLOWUP:

CORRECTIVE ACTION VERIFIED BY: ______________________________ DATE:______________

9.0 REFERENCES

NYSDEC. Division of Environmental Remediation. DER-10/Technical Guidance for Site Investigation and Remediation, dated May 3, 2010.

Taylor, J. K., 1987. Quality Assurance of Chemical Measurements. Lewis Publishers, Inc., Chelsea, Michigan

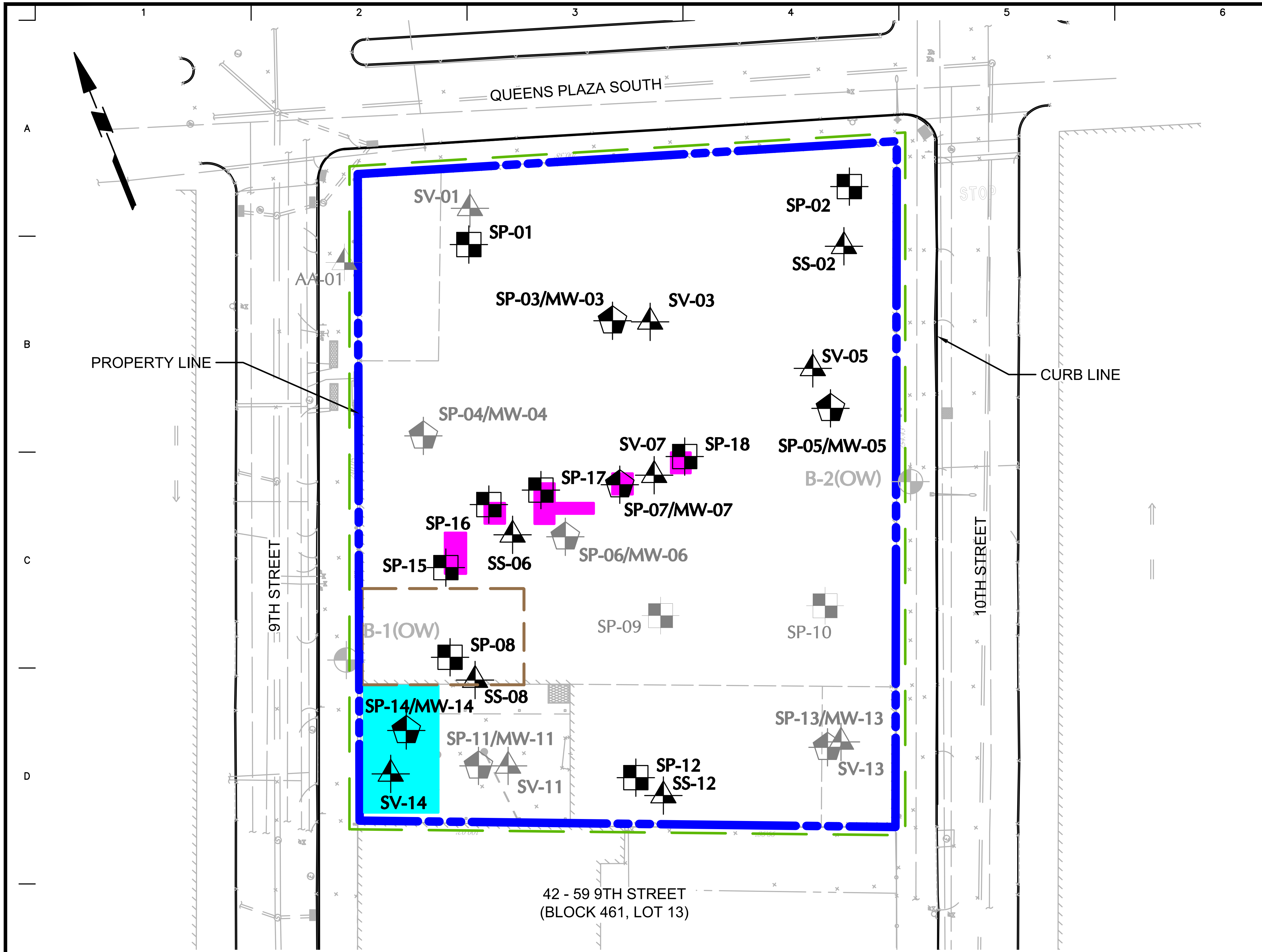
USEPA, 1986. SW-846 "Test Method for Evaluating Solid Waste," dated November 1986. U.S. Environmental Protection Agency, Washington, D.C.

USEPA, 1987. Data Quality Objectives for Remedial Response Actions Activities: Development Process, EPA/540/G-87/003, OSWER Directive 9355.0-7- U.S. Environmental Protection Agency, Washington, D.C.

USEPA, 1992a. CLP Organics Data Review and Preliminary Review. SOP No. HW-6, Revision #8, dated January 1992. USEPA Region II.

USEPA, 1992b. Evaluation of Metals Data for the Contract Laboratory Program (CLP) based on SOW 3/90. SOP No. HW-2, Revision XI, dated January 1992. USEPA Region II.

USEPA. Hazardous Waste Support Section. Analysis of Volatile Organic Compounds in Air Contained in Canisters by Method TO-15. SOP No. HW-31, Revision #6, dated June 2014.



LEGEND

B-1	2018 COMPLETED GEOTECHNICAL BORING LOCATION
SP-11	2019 COMPLETED SOIL PROBE LOCATION
SP-12/MW-12	2019 COMPLETED SOIL PROBE/MONITORING WELL LOCATION
SV-08	2019 COMPLETED VAPOR SAMPLE LOCATION
AA-01	2019 COMPLETED AMBIENT AIR SAMPLE LOCATION
(OW)	OBSERVATION WELL
SP-01	PROPOSED SOIL BORING LOCATION
SV-05	PROPOSED SUB-SURFACE SOIL VAPOR SAMPLE LOCATION
SS-02	PROPOSED SUB-SLAB SOIL VAPOR SAMPLE LOCATION
SP-05/MW-05	PROPOSED BORING/MONITORING WELL LOCATION
	AOC 1: APPROXIMATE LOCATION OF PREVIOUSLY IDENTIFIED TRENCHES
	AOC 2: APPROXIMATE LOCATION OF FORMER NO.2 FUEL OIL TANK
	AOC 3: SITE - MACHINE SHOP (1998 - PRESENT), PLASTIC HANGER MANUFACTURING (1970 - 1977)
	APPROXIMATE EXTENTS OF EXISTING PARTIAL CELLAR

GENERAL NOTES

1. ELEVATIONS ARE RELATIVE TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88), WHICH IS 1.1 FT ABOVE MEAN SEA LEVEL AT SANDY HOOK, NJ, U.S.C. & G SURVEY-DATUM.
2. THE BASE PLAN TAKEN FROM THE BOUNDARY AND TOPOGRAPHICAL SURVEY FOR 4211 9TH STREET PREPARED BY CONTROL POINT ASSOCIATES INC DATED 14 MARCH 2018.
3. ALL LOCATIONS ARE APPROXIMATE.
4. SOIL BORINGS AND SAMPLING POINTS WILL BE BACKFILLED WITH SOIL CUTTINGS FOLLOWING COMPLETION.
5. A CO-LOCATED INDOOR AIR SAMPLE WILL BE COLLECTED WITH EACH SUB-SLAB SOIL VAPOR SAMPLE.
6. AOC = AREA OF CONCERN.

40 0 10 25 40

SCALE IN FEET

LANGAN

Langan Engineering, Environmental, Surveying, Landscape Architecture and Geology, D.P.C.
21 Penn Plaza, 360 West 31st Street, 8th Floor
New York, NY 10001
T: 212.479.5400 F: 212.479.5444 www.langan.com

Project	Figure Title	Project No. / Date / Drawn By / Checked By	Figure No.
42-11 9TH STREET BLOCK No. 461, LOT No.16 QUEENS NEW YORK	PROPOSED SAMPLE LOCATION PLAN	Project No. 170514701 Date 01/08/2018 Drawn By MP Checked By TC	1 Figure 1 of 1

Filename: \\Langan.com\data\NYC\data7\170514701\Project Data\CAD\01\SheetFiles\Environmental\Remedial Investigation\Figure 2 - Sample Location and AOC Map_3.24.2020.dwg Date: 3/25/2020 Time: 12:07 User: ksaxena Style Table: Langan.stb Layout: ANSIB-BL

ATTACHMENT A
Resumes

MICHAEL D. BURKE, PG, CHMM, LEED AP

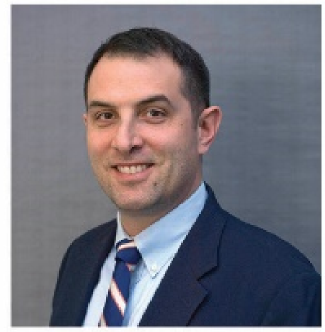
PRINCIPAL/VICE PRESIDENT

ENVIRONMENTAL ENGINEERING AND REMEDIATION

Mr. Burke is a geologist/environmental scientist whose practice involves site investigation and remediation, transactional due diligence, environmental site assessments, in-situ remedial technology, and manufactured gas plant (MGP) site characterization and remediation. His additional services include multi-media compliance audits, sub-slab depressurization system design, non-hazardous and hazardous waste management, emergency response, community air monitoring programs, environmental and geotechnical site investigations, and health and safety monitoring. He has experience with projects in the New York State Department of Environmental Conservation (NYSDEC) and New York State Brownfield Cleanup (NYS BCP) Programs; Inactive Hazardous Waste, and Spill Programs, and New York City Office of Environmental Remediation (OER) e-designated and New York City Voluntary Cleanup Program (NYC VCP) sites.

SELECTED PROJECTS

- 227-14 North Conduit Avenue, Industrial Wastewater Compliance, Jamaica, NY
- 420 Kent Avenue, NYS Brownfield Cleanup Program, Brooklyn, NY
- 572 Eleventh Avenue, NYC VCP, New York, NY
- Monian Site A, OER E-Designated Site, New York, NY
- 537 Sackett Street, Gowanus Canal Due Diligence/MGP Site, Brooklyn, NY
- ABC Blocks 25, 26 and 27, NYS Brownfield Cleanup Program Sites, Long Island City, NY
- 432 Rodney Street, NYS Brownfield Cleanup Program, Petroleum and Chlorinated Volatile Organic Compound Investigation and Remediation, Brooklyn, NY
- 787 Eleventh Avenue, NYS Brownfield Cleanup Program Site, New York, NY
- President Street at Gowanus Canal, NYS Brownfield Cleanup Program Site, Brooklyn, NY
- 22-36 Second Avenue at Gowanus Canal, NYS Brownfield Cleanup Program Site, Brooklyn, NY
- 563 Sacket Street, NYS Brownfield Cleanup Program Site, MGP Investigation, and Remediation, Brooklyn, NY
- 156-162 Perry Street, NYS Brownfield Cleanup Program Site, New York, NY
- Christopher and Weehawken Streets, NYS Brownfield Cleanup Program, New York, NY
- Phelps Dodge Block 2529 (Lots 40, 50, and 45), Inactive Hazardous Waste Disposal Site, Maspeth NY
- 42-50 24th Street, NYS Brownfield Cleanup Program Site, Long Island City, NY
- Storage Deluxe (163 6th Street), OER E-Designation Site, New York, NY



EDUCATION

M.S., Environmental Geology
Rutgers University

B.S., Geological Sciences
Rutgers University

B.S., Environmental Science
Rutgers University

PROFESSIONAL REGISTRATION

Professional Geologist (PG) in NY

Certified Hazardous Materials Manager – CHMM No. 15998

LEED Accredited Professional (LEED AP)

OSHA Certification for Hazardous Waste Site Supervisor

OSHA 29 CFR 1910.120 Certification for Hazardous Waste Operations and Emergency Response

NJDEP Certification for Community Noise Enforcement

Troxler Certification for Nuclear Densometer Training

- Prospect Park Redevelopment, Landfill Reclamation, Prospect Park, NJ
- 431 Carroll Street, Gowanus Canal Due Diligence, Brooklyn, NY
- 76 4th Street Property, Gowanus Due Diligence, Brooklyn, NY
- Foxgate/MREC, Due Diligence and Solid Waste Compliance, Central Islip, NY
- 175-225 3rd Street at Gowanus Canal, NYS Brownfield Cleanup Program, Brooklyn, NY
- New York University Tandon School of Engineering, Spill Investigation/Remediation Dual Phase Recovery, and Laser Fluorescence Investigation, Brooklyn, NY
- 2420-2430 Amsterdam Avenue, NYS Brownfield Cleanup Program/Board of Standards and Appeals Variance, New York, NY
- 170 Amsterdam Avenue, NYC VCP, New York, NY
- 538-540 Hudson Street, NYS Brownfield Cleanup Program (Former Gas Station), New York, NY
- 234 Butler Street, Gowanus Canal Due Diligence, Brooklyn, NY
- 550 Clinton Street, NYS Brownfield Cleanup Program E-Designation, Brooklyn, NY
- 111 Leroy Street, OER E-Designation Site, New York, NY
- 335 Bond Street, NYS Brownfield Cleanup Program, New York, NY
- Gowanus Canal Northside, NYS BCP Former Fuel Oil Terminal, Brooklyn, NY
- Multiple Buildings, Major Oil Storage Facility, Gowanus Canal Location, Brooklyn, NY
- 197-205 Smith Street at Gowanus Canal, MGP Due Diligence, Brooklyn, NY
- 450 Union Street at Gowanus Canal, NYS Brownfield Cleanup Program, Brooklyn, NY
- 86 Fleet Place, NYC VCP E-Designation, Brooklyn, NY
- New York University College of Nursing at 433 1st Avenue, NYS BCP, Bronx, NY
- Retail Building at 225 3rd Street, Brooklyn, NY
- 29-37 41st Avenue, NYS Brownfield Cleanup Program, Long Island City, NY
- 43-01 22nd Street, NYS Brownfield Cleanup Program, Long Island City, NY
- Compliance Audit for NYU at Washington Square Park, New York, NY
- Former Watermark Locations, NYS Brownfield Cleanup Program, Chlorinated Volatile Organic Compound Investigation and Remediation; AS/SVE, Brooklyn, NY
- Former Gas Station (1525 Bedford Avenue), Brooklyn, NY
- NYS Brownfield Cleanup Program at 514 West 24th Street, New York, NY
- Gowanus Canal Due Diligence at 76 4th Street, Brooklyn, NY
- Urban Health Plan, Medical Building, NYS Brownfield Cleanup Program CVOC Investigation and Remediation, Bronx, NY
- 420 East 54th Street, NYS Spill Closure, New York, NY
- Equity Residential at 160 Riverside Boulevard, NYS Spill Closure, New York, NY
- 357-359 West Street and 156 Leroy Street, NYC VCP, New York, NY
- Emergency Spill Response at 322 West 57th Street, Investigation and Closure, New York, NY

- Hurricane Sandy, Emergency Response at 21 West Street, New York, NY
- Hurricane Sandy, Emergency Response at 71 Pine Street, New York, NY
- Greenpoint Landing, NYC E-Designation, Brooklyn, NY
- 23-01 42nd Road, NYS Brownfield Cleanup Program, Long Island City, NY
- Greenpoint Waterfront Development, NYS Brownfield Cleanup Program, Brooklyn, NY
- 125th Street and Lenox Avenue, NYC VCP, New York, NY
- Whitehead Realty Solvent Site, Inactive Hazardous Waste site, CVOC Investigation and Remediation, Brooklyn, NY
- SunCap Property Group Environmental On-Call Consulting, Various Locations, Nationwide
- Consolidated Edison Company of New York, Underground Storage Tank On-Call Contract, Five Boroughs of New York City, NY
- Consolidated Edison Company of New York, Appendix B Spill Sites On-Call Contract, Five Boroughs of New York City, NY
- Meeker Avenue Plume Trackdown Site, Brooklyn, NY
- Distribution Facility, Superfund Redevelopment, Long Island City, NY
- Edison Properties, West 17th Street Development Site (Former MGP Site), New York, NY
- Con Edison on Governors Island, Dielectric Fluid Spill, Investigation and Remediation, New York, NY
- 144-150 Barrow Street, NYS Brownfield Cleanup Program, New York, NY
- West 17th Street Development, NYS Brownfield Cleanup Program, MGP Investigation and Remediation, New York, NY
- Montefiore Medical Center, Emergency Response, PCB Remediation, Bronx, NY
- New York University, 4 Washington Square Village Fuel Oil Remediation, New York, NY
- NYCSCA, Proposed New York City School Construction Sites, Five Boroughs of New York City, NY
- Con Edison, East 60th Street Generating Station, New York, NY
- Residential Building at 82 Irving Place, Environmental Remediation, New York, NY
- 1113 York Avenue, Storage Tank Closures, New York, NY
- Peter Cooper Village/Stuyvesant Town, Phase I ESA, New York, NY
- Superior Ink, Waste Characterization and Remedial Action Plans, New York, NY
- Bronx Mental Health Redevelopment Project, Phase I ESA, Bronx, NY
- 2950 Atlantic Avenue, Site Characterization Investigation, Brooklyn, NY
- Con Edison, East 74th Street Generating Station, Sediment Investigation, New York, NY
- Con Edison, First Avenue Properties, New York, NY
- Queens West Development Corp. Stage II, Long Island City, NY
- Article X Project Environmental Reviews, Various New York State Electrical Generation Sites, NY
- Poletti Generating Station, Astoria, NY
- Arthur Kill Generating Station, Staten Island, NY

- Distribution Facility, Phase I & Phase II ESA and Regulatory Compliance, Bohemia, NY
- Huntington Station Superfund Due Diligence, Huntington Station, NY
- Garvies Point Bulkhead, Glen Cove, NY
- Johnson & Hoffman Metal Stamping Facility, Environmental Compliance, Carle Place, NY
- Floral Park Storage Facility, Phase I and Phase II ESA
- Garden City Phase I ESAs at two sites, including part of a Superfund Site, Garden City, NY
- Huntington Station Storage Facility, Phase I and II ESA, Huntington Station, NY
- Trevor Day School, NYS Spill Site Expert Testimony, New York, NY

SELECTED PUBLICATIONS, REPORTS, AND PRESENTATIONS

Burke, M., Ciambruschini, S., Nicholls, G., Tashji, A., Vaidya, S., “Redeveloping a Remediated MGP Site”, MGP Symposium 2019, Atlantic City, NJ.

Jason J. Hayes, PE, LEED AP

Principal/Vice President
Environmental Engineering

18 years in the industry

Mr. Hayes has experience in New York, New Jersey, Washington D.C., California, Washington, Oregon, Alaska, and Internationally. His experience includes Environmental Protection Agency (EPA), New York State (NYS) Brownfields applications, investigation, and remediation; New York City Department of Environmental Protection (NYCDEP) and New York City Office of Environmental Remediation (OER) E-designated site applications, investigations, and remediation. His expertise also includes Phase I and II Environmental Site Investigations and Assessments; contaminated building cleanup and demolition; Underground Storage Tank (UST) permitting, removal specifications, and closure reporting; soil vapor intrusion investigation and mitigation system design (depressurization systems, etc.); development of groundwater contaminant plume migration models; environmental analysis; and oversight, design and specification generation for remediation operations with contaminants of concern to include polychlorinated biphenyls (PCBs), solvents, mercury, arsenic, petroleum products, asbestos, mold and lead.

Selected Projects

- Confidential Location (Remediation for Mercury-Contaminated Site), New York, NY
- Confidential Location (Phase II ESI and Remedial Design for Mercury Impacted Site), Brooklyn, NY
- NYC School Construction Authority (PCB Remediation), Various Locations, New York, NY
- 28-29 High Line (Phase I ESA, Phase II ESI, and Environmental Remediation), New York, NY
- Georgetown Heating Plant (Phase II ESI and Remedial Design for Mercury Impacted Site), Washington D.C.
- 268 West Street (BCP Application, RI and RIWP), New York, NY
- Confidential Multiple Mixed-Use Tower Location (BCP Application, RI, Phase I ESA, and Phase II ESI), New York, NY
- Dock 72 at Brooklyn Navy Yard, (NYS Voluntary Cleanup Program), Brooklyn, NY
- 27-21 44th Drive (BCP Application, Remedial Investigation Phase I ESA, and Phase II ESI), Long Island City, NY
- Purves Street Development, BCP Application, RAWP, and Phase II ESI, Long Island City, NY
- 267-273 West 87th Street (BCP Application, Remedial Investigation, RIWP, RAWP), New York, NY
- New York Aquarium, Shark Tank and Animal Care Facility (Environmental Remediation), Coney Island, NY
- International Leadership Charter School (Environmental Remediation), Bronx, NY
- West & Watts (BCP Application), New York, NY

Education

M.S., Environmental Engineering
Columbia University

B.S., Chemistry, Environmental Toxicology
Humboldt State University

Business Administration (minor)
Humboldt State University

Professional Registration

Professional Engineer (PE) in NY

LEED Accredited Professional (LEED AP)

Troxler Certification for Nuclear Densometer Training

CPR and First Aid Certification

OSHA 40-Hour HAZWOPER

OSHA HAZWOPER Site Supervisor

Affiliations

US Green Building Council, NYC Chapter (USGBC), Communications Committee

Urban Land Institute (ULI), member

Commercial Real Estate Development Association (NAIOP), member

NYC Brownfield Partnership, member

- Hudson Yards Redevelopment (Phase I ESA and Phase II ESI), New York, NY
- 627 Smith Street (RI and Report), Brooklyn, NY
- Gateway Center II Retail (Phase I ESA and Phase II ESI), Brooklyn, NY
- 261 Hudson Street (Phase I ESA, Phase II ESI, BCP, and RAWP), New York, NY
- Riverside Center, Building 2 (BCP, Phase I ESA and Phase II ESI), New York, NY
- New York Police Academy, (Sub-Slab Depressurization and Vapor Barrier System), College Point, NY
- Bronx Terminal Market (BCP, RIWP, RAWP, Phase I ESA and Phase II ESI), Bronx, NY
- Jacob Javits Convention Center (Phase I ESA and Phase II ESI), New York, NY
- Yankee Stadium Development Waterfront Park (NYSDEC Spill Sites), Bronx, NY
- Bushwick Inlet Park (Phase I ESA, Approvals for NYC E-Designation), Brooklyn, NY
- Silvercup West (BCP, RIWP, RIR, RAWP, and RAA), Long Island City, NY
- 29 Flatbush, Tall Residential Building (Groundwater Studies, RIR and RAWP), Brooklyn, NY
- Gowanus Village I (BCP, RIWP and RIR), Brooklyn, NY
- Sullivan Street Hotel (Site Characterization Study and Owner Representation), New York, NY
- Riker’s Island Co-Generation Plant (Soil and Soil Vapor Quality Investigations), Bronx, NY
- The Shops at Atlas Park (Sub-Slab Depressurization and Vapor Barrier Design), Glendale, NY
- Memorial Sloan-Kettering Cancer Center (Subsurface and Soil Vapor Intrusion Investigations), New York, NY
- Element West 59th Street (Oversight and Monitoring of Sub-Slab Depressurization and Vapor Barrier Systems), New York, NY
- Teterboro Airport (Delineation and Remedial Oversight of Petroleum-Contaminated Soils), Teterboro, NJ
- Proposed New York JETS Stadium (Phase I ESA), New York, NY
- Former Con Edison Manufactured Gas Plant Sites (Research Reports), New York, NY
- 7 World Trade Center (Endpoint Sampling and Final Closure Report), New York, NY
- Peter Cooper Village, Environmental Subsurface Investigations, New York, NY

Selected Publications, Reports, and Presentations

NYC Mayor’s Office of Environmental Remediation – Big Apple Brownfield Workshop – Presented on Soil Vapor Intrusion Remedies (e.g., SSD Systems, Vapor Barriers, Modified HVAC)

New York City Brownfield Partnership – Presented on environmental considerations and complications of the Hudson Yards Development

Waterfront Development Technical Course – Presented on Impacted Waterfront Planning Considerations

Emily G. Strake

Project Chemist/ Risk Assessor
Environmental Engineering

17 years in the industry

Ms. Strake has 17 years of environmental chemistry, risk assessment, auditing, and quality assurance experience. Most recently, she has focused her efforts on human health risk assessment, and has been the primary author or key contributor of risk assessment reports and screening evaluations for projects governed under RCRA, CERCLA, NJDEP, DNREC, SWRCB, DTSC, PADEP, CTDEEP, ODEQ, NYSDEC and MDE. She has experience in site-specific strategy development, which has enabled her to perform assessments to focus areas of investigation and identify risk-based alternatives for reducing remediation costs. Ms. Strake is a member of the Interstate Technology and Regulatory Council Risk Assessment Team responsible for the development and review of organizational risk assessment guidance documents and serves as a National Trainer in risk assessment for the organization.

Ms. Strake has extensive experience in environmental data validation, focused on ensuring laboratory deliverables follow specific guidelines as described by regulatory agencies and the analytical methods employed. In addition, she has experience in EQuIS chemical database management. She also has a broad range of environmental field experience and maintains current OSHA HAZWOPER certification. Ms. Strake is experienced in auditing laboratory and field-sampling activities for compliance with Quality Assurance Project Plans (QAPPs), the National Environmental Laboratory Accreditation Conference Standards Quality Systems manual, and applicable USEPA Guidance. Ms. Strake has also audited on-site laboratories in support of groundwater treatment operations and implemented corrective actions. Her responsibilities include writing reports on the value of laboratory work, writing/editing QAPPs for clients and project-specific sites, peer reviewing colleague's work, and mentoring staff within the office. She has also served as the Quality Assurance officer for several long-term projects, responsible for the achievement of all forms of Quality Control/Quality Assurance by onsite personnel relating to sampling, analysis, and data evaluation.

Selected Project Experience

- Major League Soccer's San Jose Earthquakes Stadium, Santa Clara, CA DuPont, Waynesboro, VA
- PECO/Exelon, Various Locations
- Texas Instruments, San Francisco, CA
- Regency, Philadelphia, PA
- Veteran's Affairs, Palo Alto, CA
- DOW Chemical, Various Locations
- Avon, Rye, NY
- Golden Gate National Parks Conservancy, San Francisco, CA
- Sunoco Refineries, Various Locations
- Honeywell, Highland Park, NJ
- Delaware City Refinery, DE
- Occidental Chemical, Bakersfield, CA

Education

MBA
The University of Scranton

B.S., Chemistry
Cedar Crest College

Professional Licenses

Board Certified Environmental Professional (CEP)

Training

40 hr. OSHA HAZWOPER Training/Nov 2002

8 hr. HAZWOPER Supervisor/June 2004

8 hr. OSHA HAZWOPER Refresher/2013

Affiliations

The Society for Risk Analysis

Interstate Technology and Regulatory Council

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ATTACHMENT B
Laboratory Reporting Limits and Method Detection Limits

ATTACHMENT B

AIR SAMPLES
LABORATORY REPORTING LIMITS AND METHOD DETECTION LIMITS

Method	Matrix	Analyte	RL	MDL	Units	RL	MDL	Units
Volatile Organic Compounds								
EPA TO-15	Air	1,1,1,2-Tetrachloroethane	1.37	0.38	ug/m^3	0.2	0.0547	ppbV
EPA TO-15	Air	1,1,1-Trichloroethane	1.09	0.31	ug/m^3	0.2	0.057	ppbV
EPA TO-15	Air	1,1,2,2-Tetrachloroethane	1.37	0.38	ug/m^3	0.2	0.0548	ppbV
EPA TO-15	Air	1,1,2-Trichloro-1,2,2-Trifluoroethane	1.53	0.39	ug/m^3	0.2	0.0511	ppbV
EPA TO-15	Air	1,1,2-Trichloroethane	1.09	0.36	ug/m^3	0.2	0.0667	ppbV
EPA TO-15	Air	1,1-Dichloroethane	0.81	0.31	ug/m^3	0.2	0.0771	ppbV
EPA TO-15	Air	1,1-Dichloroethene	0.79	0.22	ug/m^3	0.2	0.0566	ppbV
EPA TO-15	Air	1,1-Dichloropropene	0.91	0.32	ug/m^3	0.2	0.0715	ppbV
EPA TO-15	Air	1,2,3-Trichlorobenzene	1.48	0.32	ug/m^3	0.2	0.0436	ppbV
EPA TO-15	Air	1,2,3-Trichloropropane	1.21	0.46	ug/m^3	0.2	0.0767	ppbV
EPA TO-15	Air	1,2,3-Trimethylbenzene	0.98	0.37	ug/m^3	0.2	0.0751	ppbV
EPA TO-15	Air	1,2,4,5-Tetramethylbenzene	1.1	0.44	ug/m^3	0.2	0.0795	ppbV
EPA TO-15	Air	1,2,4-Trichlorobenzene	1.48	0.45	ug/m^3	0.2	0.0611	ppbV
EPA TO-15	Air	1,2,4-Trimethylbenzene	0.98	0.34	ug/m^3	0.2	0.0694	ppbV
EPA TO-15	Air	1,2-Dibromo-3-chloropropane	1.93	0.72	ug/m^3	0.2	0.0744	ppbV
EPA TO-15	Air	1,2-Dibromoethane	1.54	0.6	ug/m^3	0.2	0.0779	ppbV
EPA TO-15	Air	1,2-Dichloro-1,1,2,2-tetrafluoroethane	1.4	0.29	ug/m^3	0.2	0.0419	ppbV
EPA TO-15	Air	1,2-Dichlorobenzene	1.2	0.37	ug/m^3	0.2	0.0614	ppbV
EPA TO-15	Air	1,2-Dichloroethane	0.81	0.22	ug/m^3	0.2	0.0552	ppbV
EPA TO-15	Air	1,2-Dichloroethene (total)	0.79	0.23	ug/m^3	0.2	0.0587	ppbV
EPA TO-15	Air	1,2-Dichloropropane	0.92	0.32	ug/m^3	0.2	0.0697	ppbV
EPA TO-15	Air	1,3,5-Trimethylbenzene	0.98	0.29	ug/m^3	0.2	0.0584	ppbV
EPA TO-15	Air	1,3-Butadiene	0.44	0.18	ug/m^3	0.2	0.0799	ppbV
EPA TO-15	Air	1,3-Dichlorobenzene	1.2	0.38	ug/m^3	0.2	0.0637	ppbV
EPA TO-15	Air	1,3-Dichloropropane	0.92	0.36	ug/m^3	0.2	0.0776	ppbV
EPA TO-15	Air	1,3-Dichloropropene, Total	0.91	0.31	ug/m^3	0.2	0.0693	ppbV
EPA TO-15	Air	1,4-Dichlorobenzene	1.2	0.25	ug/m^3	0.2	0.0418	ppbV
EPA TO-15	Air	1,4-Dioxane	0.72	0.28	ug/m^3	0.2	0.078	ppbV
EPA TO-15	Air	1-Methylnaphthalene	5.82	1.66	ug/m^3	1	0.286	ppbV
EPA TO-15	Air	2,2,4-Trimethylpentane	0.93	0.31	ug/m^3	0.2	0.0659	ppbV
EPA TO-15	Air	2,2-Dichloropropane	0.92	0.27	ug/m^3	0.2	0.0581	ppbV
EPA TO-15	Air	2-Butanone	1.47	0.15	ug/m^3	0.5	0.0522	ppbV
EPA TO-15	Air	2-Ethylthiophene	0.92	0.26	ug/m^3	0.2	0.0571	ppbV
EPA TO-15	Air	2-Hexanone	0.82	0.25	ug/m^3	0.2	0.0604	ppbV
EPA TO-15	Air	2-Methylnaphthalene	5.82	0.16	ug/m^3	1	0.0273	ppbV
EPA TO-15	Air	2-Methylthiophene	0.8	0.32	ug/m^3	0.2	0.0789	ppbV
EPA TO-15	Air	3-Chloropropene	0.63	0.25	ug/m^3	0.2	0.0812	ppbV
EPA TO-15	Air	3-Methylthiophene	0.8	0.27	ug/m^3	0.2	0.0669	ppbV
EPA TO-15	Air	4-Ethyltoluene	0.98	0.38	ug/m^3	0.2	0.0776	ppbV
EPA TO-15	Air	4-Methyl-2-pentanone	2.05	0.25	ug/m^3	0.5	0.0607	ppbV
EPA TO-15	Air	Acetaldehyde	4.5	0.99	ug/m^3	2.5	0.547	ppbV
EPA TO-15	Air	Acetone	2.38	0.64	ug/m^3	1	0.269	ppbV
EPA TO-15	Air	Acetonitrile	0.34	0.13	ug/m^3	0.2	0.0761	ppbV
EPA TO-15	Air	Acrolein	1.15	0.26	ug/m^3	0.5	0.114	ppbV
EPA TO-15	Air	Acrylonitrile	1.09	0.17	ug/m^3	0.5	0.079	ppbV
EPA TO-15	Air	Benzene	0.64	0.17	ug/m^3	0.2	0.0537	ppbV
EPA TO-15	Air	Benzothiophene	2.74	0.26	ug/m^3	0.5	0.0468	ppbV
EPA TO-15	Air	Benzyl chloride	1.04	0.33	ug/m^3	0.2	0.0645	ppbV
EPA TO-15	Air	Bromobenzene	0.79	0.31	ug/m^3	0.2	0.079	ppbV
EPA TO-15	Air	Bromodichloromethane	1.34	0.44	ug/m^3	0.2	0.0656	ppbV
EPA TO-15	Air	Bromoform	2.07	0.54	ug/m^3	0.2	0.0523	ppbV
EPA TO-15	Air	Bromomethane	0.78	0.27	ug/m^3	0.2	0.0696	ppbV
EPA TO-15	Air	Butane	0.48	0.11	ug/m^3	0.2	0.0442	ppbV
EPA TO-15	Air	Butyl Acetate	2.38	0.54	ug/m^3	0.5	0.114	ppbV
EPA TO-15	Air	Carbon disulfide	0.62	0.11	ug/m^3	0.2	0.0345	ppbV
EPA TO-15	Air	Carbon tetrachloride	1.26	0.3	ug/m^3	0.2	0.0471	ppbV
EPA TO-15	Air	Chlorobenzene	0.92	0.36	ug/m^3	0.2	0.0789	ppbV
EPA TO-15	Air	Chlorodifluoromethane	0.71	0.22	ug/m^3	0.2	0.0626	ppbV

ATTACHMENT B

AIR SAMPLES
LABORATORY REPORTING LIMITS AND METHOD DETECTION LIMITS

Method	Matrix	Analyte	RL	MDL	Units	RL	MDL	Units
EPA TO-15	Air	Chloroethane	0.53	0.2	ug/m^3	0.2	0.0767	ppbV
EPA TO-15	Air	Chloroform	0.98	0.22	ug/m^3	0.2	0.0452	ppbV
EPA TO-15	Air	Chloromethane	0.41	0.2	ug/m^3	0.2	0.0958	ppbV
EPA TO-15	Air	cis-1,2-Dichloroethene	0.79	0.23	ug/m^3	0.2	0.0587	ppbV
EPA TO-15	Air	cis-1,3-Dichloropropene	0.91	0.34	ug/m^3	0.2	0.0745	ppbV
EPA TO-15	Air	Cyclohexane	0.69	0.23	ug/m^3	0.2	0.0656	ppbV
EPA TO-15	Air	Decane (C10)	1.16	0.28	ug/m^3	0.2	0.0484	ppbV
EPA TO-15	Air	Dibromochloromethane	1.7	0.64	ug/m^3	0.2	0.0747	ppbV
EPA TO-15	Air	Dibromomethane	1.42	0.34	ug/m^3	0.2	0.0476	ppbV
EPA TO-15	Air	Dichlorodifluoromethane	0.99	0.23	ug/m^3	0.2	0.0466	ppbV
EPA TO-15	Air	Dichlorofluoromethane	0.84	0.24	ug/m^3	0.2	0.0572	ppbV
EPA TO-15	Air	Dodecane (C12)	1.39	0.39	ug/m^3	0.2	0.0564	ppbV
EPA TO-15	Air	Ethyl Acetate	1.8	0.47	ug/m^3	0.5	0.131	ppbV
EPA TO-15	Air	Ethyl Alcohol	4.71	1.02	ug/m^3	2.5	0.542	ppbV
EPA TO-15	Air	Ethyl ether	0.61	0.18	ug/m^3	0.2	0.0591	ppbV
EPA TO-15	Air	Ethylbenzene	0.87	0.24	ug/m^3	0.2	0.0555	ppbV
EPA TO-15	Air	Ethyl-Tert-Butyl-Ether	0.84	0.22	ug/m^3	0.2	0.0515	ppbV
EPA TO-15	Air	Heptane	0.82	0.23	ug/m^3	0.2	0.0553	ppbV
EPA TO-15	Air	Hexachlorobutadiene	2.13	0.78	ug/m^3	0.2	0.0732	ppbV
EPA TO-15	Air	Indane	0.97	0.38	ug/m^3	0.2	0.0795	ppbV
EPA TO-15	Air	Indene	0.95	0.29	ug/m^3	0.2	0.0608	ppbV
EPA TO-16	Air	iso-Propyl Alcohol	1.23	0.28	ug/m^3	0.5	0.114	ppbV
EPA TO-17	Air	Isopropyl Ether	0.84	0.27	ug/m^3	0.2	0.0656	ppbV
EPA TO-18	Air	Isopropylbenzene	0.98	0.21	ug/m^3	0.2	0.043	ppbV
EPA TO-19	Air	Methanol	6.55	0.96	ug/m^3	5	0.736	ppbV
EPA TO-20	Air	Methyl Methacrylate	2.05	0.61	ug/m^3	0.5	0.148	ppbV
EPA TO-21	Air	Methyl tert butyl ether	0.72	0.16	ug/m^3	0.2	0.0452	ppbV
EPA TO-22	Air	Methylene chloride	1.74	0.65	ug/m^3	0.5	0.188	ppbV
EPA TO-23	Air	Naphthalene	1.05	0.23	ug/m^3	0.2	0.0432	ppbV
EPA TO-24	Air	n-Butylbenzene	1.1	0.35	ug/m^3	0.2	0.0639	ppbV
EPA TO-25	Air	n-Heptane	0.82	0.23	ug/m^3	0.2	0.0553	ppbV
EPA TO-26	Air	n-Hexane	0.7	0.18	ug/m^3	0.2	0.0518	ppbV
EPA TO-27	Air	Nonane (C9)	1.05	0.34	ug/m^3	0.2	0.0644	ppbV
EPA TO-28	Air	n-Propylbenzene	0.98	0.27	ug/m^3	0.2	0.0559	ppbV
EPA TO-29	Air	o-Chlorotoluene	1.04	0.25	ug/m^3	0.2	0.0487	ppbV
EPA TO-30	Air	Octane	0.93	0.2	ug/m^3	0.2	0.0421	ppbV
EPA TO-31	Air	o-Xylene	0.87	0.27	ug/m^3	0.2	0.0631	ppbV
EPA TO-32	Air	p/m-Xylene	1.74	0.6	ug/m^3	0.4	0.139	ppbV
EPA TO-33	Air	p-Chlorotoluene	1.04	0.4	ug/m^3	0.2	0.0764	ppbV
EPA TO-34	Air	Pentane	0.59	0.14	ug/m^3	0.2	0.0475	ppbV
EPA TO-35	Air	p-Isopropyltoluene	1.1	0.33	ug/m^3	0.2	0.0608	ppbV
EPA TO-36	Air	Propane	0.9	0.21	ug/m^3	0.5	0.114	ppbV
EPA TO-37	Air	Propylene	0.86	0.16	ug/m^3	0.5	0.0929	ppbV
EPA TO-38	Air	sec-Butylbenzene	1.1	0.4	ug/m^3	0.2	0.0731	ppbV
EPA TO-39	Air	Styrene	0.85	0.34	ug/m^3	0.2	0.0799	ppbV
EPA TO-40	Air	tert-Butyl Alcohol	1.52	0.18	ug/m^3	0.5	0.0599	ppbV
EPA TO-41	Air	tert-Butylbenzene	1.1	0.22	ug/m^3	0.2	0.0402	ppbV
EPA TO-42	Air	Tertiary-Amyl Methyl Ether	0.84	0.33	ug/m^3	0.2	0.0795	ppbV
EPA TO-43	Air	Tetrachloroethene	1.36	0.51	ug/m^3	0.2	0.0758	ppbV
EPA TO-44	Air	Tetrahydrofuran	1.47	0.18	ug/m^3	0.5	0.0622	ppbV
EPA TO-45	Air	Thiophene	0.69	0.18	ug/m^3	0.2	0.0528	ppbV
EPA TO-46	Air	Toluene	0.75	0.24	ug/m^3	0.2	0.0628	ppbV
EPA TO-47	Air	Total HC As Hexane	39.34	0.2	ug/m^3	10	0.0518	ppbV
EPA TO-48	Air	Total VOCs As Toluene	37.69	0.24	ug/m^3	10	0.0628	ppbV
EPA TO-49	Air	trans-1,2-Dichloroethene	0.79	0.29	ug/m^3	0.2	0.074	ppbV
EPA TO-50	Air	trans-1,3-Dichloropropene	0.91	0.31	ug/m^3	0.2	0.0693	ppbV
EPA TO-51	Air	Trichloroethene	1.07	0.38	ug/m^3	0.2	0.071	ppbV
EPA TO-52	Air	Trichlorofluoromethane	1.12	0.23	ug/m^3	0.2	0.0416	ppbV
EPA TO-53	Air	Undecane	1.28	0.34	ug/m^3	0.2	0.0528	ppbV
EPA TO-54	Air	Vinyl acetate	3.52	0.2	ug/m^3	1	0.0567	ppbV
EPA TO-55	Air	Vinyl bromide	0.87	0.31	ug/m^3	0.2	0.0699	ppbV
EPA TO-56	Air	Vinyl chloride	0.51	0.14	ug/m^3	0.2	0.0533	ppbV
EPA TO-57	Air	Xylene (Total)	0.87	0.27	ug/m^3	0.2	0.0631	ppbV

ATTACHMENT B

GROUNDWATER SAMPLES
LABORATORY REPORTING LIMITS AND METHOD DETECTION LIMITS

Method	Matrix	Analyte	RL	MDL	Units
		Volatile Organic Compounds			
EPA 8260C	Groundwater	1,1,1,2-Tetrachloroethane	0.5	0.164	ug/L
EPA 8260C	Groundwater	1,1,1-Trichloroethane	0.5	0.158	ug/L
EPA 8260C	Groundwater	1,1,2,2-Tetrachloroethane	0.5	0.144	ug/L
EPA 8260C	Groundwater	1,1,2-Trichloro-1,2,2-Trifluoroethane	10	0.148	ug/L
EPA 8260C	Groundwater	1,1,2-Trichloroethane	0.75	0.144	ug/L
EPA 8260C	Groundwater	1,1-Dichloroethane	0.75	0.21	ug/L
EPA 8260C	Groundwater	1,1-Dichloroethene	0.5	0.142	ug/L
EPA 8260C	Groundwater	1,1-Dichloropropene	2.5	0.173	ug/L
EPA 8260C	Groundwater	1,2,3-Trichlorobenzene	2.5	0.234	ug/L
EPA 8260C	Groundwater	1,2,3-Trichloropropane	5	0.176	ug/L
EPA 8260C	Groundwater	1,2,4,5-Tetramethylbenzene	2	0.542	ug/L
EPA 8260C	Groundwater	1,2,4-Trichlorobenzene	2.5	0.22	ug/L
EPA 8260C	Groundwater	1,2,4-Trimethylbenzene	2.5	0.191	ug/L
EPA 8260C	Groundwater	1,2-Dibromo-3-chloropropane	2.5	0.327	ug/L
EPA 8260C	Groundwater	1,2-Dibromoethane	2	0.193	ug/L
EPA 8260C	Groundwater	1,2-Dichlorobenzene	2.5	0.184	ug/L
EPA 8260C	Groundwater	1,2-Dichloroethane	0.5	0.132	ug/L
EPA 8260C	Groundwater	1,2-Dichloropropane	1.75	0.133	ug/L
EPA 8260C	Groundwater	1,3,5-Trimethylbenzene	2.5	0.174	ug/L
EPA 8260C	Groundwater	1,3-Dichlorobenzene	2.5	0.186	ug/L
EPA 8260C	Groundwater	1,3-Dichloropropane	2.5	0.212	ug/L
EPA 8260C	Groundwater	1,4-Dichlorobenzene	2.5	0.187	ug/L
EPA 8260C	Groundwater	1,4-Diethylbenzene	2	0.392	ug/L
EPA 8270 SIM Isotope Dilution	Groundwater	1,4-Dioxane	0.15	0.075	ug/L
EPA 8260C	Groundwater	2,2-Dichloropropane	2.5	0.204	ug/L
EPA 8260C	Groundwater	2-Butanone	5	1.94	ug/L
EPA 8260C	Groundwater	2-Hexanone	5	0.515	ug/L
EPA 8260C	Groundwater	4-Ethyltoluene	2	0.34	ug/L
EPA 8260C	Groundwater	4-Methyl-2-pentanone	5	0.416	ug/L
EPA 8260C	Groundwater	Acetone	5	1.46	ug/L
EPA 8260C	Groundwater	Acrolein	5	0.633	ug/L
EPA 8260C	Groundwater	Acrylonitrile	5	0.43	ug/L
EPA 8260C	Groundwater	Benzene	0.5	0.159	ug/L
EPA 8260C	Groundwater	Bromobenzene	2.5	0.152	ug/L
EPA 8260C	Groundwater	Bromochloromethane	2.5	0.138	ug/L
EPA 8260C	Groundwater	Bromodichloromethane	0.5	0.192	ug/L
EPA 8260C	Groundwater	Bromoform	2	0.248	ug/L
EPA 8260C	Groundwater	Bromomethane	1	0.256	ug/L
EPA 8260C	Groundwater	Carbon disulfide	5	0.299	ug/L
EPA 8260C	Groundwater	Carbon tetrachloride	0.5	0.134	ug/L
EPA 8260C	Groundwater	Chlorobenzene	0.5	0.178	ug/L
EPA 8260C	Groundwater	Chloroethane	1	0.134	ug/L
EPA 8260C	Groundwater	Chloroform	0.75	0.162	ug/L
EPA 8260C	Groundwater	Chloromethane	2.5	0.176	ug/L
EPA 8260C	Groundwater	cis-1,2-Dichloroethene	0.5	0.187	ug/L
EPA 8260C	Groundwater	cis-1,3-Dichloropropene	0.5	0.144	ug/L
EPA 8260C	Groundwater	Cyclohexane	10	0.271	ug/L
EPA 8260C	Groundwater	Dibromochloromethane	0.5	0.149	ug/L
EPA 8260C	Groundwater	Dibromomethane	5	0.363	ug/L
EPA 8260C	Groundwater	Dichlorodifluoromethane	5	0.245	ug/L
EPA 8260C	Groundwater	Ethyl ether	2.5	0.15	ug/L
EPA 8260C	Groundwater	Ethylbenzene	0.5	0.168	ug/L
EPA 8260C	Groundwater	Hexachlorobutadiene	0.5	0.217	ug/L
EPA 8260C	Groundwater	Isopropylbenzene	0.5	0.187	ug/L
EPA 8260C	Groundwater	Methyl Acetate	10	0.234	ug/L
EPA 8260C	Groundwater	Methyl cyclohexane	10	0.396	ug/L
EPA 8260C	Groundwater	Methyl tert butyl ether	1	0.16	ug/L
EPA 8260C	Groundwater	Methylene chloride	3	0.289	ug/L
EPA 8260C	Groundwater	Naphthalene	2.5	0.216	ug/L
EPA 8260C	Groundwater	n-Butylbenzene	0.5	0.192	ug/L
EPA 8260C	Groundwater	n-Propylbenzene	0.5	0.173	ug/L
EPA 8260C	Groundwater	o-Chlorotoluene	2.5	0.17	ug/L
EPA 8260C	Groundwater	o-Xylene	1	0.33	ug/L
EPA 8260C	Groundwater	p/m-Xylene	1	0.332	ug/L
EPA 8260C	Groundwater	p-Chlorotoluene	2.5	0.185	ug/L
EPA 8260C	Groundwater	p-Isopropyltoluene	0.5	0.188	ug/L
EPA 8260C	Groundwater	sec-Butylbenzene	0.5	0.181	ug/L
EPA 8260C	Groundwater	Styrene	1	0.359	ug/L
EPA 8260C	Groundwater	tert-Butyl Alcohol	10	0.899	ug/L
EPA 8260C	Groundwater	tert-Butylbenzene	2.5	0.185	ug/L
EPA 8260C	Groundwater	Tetrachloroethene	0.5	0.181	ug/L
EPA 8260C	Groundwater	Toluene	0.75	0.161	ug/L
EPA 8260C	Groundwater	trans-1,2-Dichloroethene	0.75	0.163	ug/L
EPA 8260C	Groundwater	trans-1,3-Dichloropropene	0.5	0.164	ug/L
EPA 8260C	Groundwater	trans-1,4-Dichloro-2-butene	2.5	0.173	ug/L
EPA 8260C	Groundwater	Trichloroethene	0.5	0.175	ug/L
EPA 8260C	Groundwater	Trichlorofluoromethane	2.5	0.161	ug/L
EPA 8260C	Groundwater	Vinyl acetate	5	0.311	ug/L
EPA 8260C	Groundwater	Vinyl chloride	1	0.0699	ug/L
EPA 8260C	Groundwater	Xylenes, Total	1	0.33	ug/L

ATTACHMENT B

GROUNDWATER SAMPLES
LABORATORY REPORTING LIMITS AND METHOD DETECTION LIMITS

Method	Matrix	Analyte	RL	MDL	Units
		Semivolatile Organic Compounds			
EPA 8270D	Groundwater	1,2,4,5-Tetrachlorobenzene	10	0.357	ug/L
EPA 8270D	Groundwater	1,2,4-Trichlorobenzene	5	0.21	ug/L
EPA 8270D	Groundwater	1,2-Dichlorobenzene	2	0.302	ug/L
EPA 8270D	Groundwater	1,3-Dichlorobenzene	2	0.35	ug/L
EPA 8270D	Groundwater	1,4-Dichlorobenzene	2	0.323	ug/L
EPA 8270D	Groundwater	2,3,4,6-Tetrachlorophenol	5	0.59	ug/L
EPA 8270D	Groundwater	2,4,5-Trichlorophenol	5	0.748	ug/L
EPA 8270D	Groundwater	2,4,6-Trichlorophenol	5	0.775	ug/L
EPA 8270D	Groundwater	2,4-Dichlorophenol	5	0.564	ug/L
EPA 8270D	Groundwater	2,4-Dimethylphenol	5	0.578	ug/L
EPA 8270D	Groundwater	2,4-Dinitrophenol	20	1.4081	ug/L
EPA 8270D	Groundwater	2,4-Dinitrotoluene	5	1.05	ug/L
EPA 8270D	Groundwater	2,6-Dinitrotoluene	5	0.89	ug/L
EPA 8270D	Groundwater	2-Chloronaphthalene	2	0.455	ug/L
EPA 8270D	Groundwater	2-Chlorophenol	2	0.58	ug/L
EPA 8270D	Groundwater	2-Methylnaphthalene	2	0.355	ug/L
EPA 8270D	Groundwater	2-Methylphenol	5	0.703	ug/L
EPA 8270D	Groundwater	2-Nitroaniline	5	0.956	ug/L
EPA 8270D	Groundwater	2-Nitrophenol	10	1.05	ug/L
EPA 8270D	Groundwater	3,3'-Dichlorobenzidine	5	0.478	ug/L
EPA 8270D	Groundwater	3-Methylphenol/4-Methylphenol	5	0.72	ug/L
EPA 8270D	Groundwater	3-Nitroaniline	5	0.668	ug/L
EPA 8270D	Groundwater	4,6-Dinitro-o-cresol	10	1.36	ug/L
EPA 8270D	Groundwater	4-Bromophenyl phenyl ether	2	0.428	ug/L
EPA 8270D	Groundwater	4-Chloroaniline	5	0.835	ug/L
EPA 8270D	Groundwater	4-Chlorophenyl phenyl ether	2	0.355	ug/L
EPA 8270D	Groundwater	4-Nitroaniline	5	0.83	ug/L
EPA 8270D	Groundwater	4-Nitrophenol	10	1.09	ug/L
EPA 8270D	Groundwater	Acenaphthene	2	0.284	ug/L
EPA 8270D	Groundwater	Acenaphthylene	2	0.372	ug/L
EPA 8270D	Groundwater	Acetophenone	5	0.428	ug/L
EPA 8270D	Groundwater	Anthracene	2	0.2	ug/L
EPA 8270D	Groundwater	Atrazine	10	0.794	ug/L
EPA 8270D	Groundwater	Azobenzene	2	0.537	ug/L
EPA 8270D	Groundwater	Benzaldehyde	5	0.986	ug/L
EPA 8270D	Groundwater	Benzidine	20	5.24	ug/L
EPA 8270D	Groundwater	Benzo(a)anthracene	2	0.323	ug/L
EPA 8270D	Groundwater	Benzo(a)pyrene	2	0.658	ug/L
EPA 8270D	Groundwater	Benzo(b)fluoranthene	2	0.371	ug/L
EPA 8270D	Groundwater	Benzo(ghi)perylene	2	0.574	ug/L
EPA 8270D	Groundwater	Benzo(k)fluoranthene	2	0.3	ug/L
EPA 8270D	Groundwater	Benzoic Acid	50	1.0104	ug/L
EPA 8270D	Groundwater	Benzyl Alcohol	2	0.677	ug/L
EPA 8270D	Groundwater	Biphenyl	2	0.237	ug/L
EPA 8270D	Groundwater	Bis(2-chloroethoxy)methane	5	0.596	ug/L
EPA 8270D	Groundwater	Bis(2-chloroethyl)ether	2	0.409	ug/L
EPA 8270D	Groundwater	Bis(2-chloroisopropyl)ether	2	0.597	ug/L
EPA 8270D	Groundwater	Bis(2-Ethylhexyl)phthalate	3	0.928	ug/L
EPA 8270D	Groundwater	Butyl benzyl phthalate	5	1.13	ug/L
EPA 8270D	Groundwater	Caprolactam	10	0.3895	ug/L
EPA 8270D	Groundwater	Carbazole	2	0.374	ug/L
EPA 8270D	Groundwater	Chrysene	2	0.304	ug/L
EPA 8270D	Groundwater	Dibenzo(a,h)anthracene	2	0.438	ug/L
EPA 8270D	Groundwater	Dibenzofuran	2	0.218	ug/L
EPA 8270D	Groundwater	Diethyl phthalate	5	0.393	ug/L
EPA 8270D	Groundwater	Dimethyl phthalate	5	0.333	ug/L
EPA 8270D	Groundwater	Di-n-butylphthalate	5	0.768	ug/L
EPA 8270D	Groundwater	Di-n-octylphthalate	5	1.2	ug/L
EPA 8270D	Groundwater	Fluoranthene	2	0.401	ug/L
EPA 8270D	Groundwater	Fluorene	2	0.32	ug/L
EPA 8270D	Groundwater	Hexachlorobenzene	2	0.396	ug/L
EPA 8270D	Groundwater	Hexachlorobutadiene	2	0.417	ug/L
EPA 8270D	Groundwater	Hexachlorocyclopentadiene	20	0.585	ug/L
EPA 8270D	Groundwater	Hexachloroethane	2	0.298	ug/L
EPA 8270D	Groundwater	Indeno(1,2,3-cd)Pyrene	2	0.433	ug/L
EPA 8270D	Groundwater	Isophorone	5	0.787	ug/L
EPA 8270D	Groundwater	Naphthalene	2	0.332	ug/L
EPA 8270D	Groundwater	Nitrobenzene	2	0.401	ug/L
EPA 8270D	Groundwater	NitrosoDiPhenylAmine(NDPA)/DPA	2	0.34	ug/L
EPA 8270D	Groundwater	n-Nitrosodimethylamine	2	0.498	ug/L
EPA 8270D	Groundwater	n-Nitrosodi-n-propylamine	5	0.645	ug/L
EPA 8270D	Groundwater	P-Chloro-M-Cresol	2	0.543	ug/L
EPA 8270D	Groundwater	Pentachlorophenol	10	3.22	ug/L
EPA 8270D	Groundwater	Phenanthrene	2	0.23	ug/L
EPA 8270D	Groundwater	Phenol	5	0.27	ug/L
EPA 8270D	Groundwater	Pyrene	2	0.524	ug/L
EPA 8270D-SIM	Groundwater	2-Chloronaphthalene	0.2	0.035	ug/L
EPA 8270D-SIM	Groundwater	2-Methylnaphthalene	0.2	0.045	ug/L
EPA 8270D-SIM	Groundwater	Acenaphthene	0.2	0.035	ug/L
EPA 8270D-SIM	Groundwater	Acenaphthylene	0.2	0.035	ug/L
EPA 8270D-SIM	Groundwater	Anthracene	0.2	0.035	ug/L
EPA 8270D-SIM	Groundwater	Benzo(a)anthracene	0.2	0.016	ug/L
EPA 8270D-SIM	Groundwater	Benzo(a)pyrene	0.2	0.039	ug/L
EPA 8270D-SIM	Groundwater	Benzo(b)fluoranthene	0.2	0.016	ug/L
EPA 8270D-SIM	Groundwater	Benzo(ghi)perylene	0.2	0.042	ug/L
EPA 8270D-SIM	Groundwater	Benzo(k)fluoranthene	0.2	0.042	ug/L
EPA 8270D-SIM	Groundwater	Chrysene	0.2	0.038	ug/L
EPA 8270D-SIM	Groundwater	Dibenzo(a,h)anthracene	0.2	0.039	ug/L
EPA 8270D-SIM	Groundwater	Fluoranthene	0.2	0.038	ug/L
EPA 8270D-SIM	Groundwater	Fluorene	0.2	0.037	ug/L
EPA 8270D-SIM	Groundwater	Hexachlorobenzene	0.8	0.032	ug/L
EPA 8270D-SIM	Groundwater	Hexachlorobutadiene	0.5	0.036	ug/L
EPA 8270D-SIM	Groundwater	Hexachloroethane	0.8	0.03	ug/L
EPA 8270D-SIM	Groundwater	Indeno(1,2,3-cd)Pyrene	0.2	0.04	ug/L
EPA 8270D-SIM	Groundwater	Naphthalene	0.2	0.043	ug/L
EPA 8270D-SIM	Groundwater	Pentachlorophenol	0.8	0.22	ug/L
EPA 8270D-SIM	Groundwater	Phenanthrene	0.2	0.015	ug/L
EPA 8270D-SIM	Groundwater	Pyrene	0.2	0.04	ug/L

ATTACHMENT B

GROUNDWATER SAMPLES
LABORATORY REPORTING LIMITS AND METHOD DETECTION LIMITS

Method	Matrix	Analyte	RL	MDL	Units
		Pesticides			
EPA 8081B	Groundwater	4,4'-DDD	0.04	0.00464	ug/L
EPA 8081B	Groundwater	4,4'-DDE	0.04	0.00381	ug/L
EPA 8081B	Groundwater	4,4'-DDT	0.04	0.00432	ug/L
EPA 8081B	Groundwater	Aldrin	0.02	0.00216	ug/L
EPA 8081B	Groundwater	Alpha-BHC	0.02	0.00439	ug/L
EPA 8081B	Groundwater	Beta-BHC	0.02	0.0056	ug/L
EPA 8081B	Groundwater	Chlordane	0.2	0.0463	ug/L
EPA 8081B	Groundwater	cis-Chlordane	0.02	0.00666	ug/L
EPA 8081B	Groundwater	Delta-BHC	0.02	0.00467	ug/L
EPA 8081B	Groundwater	Dieldrin	0.04	0.00429	ug/L
EPA 8081B	Groundwater	Endosulfan I	0.02	0.00345	ug/L
EPA 8081B	Groundwater	Endosulfan II	0.04	0.00519	ug/L
EPA 8081B	Groundwater	Endosulfan sulfate	0.04	0.00481	ug/L
EPA 8081B	Groundwater	Endrin	0.04	0.00429	ug/L
EPA 8081B	Groundwater	Endrin aldehyde	0.04	0.0081	ug/L
EPA 8081B	Groundwater	Endrin ketone	0.04	0.00477	ug/L
EPA 8081B	Groundwater	Heptachlor	0.02	0.0031	ug/L
EPA 8081B	Groundwater	Heptachlor epoxide	0.02	0.00415	ug/L
EPA 8081B	Groundwater	Lindane	0.02	0.00434	ug/L
EPA 8081B	Groundwater	Methoxychlor	0.2	0.00684	ug/L
EPA 8081B	Groundwater	Toxaphene	0.2	0.0627	ug/L
EPA 8081B	Groundwater	trans-Chlordane	0.02	0.00627	ug/L
		Polychlorinated Biphenyls			
EPA 8082A	Groundwater	Aroclor 1016	0.083	0.05478	ug/L
EPA 8082A	Groundwater	Aroclor 1221	0.083	0.05312	ug/L
EPA 8082A	Groundwater	Aroclor 1232	0.083	0.03071	ug/L
EPA 8082A	Groundwater	Aroclor 1242	0.083	0.05976	ug/L
EPA 8082A	Groundwater	Aroclor 1248	0.083	0.05063	ug/L
EPA 8082A	Groundwater	Aroclor 1254	0.083	0.03403	ug/L
EPA 8082A	Groundwater	Aroclor 1260	0.083	0.03154	ug/L
EPA 8082A	Groundwater	Aroclor 1262	0.083	0.02905	ug/L
EPA 8082A	Groundwater	Aroclor 1268	0.083	0.03735	ug/L
EPA 8082A	Groundwater	PCBs, Total	0.083	0.02905	ug/L
		Herbicides			
EPA 8151A	Groundwater	2,4,5-T	2	0.531	ug/L
EPA 8151A	Groundwater	2,4,5-TP (Silvex)	2	0.539	ug/L
EPA 8151A	Groundwater	2,4-D	10	0.498	ug/L
		Metals			
EPA 6010A	Groundwater	Aluminum, Dissolved	0.01	0.00169	mg/L
EPA 6010A	Groundwater	Aluminum, Total	0.01	0.00169	mg/L
EPA 6010A	Groundwater	Antimony, Dissolved	0.0005	0.0000699	mg/L
EPA 6010A	Groundwater	Antimony, Total	0.0005	0.0000699	mg/L
EPA 6010A	Groundwater	Arsenic, Dissolved	0.0005	0.000123	mg/L
EPA 6010A	Groundwater	Arsenic, Total	0.0005	0.000123	mg/L
EPA 6010A	Groundwater	Barium, Dissolved	0.0005	0.0000625	mg/L
EPA 6010A	Groundwater	Barium, Total	0.0005	0.0000625	mg/L
EPA 6010A	Groundwater	Beryllium, Dissolved	0.0005	0.00015	mg/L
EPA 6010A	Groundwater	Beryllium, Total	0.0005	0.00015	mg/L
EPA 6010A	Groundwater	Cadmium, Dissolved	0.0002	0.00005	mg/L
EPA 6010A	Groundwater	Cadmium, Total	0.0002	0.00005	mg/L
EPA 6010A	Groundwater	Calcium, Dissolved	0.1	0.032	mg/L
EPA 6010A	Groundwater	Calcium, Total	0.1	0.032	mg/L
EPA 6010A	Groundwater	Chromium, Dissolved	0.001	0.000253	mg/L
EPA 6010A	Groundwater	Chromium, Total	0.001	0.000253	mg/L
EPA 7196A	Groundwater	Chromium, Hexavalent, Dissolved	0.01	0.003	mg/L
EPA 7196A	Groundwater	Chromium, Hexavalent, Total	0.01	0.003	mg/L
EPA 6010A	Groundwater	Cobalt, Dissolved	0.0002	0.0000621	mg/L
EPA 6010A	Groundwater	Cobalt, Total	0.0002	0.0000621	mg/L
EPA 6010A	Groundwater	Copper, Dissolved	0.001	0.000262	mg/L
EPA 6010A	Groundwater	Copper, Total	0.001	0.000262	mg/L
EPA 6010A	Groundwater	Iron, Dissolved	0.05	0.012	mg/L
EPA 6010A	Groundwater	Iron, Total	0.05	0.012	mg/L
EPA 6010A	Groundwater	Lead, Dissolved	0.001	0.000129	mg/L
EPA 6010A	Groundwater	Lead, Total	0.001	0.000129	mg/L
EPA 6010A	Groundwater	Magnesium, Dissolved	0.07	0.0223	mg/L
EPA 6010A	Groundwater	Magnesium, Total	0.07	0.0223	mg/L
EPA 6010A	Groundwater	Manganese, Dissolved	0.001	0.000302	mg/L
EPA 6010A	Groundwater	Manganese, Total	0.001	0.000302	mg/L
EPA 7470A	Groundwater	Mercury, Dissolved	0.0002	0.000066	mg/L
EPA 7470A	Groundwater	Mercury, Total	0.0002	0.000066	mg/L
EPA 6010A	Groundwater	Nickel, Dissolved	0.0005	0.0000865	mg/L
EPA 6010A	Groundwater	Nickel, Total	0.0005	0.0000865	mg/L
EPA 6010A	Groundwater	Potassium, Dissolved	0.1	0.0193	mg/L
EPA 6010A	Groundwater	Potassium, Total	0.1	0.0193	mg/L
EPA 6010A	Groundwater	Selenium, Dissolved	0.005	0.001	mg/L
EPA 6010A	Groundwater	Selenium, Total	0.005	0.001	mg/L
EPA 6010A	Groundwater	Silver, Dissolved	0.00025	0.0000779	mg/L
EPA 6010A	Groundwater	Silver, Total	0.00025	0.0000779	mg/L
EPA 6010A	Groundwater	Sodium, Dissolved	0.1	0.0161	mg/L
EPA 6010A	Groundwater	Sodium, Total	0.1	0.0161	mg/L
EPA 6010A	Groundwater	Thallium, Dissolved	0.0002	0.0000566	mg/L
EPA 6010A	Groundwater	Thallium, Total	0.0002	0.0000566	mg/L
EPA 6010A	Groundwater	Vanadium, Dissolved	0.005	0.000551	mg/L
EPA 6010A	Groundwater	Vanadium, Total	0.005	0.000551	mg/L
EPA 6010A	Groundwater	Zinc, Dissolved	0.01	0.00256	mg/L
EPA 6010A	Groundwater	Zinc, Total	0.01	0.00256	mg/L
		Other			
SM21 5210B	Groundwater	Biological Oxygen Demand	2	1.1	mg/L
SM21 5220C	Groundwater	Chemical Oxygen Demand	20	5.7	mg/L
SM21 5310B, SW8469060	Groundwater	Total Organic Carbon	1	0.35	mg/L
ASTM516-90,02	Groundwater	Sulfate	5	1.1	mg/L
SM21 4500 S F	Groundwater	Sulfide	2	0.94	mg/L
EPA 353.2	Groundwater	Nitrate	0.1	0.018	mg/L
SM 21 4500 NO2 B	Groundwater	Nitrite	0.1	0.001	mg/L
EPA 365.4/4500PE	Groundwater	Total Phosphorous	0.1	0.04	mg/L
SM18 4500 NH3F	Groundwater	Ammonia	0.1	0.034	mg/L
N/A	Groundwater	Naphthalene Dioxygenase (NAH)	100	5000	cells/mL
N/A	Groundwater	Napthalene Inducible Dioxygenase (NIDA)	100	5000	cells/mL
N/A	Groundwater	Phenol Hydroxylase (PHE)	100	5000	cells/mL
N/A	Groundwater	Naphthyl-2-methyl-succinate synthase (NMS)	100	5000	cells/mL
N/A	Groundwater	Naphthalene Carboxylase (ANC)	100	5000	cells/mL

York Analvtical Laboratories. Inc.

2/17/2020

Analytical Method Information

PFAS Target compounds by LC/MS-MS

Analyte	MDL	Reporting Limit	Surrogate %R	Duplicate RPD	Matrix Spike %R	Matrix Spike RPD	Blank Spike / LCS %R	Blank Spike / LCS RPD
PFAS, NYSDEC Target List in Water (EPA 537m)					Units:	ng/L		
Preservation: Cool 4°C					**Hold Time to Analysis**		28 days	
Container: 10_250mL Plastic Cool to 4° C		**Amount Required:**	250 mL		**Hold Time to Extr.**		14 days	
1H,1H,2H,2H-Perfluorodecanesulfonic acid (8:2 FTS)	0.399	2.00 ng/L		30	25 - 150	35	50 - 130	30
1H,1H,2H,2H-Perfluorooctanesulfonic acid (6:2 FTS)	0.492	5.00 ng/L		30	25 - 150	35	50 - 130	30
N-EtFOSAA	0.557	2.00 ng/L		30	25 - 150	35	50 - 130	30
N-MeFOSAA	0.529	2.00 ng/L		30	25 - 150	35	50 - 130	30
Perfluoro-1-decanesulfonic acid (PFDS)	0.574	2.00 ng/L		30	25 - 150	35	50 - 130	30
Perfluoro-1-heptanesulfonic acid (PFHpS)	0.415	2.00 ng/L		30	25 - 150	35	50 - 130	30
Perfluoro-1-octanesulfonamide (FOSA)	0.296	2.00 ng/L		30	25 - 150	35	50 - 130	30
Perfluorobutanesulfonic acid (PFBS)	0.294	2.00 ng/L		30	25 - 150	35	50 - 130	30
Perfluorodecanoic acid (PFDA)	0.524	2.00 ng/L		30	25 - 150	35	50 - 130	30
Perfluorododecanoic acid (PFDoA)	0.777	2.00 ng/L		30	25 - 150	35	50 - 130	30
Perfluoroheptanoic acid (PFHpA)	0.635	2.00 ng/L		30	25 - 150	35	50 - 130	30
Perfluorohexanesulfonic acid (PFHxS)	0.281	2.00 ng/L		30	25 - 150	35	50 - 130	30
Perfluorohexanoic acid (PFHxA)	0.471	2.00 ng/L		30	25 - 150	35	50 - 130	30
Perfluoro-n-butanoic acid (PFBA)	1.63	2.00 ng/L		30	25 - 150	35	50 - 130	30
Perfluorononanoic acid (PFNA)	0.574	2.00 ng/L		30	25 - 150	35	50 - 130	30
Perfluorooctanesulfonic acid (PFOS)	0.292	2.00 ng/L		30	25 - 150	35	50 - 130	30
Perfluorooctanoic acid (PFOA)	0.531	2.00 ng/L		30	25 - 150	35	50 - 130	30
Perfluoropentanoic acid (PFPeA)	0.452	2.00 ng/L		30	25 - 150	35	50 - 130	30
Perfluorotetradecanoic acid (PFTA)	0.531	2.00 ng/L		30	25 - 150	35	50 - 130	30
Perfluorotridecanoic acid (PFTrDA)	1.37	2.00 ng/L		30	25 - 150	35	50 - 130	30
Perfluoroundecanoic acid (PFUnA)	0.657	2.00 ng/L		30	25 - 150	35	50 - 130	30

York Analytical Laboratories, Inc.	Method:	PFAS by EPA 537.1, Modified
	Matrix:	NPW
PFAS MDL Study - 2020	Instrument:	QQQ1

Final MDL

Compound	MDL_b (ng/mL)	MDL_s (ng/mL)	Raw MDL (ng/mL)	Final MDL* (ng/L)
1H,1H,2H,2H-perfluoro-1-decanesulfonate (8 2FTS)	0.0083	0.0498	0.0498	***0.399***
1H,1H,2H,2H-perfluoro-1-hexanesulfonate (4 2FTS)	0.0032	0.0411	0.0411	***0.329***
1H,1H,2H,2H-perfluoro-1-octanesulfonate (6 2FTS)	0.0279	0.0616	0.0616	***0.492***
N-EtFOSAA	0.0696	0.0623	0.0696	***0.557***
N-MeFOSAA	0.0662	0.0487	0.0662	***0.529***
Perfluoro-1-decanesulfonate (L-PFDS)	0.0078	0.0718	0.0718	***0.574***
Perfluoro-1-heptanesulfonate (L-PFHpS)	0.0030	0.0518	0.0518	***0.415***
Perfluoro-1-octanesulfonamide (FOSA)	0.0098	0.0370	0.0370	***0.296***
Perfluoro-1-pentanesulfonate (L-PFPeS)	0.0010	0.0427	0.0427	***0.342***
Perfluorobutanesulfonic acid (PFBS)	0.0026	0.0367	0.0367	***0.294***
Perfluorodecanoic acid (PFDA)	0.0209	0.0654	0.0654	***0.524***
Perfluorododecanoic acid (PFDoA)	0.0154	0.0972	0.0972	***0.777***
Perfluoroheptanoic acid (PFHpA)	0.0163	0.0794	0.0794	***0.635***
Perfluorohexanesulfonic acid (PFHxS)	0.0044	0.0351	0.0351	***0.281***
Perfluorohexanoic acid (PFHxA)	0.0244	0.0588	0.0588	***0.471***
Perfluoro-n-butanoic acid (PFBA)	0.2037	0.0415	0.2037	***1.630***
Perfluorononanesulfonate (L-PFNS)	0.0049	0.0629	0.0629	***0.503***
Perfluorononanoic acid (PFNA)	0.0117	0.0718	0.0718	***0.574***
Perfluoro-n-pentanoic acid (PFPeA)	0.0565	0.0371	0.0565	***0.452***
Perfluorooctanesulfonic acid (PFOS)	0.0068	0.0366	0.0366	***0.292***
Perfluorooctanoic acid (PFOA)	0.0535	0.0663	0.0663	***0.531***
Perfluorotetradecanoic acid (PFTA)	0.0356	0.0613	0.0613	***0.491***
Perfluorotridecanoic acid (PFTrDA)	0.0177	0.1711	0.1711	***1.369***
Perfluoroundecanoic acid (PFUnA)	0.0162	0.0821	0.0821	***0.657***

Based on 125 mL extraction volume

York Analytical Laboratories, Inc.	Method:	PFAS by EPA 537.1, Modified
	Matrix:	NPW
PFAS MDL Study - 2020 Data & Calculations	Instrument:	QQQ1

MDL_b		*Batch 1: BA01164* *Extraction Date: 1/24/2020* *Analysis Date: 1/27/2020*				*Batch 2: BA01233* *Extraction Date: 1/25/2020* *Analysis Date: 1/28/2020*				*Batch 3: BA01239* *Extraction Date: 1/27/2020* *Analysis Date: 1/29/2020*				MDL Calculations $t_{0.99}$ = 2.718		
Compound	Compound Type	BA01164-BLK1 QQQ3334.d Result (ng/mL)	BA01164-BLK2 QQQ3335.d Result (ng/mL)	BA01164-BLK3 QQQ3336.d Result (ng/mL)	BA01164-BLK4 QQQ3337.d Result (ng/mL)	BA01233-BLK1 QQQ3397.d Result (ng/mL)	BA01233-BLK2 QQQ3398.d Result (ng/mL)	BA01233-BLK3 QQQ3400.d Result (ng/mL)	BA01233-BLK4 QQQ3401.d Result (ng/mL)	BA01239-BLK1 QQQ3431.d Result (ng/mL)	BA01239-BLK2 QQQ3433.d Result (ng/mL)	BA01239-BLK3 QQQ3434.d Result (ng/mL)	BA01239-BLK4 QQQ3435.d Result (ng/mL)	Average	Standard Deviation	MDL_b
1H,1H,2H,2H-perfluoro-1-decanesulfonate (8 2FTS)	Target	0.008289	0.002531	0.001068	0.000775	0.000025	0.001124	0.003603	0.003017	0.002976	0.000866	0.000511	0.000070	0.002071	0.002308	0.008344
1H,1H,2H,2H-perfluoro-1-hexanesulfonate (4 2FTS)	Target	0.002208	0.001059	0.001835	0.000445	0.001413	0.002278	0.000553	0.001361	0.002275	0.001371	0.001774	0.001644	0.001518	0.000615	0.003190
1H,1H,2H,2H-perfluoro-1-octanesulfonate (6 2FTS)	Target	0.022867	0.010795	0.019539	0.020501	0.017218	0.019435	0.019823	0.020826	0.022085	0.015470	0.014283	0.016201	0.018254	0.003536	0.027866
N-EtFOSAA	Target	0.062805	0.020672	0.008224	0.007165	0.004523	0.003820	0.034385	0.012347	0.009785	0.042662	0.000714	0.010763	0.018155	0.018919	0.069578
N-MeFOSAA	Target	0.064474	0.011165	0.006682	0.009429	0.002684	0.002534	0.037417	0.009581	0.007153	0.027880	0.009959	0.006898	0.016321	0.018338	0.066165
Perfluoro-1-decanesulfonate (L-PFDS)	Target	0.008000	0.000307	0.002237	0.001598	0.000446	0.001003	0.000335	0.000595	0.001569	0.003768	0.001199	0.000195	0.001771	0.002212	0.007783
Perfluoro-1-heptanesulfonate (L-PFHpS)	Target	0.003093	0.001011	0.000250	0.000506	0.001114	0.000364	0.001327	0.001023	0.000303	0.001023	0.000650	0.000276	0.000912	0.000784	0.003041
Perfluoro-1-octanesulfonamide (FOSA)	Target	0.007057	0.007652	0.000063	0.002553	0.000520	0.004234	0.003383	0.002419	0.000048	0.002932	0.000027	0.001164	0.002671	0.002606	0.009755
Perfluoro-1-pentanesulfonate (L-PFPeS)	Target	0.000302	0.000457	0.000312	0.000074	0.000482	0.000286	0.000576	0.000315	0.000173	0.000979	0.000019	0.000164	0.000345	0.000259	0.001048
Perfluorobutanesulfonic acid (PFBS)	Target	0.000239	0.001594	0.000911	0.001569	0.001219	0.001747	0.001906	0.001467	0.000919	0.001543	0.001797	0.001397	0.001359	0.000472	0.002643
Perfluorodecanoic acid (PFDA)	Target	0.013534	0.014076	0.008300	0.011094	0.006586	0.009122	0.001282	0.007957	0.001435	0.014420	0.002695	0.004719	0.007935	0.004756	0.020861
Perfluorododecanoic acid (PFDoA)	Target	0.010318	0.009669	0.003559	0.012376	0.000742	0.003964	0.006257	0.003404	0.004199	0.002529	0.001079	0.002243	0.005028	0.003809	0.015381
Perfluoroheptanoic acid (PFHpA)	Target	0.011399	0.009276	0.010164	0.013330	0.007449	0.010837	0.008732	0.011017	0.009699	0.015097	0.008143	0.010924	0.010506	0.002148	0.016344
Perfluorohexanesulfonic acid (PFHxS)	Target	0.003948	0.002634	0.003032	0.002299	0.002121	0.001958	0.003613	0.002258	0.002057	0.001975	0.002923	0.002101	0.002577	0.000668	0.004393
Perfluorohexanoic acid (PFHxA)	Target	0.023259	0.020787	0.017088	0.015491	0.016253	0.014717	0.016340	0.017808	0.016991	0.016341	0.020240	0.017175	0.017708	0.002479	0.024446
Perfluoro-n-butanoic acid (PFBA)	Target	0.141694	0.142038	0.137448	0.141449	0.149966	0.141430	0.143501	0.140547	0.212370	0.141437	0.138088	0.142664	0.147719	0.020593	0.203691
Perfluorononanesulfonate (L-PFNS)	Target	0.002368	0.002161	0.001245	0.001213	0.000584	0.001068	0.003559	0.004015	0.000305	0.001444	0.000281	0.000443	0.001557	0.001240	0.004928
Perfluorononanoic acid (PFNA)	Target	0.002926	0.005293	0.005104	0.004230	0.007785	0.008628	0.008542	0.002219	0.005453	0.007730	0.004689	0.002558	0.005430	0.002290	0.011654
Perfluoro-n-pentanoic acid (PFPeA)	Target	0.040724	0.043043	0.046442	0.043165	0.045842	0.040780	0.040794	0.042472	0.055191	0.048532	0.047001	0.046938	0.045077	0.004202	0.056497
Perfluorooctanesulfonic acid (PFOS)	Target	0.004774	0.002627	0.003756	0.002358	0.002960	0.003420	0.002941	0.000760	0.004883	0.004050	0.004354	0.004776	0.003472	0.001223	0.006795
Perfluorooctanoic acid (PFOA)	Target	0.049414	0.037451	0.043298	0.040125	0.027488	0.036947	0.036053	0.036242	0.030541	0.038944	0.034420	0.027926	0.036571	0.006238	0.053525
Perfluorotetradecanoic acid (PFTA)	Target	0.015962	0.002632	0.004620	0.008750	0.012107	0.011634	0.013015	0.003433	0.017622	0.018930	0.005616	0.033130	0.012287	0.008576	0.035596
Perfluorotridecanoic acid (PFTrDA)	Target	0.015310	0.003073	0.006458	0.007216	0.001104	0.008759	0.010238	0.003790	0.001068	0.001796	0.000536	0.000516	0.004989	0.004681	0.017711
Perfluoroundecanoic acid (PFUnA)	Target	0.011066	0.013939	0.004012	0.000859	0.005065	0.008205	0.002656	0.003604	0.002713	0.007229	0.001569	0.004995	0.005493	0.003949	0.016228

MDL_s		*Batch 1: BA01164* *Extraction Date: 1/24/2020* *Analysis Date: 1/27/2020*				*Batch 2: BA01233* *Extraction Date: 1/25/2020* *Analysis Date: 1/28/2020*				*Batch 3: BA01239* *Extraction Date: 1/27/2020* *Analysis Date: 1/29/2020*				MDL Calculations $t_{0.99}$ = 2.718		
Compound	Compound Type	BA01164-BS1 QQQ3334.d Result (ng/mL)	BA01164-BS2 QQQ3335.d Result (ng/mL)	BA01164-BS3 QQQ3336.d Result (ng/mL)	BA01164-BS4 QQQ3337.d Result (ng/mL)	BA01233-BS1 QQQ3402.d Result (ng/mL)	BA01233-BS2 QQQ3403.d Result (ng/mL)	BA01233-BS3 QQQ3404.d Result (ng/mL)	BA01233-BS4 QQQ3405.d Result (ng/mL)	BA01239-BS1 QQQ3436.d Result (ng/mL)	BA01239-BS2 QQQ3437.d Result (ng/mL)	BA01239-BS3 QQQ3438.d Result (ng/mL)	BA01239-BS4 QQQ3439.d Result (ng/mL)	Average	Standard Deviation	MDL_s
1H,1H,2H,2H-perfluoro-1-decanesulfonate (8 2FTS)	Target	0.222361	0.247535	0.240147	0.265272	0.202872	0.219556	0.251734	0.229892	0.227095	0.234705	0.256971	0.255149	0.237774	0.018329	0.049818
1H,1H,2H,2H-perfluoro-1-hexanesulfonate (4 2FTS)	Target	0.237032	0.250152	0.263008	0.252453	0.266471	0.244672	0.283837	0.255324	0.262678	0.267925	0.272674	0.287952	0.262015	0.015138	0.041144
1H,1H,2H,2H-perfluoro-1-octanesulfonate (6 2FTS)	Target	0.255828	0.276589	0.278913	0.254366	0.291144	0.264964	0.324740	0.269137	0.273006	0.282159	0.315273	0.306659	0.282731	0.022650	0.061562
N-EtFOSAA	Target	0.226675	0.230454	0.248541	0.222855	0.237745	0.247637	0.261653	0.251178	0.247703	0.274708	0.293311	0.287537	0.252500	0.022930	0.062324
N-MeFOSAA	Target	0.217530	0.266022	0.230631	0.261773	0.257043	0.248017	0.250965	0.260173	0.228084	0.258538	0.278934	0.264322	0.251836	0.017934	0.048744
Perfluoro-1-decanesulfonate (L-PFDS)	Target	0.210038	0.238289	0.253836	0.255782	0.255327	0.279194	0.296550	0.279182	0.234990	0.246765	0.275638	0.214924	0.253376	0.026403	0.071762
Perfluoro-1-heptanesulfonate (L-PFHpS)	Target	0.247114	0.254305	0.270192	0.247739	0.261812	0.276170	0.279454	0.282003	0.264792	0.289318	0.292675	0.309851	0.272952	0.019074	0.051844
Perfluoro-1-octanesulfonamide (FOSA)	Target	0.251756	0.257970	0.251981	0.245125	0.259725	0.237710	0.282946	0.245932	0.249548	0.260885	0.278096	0.269465	0.257595	0.013607	0.036984
Perfluoro-1-pentanesulfonate (L-PFPeS)	Target	0.231388	0.244732	0.249313	0.246663	0.240241	0.238205	0.246247	0.246970	0.251578	0.269816	0.281037	0.277566	0.251980	0.015710	0.042699
Perfluorobutanesulfonic acid (PFBS)	Target	0.221696	0.232862	0.237416	0.233106	0.237762	0.226166	0.248613	0.237002	0.224934	0.246761	0.263019	0.262113	0.239288	0.013502	0.036697
Perfluorodecanoic acid (PFDA)	Target	0.218583	0.253632	0.241891	0.248504	0.221424	0.203976	0.262703	0.247848	0.276624	0.220835	0.245157	0.283195	0.243698	0.024078	0.065444
Perfluorododecanoic acid (PFDoA)	Target	0.247820	0.263524	0.239078	0.239881	0.275292	0.205020	0.343913	0.241068	0.249582	0.302409	0.268947	0.283253	0.263316	0.035746	0.097158
Perfluoroheptanoic acid (PFHpA)	Target	0.252453	0.290089	0.304855	0.280677	0.236442	0.258853	0.276797	0.276719	0.257373	0.301418	0.299414	0.345077	0.281681	0.029222	0.079425
Perfluorohexanesulfonic acid (PFHxS)	Target	0.183275	0.192098	0.197260	0.196876	0.186819	0.180847	0.208198	0.203991	0.189349	0.212609	0.216687	0.217821	0.198819	0.012915	0.035104
Perfluorohexanoic acid (PFHxA)	Target	0.234370	0.264472	0.267038	0.256377	0.238696	0.257936	0.276797	0.269179	0.246832	0.292481	0.290610	0.304099	0.266574	0.021649	0.058843
Perfluoro-n-butanoic acid (PFBA)	Target	0.372215	0.392175	0.386163	0.377580	0.397244	0.382078	0.409186	0.402001	0.379885	0.405199	0.417960	0.414378	0.394672	0.015270	0.041503
Perfluorononanesulfonate (L-PFNS)	Target	0.235260	0.240016	0.261567	0.213285	0.261044	0.254326	0.284161	0.242284	0.220038	0.274910	0.281151	0.268664	0.253059	0.023141	0.062897
Perfluorononanoic acid (PFNA)	Target	0.219526	0.254971	0.241955	0.229625	0.218631	0.231086	0.299104	0.243661	0.218314	0.210083	0.257527	0.275056	0.241628	0.026401	0.071758
Perfluoro-n-pentanoic acid (PFPeA)	Target	0.269339	0.283921	0.287200	0.285449	0.281190	0.281527	0.307135	0.292759	0.278559	0.304028	0.311733	0.307681	0.290877	0.013639	0.037072
Perfluorooctanesulfonic acid (PFOS)	Target	0.178370	0.214008	0.207225	0.189083	0.196861	0.186779	0.217538	0.198857	0.196091	0.190335	0.217742	0.215600	0.200707	0.013450	0.036556
Perfluorooctanoic acid (PFOA)	Target	0.252892	0.279800	0.284005	0.245800	0.282231	0.249262	0.310667	0.239378	0.261438	0.300347	0.305328	0.262104	0.272771	0.024410	0.066346
Perfluorotetradecanoic acid (PFTA)	Target	0.262027	0.230146	0.283946	0.242690	0.234636	0.268780	0.266749	0.300907	0.270980	0.273589	0.299331	0.272888	0.267222	0.022563	0.061327
Perfluorotridecanoic acid (PFTrDA)	Target	0.218460	0.207984	0.150138	0.245042	0.345742	0.205627	0.322715	0.256108	0.166393	0.201104	0.269216	0.148087	0.228051	0.062938	0.171065
Perfluoroundecanoic acid (PFUnA)	Target	0.242314	0.245844	0.259243	0.244941	0.238591	0.249218	0.265025	0.232887	0.273411	0.293580	0.341367	0.273078	0.263292	0.030218	0.082134

PREPARATION BENCH SHEET-AQUEOUS: BA01164

Prepared: **01/24/2020 16:40**

York Analytical Laboratories, Inc. **Printed: 1/31/2020 3:36:17PM**

Matrix: Water **Preparation SPE Ext-PFAS-EPA 537.1M** **Surrogate used: Y20A283 100 ul**

Lab Number	Analysis	Initial (mL)	Final (mL)	Spike 1 ID	ul Spike 1	Spike 2 ID	ul Spike 2	Source ID	pH Data			Decanted Y/N	Comments
									Initial	Acid	Basic		
BA01164-BLK1	QC	125	1							NA			
BA01164-BLK2	QC	125	1							NA			
BA01164-BLK3	QC	125	1							NA			
BA01164-BLK4	QC	125	1							NA			
BA01164-BS1	QC	125	1	Y19L387	5					NA			
BA01164-BS2	QC	125	1	Y19L387	5					NA			
BA01164-BS3	QC	125	1	Y19L387	5					NA			
BA01164-BS4	QC	125	1	Y19L387	5					NA			

Reagents:

ID Number	Description	Lot Number	ID Number	Description	Lot Number
Y19I303	0.3% NH4OH/Methanol Soluiton	YorkPFAS-1	Y20A132	Water, HPLC Plus Grade	SHBL4724
Y20A133	Methanol, HPLC Plus Grade	SHBL1471	Y20A153	Strata XL-AW 100 um PWA 500mg	S322-0027_S19-007117

Preparation Performed by WL **Date:** 01/24/2020 16:40

PREPARATION BENCH SHEET-AQUEOUS: BA01233

Prepared: **01/25/2020 15:29**

York Analytical Laboratories, Inc.

Printed: 1/31/2020 3:36:50PM

Matrix: Water **Preparation SPE Ext-PFAS-EPA 537.1M** **Surrogate used: Y20A283 100 ul**

Lab Number	Analysis	Initial (mL)	Final (mL)	Spike 1 ID	ul Spike 1	Spike 2 ID	ul Spike 2	Source ID	pH Data			Decanted Y/N	Comments
									Initial	Acid	Basic		
BA01233-BLK1	QC	125	1							NA			
BA01233-BLK2	QC	125	1							NA			
BA01233-BLK3	QC	125	1							NA			
BA01233-BLK4	QC	125	1							NA			
BA01233-BS1	QC	125	1	Y19L387	5					NA			
BA01233-BS2	QC	125	1	Y19L387	5					NA			
BA01233-BS3	QC	125	1	Y19L387	5					NA			
BA01233-BS4	QC	125	1	Y19L387	5					NA			

Reagents:

ID Number	Description	Lot Number	ID Number	Description	Lot Number
Y19I303	0.3% NH4OH/Methanol Soluiton	YorkPFAS-1	Y20A132	Water, HPLC Plus Grade	SHBL4724
Y20A133	Methanol, HPLC Plus Grade	SHBL1471	Y20A153	Strata XL-AW 100 um PWA 500mg	S322-0027_S19-007117

Preparation Performed by <u>KT</u> **Date:** <u>01/25/2020 15:29</u>

PREPARATION BENCH SHEET-AQUEOUS: BA01239

Prepared: **01/27/2020 17:25**

York Analytical Laboratories, Inc. **Printed: 1/31/2020 3:37:25PM**

Matrix: Water **Preparation SPE Ext-PFAS-EPA 537.1M** **Surrogate used: Y20A283 100 ul**

Lab Number	Analysis	Initial (mL)	Final (mL)	Spike 1 ID	ul Spike 1	Spike 2 ID	ul Spike 2	Source ID	pH Data Initial	pH Data Acid	pH Data Basic	Decanted Y/N	Comments
BA01239-BLK1	QC	125	1							NA			
BA01239-BLK2	QC	125	1							NA			
BA01239-BLK3	QC	125	1							NA			
BA01239-BLK4	QC	125	1							NA			
BA01239-BS1	QC	125	1	Y19L387	5					NA			
BA01239-BS2	QC	125	1	Y19L387	5					NA			
BA01239-BS3	QC	125	1	Y19L387	5					NA			
BA01239-BS4	QC	125	1	Y19L387	5					NA			

Reagents:

ID Number	Description	Lot Number	ID Number	Description	Lot Number
Y19I303	0.3% NH4OH/Methanol Soluiton	YorkPFAS-1	Y20A132	Water, HPLC Plus Grade	SHBL4724
Y20A133	Methanol, HPLC Plus Grade	SHBL1471	Y20A153	Strata XL-AW 100 um PWA 500mg	S322-0027_S19-007117

Preparation Performed by WL **Date:** 01/27/2020 17:25

ATTACHMENT B

SOIL SAMPLES
LABORATORY REPORTING LIMITS AND METHOD DETECTION LIMITS

Method	Matrix	Analyte	RL	MDL	Units
Volatile Organic Compounds					
EPA 8260C/5035	Soil	1,1,1,2-Tetrachloroethane	0.001	0.000318	mg/kg
EPA 8260C/5035	Soil	1,1,1-Trichloroethane	0.001	0.0001108	mg/kg
EPA 8260C/5035	Soil	1,1,2,2-Tetrachloroethane	0.001	0.0001008	mg/kg
EPA 8260C/5035	Soil	1,1,2-Trichloro-1,2,2-Trifluoroethane	0.02	0.000274	mg/kg
EPA 8260C/5035	Soil	1,1,2-Trichloroethane	0.0015	0.000304	mg/kg
EPA 8260C/5035	Soil	1,1-Dichloroethane	0.0015	0.0000856	mg/kg
EPA 8260C/5035	Soil	1,1-Dichloroethene	0.001	0.000262	mg/kg
EPA 8260C/5035	Soil	1,1-Dichloropropene	0.005	0.0001414	mg/kg
EPA 8260C/5035	Soil	1,2,3-Trichlorobenzene	0.005	0.0001476	mg/kg
EPA 8260C/5035	Soil	1,2,3-Trichloropropane	0.01	0.0001626	mg/kg
EPA 8260C/5035	Soil	1,2,4,5-Tetramethylbenzene	0.004	0.0001302	mg/kg
EPA 8260C/5035	Soil	1,2,4-Trichlorobenzene	0.005	0.0001818	mg/kg
EPA 8260C/5035	Soil	1,2,4-Trimethylbenzene	0.005	0.0001414	mg/kg
EPA 8260C/5035	Soil	1,2-Dibromo-3-chloropropane	0.005	0.000396	mg/kg
EPA 8260C/5035	Soil	1,2-Dibromoethane	0.004	0.0001744	mg/kg
EPA 8260C/5035	Soil	1,2-Dichlorobenzene	0.005	0.0001532	mg/kg
EPA 8260C/5035	Soil	1,2-Dichloroethane	0.001	0.0001134	mg/kg
EPA 8260C/5035	Soil	1,2-Dichloropropane	0.0035	0.000228	mg/kg
EPA 8260C/5035	Soil	1,3,5-Trimethylbenzene	0.005	0.0001434	mg/kg
EPA 8260C/5035	Soil	1,3-Dichlorobenzene	0.005	0.000135	mg/kg
EPA 8260C/5035	Soil	1,3-Dichloropropane	0.005	0.0001452	mg/kg
EPA 8260C/5035	Soil	1,4-Dichlorobenzene	0.005	0.0001384	mg/kg
EPA 8260C/5035	Soil	1,4-Diethylbenzene	0.004	0.0001598	mg/kg
EPA 8260C/5035	Soil	1,4-Dioxane	0.1	0.01442	mg/kg
EPA 8260C/5035	Soil	2,2-Dichloropropane	0.005	0.000226	mg/kg
EPA 8260C/5035	Soil	2-Butanone	0.01	0.000272	mg/kg
EPA 8260C/5035	Soil	2-Hexanone	0.01	0.000666	mg/kg
EPA 8260C/5035	Soil	4-Ethyltoluene	0.004	0.000124	mg/kg
EPA 8260C/5035	Soil	4-Methyl-2-pentanone	0.01	0.000244	mg/kg
EPA 8260C/5035	Soil	Acetone	0.01	0.001036	mg/kg
EPA 8260C/5035	Soil	Acrolein	0.025	0.00806	mg/kg
EPA 8260C/5035	Soil	Acrylonitrile	0.01	0.000514	mg/kg
EPA 8260C/5035	Soil	Benzene	0.001	0.000118	mg/kg
EPA 8260C/5035	Soil	Bromobenzene	0.005	0.000208	mg/kg
EPA 8260C/5035	Soil	Bromochloromethane	0.005	0.000276	mg/kg
EPA 8260C/5035	Soil	Bromodichloromethane	0.001	0.0001732	mg/kg
EPA 8260C/5035	Soil	Bromoform	0.004	0.000236	mg/kg
EPA 8260C/5035	Soil	Bromomethane	0.002	0.000338	mg/kg
EPA 8260C/5035	Soil	Carbon disulfide	0.01	0.001102	mg/kg
EPA 8260C/5035	Soil	Carbon tetrachloride	0.001	0.00021	mg/kg
EPA 8260C/5035	Soil	Chlorobenzene	0.001	0.000348	mg/kg
EPA 8260C/5035	Soil	Chloroethane	0.002	0.000316	mg/kg
EPA 8260C/5035	Soil	Chloroform	0.0015	0.00037	mg/kg
EPA 8260C/5035	Soil	Chloromethane	0.005	0.000294	mg/kg
EPA 8260C/5035	Soil	cis-1,2-Dichloroethene	0.001	0.0001428	mg/kg
EPA 8260C/5035	Soil	cis-1,3-Dichloropropene	0.001	0.0001176	mg/kg
EPA 8260C/5035	Soil	Cyclohexane	0.02	0.000146	mg/kg
EPA 8260C/5035	Soil	Dibromochloromethane	0.001	0.0001536	mg/kg
EPA 8260C/5035	Soil	Dibromomethane	0.01	0.0001636	mg/kg
EPA 8260C/5035	Soil	Dichlorodifluoromethane	0.01	0.0001908	mg/kg
EPA 8260C/5035	Soil	Ethyl ether	0.005	0.00026	mg/kg
EPA 8260C/5035	Soil	Ethylbenzene	0.001	0.0001274	mg/kg
EPA 8260C/5035	Soil	Hexachlorobutadiene	0.005	0.000228	mg/kg
EPA 8260C/5035	Soil	Isopropylbenzene	0.001	0.0001038	mg/kg
EPA 8260C/5035	Soil	Methyl Acetate	0.02	0.00027	mg/kg
EPA 8260C/5035	Soil	Methyl cyclohexane	0.004	0.0001546	mg/kg
EPA 8260C/5035	Soil	Methyl tert butyl ether	0.002	0.0000844	mg/kg
EPA 8260C/5035	Soil	Methylene chloride	0.01	0.001104	mg/kg
EPA 8260C/5035	Soil	Naphthalene	0.005	0.0001384	mg/kg
EPA 8260C/5035	Soil	n-Butylbenzene	0.001	0.0001148	mg/kg
EPA 8260C/5035	Soil	n-Propylbenzene	0.001	0.0001092	mg/kg
EPA 8260C/5035	Soil	o-Chlorotoluene	0.005	0.0001598	mg/kg
EPA 8260C/5035	Soil	o-Xylene	0.002	0.0001718	mg/kg
EPA 8260C/5035	Soil	p/m-Xylene	0.002	0.0001978	mg/kg
EPA 8260C/5035	Soil	p-Chlorotoluene	0.005	0.0001328	mg/kg
EPA 8260C/5035	Soil	p-Isopropyltoluene	0.001	0.000125	mg/kg
EPA 8260C/5035	Soil	sec-Butylbenzene	0.001	0.000122	mg/kg
EPA 8260C/5035	Soil	Styrene	0.002	0.000402	mg/kg
EPA 8260C/5035	Soil	tert-Butyl Alcohol	0.06	0.00292	mg/kg
EPA 8260C/5035	Soil	tert-Butylbenzene	0.005	0.0001354	mg/kg
EPA 8260C/5035	Soil	Tetrachloroethene	0.001	0.0001402	mg/kg
EPA 8260C/5035	Soil	Toluene	0.0015	0.0001948	mg/kg
EPA 8260C/5035	Soil	trans-1,2-Dichloroethene	0.0015	0.000212	mg/kg
EPA 8260C/5035	Soil	trans-1,3-Dichloropropene	0.001	0.0001208	mg/kg
EPA 8260C/5035	Soil	trans-1,4-Dichloro-2-butene	0.005	0.000392	mg/kg
EPA 8260C/5035	Soil	Trichloroethene	0.001	0.000125	mg/kg
EPA 8260C/5035	Soil	Trichlorofluoromethane	0.005	0.000388	mg/kg
EPA 8260C/5035	Soil	Vinyl acetate	0.01	0.0001322	mg/kg
EPA 8260C/5035	Soil	Vinyl chloride	0.002	0.0001174	mg/kg
EPA 8260C/5035	Soil	Xylenes, Total	0.002	0.0001978	mg/kg

ATTACHMENT B

SOIL SAMPLES
LABORATORY REPORTING LIMITS AND METHOD DETECTION LIMITS

Method	Matrix	Analyte	RL	MDL	Units
Semivolatile Organic Compounds					
EPA 8270D	Soil	1,2,4,5-Tetrachlorobenzene	0.1665	0.0515817	mg/kg
EPA 8270D	Soil	1,2,4-Trichlorobenzene	0.1665	0.0545787	mg/kg
EPA 8270D	Soil	1,2-Dichlorobenzene	0.1665	0.0546453	mg/kg
EPA 8270D	Soil	1,3-Dichlorobenzene	0.1665	0.0524808	mg/kg
EPA 8270D	Soil	1,4-Dichlorobenzene	0.1665	0.050616	mg/kg
EPA 8270D	Soil	2,3,4,6-Tetrachlorophenol	0.1665	0.028305	mg/kg
EPA 8270D	Soil	2,4,5-Trichlorophenol	0.1665	0.053946	mg/kg
EPA 8270D	Soil	2,4,6-Trichlorophenol	0.0999	0.0314019	mg/kg
EPA 8270D	Soil	2,4-Dichlorophenol	0.14985	0.053946	mg/kg
EPA 8270D	Soil	2,4-Dimethylphenol	0.1665	0.049617	mg/kg
EPA 8270D	Soil	2,4-Dinitrophenol	0.7992	0.227772	mg/kg
EPA 8270D	Soil	2,4-Dinitrotoluene	0.1665	0.0359307	mg/kg
EPA 8270D	Soil	2,6-Dinitrotoluene	0.1665	0.042624	mg/kg
EPA 8270D	Soil	2-Chloronaphthalene	0.1665	0.054279	mg/kg
EPA 8270D	Soil	2-Chlorophenol	0.1665	0.050283	mg/kg
EPA 8270D	Soil	2-Methylnaphthalene	0.1998	0.0531801	mg/kg
EPA 8270D	Soil	2-Methylphenol	0.1665	0.053613	mg/kg
EPA 8270D	Soil	2-Nitroaniline	0.1665	0.046953	mg/kg
EPA 8270D	Soil	2-Nitrophenol	0.35964	0.051948	mg/kg
EPA 8270D	Soil	3,3'-Dichlorobenzidine	0.1665	0.044289	mg/kg
EPA 8270D	Soil	3-Methylphenol/4-Methylphenol	0.23976	0.054612	mg/kg
EPA 8270D	Soil	3-Nitroaniline	0.1665	0.045954	mg/kg
EPA 8270D	Soil	4,6-Dinitro-o-cresol	0.4329	0.060939	mg/kg
EPA 8270D	Soil	4-Bromophenyl phenyl ether	0.1665	0.038295	mg/kg
EPA 8270D	Soil	4-Chloroaniline	0.1665	0.043956	mg/kg
EPA 8270D	Soil	4-Chlorophenyl phenyl ether	0.1665	0.0506493	mg/kg
EPA 8270D	Soil	4-Nitroaniline	0.1665	0.044955	mg/kg
EPA 8270D	Soil	4-Nitrophenol	0.2331	0.053946	mg/kg
EPA 8270D	Soil	Acenaphthene	0.1332	0.034299	mg/kg
EPA 8270D	Soil	Acenaphthylene	0.1332	0.0311355	mg/kg
EPA 8270D	Soil	Acetophenone	0.1665	0.051615	mg/kg
EPA 8270D	Soil	Anthracene	0.0999	0.0277056	mg/kg
EPA 8270D	Soil	Atrazine	0.1332	0.0377289	mg/kg
EPA 8270D	Soil	Azobenzene	0.1665	0.044622	mg/kg
EPA 8270D	Soil	Benzaldehyde	0.21978	0.067266	mg/kg
EPA 8270D	Soil	Benzidine	0.54945	0.130203	mg/kg
EPA 8270D	Soil	Benzo(a)anthracene	0.0999	0.0326007	mg/kg
EPA 8270D	Soil	Benzo(a)pyrene	0.1332	0.0407259	mg/kg
EPA 8270D	Soil	Benzo(b)fluoranthene	0.0999	0.033633	mg/kg
EPA 8270D	Soil	Benzo(ghi)perylene	0.1332	0.034632	mg/kg
EPA 8270D	Soil	Benzo(k)fluoranthene	0.0999	0.0317682	mg/kg
EPA 8270D	Soil	Benzoic Acid	0.53946	0.168498	mg/kg
EPA 8270D	Soil	Benzyl Alcohol	0.1665	0.051282	mg/kg
EPA 8270D	Soil	Biphenyl	0.37962	0.0549117	mg/kg
EPA 8270D	Soil	Bis(2-chloroethoxy)methane	0.17982	0.0504162	mg/kg
EPA 8270D	Soil	Bis(2-chloroethyl)ether	0.14985	0.0466866	mg/kg
EPA 8270D	Soil	Bis(2-chloroisopropyl)ether	0.1998	0.058608	mg/kg
EPA 8270D	Soil	Bis(2-Ethylhexyl)phthalate	0.1665	0.043623	mg/kg
EPA 8270D	Soil	Butyl benzyl phthalate	0.1665	0.0325341	mg/kg
EPA 8270D	Soil	Caprolactam	0.1665	0.045954	mg/kg
EPA 8270D	Soil	Carbazole	0.1665	0.0357975	mg/kg
EPA 8270D	Soil	Chrysene	0.0999	0.0327006	mg/kg
EPA 8270D	Soil	Dibenzo(a,h)anthracene	0.0999	0.0322344	mg/kg
EPA 8270D	Soil	Dibenzofuran	0.1665	0.0555777	mg/kg
EPA 8270D	Soil	Diethyl phthalate	0.1665	0.0351981	mg/kg
EPA 8270D	Soil	Dimethyl phthalate	0.1665	0.042291	mg/kg
EPA 8270D	Soil	Di-n-butylphthalate	0.1665	0.0321345	mg/kg
EPA 8270D	Soil	Di-n-octylphthalate	0.1665	0.040959	mg/kg
EPA 8270D	Soil	Fluoranthene	0.0999	0.0305694	mg/kg
EPA 8270D	Soil	Fluorene	0.1665	0.0477189	mg/kg
EPA 8270D	Soil	Hexachlorobenzene	0.0999	0.0310356	mg/kg
EPA 8270D	Soil	Hexachlorobutadiene	0.1665	0.046953	mg/kg
EPA 8270D	Soil	Hexachlorocyclopentadiene	0.47619	0.106893	mg/kg
EPA 8270D	Soil	Hexachloroethane	0.1332	0.0302697	mg/kg
EPA 8270D	Soil	Indeno(1,2,3-cd)Pyrene	0.1332	0.036963	mg/kg
EPA 8270D	Soil	Isophorone	0.14985	0.044289	mg/kg
EPA 8270D	Soil	Naphthalene	0.1665	0.055278	mg/kg
EPA 8270D	Soil	Nitrobenzene	0.14985	0.039627	mg/kg
EPA 8270D	Soil	NitrosoDiPhenylAmine(NDPA)/DPA	0.1332	0.034965	mg/kg
EPA 8270D	Soil	n-Nitrosodimethylamine	0.333	0.0539127	mg/kg
EPA 8270D	Soil	n-Nitrosodi-n-propylamine	0.1665	0.049617	mg/kg
EPA 8270D	Soil	P-Chloro-M-Cresol	0.1665	0.048285	mg/kg
EPA 8270D	Soil	Pentachlorophenol	0.1332	0.035631	mg/kg
EPA 8270D	Soil	Phenanthrene	0.0999	0.0325674	mg/kg
EPA 8270D	Soil	Phenol	0.1665	0.049284	mg/kg
EPA 8270D	Soil	Pyrene	0.0999	0.0323676	mg/kg

ATTACHMENT B

SOIL SAMPLES
LABORATORY REPORTING LIMITS AND METHOD DETECTION LIMITS

Method	Matrix	Analyte	RL	MDL	Units
Pesticides					
EPA 8081B	Soil	4,4'-DDD	0.007992	0.00285048	mg/kg
EPA 8081B	Soil	4,4'-DDE	0.007992	0.00184815	mg/kg
EPA 8081B	Soil	4,4'-DDT	0.014985	0.0064269	mg/kg
EPA 8081B	Soil	Aldrin	0.007992	0.00281385	mg/kg
EPA 8081B	Soil	Alpha-BHC	0.00333	0.00094572	mg/kg
EPA 8081B	Soil	Beta-BHC	0.007992	0.0030303	mg/kg
EPA 8081B	Soil	Chlordane	0.064935	0.0264735	mg/kg
EPA 8081B	Soil	cis-Chlordane	0.00999	0.00278388	mg/kg
EPA 8081B	Soil	Delta-BHC	0.007992	0.0015651	mg/kg
EPA 8081B	Soil	Dieldrin	0.004995	0.0024975	mg/kg
EPA 8081B	Soil	Endosulfan I	0.007992	0.00188811	mg/kg
EPA 8081B	Soil	Endosulfan II	0.007992	0.00267066	mg/kg
EPA 8081B	Soil	Endosulfan sulfate	0.00333	0.00158508	mg/kg
EPA 8081B	Soil	Endrin	0.00333	0.0013653	mg/kg
EPA 8081B	Soil	Endrin aldehyde	0.00999	0.0034965	mg/kg
EPA 8081B	Soil	Endrin ketone	0.007992	0.00205794	mg/kg
EPA 8081B	Soil	Heptachlor	0.003996	0.00179154	mg/kg
EPA 8081B	Soil	Heptachlor epoxide	0.014985	0.0044955	mg/kg
EPA 8081B	Soil	Lindane	0.00333	0.00148851	mg/kg
EPA 8081B	Soil	Methoxychlor	0.014985	0.004662	mg/kg
EPA 8081B	Soil	Toxaphene	0.14985	0.041958	mg/kg
EPA 8081B	Soil	trans-Chlordane	0.00999	0.00263736	mg/kg
Polychlorinated Biphenyls					
EPA 8082A	Soil	Aroclor 1016	0.0335	0.0026465	mg/kg
EPA 8082A	Soil	Aroclor 1221	0.0335	0.0030887	mg/kg
EPA 8082A	Soil	Aroclor 1232	0.0335	0.0039262	mg/kg
EPA 8082A	Soil	Aroclor 1242	0.0335	0.0041004	mg/kg
EPA 8082A	Soil	Aroclor 1248	0.0335	0.0028274	mg/kg
EPA 8082A	Soil	Aroclor 1254	0.0335	0.0027537	mg/kg
EPA 8082A	Soil	Aroclor 1260	0.0335	0.0025527	mg/kg
EPA 8082A	Soil	Aroclor 1262	0.0335	0.0016616	mg/kg
EPA 8082A	Soil	Aroclor 1268	0.0335	0.0048575	mg/kg
EPA 8082A	Soil	Total PCBs	0.0335	0.0016616	mg/kg
Herbicides					
EPA 8151A	Soil	2,4-D	0.1665	0.0051615	mg/kg
EPA 8151A	Soil	2,4,5-TP (Silvex)	0.1665	0.0044289	mg/kg
EPA 8151A	Soil	2,4,5-T	0.1665	0.0104895	mg/kg
Metals					
EPA 6010C	Soil	Aluminum	4	0.8	mg/kg
EPA 6010C	Soil	Antimony	2	0.32	mg/kg
EPA 6010C	Soil	Arsenic	0.4	0.08	mg/kg
EPA 6010C	Soil	Barium	0.4	0.12	mg/kg
EPA 6010C	Soil	Beryllium	0.2	0.04	mg/kg
EPA 6010C	Soil	Cadmium	0.4	0.028	mg/kg
EPA 6010C	Soil	Calcium	4	1.2	mg/kg
EPA 6010C	Soil	Chromium	0.4	0.08	mg/kg
EPA 7196A	Soil	Hexvalent Chromium	0.8	0.16	mg/kg
EPA 6010C	Soil	Cobalt	0.8	0.2	mg/kg
EPA 6010C	Soil	Copper	0.4	0.08	mg/kg
EPA 6010C	Soil	Iron	2	0.8	mg/kg
EPA 6010C	Soil	Lead	2	0.08	mg/kg
EPA 6010C	Soil	Magnesium	4	0.4	mg/kg
EPA 6010C	Soil	Manganese	0.4	0.08	mg/kg
EPA 7473	Soil	Mercury	0.08	0.016896	mg/kg
EPA 6010C	Soil	Nickel	1	0.16	mg/kg
EPA 6010C	Soil	Potassium	100	16	mg/kg
EPA 6010C	Soil	Selenium	0.8	0.12	mg/kg
EPA 6010C	Soil	Silver	0.4	0.08	mg/kg
EPA 6010C	Soil	Sodium	80	12	mg/kg
EPA 6010C	Soil	Thallium	0.8	0.16	mg/kg
EPA 6010C	Soil	Vanadium	0.4	0.04	mg/kg
EPA 6010C	Soil	Zinc	2	0.28	mg/kg
Other					
ASTM D422-63	Soil	Grain Size	N/A	N/A	N/A
SM21 5210B	Soil	Biological Oxygen Demand (BOD)	N/A	N/A	N/A
SM21 5220C	Soil	Chemical Oxygen Demand (COD)	100	28	mg/kg
EPA 9040C	Soil	pH	N/A	N/A	N/A
SM21 5310B, SW8469060	Soil	Total Organic Carbon (TOC)	1000	160	mg/kg
ASTM516-90,02	Soil	Sulfate	50	7	mg/kg
SM21 4500 S F	Soil	Sulfide	4	1.5	mg/kg
EPA 351.2	Soil	Total Kjeldahl Nitrogen (TKN)	5	1.2	mg/kg
EPA 365.4/4500PE	Soil	Total Phosphorous	10	0.24	mg/kg
SM18 4500 NH3F	Soil	Ammonia	5	1.8	mg/kg

2/17/2020

Analytical Method Information

PFAS Target compounds by LC/MS-MS

PFAS, NYSDEC Target List in Soil (EPA 537m) Units: ug/kg

Preservation: Cool 4°C **Hold Time to Analysis** 28 days

Container: 10_250mL Plastic Cool to 4° C **Amount Required:** 250 mL **Hold Time to Extr.** 14 days

Analyte	MDL	Reporting Limit	Surrogate %R	Duplicate RPD	Matrix Spike %R	Matrix Spike RPD	Blank Spike / LCS %R	Blank Spike / LCS RPD
1H,1H,2H,2H-Perfluorodecanesulfonic acid (8:2 FTS)	0.0256	0.750 ug/kg		30	25 - 150	35	50 - 130	30
1H,1H,2H,2H-Perfluorooctanesulfonic acid (6:2 FTS)	0.0660	0.750 ug/kg		30	25 - 150	35	50 - 130	30
N-EtFOSAA	0.104	0.750 ug/kg		30	25 - 150	35	50 - 130	30
N-MeFOSAA	0.104	0.750 ug/kg		30	25 - 150	35	50 - 130	30
Perfluoro-1-decanesulfonic acid (PFDS)	0.0512	0.750 ug/kg		30	25 - 150	35	50 - 130	30
Perfluoro-1-heptanesulfonic acid (PFHpS)	0.0493	0.750 ug/kg		30	25 - 150	35	50 - 130	30
Perfluoro-1-octanesulfonamide (FOSA)	0.0467	0.750 ug/kg		30	25 - 150	35	50 - 130	30
Perfluorobutanesulfonic acid (PFBS)	1.65	2.00 ug/kg		30	25 - 150	35	50 - 130	30
Perfluorodecanoic acid (PFDA)	0.0512	0.750 ug/kg		30	25 - 150	35	50 - 130	30
Perfluorododecanoic acid (PFDoA)	0.0750	0.750 ug/kg		30	25 - 150	35	50 - 130	30
Perfluoroheptanoic acid (PFHpA)	0.0455	0.750 ug/kg		30	25 - 150	35	50 - 130	30
Perfluorohexanesulfonic acid (PFHxS)	0.0310	0.750 ug/kg		30	25 - 150	35	50 - 130	30
Perfluorohexanoic acid (PFHxA)	0.0659	0.750 ug/kg		30	25 - 150	35	50 - 130	30
Perfluoro-n-butanoic acid (PFBA)	0.183	0.750 ug/kg		30	25 - 150	35	50 - 130	30
Perfluorononanoic acid (PFNA)	0.0598	0.750 ug/kg		30	25 - 150	35	50 - 130	30
Perfluorooctanesulfonic acid (PFOS)	0.0438	0.750 ug/kg		30	25 - 150	35	50 - 130	30
Perfluorooctanoic acid (PFOA)	0.0772	0.750 ug/kg		30	25 - 150	35	50 - 130	30
Perfluoropentanoic acid (PFPeA)	0.0919	0.750 ug/kg		30	25 - 150	35	50 - 130	30
Perfluorotetradecanoic acid (PFTA)	0.0747	0.750 ug/kg		30	25 - 150	35	50 - 130	30
Perfluorotridecanoic acid (PFTrDA)	0.0435	0.750 ug/kg		30	25 - 150	35	50 - 130	30
Perfluoroundecanoic acid (PFUnA)	0.116	0.750 ug/kg		30	25 - 150	35	50 - 130	30

York Analytical Laboratories, Inc.	Method:	PFAS by EPA 537.1, Modified
	Matrix:	Soil
PFAS MDL Study - 2020	Instrument:	QQQ1

Final MDL

Compound	MDL_b (µg/kg)	MDL_s (µg/kg)	MDL (µg/kg)
1H,1H,2H,2H-perfluoro-1-decanesulfonate (8 2FTS)	0.0044	0.0256	0.0256
1H,1H,2H,2H-perfluoro-1-hexanesulfonate (4 2FTS)	0.0032	0.0520	0.0520
1H,1H,2H,2H-perfluoro-1-octanesulfonate (6 2FTS)	0.0660	0.0572	0.0660
N-EtFOSAA	0.1042	0.0369	0.1042
N-MeFOSAA	0.1044	0.0370	0.1044
Perfluoro-1-decanesulfonate (L-PFDS)	0.0094	0.0439	0.0439
Perfluoro-1-heptanesulfonate (L-PFHpS)	0.0024	0.0493	0.0493
Perfluoro-1-octanesulfonamide (FOSA)	0.0104	0.0467	0.0467
Perfluoro-1-pentanesulfonate (L-PFPeS)	0.0022	0.0297	0.0297
Perfluorobutanesulfonic acid (PFBS)	1.6464	1.4926	1.6464
Perfluorodecanoic acid (PFDA)	0.0111	0.0512	0.0512
Perfluorododecanoic acid (PFDoA)	0.0483	0.0750	0.0750
Perfluoroheptanoic acid (PFHpA)	0.0153	0.0455	0.0455
Perfluorohexanesulfonic acid (PFHxS)	0.0055	0.0310	0.0310
Perfluorohexanoic acid (PFHxA)	0.0472	0.0659	0.0659
Perfluoro-n-butanoic acid (PFBA)	0.1827	0.0411	0.1827
Perfluorononanesulfonate (L-PFNS)	0.0027	0.0376	0.0376
Perfluorononanoic acid (PFNA)	0.0220	0.0598	0.0598
Perfluoro-n-pentanoic acid (PFPeA)	0.0919	0.0233	0.0919
Perfluorooctanesulfonic acid (PFOS)	0.0074	0.0438	0.0438
Perfluorooctanoic acid (PFOA)	0.0772	0.0538	0.0772
Perfluorotetradecanoic acid (PFTA)	0.0146	0.0747	0.0747
Perfluorotridecanoic acid (PFTrDA)	0.0435	0.0373	0.0435
Perfluoroundecanoic acid (PFUnA)	0.0285	0.1163	0.1163

York Analytical Laboratories, Inc.	Method:	PFAS by EPA 537.1, Modified
	Matrix:	Soil
PFAS MDL Study - 2020 Data & Calculations	Instrument:	QQQ1

MDL$_b$ (µg/kg)		*Batch 1: BA01240* *Extraction Date: 1/27/2020* *Analysis Date: 1/29/2020*		*Batch 2: BA01266* *Extraction Date: 1/28/2020* *Analysis Date: 1/30/2020*		*Batch 3: BB00068* *Extraction Date: 2/3/2020* *Analysis Date: 2/5/2020*			MDL Calculations $t_{0.99}$ = 3.143		
		BA01240-BLK3 QQQ3442.d	BA01240-BLK4 QQQ3444.d	BA01266-BLK3 QQQ3458.d	BA01266-BLK4 QQQ3459.d	BB00068-BLK2 QQQ3509.d	BB00068-BLK3 QQQ3510.d	BB00068-BLK4 QQQ3511.d	Average	Standard Deviation	Raw MDL$_b$ (µg/kg)
		Extraction Volume (g)		*Extraction Volume (g)*		*Extraction Volume (g)*					
Compound	Compound Type	*2.0893*	*2.0745*	*2.1480*	*2.1321*	*2.1149*	*2.1175*	*2.1036*			
		Result (µg/mL)	Result (µg/mL)	Result (µg/mL)	Result (µg/mL)	Result (µg/mL)	Result (µg/mL)	Result (µg/mL)			
1H,1H,2H,2H-perfluoro-1-decanesulfonate (8 2FTS)	Target	0.001720	0.002355	0.000340	0.001161	0.002484	0.000113	0.001964	0.001448	0.000942	0.004410
1H,1H,2H,2H-perfluoro-1-hexanesulfonate (4 2FTS)	Target	0.002225	0.001647	0.001297	0.002401	0.002125	0.001432	0.001974	0.001872	0.000419	0.003189
1H,1H,2H,2H-perfluoro-1-octanesulfonate (6 2FTS)	Target	0.044059	0.053377	0.030932	0.030435	0.026859	0.029860	0.029025	0.034935	0.009879	0.065984
N-EtFOSAA	Target	0.004032	0.045669	0.000727	0.000543	0.067370	0.000304	0.000336	0.016997	0.027747	0.104206
N-MeFOSAA	Target	0.002475	0.047597	0.002614	0.002763	0.068582	0.013042	0.005124	0.020314	0.026762	0.104428
Perfluoro-1-decanesulfonate (L-PFDS)	Target	0.000350	0.007138	0.001358	0.000294	0.000831	0.000413	0.001864	0.001750	0.002447	0.009439
Perfluoro-1-heptanesulfonate (L-PFHpS)	Target	0.000657	0.001463	0.000592	0.000364	0.001384	0.001120	0.000272	0.000836	0.000484	0.002358
Perfluoro-1-octanesulfonamide (FOSA)	Target	0.001292	0.006550	0.002275	0.000408	0.002590	0.005992	0.002078	0.003027	0.002336	0.010367
Perfluoro-1-pentanesulfonate (L-PFPeS)	Target	0.000345	0.000318	0.000081	0.001108	0.000314	0.001473	0.000042	0.000526	0.000546	0.002241
Perfluorobutanesulfonic acid (PFBS)	Target	1.043813	1.042464	0.302075	0.236259	0.419587	0.317608	0.338326	0.528590	0.355641	1.646370
Perfluorodecanoic acid (PFDA)	Target	0.007407	0.002173	0.001956	0.001032	0.006177	0.002145	0.003863	0.003536	0.002402	0.011086
Perfluorododecanoic acid (PFDoA)	Target	0.000429	0.001460	0.002608	0.008242	0.036187	0.007295	0.000620	0.008120	0.012771	0.048259
Perfluoroheptanoic acid (PFHpA)	Target	0.004388	0.007113	0.004792	0.006551	0.012276	0.007974	0.006095	0.007027	0.002631	0.015295
Perfluorohexanesulfonic acid (PFHxS)	Target	0.002440	0.003340	0.002157	0.003202	0.001288	0.003915	0.002862	0.002743	0.000867	0.005467
Perfluorohexanoic acid (PFHxA)	Target	0.015940	0.037195	0.020696	0.017936	0.028921	0.024758	0.025927	0.024482	0.007230	0.047205
Perfluoro-n-butanoic acid (PFBA)	Target	0.141733	0.142368	0.158687	0.156440	0.163138	0.158559	0.161868	0.154685	0.008913	0.182697
Perfluorononanesulfonate (L-PFNS)	Target	0.001317	0.000409	0.001456	0.000605	0.001145	0.001827	0.000572	0.001047	0.000530	0.002714
Perfluorononanoic acid (PFNA)	Target	0.008515	0.017734	0.010675	0.008606	0.008668	0.011701	0.006243	0.010306	0.003709	0.021964
Perfluoro-n-pentanoic acid (PFPeA)	Target	0.042602	0.042310	0.042213	0.007470	0.046454	0.004049	0.003179	0.026897	0.020669	0.091859
Perfluorooctanesulfonic acid (PFOS)	Target	0.004087	0.004311	0.000747	0.002900	0.003796	0.004311	0.002071	0.003175	0.001353	0.007428
Perfluorooctanoic acid (PFOA)	Target	0.035331	0.031241	0.041464	0.045559	0.061810	0.051696	0.047872	0.044996	0.010257	0.077235
Perfluorotetradecanoic acid (PFTA)	Target	0.000780	0.001655	0.001643	0.000493	0.002782	0.008021	0.009000	0.003482	0.003524	0.014557
Perfluorotridecanoic acid (PFTrDA)	Target	0.003306	0.002699	0.002669	0.002785	0.033195	0.000588	0.002018	0.006752	0.011693	0.043502
Perfluoroundecanoic acid (PFUnA)	Target	0.008602	0.000873	0.011616	0.001764	0.019109	0.002954	0.000357	0.006468	0.007000	0.028468

York Analytical Laboratories, Inc.	Method:	PFAS by EPA 537.1, Modified
	Matrix:	Soil
PFAS MDL Study - 2020 Data & Calculations	Instrument:	QQQ1

MDL$_s$ (µg/kg)		*Batch 1: BA01240* *Extraction Date: 1/27/2020* *Analysis Date: 1/29/2020*		*Batch 2: BA01266* *Extraction Date: 1/28/2020* *Analysis Date: 1/30/2020*		*Batch 3: BB00068* *Extraction Date: 2/3/2020* *Analysis Date: 2/5/2020*			MDL Calculations $t_{0.99}$ = 3.143		
		BA01240-BS3 QQQ3447.d	BA01240-BS4 QQQ3448.d	BA01266-BS3 QQQ3462.d	BA01266-BS4 QQQ3463.d	BB00068-BS2 QQQ3513.d	BB00068-BS3 QQQ3514.d	BB00068-BS4 QQQ3515.d	Average	Standard Deviation	Raw MDL$_s$ (µg/kg)
		Extraction Volume (g)		*Extraction Volume (g)*		*Extraction Volume (g)*					
Compound	Compound Type	*2.0655*	*2.0666*	*2.1777*	*2.1467*	*2.1133*	*2.1475*	*2.1163*			
		Result (µg/mL)	Result (µg/mL)	Result (µg/mL)	Result (µg/mL)	Result (µg/mL)	Result (µg/mL)	Result (µg/mL)			
1H,1H,2H,2H-perfluoro-1-decanesulfonate (8 2FTS)	Target	0.236569	0.234923	0.223776	0.232631	0.233002	0.231134	0.250708	0.234678	0.008155	0.025631
1H,1H,2H,2H-perfluoro-1-hexanesulfonate (4 2FTS)	Target	0.244762	0.248489	0.234432	0.284526	0.250230	0.267571	0.260062	0.255724	0.016557	0.052038
1H,1H,2H,2H-perfluoro-1-octanesulfonate (6 2FTS)	Target	0.294134	0.299161	0.269013	0.308595	0.261640	0.278617	0.266290	0.282493	0.018206	0.057222
N-EtFOSAA	Target	0.207273	0.224289	0.216864	0.239952	0.221819	0.239546	0.225788	0.225076	0.011739	0.036894
N-MeFOSAA	Target	0.229575	0.253733	0.254430	0.233745	0.231737	0.235353	0.224628	0.237600	0.011765	0.036977
Perfluoro-1-decanesulfonate (L-PFDS)	Target	0.222529	0.248891	0.234073	0.245578	0.245764	0.219821	0.215354	0.233144	0.013960	0.043878
Perfluoro-1-heptanesulfonate (L-PFHpS)	Target	0.253920	0.257493	0.264311	0.300810	0.269743	0.259522	0.264982	0.267255	0.015700	0.049345
Perfluoro-1-octanesulfonamide (FOSA)	Target	0.259800	0.250089	0.230205	0.258941	0.266044	0.251766	0.227617	0.249209	0.014860	0.046707
Perfluoro-1-pentanesulfonate (L-PFPeS)	Target	0.238404	0.242146	0.236804	0.261357	0.242723	0.240746	0.231119	0.241900	0.009443	0.029681
Perfluorobutanesulfonic acid (PFBS)	Target	1.557948	1.269966	0.432434	0.467426	0.449365	0.453126	0.478736	0.729857	0.474886	1.492567
Perfluorodecanoic acid (PFDA)	Target	0.238015	0.226746	0.229033	0.247759	0.255400	0.205837	0.242025	0.234974	0.016287	0.051190
Perfluorododecanoic acid (PFDoA)	Target	0.260739	0.260766	0.224530	0.291134	0.249475	0.258850	0.221521	0.252431	0.023875	0.075041
Perfluoroheptanoic acid (PFHpA)	Target	0.241305	0.271516	0.225801	0.234677	0.247474	0.252663	0.244439	0.245411	0.014468	0.045472
Perfluorohexanesulfonic acid (PFHxS)	Target	0.187110	0.191007	0.174272	0.207026	0.188327	0.190168	0.183264	0.188739	0.009863	0.031000
Perfluorohexanoic acid (PFHxA)	Target	0.270655	0.294261	0.260002	0.303254	0.274964	0.242532	0.259964	0.272233	0.020975	0.065925
Perfluoro-n-butanoic acid (PFBA)	Target	0.382858	0.377055	0.389737	0.411161	0.402833	0.401301	0.408306	0.396179	0.013081	0.041114
Perfluorononanesulfonate (L-PFNS)	Target	0.219261	0.227936	0.237873	0.252640	0.221317	0.242976	0.232845	0.233550	0.011957	0.037581
Perfluorononanoic acid (PFNA)	Target	0.191715	0.227906	0.227588	0.254892	0.219447	0.217891	0.233708	0.224735	0.019032	0.059817
Perfluoro-n-pentanoic acid (PFPeA)	Target	0.272731	0.280874	0.276700	0.292125	0.291678	0.282513	0.277798	0.282060	0.007409	0.023286
Perfluorooctanesulfonic acid (PFOS)	Target	0.189924	0.185800	0.200341	0.226678	0.202483	0.203644	0.188406	0.199611	0.013951	0.043848
Perfluorooctanoic acid (PFOA)	Target	0.286327	0.255907	0.283019	0.254316	0.281346	0.241807	0.269515	0.267462	0.017124	0.053821
Perfluorotetradecanoic acid (PFTA)	Target	0.250377	0.229178	0.244456	0.263243	0.248949	0.304756	0.263055	0.257716	0.023779	0.074739
Perfluorotridecanoic acid (PFTrDA)	Target	0.252372	0.268339	0.278099	0.259273	0.249343	0.275190	0.251400	0.262002	0.011875	0.037322
Perfluoroundecanoic acid (PFUnA)	Target	0.228293	0.268792	0.204222	0.283066	0.231955	0.286456	0.195861	0.242664	0.037019	0.116350

PREPARATION BENCH SHEET-SOILS/SOLIDS: BA01240

Preparation Date: 01/27/2020 17:28

York Analytical Laboratories, Inc. **Printed: 2/17/2020 3:28:04PM**

Matrix: Soil **Preparation: SPE PFAS Extractic** **Surrogate used: Y20A283 100 ul**

Lab Number	Analysis	Initial (g)	Final (mL)	Spike ID	Source ID	ul Spike	Comments
BA01240-BLK3	QC	2.0893	2				
BA01240-BLK4	QC	2.0745	2				
BA01240-BS3	QC	2.0655	2	Y19L387		5	
BA01240-BS4	QC	2.0666	2	Y19L387		5	

Reagents:

ID Number	Description	Lot Number	ID Number	Description	Lot Number
Y19I302	0.4 % KOH/Methanol Solution	YorkPFAS-2	Y19I303	0.3% NH4OH/Methanol Soluito	YorkPFAS-1
Y19K172	Ottawa Sand	814140-AI	Y20A132	Water, HPLC Plus Grade	SHBL4724
Y20A133	Methanol, HPLC Plus Grade	SHBL1471	Y20A153	Strata XL-AW 100 um PWA 50(	S322-0027_S19-007117

Preparations Performed by **WL** **Date:** **01/27/2020 17:28**

PREPARATION BENCH SHEET-SOILS/SOLIDS: BA01266

Preparation Date: 01/28/2020 11:02

York Analytical Laboratories, Inc.

Printed: 2/17/2020 3:28:46PM

Matrix: Soil **Preparation: SPE PFAS Extractic** **Surrogate used: Y20A283 100 ul**

Lab Number	Analysis	Initial (g)	Final (mL)	Spike ID	Source ID	ul Spike	Comments
BA01266-BLK3	QC	2.148	2				
BA01266-BLK4	QC	2.1321	2				
BA01266-BS3	QC	2.1777	2	Y19L387		5	
BA01266-BS4	QC	2.1467	2	Y19L387		5	

Reagents:

ID Number	Description	Lot Number	ID Number	Description	Lot Number
Y19E171	Strata XL-AW 100 um PWA 20(	S322-0024_S19-000746	Y19I302	0.4 % KOH/Methanol Solution	YorkPFAS-2
Y19I303	0.3% NH4OH/Methanol Soluito	YorkPFAS-1	Y19K172	Ottawa Sand	814140-AI
Y20A133	Methanol, HPLC Plus Grade	SHBL1471	Y20A254	Water, HPLC Plus Grade	SHBL4724

Preparations Performed by WL

Date: 01/28/2020 11:02

PREPARATION BENCH SHEET-SOILS/SOLIDS: BB00068

Preparation Date: 02/03/2020 15:53

York Analytical Laboratories, Inc. **Printed: 2/17/2020 3:29:19PM**

Matrix: Soil **Preparation: SPE PFAS Extractic** **Surrogate used: Y20A283 100 ul**

Lab Number	Analysis	Initial (g)	Final (mL)	Spike ID	Source ID	ul Spike	Comments
BB00068-BLK2	QC	2.117	2				
BB00068-BLK3	QC	2.1177	2				
BB00068-BLK4	QC	2.1883	2				
BB00068-BS2	QC	2.1976	2	Y19L387		5	
BB00068-BS3	QC	2.1405	2	Y19L387		5	
BB00068-BS4	QC	2.1183	2	Y19L387		5	

Reagents:

ID Number	Description	Lot Number	ID Number	Description	Lot Number
Y19I302	0.4 % KOH/Methanol Solution	YorkPFAS-2	Y19I303	0.3% NH4OH/Methanol Soluito	YorkPFAS-1
Y19K172	Ottawa Sand	814140-AI	Y20A254	Water, HPLC Plus Grade	SHBL4724
Y20A390	Strata XL-AW 100 um PWA 50(	S322-0027_S19-007117	Y20A420	Methanol, HPLC Plus Grade	SHBL4287

Preparations Performed by WL

Date: 02/03/2020 15:53

PFAS Compound Analyte List for Soil And Groundwater Samples

Compound Name	Analytical Method
Perfluorohexanoic acid (PFHxA)	USEPA Method 537 Modified
Perfluoroheptanoic acid (PFHpA)	
Perfluorooctanoic acid (PFOA)	
Perfluorobutanoic acid (PFBA)	
Perfluoropentanoic acid (PFPeA)	
Perfluorononanoic acid (PFNA)	
Perfluorodecanoic acid (PFDA)	
Perfluoroundecanoic acid (PFUA/PFUdA)	
Perfluorododecanoic acid (PFDoA)	
Perfluorotridecanoic acid (PFTriA/PFTrDA)	
Perfluorotetradecanoic acid (PFTA/PFTeDA)	
Perfluorobutanesulfonic acid (PFBS)	
Perfluorohexanesulfonic acid (PFHxS)	
Perfluoroheptanesulfonic acid (PFHpS)	
Perfluorodecanesulfonic acid (PFDS)	
Perfluorooctanesulfonic acid (PFOS)	
N-methyl perfluorooctanesulfonamidoacetic acid (N-MeFOSAA)	
N-ethyl perfluorooctanesulfonamidoacetic acid (N-EtFOSAA)	
6:2 Fluorotelomer sulfonate (6:2 FTS)	
8:2 Fluorotelomer sulfonate (8:2 FTS)	
Perfluoroctancesulonamide (FOSA)	

Notes:

1. PFAS - per- and polyfluoroalkyl substances

ATTACHMENT C
Analytical Methods/Quality Assurance Summary Table

ATTACHMENT C

ANALYTICAL METHODS/QUALITY ASSURANCE SUMMARY TABLE

Matrix Type	Field Parameters	Laboratory Parameters	Analytical Methods	Sample Preservation	Sample Container Volume and Type	Sample Hold Time	Field Duplicate Samples	Field Blank Samples	Equipment Blank Samples	Trip Blank Samples	Ambient Air Samples	MS/MSD Samples
		Part 375 + TCL VOCs	EPA 8260C	Cool to 4°C	Two 40-ml VOC vials with 5ml H_2O, one with MeOH or 3 En Core Samplers (separate container for % solids)	14 days						
		Part 375 + TCL SVOCs	EPA 8270D	Cool to 4°C	4 oz. amber glass jar	14 days extract, 40 days after extraction to analysis						
		Part 375 + TAL Metals + Cyanide	EPA 6010C, EPA 7470A, EPA 7196A, EPA 9014/9010C	Cool to 4°C	2 oz. amber glass jar	6 months, except mercury 28 days			NA			
Soil	Total VOCs via PID	Part 375 + TCL Pesticides	EPA 8081B	Cool to 4°C	4 oz. amber glass jar	14 days extract, 40 days after extraction to analysis	1 per 20 samples (minimum 1)	1 per 20 samples (minimum 1)		NA	NA	1 per 20 samples
		Part 375 + TCL PCBs	EPA 8082A	Cool to 4°C	4 oz. amber glass jar	14 days extract, 40 days after extraction to analysis						
		NYSDEC List PFAS	EPA 537 Modified	Cool to 4°C	8 oz. HDPE jar	14 days to extract, 28 days after extraction to analysis			1 per day			
		1,4-Dioxane	8270 SIM	Cool to 4°C	4 oz. amber glass jar	14 days extract, 40 days after extraction to analysis			NA			
		Part 375 + TCL VOCs	EPA 8260C	Cool to 4°C; HCl to pH <2;no headspace	Three 40-mL VOC vials with Teflon®-lined cap	Analyze within 14 days of collection						
		Part 375 + TCL SVOCs	EPA 8270D	Cool to 4°C	Two 1-Liter amber glass	7 days to extract, 40 days after extraction to analysis						
		Part 375 + TAL Metals	EPA 6010C, EPA 7470A	HNO_3	250 ml plastic	6 months, except Mercury 28 days						
		Hexavalent Chromium	EPA 7196A	Cool to 4°C	250 ml plastic	24 hours			NA			
Groundwater	Temperature, Turbidity, pH, ORP, Conductivity, DO	Cyanide	SM 4500 C/E	NaOH plus 0.6g ascorbic acid	250 ml plastic	14 days	1 per 20 samples (minimum 1)	1 per 20 samples (minimum 1)		1 per shipment of VOC samples	NA	1 per 20 samples
		Part 375 + TCL Pesticides	EPA 8081B	Cool to 4°C	Two 1-Liter Amber Glass for Pesticides/PCB	7 days to extract, 40 days after extraction to analysis						
		PCBs	EPA 8082A	Cool to 4°C		7 days to extract, 40 days after extraction to analysis						
		PFAS	EPA 537 Modified	Cool to 4°C	Two 250 mL HDPE	14 days to extract, 28 days after extraction to analysis			1 per day			
		1,4-dioxane	8270 SIM	Cool to 4°C	One 1 -Liter Amber Glass	7 days to extract, 40 days after extraction to analysis			NA			
Soil Vapor	Total VOCs, Oxygen, LEL, CO, and H_2S, with MultiGas Meter	TO-15 Listed VOCs	TO-15	Ambient Temperature	2.7-Liter Summa Canister	Analyze within 30 days of collection	1 per 20 samples (minimum 1)	NA	NA	NA	1 per 10 samples (minimum 1)	NA
Ambient/Indoor Air	Total VOCs via PID				6-Liter Summa Canister		NA	NA	NA			

Notes:
1. PID - Photoionization Detector
2. VOC - Volatile organic compound
3. EPA - Environmental Protection Agency
4. TCL - Target compound list
5. TAL - Target analyte list
6. ORP - Oxidation reduction potential
7. DO - Dissolved oxygen
8. LEL - Lower explosive limit
9. CO -Carbon monoxide
10. H_2S - Hydrogen sulfide
11. PFAS - Per-fluoroalkyl substances
12. HDPE - High-Density Polyethylene

ATTACHMENT D
Sample Nomenclature

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SAMPLE NOMENCLATURE

The sample nomenclature outlined below provides consistency between sample events and projects but, most importantly, establish unique sample IDs that will avoid confusion months or years after the sample has been collected. Furthermore, unique sample IDs are required for any data submitted to the NYSDEC in EDD format or being uploaded to an EQuIS database.

1.0 INVESTIGATION LOCATION CODES

SB	Soil Boring	SV	Soil Vapor Point
WC	Waste Characterization Boring	IA	Indoor Air
TP	Test Pit	AA	Ambient Air
EPSW	Endpoint Location (Sidewall)	SVE	Vapor Extraction Well
EPB	Endpoint Location (Bottom)	DS	Drum
MW	Monitoring Well	IDW	Investigation Derived Waste
TMW	Temporary Monitoring Well	SL	Sludge
SW	Surface Water	FP	Free Product

2.0 SAMPLE NOMENCLATURE

Each sample at a site must have a unique value.

- **<u>Soil/Sediment Samples:</u>**

SBxx_y-y

Sample Location Code + Number (two digits minimum) → SBxx ; Sampling Interval (y-y) → y-y

Sample Type	Sample Location Code	Sampling Depth or Interval (feet bgs or approx. elevation)	Sample Name
Phase II/Remedial Investigation			
Grab Soil Sample	SB01	2 to 4	SB01_2-4
	SB02	4	SB02_4
Waste Characterization			
Grab Soil Sample	WC01	2 to 4	WC01_2-4
	WC02	4	WC02_4
Composite Soil Sample from one or more locations	COMP01 or COMP02 + COMP03	0 to 10 (Fill)	COMP01_0-10

Sample Type	Sample Location Code	Sampling Depth or Interval (feet bgs or approx. elevation)	Sample Name
Endpoint Sampling			
Grab Soil Sample	EPSW01_N	5	EPSW01_N_5
	EPSW01_S	5	EPSW01_S_5
	EPSW01_E	5	EPSW01_E_5
	EPSW01_W	5	EPSW01_W_5
	EPB01	6	EPB01_6

- **Groundwater/Surface Water Samples:**

MWxx_MMDDYY

Sample Location Code + Number (two digits minimum)

Sampling Date (MMDDYY)

Sample Type	Sample Location Code	Sampling Date	Sample Name
Groundwater Sample	MW01	02/21/2013	MW01_022113

- **Air/Soil Vapor Samples:**

IAxx_MMDDYY

Sample Location Code + Number (two digits minimum)

Sampling Date (MMDDYY)

Sample Type	Sample Location Code	Date	Sample Name
Air Sample	IA01	02/21/2013	IA01_022113
Soil Vapor Sample	SV01	02/21/2013	SV01_022113
Vapor Extraction Well Sample	SVE01 (INLET/MIDPOINT/OUTLET)	02/21/2013	SVE01_IN_022113 SVE01_ MID_022113 SVE01_ OUT_022113

- **QA/QC Samples:**

Sample Matrix Codes

SO	Soil	AS	Air
SE	Sediment	SV	Soil Vapor
GW	Groundwater	SL	Sludge
SW	Surface Water	FP	Free Product

- Duplicates Samples

SODUPxx_MMDDYY

Sample Matrix Code

Sample Type +
Number (two digits minimum)

Sampling Date (MMDDYY)

Sample Type	Parent Sample Code	Date	Sample Name
Groundwater Duplicate Sample (DUP)	MW01_022113	02/21/2013	GWDUP01_022113
Soil boring Duplicate Sample (DUP)	SBP01_022113	02/21/2013	SODUP01_022113
Grab Waste Characterization	WC01	02/21/2013	WCDUP01_022113
Composite Waste Characterization	COMP01	02/21/2013	COMPDUP01_022113

- Field Blanks and Trip Blanks

SBFBxx_MMDDYY

Sample Matrix Code

Sample Type +
Number (two digits minimum)

Sampling Date (MMDDYY)

Sample Type	Date	Sample Name
Groundwater Field Blank (FB)	02/21/2013	GWFB01_022113
Groundwater Trip Blank (TB)	02/21/2013	GWTB01_022113
Soil Field Blank	02/21/2013	SOFB01_022113
Soil Trip Blank	02/21/2013	SOTB01_022113

- Matrix Spike/Matrix Spike Duplicate (MS/MSD)

Parent Sample Name_MS or MSD

Sample Type	Sample Location	Parent Sample Name	Sample Name
Matrix Spike Soil (MS)	SB01	SB01_2-4	SB01_2-4_MS
Matrix Spike Soil Duplicate (MSD)	SB01	SB01_2-4	SB01_2-4_MSD
Matrix Spike GW (MS)	MW01	MW01	MW01_MS
Matrix Spike GW Duplicate (MSD)	MW01	MW01	MW01_MSD

3.0 NOTES

1. The sample location code should not exceed 20 characters and the sample name should not exceed 40 characters.
2. Sample location code (**SB01, MW01, etc.)** is a sequential number (starting with 01) and should be a minimum of two digits.
3. Sample Interval (SB01_**0-5**) is separated from the sample location code with an underscore, and the top and bottom interval with a dash. Soil and sediment sample intervals should always be in

feet. Soil and sediment sample intervals should contain no "/" or "()" or unit.

4. Sample date (MW01_**022113**) is separated from the sample location code with an underscore and should be provided in MMDDYY format [the date should contain no "/" or "-"].
5. If groundwater samples are collected from multiple intervals within one well, you may assign a letter designation (in lower case) to the well ID to differentiate between intervals (i.e., MW01a_022113, MW01b_022113, and MW01c_022113). The letter "a" would indicate the shallowest interval and "c" the deepest. The actual depth intervals should be documented in the project field book or field sheets and the letter designations should be used consistently between sampling events.
6. According to USEPA's Contract Laboratory Program (CLP) Guidance for Field Samplers (January 2011), field duplicate samples should remain "blind" to the laboratory (i.e., they should have separate CLP Sample numbers). Assign two separate (unique) CLP sample numbers (i.e., one number to the field sample and one to the duplicate). Submit blind to the laboratory. (http://www.epa.gov/superfund/programs/clp/download/sampler/CLPSamp-01-2011.pdf)

ATTACHMENT E
Perfluorinated Compound Sampling Protocol

Collection of Groundwater Samples for Perfluorooctanoic Acid (PFOA) and Perfluorinated Compounds (PFCs) from Monitoring Wells Sample Protocol

Samples collected using this protocol are intended to be analyzed for perfluorooctanoic acid (PFOA) and other perfluorinated compounds by Modified (Low Level) Test Method 537.

The sampling procedure used must be consistent with the NYSDEC March 1991 <u>SAMPLING GUIDELINES AND PROTOCOLS</u>
http://www.dec.ny.gov/regulations/2636.html with the following materials limitations.

At this time acceptable materials for sampling include: stainless steel, high density polyethylene (HDPE) and polypropylene. Additional materials may be acceptable if proven not to contain PFCs. **NOTE: Grunfos pumps and bladder pumps are known to contain PFC materials (e.g. Teflon™ washers for Grunfos pumps and LDPE bladders for bladder pumps).** <u>All sampling equipment components and sample containers should not come in contact with aluminum foil, low density polyethylene (LDPE), glass or polytetrafluoroethylene (PTFE, Teflon™) materials</u> including sample bottle cap liners with a PTFE layer. Standard two step decontamination using detergent and clean water rinse should be considered for equipment that does come in contact with PFC materials. Clothing that contains PTFE material (including GORE-TEX®) or that have been waterproofed with PFC materials must be avoided. Many food and drink packaging materials and “plumbers thread seal tape” contain PFCs.

All clothing worn by sampling personnel must have been laundered multiple times. The sampler must wear nitrile gloves while filling and sealing the sample bottles.

Pre-cleaned sample bottles with closures, coolers, ice, sample labels and a chain of custody form will be provided by the laboratory.

1. Fill two pre-cleaned 500 mL HDPE or polypropylene bottle with the sample.
2. Cap the bottles with an acceptable cap and liner closure system.
3. Label the sample bottles.
4. Fill out the chain of custody.
5. Place in a cooler maintained at 4 ± 2º Celsius.

Collect one equipment blank for every sample batch, not to exceed 20 samples.

Collect one field duplicate for every sample batch, not to exceed 20 samples.

Collect one matrix spike / matrix spike duplicate (MS/MSD) for every sample batch, not to exceed 20 samples.

Request appropriate data deliverable (Category A or B) and an electronic data deliverable.

Standard Operating Procedure

Preparation of Non-Potable Water and Soils for Target Per- and Polyfluorinated Alkyl Substances (PFAS) for analysis by LC-MS/MS

Approvals

Laboratory Director ______________________ Ben Gulizia

Corporate Technical Director ______________________ Robert Bradley

Corporate QA/QC Officer ______________________ Sarah Widomski

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Issued to: ______________________

1. SCOPE AND APPLICATION

This method is an Isotopic Dilution method and is used to prepare non-potable water and soil for analysis of specific PFAS using HPLC/MS-MS (high pressure liquid chromatography/ tandem mass spectrometry. Currently the compounds (26) that can be extracted and measured by this methodology at the date/revision of this SOP are listed in the table below.

1H,1H,2H,2H-perfluoro-1-decanesulfonate (8 2FTS)
1H,1H,2H,2H-perfluoro-1-hexanesulfonate (4 2FTS)
1H,1H,2H,2H-perfluoro-1-octanesulfonate (6 2FTS)
N-EtFOSAA
N-MeFOSAA
Perfluoro-1-decanesulfonate (L-PFDS)
Perfluoro-1-heptanesulfonate (L-PFHpS)
Perfluoro-1-octanesulfonamide (FOSA)
Perfluoro-1-pentanesulfonate (L-PFPeS)
Perfluorobutanesulfonic acid (PFBS)
Perfluorodecanoic acid (PFDA)
Perfluorododecanoic acid (PFDoA)
Perfluoroheptanoic acid (PFHpA)
Perfluorohexanesulfonic acid (PFHxS)
Perfluorohexanoic acid (PFHxA)
Perfluoro-n-butanoic acid (PFBA)
Perfluorononanesulfonate (L-PFNS)
Perfluorononanoic acid (PFNA)
Perfluoro-n-pentanoic acid (PFPeA)
Perfluorooctanesulfonic acid (PFOS)
Perfluorooctanoic acid (PFOA)
Perfluorotetradecanoic acid (PFTA)
Perfluorotridecanoic acid (PFTrDA)
Perfluoroundecanoic acid (PFUnA) 2,3,3,3-tetrafluoro-2-(heptafluoropropoxy) propanoic acid (GenX) 4,8-dioxa-3H-perfluorononanoic acid (ADONA)

The estimated reporting limit based upon the preparation/analysis parameters herein at the time of this revision are 2.0 ng/L (ppt) for aqueous samples 0.5-2 ug/kG for soil samples. The linear range for these PFAS can be extended by dilution.

2. SUMMARY

2.1 This procedure involves fortifying samples and related QC with specific isotopes of target PFAS followed by extraction, concentration to a known volume. The analysis of the extracts of non-potable water and soils is detailed in a separate SOP-PFAS_LCMSMS_MOD051019, Rev. 1.0. and updates.

2.2 For non-potable waters, a known volume of aqueous sample extracted using automated or manual Solid Phase Extraction (SPE). The compounds are eluted from the solid phase using ammoniated methanol. The extract is then slowly evaporated to a small volume using a nitrogen evaporation system. The resulting extract residue is reconstituted in 96%/4% Methanol/water to a final volume of 1.0 mL.

2.3 For soils, a known weight of sample (as received) is extracted with methanolic potassium hydroxide followed by vigourous vortex mixing, orbital agitation and ultrasonic extraction techniques. Prior to SPE cleanup/extraction the extract is fortified with PFAS free water and the methanol is removed by evaporation. The resulting aqueous extract brought to a 20 mL volume and is pH adjusted to pH 6-8. The aqueous extract is then extracted using automated or manual SPE extraction techniques followed by concentration of the SPE extract to a known final volume.

3. DEFINITIONS

3.1 ANALYSIS BATCH – A set of samples that is analyzed on the same instrument during a 24-hour period, including no more than 20 Field Samples, that begins and ends with the analysis of the appropriate Continuing Calibration Check (CCC) standards. Additional CCCs may be required depending on the length of the analysis batch and/or the number of Field Samples.

3.2 EXTRACTION BATCH – A set of up to 20 Field Samples (not including QC samples) extracted together by the same person(s) during a work day using the same lot of SPE devices, solvents, surrogate, internal standard and fortifying solutions. Required QC samples include Method Blank, Blank Spike, Matrix Spike/Matrix Spike Duplicate.

3.3 FIELD DUPLICATES (FD1 and FD2) – Two separate samples collected at the same time and place under identical circumstances, and treated exactly the same throughout field and laboratory procedures. Analyses of FD1 and FD2 give a measure of the precision associated with sample collection, preservation, and storage, as well as lab procedures.

3.4 FIELD BLANK – An aliquot of reagent water that is placed in a sample container in the laboratory and treated as a sample in all respects, including shipment to the sampling site, exposure to sampling site conditions, storage, preservation, and all analytical procedures. The purpose of the Field Blank is to determine if method analytes or other interferences are present in the field environment.

3.5 BLANK SPIKE (BS) – A volume of reagent water or other blank matrix to which known quantities of the method analytes and any preservation compounds are added in the laboratory. The Blank Spike is prepared and analyzed exactly like a sample, and its purpose is to determine whether the methodology is in control, and whether the laboratory is capable of making accurate measurements.

3.6 MATRIX SPIKE (MS) – A preserved field sample to which known quantities of the method analytes are added in the laboratory.
The MS is processed and analyzed exactly like a sample, and its purpose is to determine whether the sample matrix contributes bias to the analytical results. The background concentrations of the analytes in the sample matrix must be determined in a separate sample extraction and the measured values in the MS corrected for background concentrations.

3.7 MATRIX SPIKE DUPLICATE (MSD) – A duplicate of the Field Sample used to prepare the MSD. The MSD is fortified, extracted, and analyzed identically to the MS. The MSD is used instead of the Field Duplicate to assess method precision when the occurrence of method analytes is low.

3.8 METHOD BLANK – An aliquot of reagent water or other blank matrix that is treated exactly as a sample including exposure to all glassware, equipment, solvents and reagents, sample preservatives, internal standard, and surrogates that are used in the analysis batch. The method blank is used to determine if method analytes or other interferences are present in the laboratory environment, the reagents, or the apparati.

3.9 SURROGATE (isotopic) ANALYTE (SUR) – A compound which is structurally identical to the target analyte or an analog of the target analyte which is isotopically labeled (deuterium, oxygen 18, or carbon13) and chemically resembles method analytes and is unlikely to be found in any environmental sample. This compound(s) is added to a sample aliquot in known amounts before processing and is measured with the same procedures used to measure other method analytes. The purpose of the isotopic surrogate is to monitor method performance with each sample, and to adjust concentration for recovery of the isotopic analog.

4. INTERFERENCES

Do not use aluminum foil because PFAS can be potentially transferred from the aluminum foil to the glassware. Only aluminum foil rinsed with HPLC plus grade or LC/MS grade methanol can be used where necessary.

4.1 PFAS have been used in a wide variety of manufacturing processes, and laboratory supplies should be considered potentially contaminated until they have been tested and shown to be otherwise. The materials and supplies used during the method validation process have been tested and shown to be clean. These items are listed in the Reagents section.

4.2 Method interferences may be caused by contaminants in solvents, reagents (including DI water), sample bottles and caps, and other sample processing hardware that lead to discrete artifacts and/or elevated baselines in the chromatograms. All items such as these must be routinely demonstrated to be free from interferences (less than 1/2 the Reporting Limit), under the conditions of the analysis by analyzing Method Blanks. Subtracting blank values from sample results is not permitted.

4.3 PTFE products can be a source of PFAS (PFOA) contamination. The use of PTFE in the procedure should be avoided. Polypropylene (PP) or polyethylene (PE, HDPE) products must be used in place of PTFE products to minimize PFOA contamination.

4.3.1 Standards and samples are injected from polypropylene autosampler vials with polypropylene snap caps, once. Multiple injections may be performed on Primers when conditioning the instrument for analysis.

4.3.2 Random evaporative losses have been observed with the polypropylene caps causing high Internal Std. recovery after the vial was punctured and sample re-injected. For this reason, it is best to inject standards and samples once in the analytical sequence, or recrimp after injection. The auto sampler system employs a refrigerated (4^{o}C) sample compartment which minimizes losses.

4.3.2 Teflon-lined screw caps have detected PFAS at low concentrations. Repeated injection from the same teflon-lined screw cap have detected PFNA at increasing concentration as each repeated injection was performed, therefore, it is required to use only polypropylene snap caps as specified in this SOP.

4.4 HPLC Plus grade or LC/MS grade methanol and water must be used for all steps where methanol or water are used in this method.

4.5 Matrix interferences may be caused by contaminants that are co-extracted from the sample. The extent of matrix interferences will vary considerably from source to source, depending upon the nature of the water or soil. SPE provides the necessary clean-up to reduce the occurrence of matrix effects.

4.6 Solid phase extraction cartridges may be a source of interferences. The analysis of laboratory method blanks can provide important information regarding the presence or absence of such interferences. The Phenomenex Strata-

XL-AW or the Oasis WAX SPE tubes have shown no interfering peaks/ions at the retention times of interest. Each new lot of SPE cartridge sorbent must be tested to ensure that contamination does not preclude analyte identification and quantitation.

4.7 Volumetric glassware and syringes are difficult to clean after being used for solutions containing high levels of PFAS. These items should be labeled for use only with similarly concentrated solutions or verified clean prior to re-use. To the extent possible, disposable labware (mechanical pipetors) are used.

4.8 Preparation work is done wearing nitrile gloves at all times to reduce the potential for contamination.

5. SAMPLE HANDLING

5.1 Aqueous and soil samples are collected by our clients in 250 mL HDPE bottles with HDPE caps.

5.2 FIELD BLANKS (FBLK)- A FBLK must be handled along with each sample set. The sample set is composed of samples collected from the same sample site and at the same time. At the laboratory, fill the field blank sample bottle with reagent water, seal, and ship to the sampling site along with the sample bottles. For each FBLK shipped, an empty sample bottle must also be shipped. At the sampling site, the sampler must open the shipped FBLK and pour the reagent water into the empty shipped sample bottle, seal and label this bottle as the FBLK. The FBLK is shipped back to the laboratory along with the samples and analyzed to ensure that PFAS were not introduced into the samples during sample collection/handling.

5.3 SAMPLE SHIPMENT AND STORAGE – Samples must be chilled during shipment and must not exceed 10 °C during the first 48 hours after collection. Sample temperature must be confirmed to be at or below 10 °C when the samples are received at the laboratory. Samples stored in the lab must be held at or below 6 °C until extraction, but should not be frozen.

NOTE: Samples that are significantly above 10° C, at the time of collection, may need to be iced or refrigerated for a period of time, in order to chill them prior to shipping. This will allow them to be shipped with sufficient ice to meet the above requirements.

5.4 SAMPLE AND EXTRACT HOLDING TIMES –PFAS have adequate stability for 14 days when collected, preserved, shipped and stored as described. Therefore, water and soil samples should be extracted within 14 days of collection. Extracts must be stored at <10°C or room temperature and analyzed within 28 days after extraction.

6. APPARATUS AND MATERIALS

6.1 250 mL High Density Polyethylene (HDPE) bottles with HDPE linerless caps-Greenwood Env. Part no. 07-GW2501: 250ml SMART Natural HDPE Leakproof Wide Mouth Bottle w/43-415 Linerless Cap, Assembled Only (250/cs) or 07-GW2503: 250ml HDPE Leakproof Wide Mouth Bottle w/43-415 Linerless Cap , Certified (250/cs), or equivalent-alternate source: VWR Scientific: Part no. 414004-113 HDPE wide moutgh bottle with HDPE liner less cap. These have been tested and demonstrated to be PFAS-free in initial studies.

6.2 Transport Tube: Virgin Polypropylene, White, Plastic, 10 mL Capacity, 16 mm OD, 93 mm Overall Lg, Self-Standing, 250 PK， Item 710Z420, Gamut.com (Grainger), with PP cap

6.3 Graduated cylinders, 50, 100, 250, 500 and 1000mL, Polypropylene, VWR Scientific or equivalent

6.4 Analytical Balance, 0.0001g., checked for accuracy each day of use with Class S weights.

6.5 Extract concentrator: Organomation Model N-EVAP 112, 24 position concentrator with water batch control and nitrogen supply controls.

6.6 Syringes, polypropylene, luer lock, 50-100 mL for filtration of turbid groundwater samples. Merck XX110500 Fisher Scientific or equivalent

6.6 3.1 Micron in-line filters, Biotage part no. 49-2814-01

6.7 1.0 mL polypropylene snap cap vials, Agilent part no. 5182-0567

6.8 Snap caps, polypropylene, 11 mm, 11/9k, Agilent Part no. 5182-0542

6.9 2mL self standing PP microcentrifuge snap cap tubes, SKS Scientific part no. 0747-17

6.10 15 mL PP or HDPE Centrifuge tubes, Corning Part no. 430791

6.11 3 mL Disposable Transfer pipets, PE, VWR part no. 16001-176

6.12 50 mL HDPE centrifuge tubes, 4 of 50ml Graduated Centrifuge Tube, PP Materials, Conical Bottom, Disposable, Blue Cap, Non-Sterile, 95kpa, Karter Scientific 208L2 - Pack of 50 or equivalent

6.13 Solid Phase Extraction Tubes:

For aqueous samples the following have been proven to meet SOP requirements: Phenomenex Strata XL-AW 100 um 200 mg 6mL tubes, part no. 8B-S051-FCH or Phenomenex Strata XL-AW 100 um 500 mg 6 mL tubes, part no. 8BS0510HCH, or Waters OASIS WAX 6cc/500 mg 60um tubes, part no. 186004647

For soils the following tubes can be used: Phenomenex Strata XL-AW 100 um 500 mg 6 mL tubes, part no. 8BS0510HCH; Biotage Evolute 500 mg/6mL 30 um tubes part no. 614-0050-CXG or Waters OASIS WAX 6cc/500 mg 60um tubes, part no. 186004647

6.14 Syringes, Hamilton or equivalent 5.0 uL, 10 uL 25 uL, 100 uL, 250 uL, 500 uL, *teflon free.*

6.15 SPE Automated Extraction System, Promochrom Technologies, Inc. 8 position simultaneous processing, PTFE free system.

6.16 Nitrogen Evaporation System- Organomation Model N-EVAP 112-24 position evaporator with water bath and individual nitrogen delivery control. Water bath capable of ambient temperature to 85 C, operated at 60 C.

6.17 Vortex Mixer- Benchmark Industries or equivalent

6.18 pH paper, short range 6-8- VWR Scientific or equivalent

6.19 Ultrasonic Baths- GT Sonic LS-10D, 240 w and Limplus VGT-1990QT, 240 w

6.20 Orbital Shaker- Jiangau Tenlin Instr. Co., Ltd., Model no. TLSK-III 20-230 RPM, 0-999 min.

6.21 Centrifuge, 50 mL, Premiere Model XC-2450 Series Centrifuge 6 x 50 mL, 3500 RPM max.

6.22 Mini Centrifuge, 2 mL Four E's Scientific, 5400 RPM

6.23 Mechanical Pipettors- 10-100 uL; 100-1000 uL; 1000-5000 uL-4 E'S Scientific or equivalent, calibrated quarterly.

7. REAGENTS AND STANDARDS

ALL REAGENTS and STANDARDS MUST BE LOGGED INTO THE ELEMENT LIMS SYSTEM. This includes lot numbers, expiration, open and prepared dates, recipe, Certification/traceability documents from supplier(s) if provided and preparer.

7.1 Methanol, hypergrade for LC/MS. (Merck) from Sigma Aldrich Part no. 1060354000. Alternatively- Methanol, HPLC plus grade, Sigma Aldrich Part. No. 646377-4L

7.2 Water, hypergrade for LC/MS. (Merck) from Sigma Aldrich Part no. 1153334000; alternatively- Water, HPLC Plus grade, Sigma Aldrich part no. 34877-4L.

7.3 Ammonium Hydroxide- 28-30%- ACS grade Sigma Aldrich Part no. 221228-500ML-A

7.3.1 Ammonium Hydroxide, 0.3%- dilute 10 mL of 30% Ammonium Hydroxide to 1 liter with HPLC plus grade MeOH

7.4 Potassium Hydroxide-BioXtra grade, Sigma Aldrich part no. P5958-250G

7.4.1 0.4% KOH/MeOH- weigh 2.00g KOH into 500 mL HPLC plus grade Methanol.

7.5 Acetic Acid, Glacial, >99.7%- ACS grade-Sigma Aldrich part no. 695092-500ML

7.6 Ottawa Sand, Restek, Resprep cat. No. 26137, new lots must be certified PFAS free by analysis before use.

7.7 **Stock Standards**

Stock Standards are purchased in mid to high concentration form from Wellington Laboratories, Inc. Guelph, ONT, CA. Currently, Wellington is the only supplier of these materials.

7.7.1 Surrogate (ISOTOPIC) Materials are purchased for this method from Wellington Labs at 50,000 ng/mL levels on an individual basis. The part nos. for 18 isotopes are listed as follows: MPFBA, M5PFPeA, M3PFBS, M5PFHxA, M4PFHpA, M3PFHxS, M2-6:2 FTS, M8PFOA, M8PFOS, M9PFNA, M2-8:2 FTS, M6PFDA, d3-N-MeFOSAA, M8FOSA, M7PFUnDA, d5-N-EtFOSAA, MPFDoA, M2PFTeDA.When GenX is a target- M3HFPO-DA.

7.7.2 Alternatively, a mixture of all the above isotopes is available from Wellington Laboratories as part no. MPFAC-24PAR at 1000 ng/mL in Methanol. NOTE: This mixture does not contain GenX or ADONA.

7.7.3 Stock Standard mixture of linear isomers of the target analytes are purchased from Wellington Labs at 2000 ng/mL concentrations under part no. PFAC-24PAR. This is used for native analyte calibration and for the BS/MS/MSDs.

7.8 **Intermediate/Working Standards Preparation**

7.8.1 **Isotopic Surrogate** Solution Intermediate Preparation-1000 ng/mL

5.0 mL of the 18 Isotope Surrogate mixture is prepared into a 10 mL polypropylene transfer tube for use at a 1000 ng/mL concentration. The GenX isotope M3HFPO-DA is not included. The intermediate is prepared by adding 100uL of each of the 18 isotopes (at 50,000 ng/mL, nominally as the anion) into 3200 uL of MeOH for a final concentration of 1000 ng/mL. Mix using the vortex mixer and carefully transfer to 3 separate labeled self standing 2 mL snap cap vials. Some isotopes are present as salts so the amount of indiv. Added may be more than 100 uL to adjust for salt vs. anion. The amount of MeOH will be reduced proportionately.

7.8.2 –Isotopic Surrogate Preparation for addition to samples/QC

<u>Preparation of Working Surrogate Mixture</u>- 10.0 mL final volume
From 1,000 ng/mL intermediate from 7.10.2 add 1000uL of the intermediate at 1000 ng./mL to 9000 uL methanol to give a final concentration of working isotopic surrogate mix at 100 ng/mL. This mixture is used for addition to all samples/QC that are to be extracted.

7.8.3 **Target Analyte Intermediate/Working Mixture-for BS/MS/MSD**

From the 2000 ng/mL stock solution (7.9.3), prepare a 100 ng/mL solution by adding 500 uL of the stock to 9500 uL Methanol. This results in a 100 ng/mL working standard. This 10 mL volume is then used for BS/MS/MSD solution (100 uL added for BS/MS/MSD).

8. PROCEDURE

Non-Potable Waters - Isotope Dilution

8.1 <u>SAMPLE PREPARATION</u>

8.1.1 Use the entire sample bottle contents(or an aliquot in cases where high levels are encountered). Do the same for the matrix spike and matrix spike duplicate analyses. If insufficient sample is provided, prepare a BS/BSD pair.

8.1.2 For the method blank and LCS matrix, use 200 mL of PFAS free water.

8.1.3 Add 100uL of the BS/MS spike mix (100 ng/mL) to the BS and MS/MSD bottles.

8.1.4 Add 100 uL of the IDA solution (100 ng/mL) into each sample and QC samples (Blank, BS, MS, MSD) onto the soil.

8.1.5 Swirl the bottles to mix the spike (s) into the matrix.

8.2 Aqueous Matrix Extraction SPE-MANUAL METHOD

8.2.1 Set up WAX 500mg/6 cc SPE columns for sample cleanup using the Visi-prep vacuum manifold.

8.2.2 Condition the SPE cartridges by passing the following through the column without drying the column.
NOTE: *The cartridges should not be allowed to go dry until the final elution step with methanol. At all of the other transition steps, the solvent/sample level should be stopped at the top of the column before the next liquid is added.*

8.2.2.1 Condition tube - add 5 mL 0.3 % NH4OH/MeOH
- add another 5 mL 0.3% NH4OH/MeOH
- add 5 mL MeOH, soak for 2 minutes, keep wet

8.2.2.2 Condition tube - add 5 mL PFAS free water
- add another 5mL PFAS free water, keep wet

8.2.3 Add 125 mL sample to Reservoir Use double fritted reservoirs for samples with visible particulate matter and allow to extract until all sample added
8.2.4 Wash sample bottle with 2 x 5 mL portions of water
8.2.5 Dry tube for 5 minutes
8.2.6 Stop vacuum and place 10 mL collection tubes in system
8.2.7 Start vacuum
8.2.8 Rinse sample bottle with 5 mL 0.3 % NH4OH/MeOH and add to Reservoir
8.2.9 Add 5 mL of 0.3% NH4OH/MeOH to reservoir (elution)
8.2.10 Allow to stay under vacuum to remove all liquid from tube for 1 minute
8.2.11 Stop vacuum and remove collection tubes.
8.2.12 Place in N-EVAP at 60C and initiate nitrogen purge.
8.2.13 Evaporate to approx. 0.5 mL-this will take approx. 2 hours
8.2.14 Rinse walls of collection tube once when volume approaches 1mL with MeOH
8.2.15 Bring up to a final volume of 1.0 mL with 96/4 MeOH/H2O
8.2.16 Cap and vortex to mix. Allow to settle then transfer to labeled snap cap vial
8.2.17 Transfer 300 uL to PP autosampler vial and add 3 uL of ISTD, cap, analyze.

8.3 SPE Extraction- Promochrom SPE-03 Automated System

Using the PromoChrom SPE-03 system there are 3 solvents used for the procedure:

- Solvent 1 is 0.3% NH_4OH/methanol
- Solvent 2 is Methanol
- Solvent 3 is Water.

8.3.1 Begin by using the PRIME system method followed by the CLEAN system method.

8.3.2 Be sure your reservoirs have sufficient liquid. The method uses approx. 100 mL of Solvent 1 (0.3% NH_4OH/methanol) for an 8 sample run.

8.3.3 Load the SPE-03 method called **PFAS AQ**. This method is set up for 125 mL of aqueous extract. Modify if using more or less sample. This method contains the following steps:

Condition
Elute (Condition) with 10 mL of Solvent 1 at 4 mL/min, wait 1 minute
Elute (Condition) with 15 mL of Solvent 2 at 5 mL/min, wait 1 minute
Elute (Condition) with 25 mL of Solvent 3 at 4 mL/min, wait 1 minute

Extract Sample
Add sample(s)-125 mL at 4 mL/min to SPE Tube
Rinse Sample container with 7.5 mL Water and deliver to SPE tube @ 5mL/min
Rinse bottle again with 7.5 mL Water and deliver to SPE tube@10 mL/min
Prime syringes with 4.5 mL of Solvent 1 delivered at 10 ml/min
Dry SPE Tube with Nitrogen for 5 minutes

Elute Sample
Rinse bottle with 3.5 mL of Solvent 1 delivered at 4 mL/min to SPE tube
Rinse bottle with 6.5 mL of Solvent 1 at 4 mL/min to SPE Tube
Elute (Collect) SPE Tube with 4.5 mL Solvent 2 at 5 mL/min
Elute (Collect) SPE Tube with 4.0 mL Solvent 2 @ 10 mL/min

8.4 EXTRACT CONCENTRATION

8.4.1 On the N-EVAP system set to $\leq$60C and conc. the methanol extract rinsing the walls once with about 1 mL MeOH when the evaporated volume is around 1-2 mls.. Continue evaporation of each sample under a gentle stream of nitrogen at 60C in the N-EVAP water bath until the final volume is approx. 0.5 mL. Transfer to 2.0 mL snap cap vial rinsing with small portions of 96/4MeOH/H20 to bring the final volume to 1.0 mL.

8.4.2 This blow down should take a minimum of 2.0 hours. Extracts cannot remain in the water bath longer than 5 minutes once concentrated to < 1.0 mL.

8.4.3 Centrifuge using the micro centrifuge if any cloudiness or sediment is apparent.

8.4.4 Store at 4C until ready to analyze.

8.4.5 For analysis, transfer 300 uL of the extract to a PP autosampler vial and add 3 uL of ISTD. Then analyze by LC-MS/MS.

8.5 PREPARATION OF SOILS

8.5.1 Visually inspect soil samples for homogeneity. Mix with spatula as practical. Pour off any free water. Stir the sample. Exclude rocks, roots or other non-soil objects.

8.5.2 Weigh a representative 2.0 g aliquot of soil into a 50 mL HDPE centrifuge tube. Weigh additional sample amounts for the matrix spike and matrix spike duplicate analyses if they are requested.

8.5.3 For the method blank and LCS matrix, use 2 g each of Ottawa sand.

8.5.4 Add 100uL of the BS/MS spike mix (100 ng/mL) to the BS and MS/MSD bottles onto the soil in the tube.

8.5.5 Add 100 uL of the IDA solution (100 ng/mL) into each sample and QC samples (Blank, BS, MS, MSD) onto the soil.

8.5.6 Allow the spike to settle into the sample matrix for a minute (approx.). Gently swirl the bottles to mix the spike into the matrix.

8.5.7 Using a mechanical pipettor, add 20 mL of 0.4% KOH/methanol to each sample. Swirl to mix and mix further for 10 seconds on the Vortex mixer.

8.5.8 Shake all samples on an orbital shaker at speed 18-20 at room temperature for 30 minutes.

8.5.9 Following the shaking, Vortex mix each sample for 20 seconds and move the samples to an ultrasonic water bath and ultrasonically extract the samples for additional 1.5 hours.

8.5.10 After the completion of extraction, centrifuge each sample at 3500 rpm for 15 minutes.

8.5.11 Decant and collect the KOH/methanol extract into a new 50 mL centrifuge tube.

8.5.12 Add another approx. 5 mL of 0.4% KOH/methanol solution to the residue, briefly swirl to mix, Vortex for 10 seconds and then centrifuge at 3500 rpm for 15 minutes.

8.5.13 Decant the rinsate again to combine with the first centrifuge tube contents (from Step 10 above).

8.5.14 To this final KOH/methanol extract, **add 2 mL of PFAS-free water.**

8.5.15 Concentrate the KOH/methanol/water extract under nitrogen to 2 mL, as indicated on the centrifuge tube and dilute with water to 20 mL final volume (centrifuge tube markings).

8.5.16 Acidify with 90 uL of glacial acetic acid (add with Mechanical pipettor), and mix the contents well with the vortex mixer. Check the pH with short range pH paper to ensure pH is between 6 to 8. If not, adjust with small increments of glacial acetic acid (5-10uL). *Do this by laying out a long strip of pH paper and using polypropylene transfer pipets (new one for each sample/QC)dip quickly into the liquid and pace the small drop on the pH paper*.

8.5.17 Centrifuge at 3500 rpm for 15 minutes.

8.6 SOIL EXTRACT CLEANUP MANUAL SPE METHOD

8.6.1 Set up WAX 500mg/6 cc SPE columns for sample cleanup using the Visi-prep vacuum manifold.

8.6.2 Condition the SPE cartridges by passing the following through the column without drying the column.
NOTE: *The cartridges should not be allowed to go dry until the final elution step with methanol. At all of the other transition steps, the solvent/sample level should be stopped at the top of the column before the next liquid is added.*

8.6.3 Condition the SPE Tube with 5.0 mL of 0.3% NH_4OH/methanol (use mech. Pipettor).

8.6.4 Next, condition the SPE Tube with another 5 mL of 0.3% NH_4OH/methanol. Close valve when ~ 500uL remains on top of tube to keep contents wet. *After this step, the tubes cannot go dry until the completion of loading and rinsing samples*

8.6.5 Next condition the tube with 10 mL of Water and let sit-do not let dry.

8.6.6 Add extract (decant from 8.5.16 above) to the tube and with vacuum, pull the entire extract(s) through the cartridge at rate of approximately 3 to 5 drops per second.

8.6.7 Rinse the sample centrifuge tube with 2 x 5 mL of water and add to the SPE column.

8.6.8 Dry the column(s) with vacuum for 5 minutes. Note: column must be dry before proceeding. Proceed to N-EVAP concentration, Section 8.8

8.6.9 **SPE ELUTION OF PFAS**
– use 10 mL polypropylene centrifuge tubes as receiving tubes in the SPE manifold:

8.6.10 Rinse reservoir with 5 mL of 0.3% NH_4OH/methanol and transfer to the column reservoir or directly onto the cartridge. Allow the solution to soak for 5 minutes and then elute into the 10 mL collection tube. Keep wet at this point.

8.6.11 Repeat rinse of column reservoir (if used) and elute the cartridge with a second 5 mL aliquot of 0.3% NH_4OH/methanol. The total collection should be approximately 10 mL.

8.6.12 Pull vacuum to dry the SPE tube for approx. 1 minute to insure full transfer of solvent. Extract is now ready for N-EVAP concentration.

8.7 SPE EXTRACTION-AUTOMATED SPE-03 SYSTEM

Using the Promochrom SPE-03 system there are 3 solvents used for the procedure: Solvent 1 is 0.3% NH_4OH/methanol; Solvent 2 is Methanol and Solvent 3 is Water.

8.7.1 Begin by using the PRIME system method followed by the CLEAN system method
8.7.2 Be sure your reservoirs have sufficient liquid. The method uses approx. 100 mL of Solvent 1 (0.3% NH_4OH/methanol) for and 8 sample run.

8.7.3 Place the SPE-03 8 sample probes into the 50 mL centrifuge tubes containing the 20 mL of aqueous extract from 8.15.16 above.

8.7.4 Load the SPE-03 method called **PFAS soil 2**. This method is set up for 20 mL of aqueous extract. This method contains the following steps:

Condition
Elute (Condition) with 10 mL of Solvent 1 at 4 mL/min, wait 1 minute
Elute (Condition) with 15 mL of Solvent 2 at 5 mL/min, wait 1 minute
Elute (Condition) with 25 mL of Solvent 3 at 4 mL/min, wait 1 minute

Extract Sample
Add sample(s)-20 mL at 4 mL/min to SPE Tube
Rinse Sample container with 7.5 mL Water and deliver to SPE tube @ 5mL/min
Rinse bottle again with 7.5 mL Water and deliver to SPE tube@10 mL/min
Prime syringes with 4.5 mL of Solvent 1 delivered at 10 ml/min
Dry SPE Tube with Nitrogen for 5 minutes

Elute Sample
Rinse bottle with 3.5 mL of Solvent 1 delivered at 4 mL/min to SPE tube
Rinse bottle with 6.5 mL of Solvent 1 at 4 mL/min to SPE Tube
Elute (Collect) SPE Tube with 4.5 mL Solvent 2 at 5 mL/min
Elute (Collect) SPE Tube with 4.0 mL Solvent 2 @ 10 mL/min

8.8 EXTRACT CONCENTRATION

8.8.1 On the N-EVAP system, conc. methanol extract down to around 2 mLs. Add 200 uL of water. Concentrate each sample under a gentle stream of nitrogen at 60C in the N-EVAP water bath until the final volume is approx. 1 mL. Transfer to 2.0 mL snap cap vial and bring volume to 2.0 mL with 96/4MeOH/H20 rinsing the tube as part of the transfer..

8.8.2 This blow down should take a minimum of 2.0 hours. Extracts cannot remain in the water bath longer than 5 minutes once concentrated.

8.8.3 Centrifuge using the micro centrifuge if any cloudiness or sediment is apparent.

8.8.4 Store at 4C until ready to analyze.

8.8.5 For analysis, transfer 300 uL of the extract to a PP autosampler vial and add 3 uL of ISTD. Then analyze by LC-MS/MS.

9.0 Quality Control

9.1 Initial Demonstration of Capability (IDOC)
The initial demonstration requirement herein must be acceptable before

9.2 The quality control batch is a set of up to 20 samples of the same matrix processed using the same procedure and reagents within the same time period. The quality control batch must contain a matrix spike/matrix spike duplicate (MS/MSD), a laboratory control sample (LCS) and a method blank. Laboratory generated QC samples (Blank, LCS, MS/MSD) do not count toward the maximum 20 samples in a batch. Field QC samples are included in the batch count. In some cases, at client request, the MS/MSD may be replaced with a matrix spike and sample duplicate. If insufficient sample is available for an MS/MSD, an LCSD may be substituted if batch precision is required by the program or client. In the event that multiple MS/MSDs are run with a batch due to client requirements, the additional MS/MSDs do not count toward the maximum 20 samples in a batch.

9.4 METHOD BLANK- One method blank (MB, laboratory reagent blank) must be extracted with every process batch of similar matrix, not to exceed twenty (20) samples. For aqueous samples, the method blank is an aliquot of laboratory reagent water. For solid samples, the method blank is a 2.0 g portion of Ottawa sand. The method blank is processed in the same manner and at the same time as the associated samples. Corrective actions must be documented on a Non-Conformance memo, and then implemented when target analytes are detected in the method blank above the reporting limit or when IDA recoveries are outside of the control limits. Re-extraction of the blank, other batch QC, and the affected samples are required when the method blank is deemed unacceptable.

9.4.1 Re-extraction and reanalysis of samples associated with an unacceptable method blank is required when reportable concentrations are determined in the samples.

9.4.2 Results are acceptable if the blank contamination is less than ½ of the reporting limit/LOQ for each analyte, or less than 1/10 of the regulatory limit, or less than 1/10 of the sample result for the same analyte, whichever is greater. If the method blank does not meet the acceptance criteria, the source of contamination must be investigated and measures taken to correct, minimize or eliminate the problem. Reprepare and reanalyze all field and QC samples associated with the contaminated method blank.

9.5 LABORATORY CONTROL SAMPLE (BLANK SPIKE) must be extracted with every process batch of similar matrix, not to exceed twenty (20) samples. The LCS is an aliquot of laboratory matrix (e.g. water for aqueous samples and Ottawa sand for solids) spiked with analytes of known identity and concentration. The LCS must be processed in the same manner and at the same time as the associated samples. Corrective actions must be documented on a Non-Conformance memo, then implemented when recoveries of any spiked analyte is outside of the control limits after isotope correction for recovery. Re-extraction of the blank, other batch QC, and all associated samples are required if the LCS is deemed unacceptable. The control limits for the LCS are stored in Element.

9.6 A matrix spike/matrix spike duplicate (MS/MSD or MS/SD) pair must be extracted with every batch of similar matrix, not to exceed twenty (20) samples. An MS/MSD pair is aliquots of a selected field sample spiked with analytes of known identity and concentration. The MS/MSD pair must be processed in the same manner and at the same time as the associated samples. Spiked analytes with recoveries or precision outside of the control limits must be within the control limits in the LCS. Corrective actions must be documented on a nonconformance memo, then implemented when recoveries of any spiked analyte are outside of the control limits provided by ELEMENT or by the client. Again if a specific method or work plan has required limits, this is preempted. Any outliers must be qualified accordingly.

9.7 An LCSD or BSD may be added when insufficient sample volume is provided to process an MS/MSD pair, or is requested by the client. The BSD is evaluated in the same manner as the BS/LCS.

9.8 Specific other QC requirements for this method are detailed in Table 1.0 as follows.

Table 1.0 QC Criteria-York PFAS Method-PREP

Requirement	**Specification and Frequency**	**Acceptance Criteria**
Sample Holding Time	14 days with appropriate preservation and storage as described in Sections 8.1-8.5.	Sample results are valid only if samples are extracted within sample hold time.
Extract Holding Time	28 days when stored room temp. in polypropylene snap cap vials	Sample results are valid only if extracts are analyzed within extract hold time.
Method Blank	One MBLK with each extraction batch of up to 20 Field Samples.	Demonstrate that the method analyte concentration < 1/2 the RL, and confirm that possible interferences do not prevent quantification. If the background concentration exceeds 1/2 the RL, results for the extraction batch are invalid.
Blank Spike (BS)	One BS is required for each extraction batch of up to 20 Field Samples. Rotate between low, mid, high levels	Results of LFB analyses at medium and High fortification for the analyte and SUR. Results of a low-level LFB must be 50-150% of the true value.
Surrogate(SUR) Standard	The SUR standard added to all calibration standards and samples, including QC samples. Calculate SUR recoveries.	Isotope SURR recovery should be within lab control limts be 25-150% of the true value. If a SUR fails this criterion, report all results for sample as suspect/SUR recovery with appropriate qualifier.
Sample Matrix Spike	Analyze one MS per extraction batch (of up to 20 Field Samples) fortified target analytes. Calculate MS recoveries (Element)	Recoveries at should be within Lab control Limits. Qualify any outliers using appropriate flags.
MSD	Extract at least one MSD with each extraction batch of 20 field samples or less. Calculate RPD.	RPD should be ≤30%. If not met, qualify data accordingly.

9.9 Initial Demonstration of Capability (IDC)

Initial Demonstration of Capability involves the following processes listed in Table 2.0 as follows.

Table 2.0 - Initial Demonstration of Capability (IDC)

Requirement	**Specification**	**Acceptance Criteria**
Initial Demonstration of Low System Background	Analyze MBLK prior to any Other IDC steps	Demonstrate that all method analytes are < 1/2 MRL and possible interferences form extraction media do not prevent identification and quantification of method analytes.
Initial Demonstration of Precision (IDP) *-537.1*	Analyze 4-7 replicate LFBs at mid-cal level	%RSD must be < 20%
Initial Demonstration of Accuracy (IDA)	Using the IDP runs above, Calc. average % Recovery	Mean Recovery ± 30% of true value
MDL Determination	Fortify, extract and analyze seven method blanks and 7 BS replicates at the proposed RL level. Extract on 3 separate days (e.g. 3 on day 1, 2 on Day 2 and 2 on Day 3) and analyze each on 3 separate days	Calculate MDLs per EPA protocol Dec. 2016

11.0 DATA REVIEW, CALCULATIONS AND REPORTING

11.1 All preparations are entered into Element. Soils are weighed to 0.0001 g..

11.2 All sample data calculations are performed by the Agilent Mass Hunter software in ng/mL and then final data are calculated taking into account final extract volumes and the initial sample volumes extracted which are entered into the Element bench sheet.

11.3 In order for the Isotope Calc report to be part of the Data pkg., it must be posted to the related Bench sheet in Element. Also, be sure the bench sheet is posted using the proper format in Element.

12. HEALTH AND SAFETY

12.1 General safety considerations and requirements are detailed in the York Laboratory Safety and Health Standard Operating Procedure No. Safety011600.

Specific safety rules applying to the conduct of this analysis requiring the following:

- When handling standards and samples, latex gloves are required.
- Also, when handling neat materials, a fume hood and safety glasses are required.
- When handling samples, gloves and glasses are required.
- Highly odorous samples must be handled in a fume hood.
- Refer to SDSs for specific safety/health information.

12.2 The analysts must exercise normal care and be supervised and trained to work in an analytical chemistry laboratory. The analysts will be handling fragile glassware, needles, syringes, volatile and flammable chemicals, toxic chemicals and corrosive chemicals.

- No smoking or open flames are allowed.
- No food or food products may be brought into the laboratory.

Solvents should not be left uncovered on the laboratory benches.
All solvent transfers should be done in the hoods.

Hood doors must be kept in the position which yields approx. 100 fpm face velocity.
Solvent evaporation must be done in the hood with exhaust elevated and in the rear.

Waste containers that had solvents must be vented to a hood until all solvents have evaporated.

Safety glasses are provided and must be worn at all times in the laboratory.
Gloves are provided and must be worn when working with chemicals.
Laboratory coats are provided and should be worn to protect the analysts' clothes.
Syringes and needles must be kept in their original cases when not in use.
Care must be exercised in using and handling syringes to avoid injury.
Report any sticking with a needle immediately to your supervisor.

12.3 Specific Safety Concerns

12.3.1 Preliminary toxicity studies indicate that PFAS could have significant toxic effects. In the interest of keeping exposure levels as low as reasonably achievable, PFAS must be handled in the laboratory as hazardous and toxic chemicals.

12.3.2 Exercise caution when using syringes with attached filter disc assemblies. Application of excessive force has, upon occasion, caused a filter disc to burst during the process.

12.3.3 Laboratory procedures such as repetitive use of pipets, repetitive transferring of extracts and manipulation of filled separatory funnels and other glassware represent a significant potential for repetitive motion or other ergonomic injuries. Laboratory associates performing these procedures are in the best position to realize when they are at risk for these types of injuries.

12.3.4 Eye protection, laboratory coat, and nitrile gloves must be worn while handling samples, standards, solvents, and reagents. Disposable gloves that have been contaminated will be removed and discarded; other gloves will be cleaned immediately.

12.3.5 Perfluorocarboxylic acids are acids and are not compatible with strong bases.

12.3.6 Primary Materials Used- The following is a list of the materials used in this method, which have a serious or significant hazard rating. NOTE: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the SDS for each of the materials listed in the table. A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the SDS for each material before using it for the first time or when there are major changes to the SDS.

Methanol (2-3-0)	Flammable Poison Irritant	200 ppm (TWA)	A slight irritant to the mucous membranes. Toxic effects exerted upon nervous system, particularly the optic nerve. Symptoms of overexposure may include headache, drowsiness and dizziness. Methyl alcohol is a defatting agent and may cause skin to become dry and cracked. Skin absorption can occur; symptoms may parallel inhalation exposure. Irritant to the eyes.

13. WASTE MANAGEMENT/POLLUTION PREVENTION

Neat Materials

Waste management procedures require the prudent use of neat materials. The ordering of neat standards and materials must be done to minimize unused material which would result in storage or handling of excess material. Quantities ordered should be sufficient to provide for necessary standards with consideration to shelf life. When ordering a unique material for a standard, be sure to order the smallest practical quantity.

Solvents

The solvents used at York for this procedure include isopropanol and Methanol. These solvents are used for sample extraction or LC cleanup, All amounts are either consumed during concentration or placed in one liter amber jars in the hood areas for evaporation. Any remaining solvent/water is transferred to a drum designated for solvent waste.

Samples

Unused or remaining soil and water samples are returned to the sample control room (CT) for continued storage for proper disposal by the sample control group.

14. REFERENCES

1. US EPA, "Method 537 - Determination of Selected Perfluorinated alkyl acids in Drinking Water by Solid Phase Extraction and Liquid Chromatography/Tandem Mass Spectrometery (LC/MS/MS)", Version 1.1, September 2009, J.A. Shoemaker, P.E. Grimmett, B.K. Boutin, EPA Document #: EPA/600/R-08/092 and Rev. 1.1 updates, Nov. 2018
2. Method ISO 25101:2009, "Determination of perfluorooctanesulfonate (PFOS) and perfluorooctanoate (PFOA) – Method for unfiltered samples using solid phase extraction and liquid chromatography/mass spectrometry", April 30, 2009.
3. EPA Technical Advisory-Laboratory Analysis of Drinking Water Samples for Perfluorooctanoic Acid (PFOA) using EPA Method 537 Rev. 1.1 EPA 815-B-16-021 September 2016 nad Nov. 2018 update.

15. REVISION HISTORY

05/10/2019	Revision 1.0 First issue

Standard Operating Procedure

Analysis of Target Per- and Polyfluorinated Alkyl Substances (PFAS) in Non-Potable Water and Soil by EPA Method 537 Modified using LC/MS-MS

Approvals

Laboratory Director ______________________ Ben Gulizia

Corporate Technical Director ______________________ Robert Bradley

Corporate QA/QC Officer ______________________ Sarah Widomski

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Issued to: ________________________

Target PFAS in Non-Potable Water and Soil Matrices

1. SCOPE AND APPLICATION

This method is used to identify and quantitate specific PFAS compounds in extracts of non-potable water and soil samples using HPLC/MS-MS (high pressure liquid chromatography/ tandem mass spectrometry. Currently the compounds (26) that can be measured by this methodology at the date/revision of this SOP are listed in the table below.

1H,1H,2H,2H-perfluoro-1-decanesulfonate (8:2 FTS)
1H,1H,2H,2H-perfluoro-1-hexanesulfonate (4:2 FTS)
1H,1H,2H,2H-perfluoro-1-octanesulfonate (6:2 FTS)
N-EtFOSAA
N-MeFOSAA
Perfluoro-1-decanesulfonate (L-PFDS)
Perfluoro-1-heptanesulfonate (L-PFHpS)
Perfluoro-1-octanesulfonamide (FOSA)
Perfluoro-1-pentanesulfonate (L-PFPeS)
Perfluorobutanesulfonic acid (PFBS)
Perfluorodecanoic acid (PFDA)
Perfluorododecanoic acid (PFDoA)
Perfluoroheptanoic acid (PFHpA)
Perfluorohexanesulfonic acid (PFHxS)
Perfluorohexanoic acid (PFHxA)
Perfluoro-n-butanoic acid (PFBA)
Perfluorononanesulfonate (L-PFNS)
Perfluorononanoic acid (PFNA)
Perfluoro-n-pentanoic acid (PFPeA)
Perfluorooctanesulfonic acid (PFOS)
Perfluorooctanoic acid (PFOA)
Perfluorotetradecanoic acid (PFTA)
Perfluorotridecanoic acid (PFTrDA)
Perfluoroundecanoic acid (PFUnA) 2,3,3,3-tetrafluoro-2-(heptafluoropropoxy) propanoic acid (GenX) 4,8-dioxa-3H-perfluorononanoic acid (ADONA)

The estimated reporting limit based upon the preparation/analysis parameters herein at the time of this revision are 2.0 ng/L (ppt) for aqueous samples 0.5-2 ug/kG for soil samples (as-received basis). The linear range for these PFAS can be extended by dilution. The MDLs are conducted according to US EPA MDL Determination Rev. 2.0 Dec. 2016. Current MDLs for both aqueous and soil matrices are attached as Attachment 4 to this SOP.

2. SUMMARY

2.1 This procedure involves fortifying samples and related QC with specific isotopes of target PFAS followed by extraction, concentration and analysis by LC/MS-MS. The preparation of non-potable water and soils is detailed in a separate SOP-PFASExtr_AQ_S_051019, Rev. 1.0 and updates.

2.2 For non-potable waters, a known volume of aqueous sample extracted using automated or manual Solid Phase Extraction (SPE). The compounds are eluted from the solid phase using ammoniated methanol. The extract is then slowly evaporated to a small volume using a nitrogen evaporation system. The resulting extract residue is reconstituted in 96%/4% Methanol/water to a final volume of 1.0 mL.

2.3 For soils, a known weight of sample (as received) is extracted with methanolic potassium hydroxide followed by vigourous vortex mixing, orbital agitation and ultrasonic extraction techniques. Prior to SPE cleanup/extraction the extract is fortified with PFAS free water and the methanol is removed by evaporation. The resulting aqueous extract brought to a 20 mL volume and is pH adjusted to pH 6-8. The aqueous extract is then extracted using automated or manual SPE extraction techniques followed by concentration of the SPE extract to a known final volume.

2.3 A portion of the extract is then fortified with internal standard and the PFAS LC separation is accomplished using a C18 LC column using a gradient program with 5mM ammonium acetate/water and methanol to effect separation followed by analysis using AJI-ESI (Electrospray) injection into a triple Quadrupole MS operated in negative ion mode.

2.4 Quantitation is done by internal standard technique and peak response is measured as the area of the peaks from the dynamic MRM (Multiple Reaction Monitoring) run.

2.5 Concentrations determined by LC/MS-MS are adjusted for isotope recoveries for final reporting into the Element LIMS.

3. DEFINITIONS

3.1 ANALYSIS BATCH – A set of samples that is analyzed on the same instrument during a 24-hour period, including no more than 20 Field Samples, that begins and ends with the analysis of the appropriate Continuing Calibration Check (CCC) standards. Additional CCCs may be required depending on the length of the analysis batch and/or the number of Field Samples.

3.2 CALIBRATION STANDARD (CAL) – A solution prepared from the primary dilution standard solution and/or stock standard solution, internal standard(s), and the surrogate(s). The CAL solutions are used to calibrate the instrument response with respect to analyte concentration.

3.3 COLLISIONALLY ACTIVATED DISSOCIATION (CAD) – The process of converting the precursor ion's translational energy into internal energy by collisions with neutral gas molecules to bring about dissociation into product ions.

3.4 CONTINUING CALIBRATION VERIFICATION (CCV) – A calibration standard containing the method analytes, internal standard(s) and surrogate(s). The CCv is analyzed periodically to verify the accuracy of the existing calibration for those analytes. The CCV is run after every ten runs and at the end of a run This also refers to a low level CCV which is at the lowest point of the calibration curve (LCV)

3.5 DETECTION LIMIT (DL) – The minimum concentration of an analyte that can be identified, measured, and reported with 99% confidence that the analyte concentration is greater than zero. This is a statistical determination of precision (Sect. 9.2.7), and accurate quantitation is not expected at this level.

3.6 EXTRACTION BATCH – A set of up to 20 Field Samples (not including QC samples) extracted together by the same person(s) during a work day using the same lot of SPE devices, solvents, surrogate, internal standard and fortifying solutions. Required QC samples include Method Blank, Blank Spike, Matrix Spike/Matrix Spike Duplicate.

3.7 FIELD DUPLICATES (FD1 and FD2) – Two separate samples collected at the same time and place under identical circumstances, and treated exactly the same throughout field and laboratory procedures. Analyses of FD1 and FD2 give a measure of the precision associated with sample collection, preservation, and storage, as well as lab procedures.

3.8 FIELD BLANK – An aliquot of reagent water that is placed in a sample container in the laboratory and treated as a sample in all respects, including shipment to the sampling site, exposure to sampling site conditions, storage, preservation, and all analytical procedures. The purpose of the Field Blank is to determine if method analytes or other interferences are present in the field environment.

3.9 INTERNAL STANDARD (IS) – A compound added to an extract or standard solution in a known amount(s) and used to measure the relative response of other method analytes and surrogates that are components of the same solution. The internal standard must be a chemical that is structurally similar to the method analytes, has no potential to be present in samples, and is not a method target analyte.

3.10 BLANK SPIKE (BS) – A volume of reagent water or other blank matrix to which known quantities of the method analytes and any preservation compounds are added in the laboratory. The Blank Spike is prepared and analyzed exactly like a sample, and its purpose is to determine whether the methodology is in control, and whether the laboratory is capable of making accurate measurements.

3.11 MATRIX SPIKE (MS) – A preserved field sample to which known quantities of the method analytes are added in the laboratory.
The MS is processed and analyzed exactly like a sample, and its purpose is to determine whether the sample matrix contributes bias to the analytical results. The background concentrations of the analytes in the sample matrix must be determined in a separate sample extraction and the measured values in the MS corrected for background concentrations.

3.12 MATRIX SPIKE DUPLICATE (MSD) – A duplicate of the Field Sample used to prepare the MSD. The MSD is fortified, extracted, and analyzed identically to the MS. The MSD is used instead of the Field Duplicate to assess method precision when the occurrence of method analytes is low.

3.13 METHOD BLANK – An aliquot of reagent water or other blank matrix that is treated exactly as a sample including exposure to all glassware, equipment, solvents and reagents, sample preservatives, internal standard, and surrogates that are used in the analysis batch. The method blank is used to determine if method analytes or other interferences are present in the laboratory environment, the reagents, or the apparati.

3.14 REPORTING LIMIT – the level at which accuracy of 50-150% is achieved and is based upon the lowest calibration standard. This level is prepared through all steps of the processing/analysis and is verified quarterly.

3.15 PRECURSOR ION – For the purpose of this method, the precursor ion is the deprotonated molecule ($[M-H]^-$) of the method analyte. In MS/MS, the precursor ion is mass selected and fragmented by collisionally activated dissociation to produce distinctive product ions of smaller *m/z*. For certain species that are labile in nature (GenX) under the conditions of analysis the [M-CO2]- is used.

3.16 PRODUCT ION – For the purpose of this method, a product ion is one of the fragment ions produced in MS/MS by collisionally activated dissociation of the precursor ion.

3.17 SURROGATE (isotopic) ANALYTE (SUR) – A compound which is structurally identical to the target analyte or an analog of the target analyte which is isotopically labeled (deuterium, oxygen 18, or carbon13) and chemically resembles method analytes and is unlikely to be found in any environmental sample. This compound(s) is added to a sample aliquot in known amounts before processing and is measured with the same procedures used to measure other method analytes. The purpose of the isotopic surrogate is to monitor method performance with each sample, and to adjust concentration for recovery of the isotopic analog.

4. INTERFERENCES

LC/MS-MS data from blanks, samples, and spikes must be evaluated for interferences. If any interferences are present, take corrective action if necessary. Do not use aluminum foil because PFAS can be potentially transferred from the aluminum foil to the glassware. Only aluminum foil rinsed with HPLC plus grade or LC/MS grade methanol can be used where necessary.

4.1 PFAS have been used in a wide variety of manufacturing processes, and laboratory supplies should be considered potentially contaminated until they have been tested and shown to be otherwise. The materials and supplies used during the method validation process have been tested and shown to be clean. These items are listed in the Reagents section.

4.2 Method interferences may be caused by contaminants in solvents, reagents (including DI water), sample bottles and caps, and other sample processing hardware that lead to discrete artifacts and/or elevated baselines in the chromatograms. All items such as these must be routinely demonstrated to be free from interferences (less than 1/2 the Reporting Limit), under the conditions of the analysis by analyzing Method Blanks. Subtracting blank values from sample results is not permitted.

4.3 PTFE products can be a source of PFAS (PFOA) contamination. The use of PTFE in the procedure should be avoided. Polypropylene (PP) or polyethylene (PE, HDPE) products must be used in place of PTFE products to minimize PFOA contamination.

4.3.1 Standards and samples are injected from polypropylene autosampler vials with polypropylene snap caps, once. Multiple injections may be performed on Primers when conditioning the instrument for analysis.

4.3.2 Random evaporative losses have been observed with the polypropylene caps causing high Internal Std. recovery after the vial was punctured and sample re-injected. For this reason, it is best to inject standards and samples once in the analytical sequence, or recrimp after injection. The auto sampler system employs a refrigerated (4^{o}C) sample compartment which minimizes losses.

4.3.2 Teflon-lined screw caps have detected PFAS at low concentrations. Repeated injection from the same teflon-lined screw cap have detected PFNA at increasing concentration as each repeated injection was performed, therefore, it is required to use only polypropylene snap caps as specified in this SOP.

4.4 HPLC Plus grade or LC/MS grade methanol and water must be used for all steps where methanol or water are used in this method.

4.5 Matrix interferences may be caused by contaminants that are co-extracted from the sample. The extent of matrix interferences will vary considerably from source to source, depending upon the nature of the water or soil. SPE provides the necessary clean-up to reduce the occurrence of matrix effects.

4.6 Solid phase extraction cartridges may be a source of interferences. The analysis of laboratory method blanks can provide important information regarding the presence or absence of such interferences. The Phenomenex Strata-XL-AW or the Oasis WAX SPE tubes have shown no interfering peaks/ions at the retention times of interest. Each new lot of SPE cartridge sorbent must be tested to ensure that contamination does not preclude analyte identification and quantitation.

4.7 Contamination by carryover can occur whenever a high-concentration and low concentration samples are sequentially analyzed. To reduce carryover, the sample syringe in automatically rinsed with solvent between injections. These operations are programmed into the LC multi-sampler system.

4.8 Volumetric glassware and syringes are difficult to clean after being used for solutions containing high levels of PFAS. These items should be labeled for use only with similarly concentrated solutions or verified clean prior to re-use. To the extent possible, disposable labware (mechanical pipetors) are used.

4.9 Both branched and linear PFAS isomers can potentially be found in the environment. Linear and branched isomers are known to exist for PFOS, PFOA, PFHxS, PFBS, EtFOSAA, and MeFOSAA based upon the scientific literature. If multiple isomers are present for one of these PFAS they will be peaks adjacent to the linear isomer (to the left under our operating conditions). The later of these peaks matches the retention time of its labeled linear analog. In general, earlier peaks are the branched isomers and are not the result of peak splitting. In the analysis of real world samples, the most often encountered branched isomers are seen for PFOS and PFHxS.

Currently, all these species are available as linear isomers. Reference standards of the technical mixtures for these specific PFAS are used to ensure that all appropriate peaks are included during peak integration. <u>These branched isomers elute before the linear isomer and are integrated and reported as total for those species.</u>

4.10 In order to reduce bias, it is required that the following ion transitions be used as the quantitation transitions:

Required Quantitation Transitions for PFAS

PFOA	413	>	369
PFOS	499	>	80
PFHxS	399	>	80
PFBS	299	>	80
6:2 FTS	427	>	407
8:2 FTS	527	>	507
N-EtFOSAA	584	>	419
N-MeFOSAA	570	>	419

5. SAMPLE HANDLING

5.1 Aqueous and soil samples are collected by our clients in 250 mL HDPE bottles with HDPE caps.

5.2 FIELD BLANKS (FBLK)- A FBLK must be handled along with each sample set. The sample set is composed of samples collected from the same sample site and at the same time. At the laboratory, fill the field blank sample bottle with reagent water, seal, and ship to the sampling site along with the sample bottles. For each FBLK shipped, an empty sample bottle must also be shipped. At the sampling site, the sampler must open the shipped FBLK and pour the reagent water into the empty shipped sample bottle, seal and label this bottle as the FBLK. The FBLK is shipped back to the laboratory along with the samples and analyzed to ensure that PFAS were not introduced into the samples during sample collection/handling.

5.3 SAMPLE SHIPMENT AND STORAGE – Samples must be chilled during shipment and must not exceed 10 °C during the first 48 hours after collection. Sample temperature must be confirmed to be at or below 10 °C when the samples are received at the laboratory. Samples stored in the lab must be held at or below 6 °C until extraction, but should not be frozen.

NOTE: Samples that are significantly above 10° C, at the time of collection, may need to be iced or refrigerated for a period of time, in order to chill them prior to shipping. This will allow them to be shipped with sufficient ice to meet the above requirements.

5.4 SAMPLE AND EXTRACT HOLDING TIMES –PFAS have adequate stability for 14 days when collected, preserved, shipped and stored as described. Therefore, water and soil samples should be extracted within 14 days of collection. Extracts must be stored at <10^{o}C or room temperature and analyzed within 28 days after extraction.

6. APPARATUS AND MATERIALS

6.1 250 mL High Density Polyethylene (HDPE) bottles with HDPE linerless caps- Greenwood Env. Part no. 07-GW2501: 250ml SMART Natural HDPE Leakproof Wide Mouth Bottle w/43-415 Linerless Cap, Assembled Only (250/cs) or 07-GW2503: 250ml HDPE Leakproof Wide Mouth Bottle w/43-415 Linerless Cap , Certified (250/cs), or equivalent-alternate source: VWR Scientific: Part no. 414004-113 HDPE wide moutgh bottle with HDPE liner less cap. These have been tested and demonstrated to be PFAS-free in initial studies.

6.2 Transport Tube: Virgin Polypropylene, White, Plastic, 10 mL Capacity, 16 mm OD, 93 mm Overall Lg, Self-Standing, 250 PK， Item 710Z420, Gamut.com (Grainger), with PP cap

6.3 Graduated cylinders, 50, 100, 250, 500 and 1000mL, Polypropylene, VWR Scientific or equivalent

6.4 Analytical Balance, 0.0001g., checked for accuracy each day of use with Class S weights.

6.5 Extract concentrator: Organomation Model N-EVAP 112, 24 position concentrator with water batch control and nitrogen supply controls.

6.6 Syringes, polypropylene, luer lock, 50-100 mL for filtration of turbid groundwater samples. Merck XX110500 Fisher Scientific or equivalent

6.6 3.1 Micron in-line filters, Biotage part no. 49-2814-01

6.7 1.0 mL polypropylene snap cap vials, Agilent part no. 5182-0567

6.8 Snap caps, polypropylene, 11 mm, 11/9k, Agilent Part no. 5182-0542

6.9 2mL self standing PP microcentrifuge snap cap tubes, SKS Scientific part no. 0747-17

6.10 15 mL PP or HDPE Centrifuge tubes, Corning Part no. 430791

6.11 3 mL Disposable Transfer pipets, PE, VWR part no. 16001-176

6.12 Solid Phase Extraction Tubes:

For aqueous samples the following have been proven to meet SOP requirements: Phenomenex Strata XL-AW 100 um 200 mg 6mL tubes, part no. 8B-S051-FCH or Phenomenex Strata XL-AW 100 um 500 mg 6 mL tubes, part no.

8BS0510HCH, or Waters OASIS WAX 6cc/500 mg 60um tubes, part no. 186004647

For soils the following tubes can be used: Phenomenex Strata XL-AW 100 um 500 mg 6 mL tubes, part no. 8BS0510HCH; Biotage Evolute 500 mg/6mL 30 um tubes part no. 614-0050-CXG or Waters OASIS WAX 6cc/500 mg 60um tubes, part no. 186004647

6.13 Syringes, Hamilton or equivalent 5.0 uL, 10 uL 25 uL, 100 uL, 250 uL, 500 uL, *teflon free.*

6.14 Solid Phase Extraction System-automated-Horizon/Biotage SmartPrep II system, 12 position autosampler system for 6 mL capacity tubes. System retrofit to remove all PTFE components and replaced with PEEK tubing. Automated bottle rinsing feature required.

6.15 SPE Automated Extraction System, Promochrom Technologies, Inc. 8 position simultaneous processing, PTFE free system.

6.16 Nitrogen Evaporation System- Organomation Model N-EVAP 112-24 position evaporator with water bath and individual nitrogen delivery control. Water bath capable of ambient temperature to 85 C, operated at 60 C.

6.17 LC/MS-MS system- Agilent 1260 HPLC system interfaced to an Agilent 6470A Triple Quadrupole system. The instrument control and qualitative/quantitative analysis software using Mass Hunter versions B.8.0 and B.9.0.

6.17.1 HPLC System-Agilent 1260 Infinity II

6.17.1.1 The Agilent 1660 Infinity II HPLC system is configured with temperature controlled column oven compartment. 4 column configuration, temperature controlled (refrigerated) autosampler compartments, injection valve, proportioning valves, variable flow controls and variable injection capabilities.

6.17.1.2 The delay column (PFAS and other interference removal) is an Agilent Eclipse Plus C18, 4.6mm x 50 mm, 3.5 um-Part no. 959943-902

6.17.1.3 The analytical column is an Agilent ZORBAX Eclipse Plus C18, 3.0 x 50 mm, 1.8 um- part no. 959757-302

6.17.2 Agilent LC/MS-MS- Agilent 6470AAR

6.14.2.1 Agilent model 6470AAR triple Quadrupole system with Agilent Jet Stream ESI source. UHP nitrogen is used as cell gas and High purity nitrogen is delivered for the sheath gas from a Peak Scientific nitrogen generator system.

6.18 Vortex Mixer- Benchmark Industries or equivalent

6.19 pH paper, short range 6-8- VWR Scientific or equivalent

6.20 Ultrasonic Baths- GT Sonic LS-10D, 240 w and Limplus VGT-1990QT, 240 w

6.21 Orbital Shaker- Jiangau Tenlin Instr. Co., Ltd., Model no. TLSK-III 20-230 RPM, 0-999 min.

6.22 Centrifuge, 50 mL, Premiere Model XC-2450 Series Centrifuge 6 x 50 mL, 3500 RPM max.

6.23 Mini Centrifuge, 2 mL Four E's Scientific, 5400 RPM

6.24 Mechanical Pipettors- 10-100 uL; 100-1000 uL; 1000-5000 uL-4 E'S Scinetific or equivalent, calibrated quarterly.

7. REAGENTS AND STANDARDS

ALL REAGENTS and STANDARDS MUST BE LOGGED INTO THE ELEMENT LIMS SYSTEM. This includes lot numbers, expiration, open and prepared dates, recipe, Certification/traceability documents from supplier(s) if provided and preparer.

7.1 Methanol, hypergrade for LC/MS. (Merck) from Sigma Aldrich Part no. 1060354000. Alternatively Methanol, HPLC plus grade, Sigma Aldrich Part. No. 646377-4L

7.2 Water, hypergrade for LC/MS. (Merck) from Sigma Aldrich Part no. 1153334000; alternatively Water, HPLC Plus grade, Sigma Aldrich part no. 34877-4L.

7.3 Isopropanol-for rinsing valve seats, etc.- Sigma Aldrich Part no. 650447-1L

7.4 Ammonium Acetate, LC-MSMS grade. Sigma Aldrich Part no. 73594-100-G-F

7.4.1 HPLC gradient A- 5 mM Ammonium Acetate/ Water
Weigh 0.3854 g ($\pm$ 0.0005) Ammonium Acetate and add to 1 liter hypergrade Water. Sonicate for 5 mins. To remove air bubbles. Stability- 2 weeks.

7.4.2 HPLC gradient B – 5 mM Ammonium Acetate/95/5 MeOH/H_2O

Weigh 0.3854 g (± 0.0005) Ammonium Acetate and add to 1 liter of 95/5 hypergrade methanol/water (950 mL MeOH/50 mL Water). Sonicate for 5 mins. To remove air bubbles. Stability – 2 weeks

7.5 Ammonium Hydroxide- 28-30%- ACS grade Sigma Aldrich Part no. 221228-500ML-A

7.6 Potassium Hydroxide-BioXtra grade, Sigma Aldrich part no. P5958-250G

7.7 Acetic Acid, Glacial, >99.7%- ACS grade-Sigma Aldrich part no. 695092-500ML

7.8 Agilent Tuning Solution-ESI-L-Agilent Part no. G1969-85000

7.9 Stock Standards

Stock Standards are purchased in mid to high concentration form from Wellington Laboratories, Inc. Guelph, ONT, CA. Currently, Wellington is the only supplier of these materials. Second source standards to serve as an initial calibration verification are not available for all compounds. Some of the target compounds from Absolute Standards, Hamden, CT in a 2000 ng/mL mix of linear and branched isomer isomers which limit their use for quantitative analysis due to the uncertainty in the amount of branched species. Until a viable second source is identified, the 5.0 ng/mL level material used for calibration will serve as the ICV for Element purposes.

7.9.1 Internal Standard used for the method described is MPFOA (Perfluoro-[1,2,3,4-$^{13}C_4$]octanoic acid). This is purchased at 50,000 ng/mL and mixed for use. This is purchased from Wellington Labs in 1.2 mL volumes with the following part nos.: MPFOA.

7.9.2 Surrogate (ISOTOPIC) Materials are purchased for this method from Wellington Labs at 50,000 ng/mL levels on an individual basis. The part nos. for 18 isotopes are listed as follows: MPFBA, M5PFPeA, M3PFBS, M5PFHxA, M4PFHpA, M3PFHxS, M2-6:2 FTS, M8PFOA, M8PFOS, M9PFNA, M2-8:2 FTS, M6PFDA, d3-N-MeFOSAA, M8FOSA, M7PFUnDA, d5-N-EtFOSAA, MPFDoA, M2PFTeDA.When GenX is a target- M3HFPO-DA.

7.9.2.1 Alternatively, a mixture of all the above isotopes is available from Wellington Laboratories as part no. MPFAC-24PAR at 1000 ng/mL in Methanol. NOTE: This mixture does not contain GenX or ADONA.

7.9.3 Stock Standard mixture of linear isomers of the target analytes are purchased from Wellington Labs at 2000 ng/mL concentrations under part no. PFAC-24PAR. This is used for native analyte calibration and for the BS/MS/MSDs.

7.10 Intermediate/Working Standards Preparation

7.10.1 **Internal Standards -** Preparation at 1000 ng/mL

Internal Standards mixture is prepared into a 10 mL polypropylene transfer tube for use. 10.0 mL final volume is prepared. Before use the mixture is mixed well using a vortex mixer. This approach yields 10 ng/mL of ISTD final concentration in each extract/QC/Cal std.when 3 uL of ISTD mix at 1000 ng/mL is added to 300 uL extract or 5 uL is added to 500 uL.

Preparation of Internal Standard Working Solution-
10.0 mL final volume

For all Calibrations, QC and Samples add 3 uL to 300 uL samples and 5 uL to 500 uL CALSTDS

ISTD Stock	Stock, ng/mL	Vol. to add (uL)	To this vol. MeOH, uL	Conc. ,ng/mL
MPFOA	50000	200	9800	1000

7.10.2 **Isotopic Surrogate** Solution Intermediate Preparation-1000 ng/mL

5.0 mL of the 18 Isotope Surrogate mixture is prepared into a 10 mL polypropylene transfer tube for use at a 1000 ng/mL concentration. The GenX isotope M3HFPO-DA is not included. The intermediate is prepared by adding 100uL of each of the 18 isotopes (at 50,000 ng/mL, nominally as the anion) into 3200 uL of MeOH for a final concentration of 1000 ng/mL. Mix using the vortex mixer and carefully transfer to 3 separate labeled self standing 2 mL snap cap vials. Some isotopes are present as salts so the amount of indiv. Added may be more than 100 uL to adjust for salt vs. anion. The amount of MeOH will be reduced proportionately.

7.10.3 –Isotopic Surrogate Preparation for addition to samples/QC

Preparation of Working Surrogate Mixture- 10.0 mL final volume
From 1,000 ng/mL intermediate from 7.10.2 add 1000uL of the intermediate at 1000 ng./mL to 9000 uL methanol to give a final concentration of working isotopic surrogate mix at 100 ng/mL. This mixture is used for addition to all samples/QC that are to be extracted.

7.10.4 **Target Analyte Intermediate/Working Mixture**

From the 2000 ng/mL stock solution (7.9.3), prepare a 100 ng/mL solution by adding 500 uL of the stock to 9500 uL Methanol. This results in a 100 ng/mL working standard. This 10 mL volume is then used for BS/MS/MSD solution (100 uL added for BS/MS/MSD).

7.10.5 **CALIBATION CURVE Preparation**

Using the 1000 ng/mL Isotopic Surrogate intermediate (7.10.2) and the 2000 ng/mL Stock native analytes (7.9.3) make 1.0 mL of an intermediate 100 ng/mL solution of isotopes and native analytes by taking 50uL of the 2000 ng/mL natives and 100 uL of the 1000 ng/mL Isotopic intermediate adding both to 850 uL methanol. This is the 100 ng/mL Calibration intermediate. Follow the preparation in the table as shown.

Initial Calibration Preparation

Initial Calibration-
use solution form 7.10.5
@ 100 ng/mL
Standards Source-Wellington Labs
500 uL Final Volumes prepared into PP vials

Cal Level ID	Std. Conc., ng/mL	Isotopes+Natives Mix @ 100 ng/mL, uL	96/4 MeOH/H2O, uL	ISTD Working MIX, uL
1	0.25	1.25	498.8	5.0
2	0.5	2.5	497.5	5.0
3	1.0	5.0	495	5.0
4	2.5	12.5	487.5	5.0
5	5.0	25.0	475	5.0
6	10.0	50.0	450	5.0
7	20.0	100.0	400	5.0

7.10.6 Second Source - Initial Calibration Verification

Use 5.0 ng/mL cal level until verification of a second source is done. Currently only the 24 compound DOD mix at 2000 ng/mL is available from Absolute Standards, Hamden, CT , part no. 99206. This contains some branched isomers therefore it may not serve its intended purpose. This is optional at this time. This is prepared as an ICV as follows:

Initial Calibration Verification Preparation

Source-Absolute Standards EPA 537 Mix @ 2000 ng/mL

Preparation of Intermediate 100 ng/mL
Take 50 uL of Stock up to 1000 uL in MeOH = 100 ng/mL Intermediate

ICV Level @ 5.0 ng/mL
Take 25 uL of 100 ng/mL ICV ng/mL plus 475 uL 96/4 MeOH/H2O + 5uL ISTDs-no Surrogates

8. PROCEDURE

8.1 Preventative and Routine Maintenance

HPLC/MS/MS Preventative Maintenance	
As Needed: Change pump seals. Change in-line filters in autosampler (HPLC). Check/replace in-line frit if excessive pressure or poor performance. Replace column if no change following in-line frit change. Clean needle. Replace or clean Capillary Replace fused silica tube in ESI interface. Clean lenses. Clean skimmer. Ballast rough pump 30 minutes. Check Nozzle flow pattern	**Daily (When in use)** Check solvent reservoirs for sufficient level of solvent. Verify that pump is primed, operating pulse free. (ripple < 1%) Check needle wash reservoir for sufficient solvent. Verify capillary heater temperature functioning. Verify vaporizer heater temperature. Verify rough pump oil levels. Verify turbo-pump functioning. Verify nitrogen pressure for auxiliary and sheath gasses. Replace HPLC Gradient solutions-2 weeks Perform Checktune once per week.
Semi-Annually Replace oil mist and odor elements. Replace activated alumina filter if applicable	**Annually** Vacuum system components including fans and fan covers. Clean/replace fan filters, if applicable.

8.2 Running Samples/QC - Acquisition Method

The acquisition methods are detailed in Attachments 1 (HPLC) and Attachments 2 and 3 (MS/MS) of this SOP. The method is a HPLC with dynamic MRM method with precursor and product ions with specific acquisition parameters to maximize sensitivity and specificity. This list may be modified to add other PFAS target analytes as necessary. It is noted that under the conditions used for analysis, GenX (attachment 3), due to its fragile nature is analyzed separately monitoring the [MCOO]- precursor and related product ion.

8.3.1 The triple Quadrupole (QQQ) system must be optimized for each target analyte (including surrogates and internal standards) using the Mass Hunter Optimizer program. This program determines the most abundant precursor and product ions for each compound and their abundances. These data are then used to build an MRM (multiple reaction monitor) method for acquisition. This is done initially or after any major maintenance procedures are performed to the triple quadrupole system. A high level standard is used for this in the $[M\text{-}H]^-$ mode.

8.3.2 The QQQ is checked for tuning on a weekly basis before analysis using the Tune context by selecting the CHECKTUNE radio button. This is done only in negative ion mode since that what we are operating under. If the Checktune fails, or significant change (50%) in the abundances compared to the most recent checktune data, run the Autotune program-note: this takes approx. 45 mins. in negative mode. NOTE: This will require a re-calibration of the instrument.

8.3.3 Before any QC or samples can be run, the HPLC must be allowed to purge/condition for at least thirty minutes. This purge must be done using the initial mobile phase conditions used in the method must be allowed to run for 30 minutes to allow the binary pump pressure to stabilize (ripple must be < 1%) and pressure should be 135-160 barr with a 90/10 gradient (initial HPLC conditions).

8.3.4 An instrument sequence (Worklist) is then made. It should begin with two double blanks if the system has been sitting more that 48 hours, or at a minimum 1 double blank and a conditioner (5 ng/mL).

8.3.5 Those will be followed by the opening low level CCV at 0.25 ng/mL followed by a CCV at 5 ng/mL. If these pass criteria (50-150% R for the LLCCV, 70-130% R for the CCV, then, the worklist can start running. After every 10 injections and at the end of the sequence a CCV at 5.0 ng/mL is run.

8.3.6 The run can end with a script to put the instrument into standby mode.

8.4 Daily Sample Preparation/Analysis Sequence

- Prepare extracts for analysis by placing a 300 ul aliquot of sample extract into a labeled PP auto-sampler vial. Add internal standard (3 uL). Apply snap cap. Vortex to mix.
- Run instrument CCV checks at the start and every ten injections (5 ng/mL) and at the end as described in 8.3.5 above.
- Enter the Worklist (injection sequence) using the naming convention mm-dd-yyyy into the instrument software and load samples onto the auto-sampler in the following order,

- 2 Double Blanks (If system idle > 48 hrs. (1 if not)
- Conditioner @ 5 ng/mL
- Low Level CCV (LLCV@ 0.25 ng/mL) (SEQ-LCV)
- CCV (5.0 ng/mL) (SEQ-CCV1)
- Method Blank
- BS
- Samples /MS/MSDs; CCV every 10 injections
- CCV (ending or continuing) at 5.0 ng/mL
- 10 injections
- Ending CCV -5.0 ng/mL

8.5 Data Review

The Agilent Mass Hunter Quantitation program is used to review all data. All identifications are based upon acceptable ion ratios for the abundance of both precursor and product ions along with retention time information. It is noted that for PFOS specifically the ratios may not always be ideal due to the branched isomer contribution. If native PFOS is found and branched are also found under the conditions of MRM acquisition identity is confirmed.

8.5.1 Since certain PFAS species are manufactured by different processes the presence of branched as well as linear isomers may be found. In order to properly quantitate these species, the analyst must manually integrate the following species to report totals for: PFOS and PFHxS., These should be annotated as total in the element report verbiage or using a qualifier PFAS-T

8.5.2 Any detection greater than the upper limit of the calibration curve requires dilution into the upper half of the curve, where possible.

9. CALIBRATION

9.1 Initial Calibration

The initial calibration covers the range 0.25 ng/mL to 20 ng/mL depending upon the linearity of the PFAS species. After acquisition, the data are quantitated in Mass Hunter and the default calibration model is generated using Average response factor. For average response factor RSDs greater than 20% an alternate model such as Quadratic regression should be used. Depending upon the response and accuracy at each level as shown in the Mass Hunter program, use Quadratic regression not forced through the origin with or without weighting to achieve the best fit which is based upon the best accuracy on a compound by compound basis. In any case, the correlation coefficient R^2) must be greater than 0.990.

9.1.1 The calibration levels as shown in Section 7.6.3 use 7 levels. All points are included in the calibration for all PFAS targets and isotopes.

9.1.2 Certain species in the calibration mixture are present as salts (as opposed to anions). This concentration must be used in the Mass Hunter software to reflect the actual anion concentration present. Also, all responses for the calibration curve are based solely upon the known concentration of the linear isomers where applicable. Refer to the Wellington Labs standard information sheets for each lot of material.

9.1.3 In order to reduce bias, it is required that the following ion transitions be used as the quantitation transitions:

Required Quantitation Transitions for PFAS

PFOA	413	>	369
PFOS	499	>	80
PFHxS	399	>	80
PFBS	299	>	80
6:2 FTS	427	>	407
8:2 FTS	527	>	507
N-EtFOSAA	584	>	419
N-MeFOSAA	570	>	419

9.2 ICV/QCS

A second-source Initial Calibration Verification, if available should be run immediately following initial calibration. The concentration of this standard should be in the middle of the calibration range (e.g. 5.0 ng/mL). Unless project-specific data quality objectives are required, the values from the second-source check should be within 30% of the expected concentration.

Corrective Action: Quantitative sample analyses should not proceed for a failing ICV. Recalibrate and re-run the ICV if necessary. When using the same source for the "ICV" then $\pm$ 20% limits apply.

9.3 Continuing Calibration Verification

The CCV must be $\pm$ 30% of the true value. The LLCCV must recover 50-150%.

Corrective Action: If any of the required calibration check criteria fail, the system must be evaluated and any appropriate instrument repair or maintenance must be performed. Sample data are unacceptable and must be rerun. Reinjection the standard may be done. If the calibration check standard still fails, the system must be recalibrated.

10. Quality Control

10.1 Initial Demonstration of Capability (IDOC)

The initial demonstration requirement herein must be acceptable before analysis of samples may begin.

10.2 Batches are defined at the sample preparation step. Batches should be kept together through the whole analytical process as far as possible, but it is not mandatory to analyze prepared extracts on the same instrument or in the same sequence.

10.2.1 The quality control batch is a set of up to 20 samples of the same matrix processed using the same procedure and reagents within the same time period. The quality control batch must contain a matrix spike/matrix spike duplicate (MS/MSD), a laboratory control sample (LCS) and a method blank. Laboratory generated QC samples (Blank, LCS, MS/MSD) do not count toward the maximum 20 samples in a batch. Field QC samples are included in the batch count. In some cases, at client request, the MS/MSD may be replaced with a matrix spike and sample duplicate. If insufficient sample is available for an MS/MSD, an LCSD may be substituted if batch precision is required by the program or client. In the event that multiple MS/MSDs are run with a batch due to client requirements, the additional MS/MSDs do not count toward the maximum 20 samples in a batch.

10.3 METHOD BLANK- One method blank (MB, laboratory reagent blank) must be extracted with every process batch of similar matrix, not to exceed twenty (20) samples. For aqueous samples, the method blank is an aliquot of laboratory reagent water. For solid samples, the method blank is a portion of Ottawa sand. The method blank is processed in the same manner and at the same time as the associated samples. Corrective actions must be documented on a Non-Conformance memo, and then implemented when target analytes are detected in the method blank above the reporting limit or when IDA recoveries are outside of the control limits. Re-extraction of the blank, other batch QC, and the affected samples are required when the method blank is deemed unacceptable.

10.3.1 If the MB produces a peak within the retention time window of any of the analytes, determine the source of the contamination and eliminate the interference before processing samples.

10.3.2 The method blank must not contain any analyte at or above 1/2 the reporting limit.

10.3.3 If there is no target analyte greater than the RL in the samples associated with an unacceptable method blank, the data may be reported with qualifiers. Such action should be taken in consultation with the client.

10.3.4 Re-extraction and reanalysis of samples associated with an unacceptable method blank is required when reportable concentrations are determined in the samples.

10.3.5 Results are acceptable if the blank contamination is less than ½ of the reporting limit/LOQ for each analyte, or less than 1/10 of the regulatory limit, or less than 1/10 of the sample result for the same analyte, whichever is greater. If the method blank does not meet the acceptance criteria, the source of contamination must be investigated and measures taken to correct, minimize or eliminate the problem. Reprepare and reanalyze all field and QC samples associated with the contaminated method blank.

10.4 LABORATORY CONTROL SAMPLE (BLANK SPIKE) must be extracted with every process batch of similar matrix, not to exceed twenty (20) samples. The LCS is an aliquot of laboratory matrix (e.g. water for aqueous samples and Ottawa sand for solids) spiked with analytes of known identity and concentration. The LCS must be processed in the same manner and at the same time as the associated samples. Corrective actions must be documented on a Non-Conformance memo, then implemented when recoveries of any spiked analyte is outside of the control limits. Re-extraction of the blank, other batch QC, and all associated samples are required if the LCS is deemed unacceptable. The control limits for the LCS are stored in Element.

10.5 A matrix spike/matrix spike duplicate (MS/MSD or MS/SD) pair must be

extracted with every process batch of similar matrix, not to exceed twenty (20) samples. An MS/MSD pair is aliquots of a selected field sample spiked with analytes of known identity and concentration. The MS/MSD pair must be processed in the same manner and at the same time as the associated samples. Spiked analytes with recoveries or precision outside of the control limits must be within the control limits in the LCS. Corrective actions must be documented on a nonconformance memo, then implemented when recoveries of any spiked analyte are outside of the control limits provided by ELEMENT or by the client. Again if a specific method or work plan has required limits, this is preempted. Any outliers must be qualified accordingly.

10.6 A LCSD or BSD may be added when insufficient sample volume is provided to process an MS/MSD pair, or is requested by the client. The BSD is evaluated in the same manner as the BS/LCS.

10.7 Initial calibration verification (ICV) –A second source standard, if available, is analyzed with the initial calibration curve. The concentration should be at the mid range of the curve and must recover within 70-130 % of expected value.

Corrective actions for the ICV, if true second source, include:

- Rerun the ICV.
- Remake or acquire a new ICV.
- Evaluate the instrument conditions.
- Evaluate the initial calibration standards.
- Rerun the initial calibration.

10.8 Internal Standard- The Internal Standard (IS) is added to each field and QC sample prior to analysis. The IS response (peak area) must not deviate by more than ½ to 2x the average response (peak area) of the initial calibration.

10.8.1 Sample IS response (peak area) must be within 50-150% of the response (peak area) in the most recent CCV.

10.9 Specific other QC requirements for this method are detailed in Table 1.0 as follows.

Table 1.0 QC Criteria-York PFAS Method

Requirement	Specification and Frequency	Acceptance Criteria
Sample Holding Time	14 days with appropriate preservation and storage as described in Sections 8.1-8.5.	Sample results are valid only if samples are extracted within sample hold time.
Extract Holding Time	28 days when stored room temp. in polypropylene snap cap vials	Sample results are valid only if extracts are analyzed within extract hold time.
Method Blank (MBLK)	One MBLK with each extraction batch of up to 20 Field Samples.	Demonstrate that the method analyte concentration < 1/2 the RL, and confirm that possible interferences do not prevent quantification. If the background concentration exceeds 1/2 the RL, results for the extraction batch are invalid.
Blank Spike (BS)	One BS is required for each extraction batch of up to 20 Field Samples.	Results of BS analyses must be 50-150% of the true value, after isotopic correction.

Internal Standard (IS)	Compare IS area to the average IS area in the initial calibration and the most recent CCC.	Peak area counts for all injections must be within −50%-200% of the average peak area calculated during the initial cal. and 50–150% from the most recent CCC. If the IS does not meet this criterion, rerun ot dilute
Surrogate(SUR) Standard (isotopes)	The SUR standard added to all calibration standards and samples, including QC samples. Calculate SUR recoveries.	Isotope SURR recovery should be within lab control limits be 25-150% of the true value. If a SUR fails this criterion, report all results for sample as suspect/SUR recovery with appropriate qualifier. Up to a 10x dilution is allowed to apply isotopic dilutions.If more dilution is necessary due to levels or matrix, a smaller volume sub-sample may be reextracted, if necessary.
Sample Matrix Spike	Analyze one MS per extraction batch (of up to 20 Field Samples) fortified target analytes. Calculate MS recoveries (Element)	Recoveries at should be within Lab control Limits. Qualify any outliers using appropriate flags.
MSD	Extract at least one MSD with each extraction batch of 20 field samples or less. Calculate RPD.	RPD should be ≤30%. If not met, qualify data accordingly.
Initial Calibration	Use ISTD technique Use minimum of 7 points at all times	When each standard is calculated against the curve, the accuracy should be 70-130%, except for the lowest standard which should be 50-150% of the true value.
Lower Level CCV (LLCCV)	Run initially with each sequence at the low level cal std. @ 0.25 ng/mL	Recovery between 50-150%
Continuing Calibration Verification(CCV)	Initially, after LLCCV and after every 10 runs and at the end of the run	Surrogates and analyte recovery 70-130% of expected value

10.10 Initial Demonstration of Capability (IDC)

Initial Demonstration of Capability involves the following processes listed in Table 2.0 as follows.

Table 2.0 - Initial Demonstration of Capability (IDC)

Requirement	**Specification**	**Acceptance Criteria**
Initial Demonstration of Low System Background	Analyze MBLK prior to any Other IDC steps	Demonstrate that all method analytes are < 1/2 MRL and possible interferences form extraction media do not prevent identification and quantification of method analytes.
Initial Demonstration of Precision (IDP) *-537.1*	Analyze 4-7 replicate LFBs at mid-cal level	%RSD must be < 20%

Initial Demonstration of Accuracy (IDA)	Using the IDP runs above, Calc. average % Recovery	Mean Recovery ± 30% of true value
Method Detection Limit (MDL Confirmation *EPA Dec. 2016 Rev.2*	Fortify, extract and analyze seven replicates and seven method blanks, extracted over 3 days and analyzed on three separate days per protocol Calculate recovery and precision for these data for MDL.	MDLs are reported with data. Element will automatically "J" flag any detections > MDL and < RL.

11.0 DATA REVIEW, CALCULATIONS AND REPORTING

Samples concentrations are determined using either Average response factor (RRF) or or quadratic regression unforced through the origin. Weighted ($1/x$ or $1/x^2$) may assist with low level accuracy and is recommended where necessary. All calibration curves have 7 points and no points can be removed. Any target analyte exceeding the calibration range will require dilution.

11.1 Data interpretation

All sample data calculations are performed by the Agilent Mass Hunter software in ng/mL and then final data are calculated taking into account final extract volumes and the initial sample volumes extracted which are entered into the Element bench sheet.

11.2 Linear and Branched Isomers are addressed in Section 8.5 and are reported for the noted species as Total which is a sum of the linear and branched isomers for affected species.

11.2.1 After MDL determination, data are reported to the RL with any target PFAS detected > MDL but <RL assigned a "J" flag by the Element LIMS system.

11.3 **Data Handling Procedures**

In order to process data from Mass Hunter, perform isotope dilution corrections and upload to Element, the following steps are followed:

11.3.1 Produce reports for LIMS (.xlsx and pdf) for all samples/QC of interest in Mass Hunter

11.3.2 Move these files to the PFAS Data for Element folder on the Backup(G) network drive in a folder reflecting the work orders in the files (i.e 19D0005_19D0111 Data)

11.3.3 Using the Content Splitter program open the program and navigate to the pdf report of interest and split the pdfs. This sends them named with the file name (e.g. QQQ0453.d.pdf) to the y:\raw_data drive automatically.

11.3.4 Open the PFAS.mdb convertor program with Access 2010 runtime. Open the Admin tab and be sure the analyst is chosen.

11.3.5 Click on the Select Excel file for import (note must be .xlsx). Navigate to the file and enter it. Examine to be sure it is the correct information then click RUN REPORTS and the reports will be sent to the directory the data came from. The files will be named QBPFASxxxxxxxx_T.pdf for the target isotope report and the isotope corrected data for Element will be in a file named QBPFASxxxxxxxx.xlsx

11.3.6 In order for the Isotope Calc report to be part of the Data pkg., it must be posted to the related Bench sheet in Element. Also, be sure the bench sheet is posted using the proper format in Element.

12. HEALTH AND SAFETY

12.1 General safety considerations and requirements are detailed in the York Laboratory Safety and Health Standard Operating Procedure No. Safety011600.

Specific safety rules applying to the conduct of this analysis requiring the following:

- When handling standards and samples, latex gloves are required.
- Also, when handling neat materials, a fume hood and safety glasses are required.
- When handling samples, gloves and glasses are required.
- Highly odorous samples must be handled in a fume hood.
- Refer to SDSs for specific safety/health information.

12.2 The analysts must exercise normal care and be supervised and trained to work in an analytical chemistry laboratory. The analysts will be handling fragile glassware, needles, syringes, volatile and flammable chemicals, toxic chemicals and corrosive chemicals.

- No smoking or open flames are allowed.
- No food or food products may be brought into the laboratory.

Solvents should not be left uncovered on the laboratory benches.
All solvent transfers should be done in the hoods.

Hood doors must be kept in the position which yields approx. 100 fpm face velocity.
Solvent evaporation must be done in the hood with exhaust elevated and in the rear.

Waste containers that had solvents must be vented to a hood until all solvents have evaporated. Safety glasses are provided and must be worn at all times in the laboratory. Gloves are provided and must be worn when working with chemicals.

Laboratory coats are provided and should be worn to protect the analysts' clothes.
Syringes and needles must be kept in their original cases when not in use.
Care must be exercised in using and handling syringes to avoid injury.
Report any sticking with a needle immediately to your supervisor.

12.3 Specific Safety Concerns

12.3.1 Preliminary toxicity studies indicate that PFAS could have significant toxic effects. In the interest of keeping exposure levels as low as reasonably achievable, PFAS must be handled in the laboratory as hazardous and toxic chemicals.

12.3.2 Exercise caution when using syringes with attached filter disc assemblies. Application of excessive force has, upon occasion, caused a filter disc to burst during the process.

12.3.3 Laboratory procedures such as repetitive use of pipets, repetitive transferring of extracts and manipulation of filled separatory funnels and other glassware represent a significant potential for repetitive motion or other ergonomic injuries. Laboratory associates performing these procedures are in the best position to realize when they are at risk for these types of injuries.

12.3.4 Eye protection, laboratory coat, and nitrile gloves must be worn while handling samples, standards, solvents, and reagents. Disposable gloves that have been contaminated will be removed and discarded; other gloves will be cleaned immediately.

12.3.5 Perfluorocarboxylic acids are acids and are not compatible with strong bases.

12.3.6 Primary Materials Used- The following is a list of the materials used in this method, which have a serious or significant hazard rating. NOTE: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the SDS for each of the materials listed in the table. A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the SDS for each material before using it for the first time or when there are major changes to the SDS.

Methanol (2-3-0)	Flammable Poison Irritant	200 ppm (TWA)	A slight irritant to the mucous membranes. Toxic effects exerted upon nervous system, particularly the optic nerve. Symptoms of overexposure may include headache, drowsiness and dizziness. Methyl alcohol is a defatting agent and may cause skin to become dry and cracked. Skin absorption can occur; symptoms may parallel inhalation exposure. Irritant to the eyes.

13. WASTE MANAGEMENT/POLLUTION PREVENTION

Neat Materials

Waste management procedures require the prudent use of neat materials. The ordering of neat standards and materials must be done to minimize unused material which would result in storage or handling of excess material. Quantities ordered should be sufficient to provide for necessary standards with consideration to shelf life. When ordering a unique material for a standard, be sure to order the smallest practical quantity.

Solvents

The solvents used at York for this procedure include isopropanol and Methanol. These solvents are used for sample extraction or LC cleanup, All amounts are either consumed during concentration or placed in one liter amber jars in the hood areas for evaporation. Any remaining solvent/water is transferred to a drum designated for solvent waste.

Samples

Unused or remaining soil and water samples are returned to the sample control room (CT) for continued storage for proper disposal by the sample control group.

14. REFERENCES

1. US EPA, "Method 537 - Determination of Selected Perfluorinated alkyl acids in Drinking Water by Solid Phase Extraction and Liquid Chromatography/Tandem Mass Spectrometery (LC/MS/MS)", Version 1.1, September 2009, J.A. Shoemaker, P.E. Grimmett, B.K. Boutin, EPA Document #: EPA/600/R-08/092 and Rev. 1.1 updates, Nov. 2018

2. Method ISO 25101:2009, "Determination of perfluorooctanesulfonate (PFOS) and perfluorooctanoate (PFOA) – Method for unfiltered samples using solid phase extraction and liquid chromatography/mass spectrometry", April 30, 2009.

3. EPA Technical Advisory-Laboratory Analysis of Drinking Water Samples for Perfluorooctanoic Acid (PFOA) using EPA Method 537 Rev. 1.1 EPA 815-B-16-021 September 2016 and Nov. 2018 update.

15. REVISION HISTORY

Rev. 1.0	05/10/2019	First issue.
Rev. 1.1	02/13/2020	Modified Sections 9.1.3-Ion Transitions required; 9.3 CCV-added Low level CCV; 11.2 Reporting requirement down to MDL with values <RL and >MDL reported as "J" Added Attachment 4-Current MDLs.

Attachment 1 -HPLC Method Parameters

Acquisition Method Report

	Channel	Name 1	Name 2	Selected	Used	Percent
1	A	Water 5mM ammonium acetate		Ch. 1	Yes	10.0 %
2	B	95% MeOH 5mM ammonium acetate		Ch. 1	Yes	90.0 %

Timetable

	Time	A	B	Flow
1	0.50 min	90.0 %	10.0 %	--- mL/min
2	2.00 min	70.0 %	30.0 %	--- mL/min
3	14.00 min	5.0 %	95.0 %	--- mL/min
4	14.50 min	0.0 %	100.0 %	--- mL/min

Name: Column Comp. **Module:** G7116A

Left Temperature Control

Temperature Control Mode	Temperature Set
Temperature	50.0 °C
Enable Analysis Left Temperature	
Enable Analysis Left Temperature On	Yes
Enable Analysis Left Temperature Value	0.8 °C
Left Temp. Equilibration Time	1.0 min
Right Temperature Control	
Right temperature Control Mode	Temperature Set
Right temperature	50.0 °C
Enable Analysis Right Temperature	
Enable Analysis Right Temperature On	Yes
Enable Analysis Right Temperature Value	0.8 °C
Right Temp. Equilibration Time	1.0 min
Enforce column for run	
Enforce column for run enabled	No
Stop Time	
Stoptime Mode	As pump/injector
Post Time	
Posttime Mode	Off
Timetable	
Valve Position	Position 1 (Port 1 -> 1')
Position Switch After Run	Do not switch

Attachment 2 - Triple Quadrupole Acquisition Method-24 Target PFAS

Method Name PFAS 24_IDA ACQ.m

MS QQQ Mass Spectrometer
Ion Source-AJS-ESI

Compound	Prec Ion	Pr	Frag (V)	CE (V)	Cell	Ret Time	Polarity
1H,1H,2H,2H-perfluoro-1-decanesulfonate (8 2FTS)	527	50	170	28	4	14.58	Negative
1H,1H,2H,2H-perfluoro-1-decanesulfonate (8 2FTS)	527	80	170	40	4	14.58	Negative
1H,1H,2H,2H-perfluoro-1-hexanesulfonate (4 2FTS)	327	30	162	20	4	10.23	Negative
1H,1H,2H,2H-perfluoro-1-hexanesulfonate (4 2FTS)	327	80	162	36	4	10.23	Negative
1H,1H,2H,2H-perfluoro-1-octanesulfonate (6 2FTS)	427	40	162	24	4	12.92	Negative
1H,1H,2H,2H-perfluoro-1-octanesulfonate (6 2FTS)	427	79	162	48	4	12.92	Negative
d3-N-MeFOSAA	572.99	41	130	20	4	14.94	Negative
d5-N-EtFOSAA	589.02	53	130	20	4	15.27	Negative
d5-N-EtFOSAA	589.02	41	130	20	4	15.27	Negative
M2-4-2FTS	329	30	156	20	4	10.1	Negative
M2-4-2FTS	329	81	156	28	4	10.1	Negative
M2-6-2FTS	429	40	162	24	4	12.9	Negative
M2-6-2FTS	429	81	162	40	4	12.9	Negative
M2-8-2FTS	529	50	165	28	4	14.6	Negative
M2-8-2FTS	529	81	165	40	4	14.6	Negative
M2PFTeDA	715	67	62	12	4	16.7	Negative
M3PFBS	302	98	114	32	4	8.7	Negative
M3PFBS	302	79	114	40	4	8.7	Negative
M3PFHxS	402	98	165	40	4	11.9	Negative
M3PFHxS	402	80	165	48	4	11.9	Negative
M4PFHpA	367	32	124	8	4	11.8	Negative
M5PFHxA	318	27	70	4	4	10.3	Negative
M6PFDA	519	47	59	8	4	14.6	Negative
M7PFUdA	570	52	64	8	4	15.3	Negative
MPFDA	514.98	46	90	8	4	14.62	Negative
MPFDA	514.98	21	90	16	4	14.62	Negative
MPFHxA	314.99	26	70	4	4	10.3	Negative
MPFHxA	314.99	12	70	20	4	10.3	Negative
MPFOA - ISTD	417	37	70	6	4	12.9	Negative
MPFOS	502.96	80	150	96	4	13.89	Negative
N-EtFOSAA	584	52	130	20	4	15.28	Negative
N-EtFOSAA	584	41	130	20	4	15.28	Negative
N-MeFOSAA	570	51	150	20	4	14.95	Negative
N-MeFOSAA	570	41	150	20	4	14.95	Negative
Perfluoro-1-[13C8]octanesulfonamide (M8FOSA)	507	80	162	52	4	15.2	Negative
Perfluoro-1-[13C8]octanesulfonamide (M8FOSA)	506	78	162	48	4	15.2	Negative
Perfluoro-1-[13C8]octanesulfonic acid (M8PFOS)	507	98	174	48	4	13.9	Negative
Perfluoro-1-[13C8]octanesulfonic acid (M8PFOS)	507	80	174	54	4	13.9	Negative
Perfluoro-1-decanesulfonate (L-PFDS)	598.9	98	156	50	4	15.181	Negative
Perfluoro-1-decanesulfonate (L-PFDS)	598.9	98	100	60	4	15.181	Negative
Perfluoro-1-decanesulfonate (L-PFDS)	598.9	79	156	50	4	15.181	Negative
Perfluoro-1-decanesulfonate (L-PFDS)	598.9	79	100	80	4	15.181	Negative
Perfluoro-1-heptanesulfonate (L-PFHpS)	448.9	98	162	48	4	13.027	Negative
Perfluoro-1-heptanesulfonate (L-PFHpS)	448.9	80	162	48	4	13.027	Negative
Perfluoro-1-octanesulfonamide (FOSA)	497.9	78	156	40	4	15.2	Negative
Perfluoro-1-octanesulfonamide (FOSA)	497.9	47	156	100	4	15.2	Negative
Perfluoro-1-pentanesulfonate (L-PFPeS)	348.9	98	150	36	4	10.6	Negative
Perfluoro-1-pentanesulfonate (L-PFPeS)	348.9	79	150	40	4	10.6	Negative
Perfluorobutanesulfonic acid (PFBS)	298.9	98	150	32	4	8.7	Negative
Perfluorobutanesulfonic acid (PFBS)	298.9	79	150	36	4	8.7	Negative
Perfluorodecanoic acid (PFDA)	513	46	90	8	4	14.63	Negative
Perfluorodecanoic acid (PFDA)	513	26	90	16	4	14.63	Negative
Perfluorododecanoic acid (PFDoA)	613	56	90	12	4	15.79	Negative
Perfluorododecanoic acid (PFDoA)	613	16	90	28	4	15.79	Negative
Perfluoroheptanoic acid (PFHpA)	363	31	90	8	4	11.8	Negative
Perfluoroheptanoic acid (PFHpA)	363	16	90	16	4	11.8	Negative
Perfluorohexanesulfonic acid (PFHxS)	398.9	98	150	40	4	11.9	Negative
Perfluorohexanesulfonic acid (PFHxS)	398.9	79	150	44	4	11.9	Negative
Perfluorohexanoic acid (PFHxA)	313	26	70	4	4	10.3	Negative
Perfluorohexanoic acid (PFHxA)	313	11	70	20	4	10.3	Negative
Perfluoro-n-[1,2-13C2]dodecanoic acid (MPFDoA)	615	57	53	8	4	15.9	Negative
Perfluoro-n-[13C4]butanoic acid (MPFBA)	217	17	59	4	4	3.9	Negative
Perfluoro-n-[13C54]pentanoic acid (M5PFPeA)	268	22	62	4	4	8	Negative
Perfluoro-n-[13C8]octanoic acid (M8PFOA)	421	37	59	4	4	12.9	Negative
Perfluoro-n-[13C8]octanoic acid (M8PFOA)	421	17	59	16	4	12.9	Negative
Perfluoro-n-[13C9]nonanoic acid (M9PFNA)	472	42	59	8	4	13.9	Negative
Perfluoro-n-[13C9]nonanoic acid (M9PFNA)	472	22	59	16	4	13.9	Negative
Perfluoro-n-butanoic acid (PFBA)	213	16	70	4	4	3.9	Negative
Perfluorononanesulfonate (L-PFNS)	548.9	98	159	48	4	14.6	Negative
Perfluorononanesulfonate (L-PFNS)	548.9	79	159	48	4	14.6	Negative
Perfluorononanoic acid (PFNA)	463	41	90	8	4	13.89	Negative
Perfluorononanoic acid (PFNA)	463	21	90	16	4	13.89	Negative
Perfluoro-n-pentanoic acid (PFPeA)	263	21	62	4	4	8	Negative
Perfluorooctanesulfonic acid (PFOS)	498.9	98	150	44	4	13.9	Negative
Perfluorooctanesulfonic acid (PFOS)	498.9	79	150	84	4	13.9	Negative
Perfluorooctanoic acid (PFOA)	413	36	90	8	4	12.9	Negative
Perfluorooctanoic acid (PFOA)	413	16	90	16	4	12.9	Negative
Perfluorotetradecanoic acid (PFTA)	713	66	110	12	4	16.71	Negative
Perfluorotetradecanoic acid (PFTA)	713	16	110	28	4	16.71	Negative
Perfluorotridecanoic acid (PFTrDA)	663	61	90	12	4	16.25	Negative
Perfluoroundecanoic acid (PFUnA)	563	51	90	8	4	15.25	Negative
Perfluoroundecanoic acid (PFUnA)	563	16	90	24	4	15.25	Negative

Attachment 3 - Triple Quadrupole Acquisition Method for GenX

Acquisition Method Info-GenX

Method Name	PFAS_GenX_IDA_ACQ.m
Method Path	D:\MassHunter\methods\PFAS_GenX_IDA_ACQ.m
Method Description	Target PFAS Isotope Dilution_Acquisition for GenX

Device List
- Multisampler
- Binary Pump
- Column Comp.
- QQQ

MS QQQ Mass Spectrometer

Ion Source	AJS ESI	**Tune File**	D:\MassHunter\Tune\QQQ\G6470A \atunes.TUNE.XML
Stop Mode	No Limit/As Pump	**Stop Time (min)**	1
Time Filter	On	**Time Filter Width (min)**	0.07
LC->Waste Pre Row	N/A	**LC->Waste Post Row**	N/A

Time Segments

Index	Start Time (min)	Scan Type	Ion Mode	Div Valve	Delta EMV	Store	Cycle Time (ms)	Triggered?	MRM Repeats
1	0	DynamicMRM	ESI+Agilent Jet Stream	To MS	200	Yes	500	No	3

Time Segment 1

Scan Segments

Cpd Name	ISTD?	Prec Ion	MS1 Res	Prod Ion	MS2 Res	Frag (V)	CE (V)	Cell Acc (V)	Ret Time (min)	Ret Window	Polarity
HPDO-DA (GenX)	No	285	Unit/Enh (6490)	169	Unit/Enh (6490)	162	1	1	10.5	2	Negative
M3HPDO-DA	No	287	Unit/Enh (6490)	169	Unit/Enh (6490)	159	1	1	10.5	2	Negative
MPFOA	Yes	417	Unit/Enh (6490)	372	Unit/Enh (6490)	70	6	4	12.9	1	Negative

Scan Parameters

Data Stg	Threshold
Centroid	0

Source Parameters

Parameter	Value (+)	Value (-)
Gas Temp (°C)	150	150
Gas Flow (l/min)	5	5
Nebulizer (psi)	15	15
SheathGasHeater	200	200
SheathGasFlow	12	12
Capillary (V)	3500	2500
VCharging	500	0

Chromatograms

Chrom Type	Label	Offset	Y-Range
TIC	TIC	0	10000000

Instrument Curves

Actual

Name: Multisampler **Module: G7167A**

Sampling Speed

Draw Speed	100.0 µL/min
Eject Speed	400.0 µL/min
Wait Time After Drawing	1.2 s

Injection

Needle Wash Mode	Multi-wash
Injection Volume	5.00 µL

Multi-wash

Report generation date: 03-May-2019 08:38:58 AM

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Attachment 4 - MDLs/RLs, Aqueous and Soil CY 2020

PFAS (24) MDLs/RLs- Summary Aqueous/Soil, Feb. 2020				
PFAS Compound	AQUEOUS		SOIL	
	MDL (ng/L)	RL (ng/L)	MDL (ug/kG)	RL (ug/kG)
1H,1H,2H,2H-perfluoro-1-decanesulfonate (8 2FTS)	0.40	2.00	0.03	0.50
1H,1H,2H,2H-perfluoro-1-hexanesulfonate (4 2FTS)	0.33	2.00	0.05	0.50
1H,1H,2H,2H-perfluoro-1-octanesulfonate (6 2FTS)	0.49	2.00	0.07	0.50
N-EtFOSAA	0.56	2.00	0.10	0.50
N-MeFOSAA	0.53	2.00	0.10	0.50
Perfluoro-1-decanesulfonate (L-PFDS)	0.57	2.00	0.04	0.50
Perfluoro-1-heptanesulfonate (L-PFHpS)	0.41	2.00	0.05	0.50
Perfluoro-1-octanesulfonamide (FOSA)	0.30	2.00	0.05	0.50
Perfluoro-1-pentanesulfonate (L-PFPeS)	0.34	2.00	0.03	0.50
Perfluorobutanesulfonic acid (PFBS)	0.29	2.00	1.65	2.00
Perfluorodecanoic acid (PFDA)	0.52	2.00	0.05	0.50
Perfluorododecanoic acid (PFDoA)	0.78	2.00	0.08	0.50
Perfluoroheptanoic acid (PFHpA)	0.64	2.00	0.05	0.50
Perfluorohexanesulfonic acid (PFHxS)	0.28	2.00	0.03	0.50
Perfluorohexanoic acid (PFHxA)	0.47	2.00	0.07	0.50
Perfluoro-n-butanoic acid (PFBA)	1.63	2.00	0.18	0.50
Perfluorononanesulfonate (L-PFNS)	0.50	2.00	0.04	0.50
Perfluorononanoic acid (PFNA)	0.57	2.00	0.06	0.50
Perfluoro-n-pentanoic acid (PFPeA)	0.45	2.00	0.09	0.50
Perfluorooctanesulfonic acid (PFOS)	0.29	2.00	0.04	0.50
Perfluorooctanoic acid (PFOA)	0.53	2.00	0.08	0.50
Perfluorotetradecanoic acid (PFTA)	0.49	2.00	0.07	0.50
Perfluorotridecanoic acid (PFTrDA)	1.37	2.00	0.04	0.50
Perfluoroundecanoic acid (PFUnA)	0.66	2.00	0.12	0.50