HALEY ALDRICH

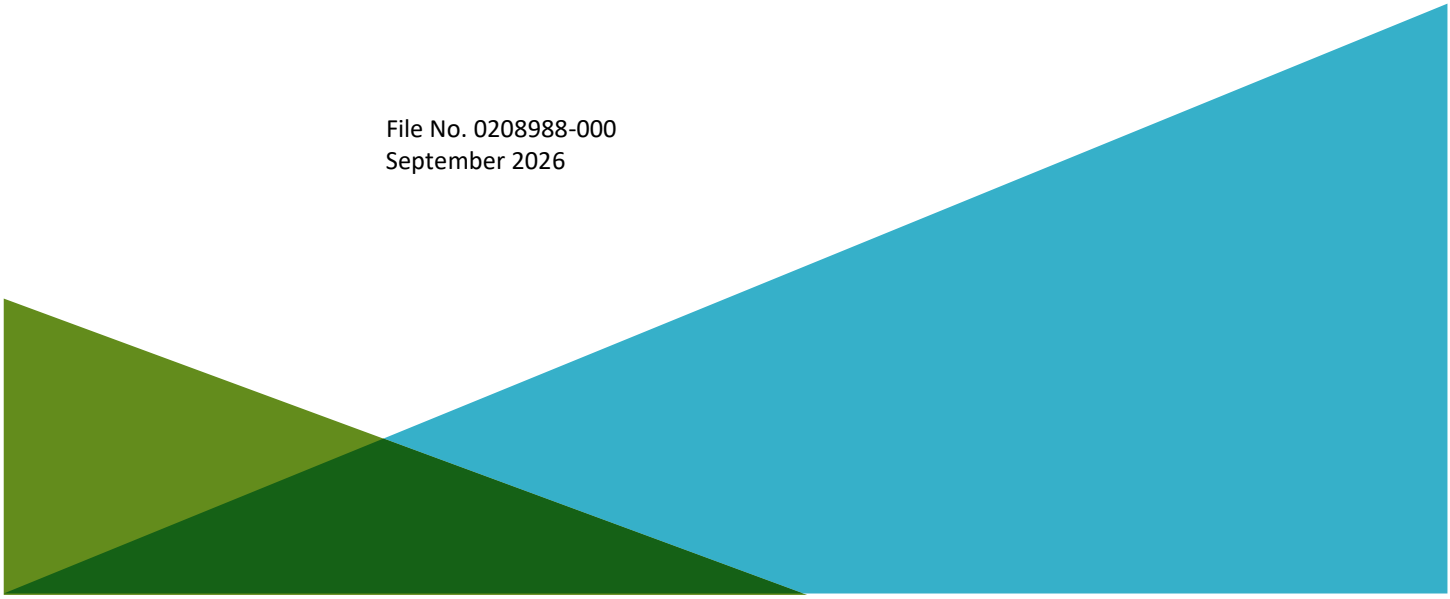
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PRE-DESIGN INVESTIGATION WORK PLAN
FORMER PORT MOBIL TERMINAL SITE
4101 ARTHUR KILL ROAD
STATEN ISLAND, NEW YORK
NYSDEC SITE NO. 243016
USEPA ID NO. NYD000824516

by
H & A of New York Engineering and Geology, LLP
New York, New York

for
NP Staten Island Industrial, LLC
Kansas City, Missouri

File No. 0208988-000
September 2026



Certification

This report details proposed pre-design investigation activities to be conducted at the Former Port Mobil Terminal located at 4101 Arthur Kill Road in Staten Island, New York.

I, Scott A. Underhill, certify that I am currently a New York State-registered Professional Engineer and that this Pre-Design Investigation Work Plan was prepared in accordance with the applicable statutes and regulations and in substantial conformance with the DER Technical Guidance for Site Investigation and Remediation (DER-10).



September 30, 2026

Scott A. Underhill, P.E.
NYS Professional Engineer #75332

Date

HALEY ALDRICH

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1. Introduction

On behalf of NP Staten Island Industrial, LLC, H & A of New York Engineering and Geology, LLP (Haley & Aldrich of New York) has prepared this Pre-Design Investigation (PDI) Work Plan (PDIWP) for the Former Port Mobil Terminal, located at 4101 Arthur Kill Road in Staten Island, New York (the "Site"; see Figure 1).

The PDI includes the following objectives:

- Investigate areas of the Site that were previously inaccessible, including the surface impoundments on the northern portion of the Site and the solar farm on the southern portion of the Site; and
- Install soil borings along the proposed permeable reactive barrier (PRB) alignment as described in the Alternatives Analysis/Remedial Action Work Plan (AA/RAWP) to characterize soil conditions and confirm depth to the confining silt layer.

This PDIWP was prepared in accordance with the New York State Department of Environmental Conservation (NYSDEC) Division of Environmental Remediation (DER)-10, which is entitled "Technical Guidance for Site Investigation and Remediation" and dated May 2010.

The Site is tracked by the NYSDEC and the U.S. Environmental Protection Agency (USEPA) as:

- NYSDEC Site 243016, Consent Order ID No. 12-111-A-SBC
- USEPA Docket No. RCRA-02-2009-7306

The Site consists of an approximately 240-acre waterfront facility located at 4101 Arthur Kill Road in Staten Island, New York (Block 7427, Lot 1 and Block 7207, Lot 60) and is depicted on Figure 2. The Site is currently owned by NP Staten Island Industrial, LLC, and was formerly a petroleum bulk storage (PBS) terminal. The facility operated as a major oil storage facility (MOSF) from 1934 to November 2019, at which time the existing aboveground storage tanks (ASTs) and pipe systems were closed in accordance with the MOSF permit and the Fire Department of the City of New York (FDNY) requirements. During the years of operation, the PBS capacity at the facility was 125 million gallons with an annual throughput of approximately 1.4 billion gallons of petroleum products. The facility previously stored and transferred gasoline, No. 6 fuel oil, and distillate fuels, such as No. 4 fuel oil, No. 2 fuel oil, marine lubricating oils, and kerosene. Facility operations included unloading barges and ships at the berth system along the bulkhead, transmitting petroleum products to ASTs through an aboveground piping network, and storing the petroleum products until shipment. The ASTs and piping have been drained, cleaned, and removed. All buildings have been demolished except for three building structures, which remain, including the marine warehouse, an office/garage, and the Dravo building (Figure 2).

1.1 PURPOSE

The purpose of the PDI is to investigate areas previously inaccessible and not investigated during the Remedial Investigation (RI) conducted by Weston Solutions, Inc. (Weston) and summarized in the

Remedial Investigation Report (RIR) (Weston, 2026). These areas include the two surface impoundments on the northern portion of the Site and the solar farm on the southern portion of the Site. Soil and groundwater samples are proposed to be collected from the areas of the surface impoundments and the solar farm.

Additionally, this PDI will include installation of soil borings along the PRB alignment to characterize soil conditions and confirm the depth to the confining silt layer.

This PDIWP was prepared in accordance with DER-10.

2. Background

2.1 CURRENT LAND USE

The Site consists of an approximately 240-acre waterfront facility located at 4101 Arthur Kill Road in Staten Island, New York (Block 7427, Lot 1 and Block 7207, Lot 60). The Project Locus is shown on Figure 1, and a Site Plan is shown on Figure 2.

The Site is currently owned by NP Staten Island Industrial, LLC, and formerly operated as a PBS terminal. The operational areas were generally comprised of a bulkhead area and berth system in the western portion of the Site, along the Arthur Kill, used as a loading and unloading area for barges and ships, and a tank farm area consisting of the entire central portion of the Site used for petroleum storage. All buildings, ASTs, and piping associated with the former PBS operations have been demolished or removed except for three building structures, including the marine warehouse, an office/garage, and the Dravo building, which housed the water treatment system. Additionally, two surface impoundments used to control precipitation-induced runoff are present on the northern portion of the Site.

The non-operational areas of the Site consist of underwater lands within the Arthur Kill in the northern portion of the Site, a portion of land developed on the southern boundary with a ground-mounted solar array operated by a third-party lessee, and undeveloped wetlands and vegetated uplands on the northern, eastern, and southern portions of the Site.

2.2 SITE HISTORY AND FACILITY DESIGN

The Site was historically operated by the Mobil Oil Corporation, which began utilizing the Site as a MOSF for the storage and transfer of petroleum products in 1934. The Mobil Oil Corporation merged with Exxon to form Exxon Mobil in 1995, and in 2005, Exxon Mobil sold the Site to Kinder Morgan. Kinder Morgan continued operation of the MOSF through November 2019, at which time the ASTs and pipe systems were closed in accordance with the MOSF permit and FDNY requirements. During operation from 1934 to 2019, the MOSF stored and transferred gasoline, No. 6 fuel oil, and distillate fuels, including No. 4 fuel oil, No. 2 fuel oil, marine lubricating oils, and kerosene. The facility had a PBS capacity of 125 million gallons with an annual throughput of approximately 1.4 billion gallons of petroleum products. Two former regional pipelines were present on the Site and connected to the Colonial Pipeline Corporation's distribution network in Woodbridge, New Jersey, and to the former Texas Eastern Pipeline. These pipelines entered the terminal in the northeastern corner of the Site.

Facility operations included unloading barges and ships at the berth system along the bulkhead, transmitting petroleum products to ASTs through an aboveground piping network, and storing the petroleum products until shipment. A total of 48 ASTs, ranging in capacity from 55 to 5,023,200 gallons, were present on the Site and were utilized for the storage and transfer of gasoline and various fuel oils, operation of the on-Site boiler system, and two tanks were used as part of the on-Site fire suppression system and stored firefighting foam. Eight smaller ASTs (Tanks 26 through 33) were utilized for lube oil storage and merchandizing marine vessels. A single dike system provided secondary containment for

these tanks, which were filled from tanker trucks via an overhead rack system. Upon shipment, products were transferred from the AST system back to ships using the same piping systems.

The former Port Mobil Terminal produced wastewater containing hydrocarbons from cleaning operations, stormwater runoff, spill containment systems, oil-water separators (OWSs), and tank bottom water. Barge cleaning was initially conducted over-water and then using an onshore system constructed in the late 1940s to early 1950s. Barge tank interiors were descaled manually, and solid scaling waste was drummed and stored on the Container Storage Pad on the western portion of the facility for off-Site disposal. Tanks 48 and 60, used to contain barge cleaning effluent and AST bottom water, were emptied to two OWSs, specifically American Petroleum Institute (API) OWSs. Oil was returned to the tanks, and water was transferred via road trenches to two stormwater holding ponds located on the western portion of the Site. Wastewater from the holding ponds was pumped through a water treatment system located in the Dravo building and discharged to the Arthur Kill. The Resource Conservation and Recovery Act (RCRA) Facility Assessment (RFA) (A.T. Kearney, 1993) reported that OWSs were not in operation from December 1989 to May 1991, and tank contents were passed directly to the holding ponds.

Three on-Site steam boilers provided heat for buildings, steam cleaning, and warming No. 6 oil to flowable conditions. A marine warehouse stored prepackaged lube oil and other supplies sold to barge or ship operators. A maintenance warehouse was used for on-Site equipment repair and storage.

Listed waste (K051: API Separator Sludge) generation began in 1981 by the Mobil Oil Corporation, which triggered RCRA regulations. The lower holding pond had a Toxicity Characteristic Leaching Procedure (TCLP) exceedance for benzene, requiring pond contents to be handled as hazardous waste. Chlorinated volatile organic compounds (CVOCs), including 1,2-dichloroethane, hexachloroethane, tetrachloroethene (PCE), and trichloroethene (TCE), were detected at concentrations below hazardous waste thresholds. Facility personnel concluded that CVOCs originated from barges (A.T. Kearney, 1993) and not from Site operations. The facility ceased discharging barge cleaning wastewater into the surface impoundments and terminated the RCRA Part B permit in 1993.

2.3 SURROUNDING LAND USE

The Site is located between Arthur Kill Road and the Arthur Kill within an urban area surrounded by commercial and industrial properties identified as the Charleston neighborhood in the borough of Staten Island. The Site is bounded by commercial buildings to the northeast, Clay Pit Ponds State Park to the east, the Arthur Kill to the north and west, and wetlands within a valley to the south. The Charleston residential area, approximately ½ mile from the Site, lies across the valley south of the Site.

Additionally, the following sensitive receptor, a day care center, is located within a 500-foot (ft) radius of the Site:

No.	Name (Approximate Distance from Site)	Address
1	Prodigy Preschool and Childcare (200 ft south across Arthur Kill Road)	3080 Arthur Kill Road, Staten Island, New York 10309

2.4 PREVIOUS INVESTIGATIONS

Previous investigations are detailed in the Remedial Investigation Report prepared by Weston (Weston, 2026) and in the AA/RAWP dated May 2026 prepared by Haley & Aldrich of New York (Haley & Aldrich of New York, 2026).

3. Pre-Design Investigation

This section describes the field activities to be conducted during the PDI and provides the sampling scope, objectives, methods, anticipated number of samples, and sample locations. A summary of the sampling and analysis plan is provided in Table 1 and Figures 3 through 5. The following investigation activities will be conducted to fill data gaps so that the full nature and extent of contamination at the Site can be determined.

3.1 UTILITY MARKOUT

Field personnel will mobilize to the Site to stake (with flagging or paint) the proposed soil sample locations. Once the sample locations are marked, Dig Safely New York will be contacted to mark underground utilities. A ground-penetrating radar (GPR) scan of the previously inaccessible areas of the Site will be performed prior to commencement of intrusive activity. The GPR scan will be completed to identify utility lines, subsurface anomalies, and potential underground storage tanks (USTs). Once the utilities are marked, field equipment and personnel will be mobilized to the Site. The findings report will be provided in the Pre-Design Investigation Report (PDIR).

3.2 SOIL SAMPLING

To further characterize surface soil conditions, additional on-Site soil samples will be collected at varying locations to identify the extent and depth of contamination at the Site. Soil samples representative of the surface water impoundment and solar panel farm will be collected.

The sampling and analysis plan is summarized in Table 1. The proposed soil borings will be installed up to 15 ft below ground surface (bgs) for samples collected in the areas of the surface impoundments and the solar farm by a track-mounted direct push drill rig (Geoprobe®) operated by a licensed operator. Soil sampling locations are shown on Figures 3 and 4. Soil samples will be collected from acetate liners using a stainless-steel trowel or sampling spoon. Samples will be placed in laboratory-provided clean bottle ware.

Soils will be logged continuously by a geologist or engineer using the Unified Soil Classification System. The presence of staining, odors, and photoionization detector (PID) response will be noted. If free product is observed in a boring, additional borings may be advanced in the vicinity of the location to delineate the extent of the contamination. Samples will be collected using laboratory-provided clean bottle ware. Volatile organic compound (VOC) grab samples will be collected using Terra Cores®. Sampling methods are described in the Field Sampling Plan (FSP) provided as Appendix A. A Quality Assurance Project Plan (QAPP) is provided as Appendix B. Laboratory data will be reported in Analytical Services Protocol (ASP) Category B deliverable format.

Sample intervals are specified in Table 1. Up to three grab samples will be collected from each soil boring in the area of the surface impoundments and the solar farm. One surface sample will be collected from the top 0 to 2 inches of soil (i.e., surface soil). A second sample will be collected from the 2-ft interval above the groundwater interface, and a third sample will be collected from the area exhibiting

the greatest evidence of impacts based on the presence of staining, odors, and PID readings above non-detect.

Soil samples collected from the surface impoundments and solar farm will be analyzed for the Site Contaminants of Concern (COCs), including:

- VOCs: benzene, ethylbenzene, toluene, xylenes, 1,2,4-trimethylbenzene (TMB), 1,3,5-trimethylbenzene, and methyl tert-butyl ether (MTBE) by USEPA Method 8260B;
- Semi-volatile organic compounds (SVOCs): naphthalene and benzo(a)anthracene by USEPA Method 8270C;
- Metals: lead by USEPA Method 6010; and
- Perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS) by USEPA Method 1633.

Additionally, soil borings will be installed using a track-mounted direct push drill rig (Geoprobe®) every 100 ft along the PRB alignment to approximately 15 ft bgs to characterize soil conditions and confirm the depth to the confining silt layer. Soil samples will not be collected from PRB alignment borings.

3.3 GROUNDWATER SAMPLING

The purpose of the groundwater sampling is to obtain current groundwater data and analyze for additional parameters (i.e., per- and polyfluoroalkyl substances [PFAS] and 1,4-dioxane) to meet NYSDEC DER-10 requirements for remedial investigations.

Eight permanent groundwater monitoring wells will be installed to approximately 15 ft bgs or to at least 5 ft below the groundwater interface (if encountered at a shallower depth). Monitoring wells will have a 2-inch annular space and be installed using either #0 or #00 certified clean sand fill. Wells will be screened to straddle the water table. Monitoring wells will be developed after installation by surging a pump in the well several times to pull fine-grained material from the well. Development will be completed until the water turbidity is 50 nephelometric turbidity units (NTU) or less, or ten well volumes are removed, if possible. Groundwater sampling will occur at a minimum of one week after monitoring well development.

The Sampling and Analysis Plan is summarized in Table 1. Proposed and existing groundwater monitoring well locations are displayed in Figure 2.

A total of eight monitoring wells will be sampled and analyzed for:

- Target Compound List (TCL) VOCs using USEPA Method 8260D;
- TCL SVOCs using USEPA Method 8270;
- Total and dissolved metals using USEPA Methods 6010/6020;
- Polychlorinated biphenyls (PCBs) using USEPA Method 8082;
- TCL pesticides using USEPA Method 8081B;
- PFAS using USEPA Method 1633; and

- 1,4-dioxane using USEPA Method 8270E-SIM.

Samples to be analyzed for PFAS and 1,4-dioxane will be collected and analyzed in accordance with the NYSDEC-issued April 2023 "Sampling, Analysis, and Assessment of Per- and Polyfluoroalkyl Substances (PFAS) Under NYSDEC's Part 375 Remedial Programs" and the June 2019 "Sampling for 1,4-dioxane and PFAS Under DEC's Part 375 Remedial Programs," respectively.

Groundwater wells will be sampled using low-flow sampling methods described in the FSP. Following the low-flow purge, samples will be collected from monitoring wells for analysis of the analytes mentioned above. Groundwater sampling will be conducted at least one week after monitoring well development.

The FSP presented in Appendix A details field procedures and protocols that will be followed during field activities. The QAPP presented in Appendix B details the analytical methods and procedures that will be used to analyze samples collected during field activities. PFAS sampling at each monitoring well will be conducted following the purge and sampling method detailed in the NYSDEC guidance documents (Sampling, Analysis, and Assessment of Per- and Polyfluoroalkyl Substances [PFAS] Under NYSDEC's Part 375 Remedial Programs, dated April 2023).

Groundwater analytical results will be compared to Title 6 of the New York Codes, Rules, and Regulations (6 NYCRR) Part 703.5, NYSDEC Technical and Operational Guidance Series 1.1.1 Ambient Water Quality Standards and Guidance Values (AWQS).

3.4 STORMWATER IMPOUNDMENT INVESTIGATION SEQUENCING

Prior to the advancement of soil borings, all water will be diverted into one surface impoundment at a time while the other is sampled; one of the impoundments will always remain in use during the PDI. The sequence for stormwater management during the PDI will be as follows:

1. A temporary route will be installed from the lower pond to the upper pond, allowing for bypass of the lower pond.
2. Once the bypass has been installed, the lower pond will be drained into the upper pond, and the lower pond will be temporarily taken out of service.
3. The PDI will commence on the lower pond.
4. Once the lower pond components of the PDI are complete, repairs will be performed on the lower pond, and the lower pond will be brought back to service.
5. A temporary route will be installed from the upper pond to the lower pond, allowing for bypass of the upper pond.
6. Once the bypass has been installed, the upper pond will be drained into the lower pond, and the upper pond will be temporarily taken out of service.
7. The PDI will commence on the upper pond.
8. Once the upper pond components of the PDI are complete, repairs will be performed on the upper pond, and the upper pond will be brought back into service.

As a contingency, a temporary holdover pond may be installed for stormwater storage and management, if the lower pond cannot be returned to service within the anticipated time frame.

3.5 HDPE AND LLDPE GEOMEMBRANE REPAIR

Advancement of soil borings within the two surface impoundments on the northern portion of the Site will result in punctures of the high-density polyethylene (HDPE) and linear low-density polyethylene (LLDPE) geomembrane liner.

Prior to initiating the investigation, a certified liner contractor will conduct an inspection to evaluate the condition of the existing liner and determine the feasibility of proposed repairs. The inspection will include any known holes, tears, or other existing damage; no known holes, tears, or other existing damage are known at this time. The liner vendor will evaluate the HDPE material and the effective repair techniques. If the certified liner vendor determines that test welds should be performed, this recommendation will be followed. Following the inspection, the certified liner contractor will prepare a liner summary report that details the results of the inspection and further repair recommendations. The liner summary report from the certified liner vendor will include any proposed liner repair procedures and associated quality assurance/quality control (QA/QC) measures.

Following the installation of soil borings within the surface water impoundment areas, boreholes will be backfilled with soil cuttings and an upper bentonite plug and restored to grade with the surrounding area. The HDPE and LLDPE geomembrane liner will be repaired in compliance with the recommendations from the certified liner contractor and the manufacturer's specifications provided in Appendix C. Following installation of the soil borings, any subgrade areas that may be deemed unsuitable for geomembrane installation will be repaired prior to replacement of the geomembrane.

Haley & Aldrich of New York personnel will coordinate with NP Staten Island Industrial, LLC and its on-Site stormwater management contractors to complete the sampling of the surface impoundments. Photo documentation of the liner repair will be included in the PDIR.

3.6 INVESTIGATION-DERIVED WASTE

Following sample collection, boreholes will be backfilled with soil cuttings and an upper bentonite plug. Boreholes will be restored to grade with the surrounding area. If soil is identified as grossly contaminated, it will be separated and placed into a sealed and labeled Department of Transportation (DOT)-approved 55-gallon drum pending characterization and off-Site disposal.

Soil borings will be installed utilizing direct-push methods (e.g., Geoprobe®) and will not utilize fluid for drilling purposes. All proposed sampling will be completed via properly decontaminated hand tools or direct-push technology tools. Decontamination fluids will be containerized in DOT-approved 55-gallon drums pending off-Site disposal.

3.6.1 Management of Sediment Waste from Surface Impoundments

Sediment exists within the surface impoundment that may impede drill rig access to the boring locations. To allow access to the boring locations, the sediment will be relocated within the surface impoundment. No sediment is planned to be removed from the surface impoundments during the PDI.

3.7 PROPOSED SAMPLING RATIONALE

Haley & Aldrich of New York has proposed this PDIWP to investigate areas previously inaccessible and not investigated during the RI conducted by Weston, including the two surface impoundments on the northern portion of the Site and the solar farm on the southern portion of the Site. Soil and groundwater samples are proposed to be collected from the areas of the surface impoundments and the solar farm.

4. Quality Assurance and Quality Control

QA/QC procedures will be used to provide performance information with regard to the accuracy, precision, sensitivity, representation, completeness, and comparability associated with the sampling and analysis for this investigation. Field QA/QC procedures will be used (1) to document that samples are representative of actual conditions at the Site and (2) to identify possible cross-contamination from field activities or sample transit. Laboratory QA/QC procedures and analyses will be used to demonstrate whether analytical results have been biased either by interfering compounds in the sample matrix or by laboratory techniques that may have introduced systematic or random errors to the analytical process.

QA/QC procedures are defined in the QAPP included in Appendix B.

5. Data Use

5.1 DATA SUBMITTAL

Analytical data will be supplied in ASP Category B Data Packages. If more stringent than those suggested by the USEPA, the laboratory's in-house QA/QC limits will be utilized. Validated data will be submitted to the NYSDEC EQuIS database in an electronic data deliverable package.

5.2 DATA VALIDATION

Data packages will be sent to a qualified data validation specialist to evaluate the accuracy and precision of the analytical results. A Data Usability Summary Report (DUSR) will be created to confirm the compliance of methods with the protocols described in the NYSDEC ASP. DUSRs will summarize and confirm the usability of the data for project-related decisions. Data validation will be completed in accordance with the DUSR guidelines from the NYSDEC DER. DUSRs will be included with the submittal of an RIR, further discussed in Section 8. Additional details on the DUSRs are provided in the QAPP in Appendix B.

6. Health and Safety

6.1 HEALTH AND SAFETY PLAN

A Site-specific Health and Safety Plan (HASP) has been prepared in accordance with NYSDEC and New York State Department of Health (NYSDOH) guidelines and is provided in Appendix G of the AA/RAWP. The HASP includes a description of health and safety protocols to be followed by Haley & Aldrich of New York field staff during implementation of the PDIWP, including monitoring within the work area, along with response actions should impacts be observed. The HASP has been developed in accordance with Occupational Safety and Health Administration (OSHA) Title 40 Code of Federal Regulations (CFR) Part 1910.120 regulatory requirements for use by Haley & Aldrich of New York field staff who will work at the Site during planned activities. Contractors or other personnel who perform work at the Site are required to develop their own HASP and procedures of comparable or higher content for their respective personnel in accordance with relevant OSHA regulatory requirements for work at hazardous waste sites as well as the general industry requirements as applicable based on the nature of work being performed.

7. Community Air Monitoring Program

Real-time air monitoring will be conducted in three locations during ground-intrusive activities and will be based on the location of work, Site conditions, and nearest receptors. Continuous monitoring will be performed for all ground-intrusive activities and during the handling of contaminated or potentially contaminated media.

The COCs at the Site include VOCs, lead, polycyclic aromatic hydrocarbons (PAHs), PFOA, and PFOS. The VOCs include benzene, toluene, ethylbenzene, xylene (collectively, BTEX compounds), 1,2,4-trimethylbenzene, and 1,3,5-trimethylbenzene. The PAHs include benzo[a]anthracene and naphthalene. VOCs may volatilize directly into the air during intrusive work activities. Lead, PAHs, PFOA, and PFOS are not volatile compounds and may be adsorbed to particulates (i.e., dust). This work will be completed in accordance with the approved Community Air Monitoring Program (CAMP) included in the AA/RAWP (Haley & Aldrich of New York, 2026).

7.1 VOC MONITORING, RESPONSE LEVELS, AND ACTIONS

VOCs will be monitored at CAMP stations at the three locations during ground-intrusive activities and will be based on the location of the work, Site conditions, and nearest receptors. Upwind concentrations will be measured at the start of each workday and periodically thereafter to establish background conditions. Roaming equipment to assess VOCs will be carried by the field support staff overseeing implementation of the waste characterization scope. The monitoring work will be performed using equipment appropriate to measure the types of contaminants known or suspected to be present. The equipment will be calibrated at least daily for the COCs or for an appropriate surrogate. The equipment will be capable of calculating 15-minute running average concentrations, which will be compared to the levels specified below:

- If the ambient air concentration of total organic vapors at the downwind perimeter of the work area or exclusion zone exceeds 5 parts per million (ppm) above background for the 15-minute average, work activities will be temporarily halted and monitoring continued. If the total organic vapor level readily decreases (per instantaneous readings) below 5 ppm over background, work activities will resume with continued monitoring.
- If total organic vapor levels at the downwind perimeter of the work area or exclusion zone persist at levels in excess of 5 ppm over 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 ft downwind of the exclusion zone or half the distance to the nearest potential receptor or residential/commercial structure, whichever is less (but in no case less than 20 ft) is below 5 ppm over background for the 15-minute average.
- If the organic vapor level is above 25 ppm at the perimeter of the work area, activities will be shut down.

All 15-minute readings must be recorded and be available for NYSDEC and USEPA personnel to review. Instantaneous readings, if any, used for decision purposes will also be recorded. Proactive measures will

be taken to control VOCs, such as the use of a foaming agent and wintergreen misting to prevent off-Site migration of VOCs and to suppress odors.

7.2 PARTICULATE MONITORING, RESPONSE LEVELS, AND ACTIONS

Dust particulates will be monitored at CAMP stations at the three locations during ground-intrusive activities and will be based on the location of the work, Site conditions, and nearest receptors. Particulate concentrations will be evaluated through particulate monitoring via real-time monitoring equipment capable of measuring particulate matter less than 10 micrometers in size (PM_{10}). The equipment will be capable of integrating over a period of 15 minutes (or less) for comparison to the airborne particulate action level discussed below:

- If the downwind PM_{10} 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 techniques will be employed. Work will continue with dust suppression techniques provided that downwind PM_{10} particulate levels do not exceed 150 $\mu g/m^3$ greater than the upwind level and provided that no visible dust is migrating from the work area.
- If, after implementation of dust suppression techniques, downwind PM_{10} particulate levels are greater than 150 $\mu g/m^3$ above the upwind level, work will be stopped, and a re-evaluation of activities initiated. Work will resume provided that dust suppression measures and other controls are successful in reducing the downwind PM_{10} particulate concentration to within 150 $\mu g/m^3$ of the upwind level and in preventing visible dust migration.

All 15-minute readings must be recorded and be available for NYSDEC and USEPA personnel to review. Instantaneous readings, if any, used for decision purposes will also be recorded. Proactive measures will be taken to control dust particulates, such as the use of water sprayers to suppress dust generation and migration off Site.

7.3 FUGITIVE DUST SUPPRESSION TECHNIQUES

Reasonable fugitive dust suppression techniques must be employed during all Site activities that may generate fugitive dust. The following techniques have been shown effective for controlling the generation and migration of dust during soil sampling activities, and they will be employed as needed during all ground-intrusive Site activities:

- applying water on haul roads;
- wetting equipment prior to and during use;
- hauling materials in properly tarped or watertight containers; and
- restricting on-Site vehicle speeds to 10 miles per hour (mph).

By employing the above techniques, the chance of exceeding the 150 $\mu g/m^3$ action level becomes extremely remote. In techniques involving water application, care must be taken not to generate unacceptably wet conditions. Using atomizing sprays will prevent such overly wet conditions, conserve water, and provide an effective means of fugitive dust suppression.

8. Project Organization

A project team for the Site has been created based on qualifications and experience with personnel suited for successfully completing the project.

The NYSDEC Case Manager is Rafi Alam. The Case Manager will be responsible for overseeing the successful completion of the project work and adherence to the work plan on behalf of NYSDEC.

The NYSDOH Case Manager will be Steve Lawrence. The Case Manager will be responsible for overseeing the successful completion of the project work and adherence to the work plan on behalf of NYSDOH.

James Bellew will be the Qualified Environmental Professional (QEP) and Principal in Charge for this work. Mr. Bellew has over 15 years of experience in investigation and remediation in New York and throughout the eastern United States. In this role, Mr. Bellew will be responsible for the overall completion of each task as per requirements outlined in this work plan and in accordance with the DER-10 guidance.

Sarah Commisso, G.I.T., will be the Project Manager for this work. In this role, Ms. Commisso will manage the day-to-day tasks, including coordination and supervision of field engineers and scientists, adherence to the work plan, and oversight of the project schedule. As the Project Manager, Ms. Commisso will also be responsible for communications with the NYSDEC Case Manager regarding project status, schedule, issues, and updates for project work.

Hailey Russell will be the Assistant Project Manager for this work as well as the Quality Assurance Officer (QAO). The QAO will ensure the application and effectiveness of the QAPP by the analytical laboratory and the project staff, provide input to the field team as to corrective actions that may be required as a result of the above-mentioned evaluations, and prepare and/or review data validation and audit reports.

Charlotte Lorthioir will be the field engineer responsible for implementing the field effort for this work. Ms. Lorthioir's responsibilities will include implementing the work plan activities and directing the subcontractors to ensure successful completion of all field activities.

The drilling subcontractor will be Lakewood Environmental Services Corp. (Lakewood) or Coastal Environmental Solutions Inc. (Coastal). Lakewood or Coastal will provide a Geoprobe® operator to implement the scope of work in this PDIWP.

The analytical laboratory will be Eurofins Test America (Eurofins), an NYSDOH – Environmental Laboratory Approval Program (ELAP)-approved laboratory (Laboratory Certification No. 68780). Eurofins will be responsible for analyzing samples as per the analyses and methods identified in Section 3.

9. Reporting

9.1 DAILY REPORTING

Daily reports will be submitted to the NYSDEC and NYSDOH summarizing the Site activities completed during the PDI. Daily reports will include a Site figure, a description of Site activities, a photo log, and a summary of community air monitoring performed. Daily reports will be submitted the following calendar day after Site work is completed.

9.2 PRE-DESIGN INVESTIGATION REPORT

Following completion of the work, a summary of the PDI will be provided to the NYSDEC in a PDIR to support the implementation of the proposed remedial action. The report will include:

- a summary of the PDI activities;
- a figure showing sampling locations;
- tables summarizing laboratory analytical results;
- laboratory analytical data reports;
- field sampling data sheets;
- community air monitoring data;
- findings regarding the nature and extent of contamination at the Site;
- qualitative exposure assessment of any contamination from an on-Site source that has migrated off the Site; and
- conclusions and recommendations.

9.3 PRB ALIGNMENT SOIL BORING OBSERVATIONS

Observations from the PRB alignment soil boring installation will be incorporated into the final AA/RAWP for the Site-wide remedy. Soil conditions and depth to the confining silt layer will support the determination of treatment depth for the PRB design.

References

1. Haley & Aldrich of New York, 2026. Alternatives Analysis / Remedial Action Work Plan. Former Port Mobil Terminal, Staten Island, New York. May.

2. Kearney, A.T., 1993. Final RCRA Facility Assessment Report. July.

3. New York State Department of Environmental Conservation, 2006. Part 375 of Title 6 of the New York Compilation of Codes, Rules, and Regulations. December 14.

4. New York State Department of Environmental Conservation, 2010. Program Policy DER-10 / Technical Guidance for Site Investigation and Remediation. May.

5. New York State Department of Environmental Conservation, 2023. Sampling, Analysis, and Assessment of Per- and Polyfluoroalkyl Substances (PFAS) Under NYSDEC's Part 375 Remedial Programs, April.

6. New York State Division of Water, 1998. Technical and Operational Guidance Series 1.1.1. June.

7. United States Environmental Protection Agency, 2017. Low Flow Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells, EQASOP-GW 001. September 19.

8. Weston Solutions, Inc., 2026. Remedial Investigation Report, Former Port Mobil Terminal, Staten Island, New York, prepared for NP Staten Island Industrial, LLC. January.

TABLE

TABLE 1
SAMPLING AND ANALYSIS PLAN
FORMER PORT MOBIL TERMINAL
STATEN ISLAND, NEW YORK

Boring Location	Sample Rationale	Sample Depth (ft bgs)	Target Compound List VOCs (8260B)	Target Compound List SVOCs (8270C)	Total Analyte List Metals (6010/7471)	PCBs (8082)	Pesticides (8081B)	PFAS (1633)	1,4-Dioxane (8270)/(8270E-SIM)	Dissolved Target Analyte List Metals (6010/7471)
SF-01	Surface sample (0-2 inches)	Surface sample (0-2 inches)	X (site COCs)	X (site COCs)	X (site COCs)			X (site COCs)		
	2-ft interval above the groundwater interface	2-ft interval above the groundwater interface	X (site COCs)	X (site COCs)	X (site COCs)			X (site COCs)		
	2-ft Interval exhibiting visual/olfactory evidence of contamination	Variable Depth above the groundwater interface	X (Site COCs)	X (Site COCs)	X (Site COCs)			X (Site COCs)		
SF-02	Surface sample (0-2 inches)	Surface sample (0-2 inches)	X (site COCs)	X (site COCs)	X (site COCs)			X (site COCs)		
	2-ft interval above the groundwater interface	2-ft interval above the groundwater interface	X (site COCs)	X (site COCs)	X (site COCs)			X (site COCs)		
	2-ft Interval exhibiting visual/olfactory evidence of contamination	Variable Depth above the groundwater interface	X (Site COCs)	X (Site COCs)	X (Site COCs)			X (Site COCs)		
SF-03	Surface sample (0-2 inches)	Surface sample (0-2 inches)	X (site COCs)	X (site COCs)	X (site COCs)			X (site COCs)		
	2-ft interval above the groundwater interface	2-ft interval above the groundwater interface	X (site COCs)	X (site COCs)	X (site COCs)			X (site COCs)		
	2-ft Interval exhibiting visual/olfactory evidence of contamination	Variable Depth above the groundwater interface	X (Site COCs)	X (Site COCs)	X (Site COCs)			X (Site COCs)		
SF-04	Surface sample (0-2 inches)	Surface sample (0-2 inches)	X (site COCs)	X (site COCs)	X (site COCs)			X (site COCs)		
	2-ft interval above the groundwater interface	2-ft interval above the groundwater interface	X (site COCs)	X (site COCs)	X (site COCs)			X (site COCs)		
	2-ft Interval exhibiting visual/olfactory evidence of contamination	Variable Depth above the groundwater interface	X (Site COCs)	X (Site COCs)	X (Site COCs)			X (Site COCs)		
SF-05	Surface sample (0-2 inches)	Surface sample (0-2 inches)	X (site COCs)	X (site COCs)	X (site COCs)			X (site COCs)		
	2-ft interval above the groundwater interface	2-ft interval above the groundwater interface	X (site COCs)	X (site COCs)	X (site COCs)			X (site COCs)		
	2-ft Interval exhibiting visual/olfactory evidence of contamination	Variable Depth above the groundwater interface	X (Site COCs)	X (Site COCs)	X (Site COCs)			X (Site COCs)		
SF-06	Surface sample (0-2 inches)	Surface sample (0-2 inches)	X (site COCs)	X (site COCs)	X (site COCs)			X (site COCs)		
	2-ft interval above the groundwater interface	2-ft interval above the groundwater interface	X (site COCs)	X (site COCs)	X (site COCs)			X (site COCs)		
	2-ft Interval exhibiting visual/olfactory evidence of contamination	Variable Depth above the groundwater interface	X (Site COCs)	X (Site COCs)	X (Site COCs)			X (Site COCs)		
SF-07	Surface sample (0-2 inches)	Surface sample (0-2 inches)	X (site COCs)	X (site COCs)	X (site COCs)			X (site COCs)		
	2-ft interval above the groundwater interface	2-ft interval above the groundwater interface	X (site COCs)	X (site COCs)	X (site COCs)			X (site COCs)		
	2-ft Interval exhibiting visual/olfactory evidence of contamination	Variable Depth above the groundwater interface	X (Site COCs)	X (Site COCs)	X (Site COCs)			X (Site COCs)		

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SF-08	Surface sample (0-2 inches)	Surface sample (0-2 inches)	X (site COCs)	X (site COCs)	X (site COCs)			X (site COCs)		
	2-ft interval above the groundwater interface	2-ft interval above the groundwater interface	X (site COCs)	X (site COCs)	X (site COCs)			X (site COCs)		
	2-ft Interval exhibiting visual/olfactory evidence of contamination	Variable Depth above the groundwater interface	X (Site COCs)	X (Site COCs)	X (Site COCs)			X (Site COCs)		
SF-09	Surface sample (0-2 inches)	Surface sample (0-2 inches)	X (site COCs)	X (site COCs)	X (site COCs)			X (site COCs)		
	2-ft interval above the groundwater interface	2-ft interval above the groundwater interface	X (site COCs)	X (site COCs)	X (site COCs)			X (site COCs)		
	2-ft Interval exhibiting visual/olfactory evidence of contamination	Variable Depth above the groundwater interface	X (Site COCs)	X (Site COCs)	X (Site COCs)			X (Site COCs)		
SF-10	Surface sample (0-2 inches)	Surface sample (0-2 inches)	X (site COCs)	X (site COCs)	X (site COCs)			X (site COCs)		
	2-ft interval above the groundwater interface	2-ft interval above the groundwater interface	X (site COCs)	X (site COCs)	X (site COCs)			X (site COCs)		
	2-ft Interval exhibiting visual/olfactory evidence of contamination	Variable Depth above the groundwater interface	X (Site COCs)	X (Site COCs)	X (Site COCs)			X (Site COCs)		
SF-11	Surface sample (0-2 inches)	Surface sample (0-2 inches)	X (site COCs)	X (site COCs)	X (site COCs)			X (site COCs)		
	2-ft interval above the groundwater interface	2-ft interval above the groundwater interface	X (site COCs)	X (site COCs)	X (site COCs)			X (site COCs)		
	2-ft Interval exhibiting visual/olfactory evidence of contamination	Variable Depth above the groundwater interface	X (Site COCs)	X (Site COCs)	X (Site COCs)			X (Site COCs)		
SF-12	Surface sample (0-2 inches)	Surface sample (0-2 inches)	X (site COCs)	X (site COCs)	X (site COCs)			X (site COCs)		
	2-ft interval above the groundwater interface	2-ft interval above the groundwater interface	X (site COCs)	X (site COCs)	X (site COCs)			X (site COCs)		
	2-ft Interval exhibiting visual/olfactory evidence of contamination	Variable Depth above the groundwater interface	X (Site COCs)	X (Site COCs)	X (Site COCs)			X (Site COCs)		
SF-13	Surface sample (0-2 inches)	Surface sample (0-2 inches)	X (site COCs)	X (site COCs)	X (site COCs)			X (site COCs)		
	2-ft interval above the groundwater interface	2-ft interval above the groundwater interface	X (site COCs)	X (site COCs)	X (site COCs)			X (site COCs)		
	2-ft Interval exhibiting visual/olfactory evidence of contamination	Variable Depth above the groundwater interface	X (Site COCs)	X (Site COCs)	X (Site COCs)			X (Site COCs)		
SF-14	Surface sample (0-2 inches)	Surface sample (0-2 inches)	X (site COCs)	X (site COCs)	X (site COCs)			X (site COCs)		
	2-ft interval above the groundwater interface	2-ft interval above the groundwater interface	X (site COCs)	X (site COCs)	X (site COCs)			X (site COCs)		
	2-ft Interval exhibiting visual/olfactory evidence of contamination	Variable Depth above the groundwater interface	X (Site COCs)	X (Site COCs)	X (Site COCs)			X (Site COCs)		

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SF-15	Surface sample (0-2 inches)	Surface sample (0-2 inches)	X (site COCs)	X (site COCs)	X (site COCs)			X (site COCs)		
	2-ft interval above the groundwater interface	2-ft interval above the groundwater interface	X (site COCs)	X (site COCs)	X (site COCs)			X (site COCs)		
	2-ft Interval exhibiting visual/olfactory evidence of contamination	Variable Depth above the groundwater interface	X (Site COCs)	X (Site COCs)	X (Site COCs)			X (Site COCs)		
SF-16	Surface sample (0-2 inches)	Surface sample (0-2 inches)	X (site COCs)	X (site COCs)	X (site COCs)			X (site COCs)		
	2-ft interval above the groundwater interface	2-ft interval above the groundwater interface	X (site COCs)	X (site COCs)	X (site COCs)			X (site COCs)		
	2-ft Interval exhibiting visual/olfactory evidence of contamination	Variable Depth above the groundwater interface	X (Site COCs)	X (Site COCs)	X (Site COCs)			X (Site COCs)		
SI-01	Surface sample (0-2 inches)	Surface sample (0-2 inches)	X (site COCs)	X (site COCs)	X (site COCs)			X (site COCs)		
	2-ft interval above the groundwater interface	2-ft interval above the groundwater interface	X (site COCs)	X (site COCs)	X (site COCs)			X (site COCs)		
	2-ft Interval exhibiting visual/olfactory evidence of contamination	Variable Depth above the groundwater interface	X (Site COCs)	X (Site COCs)	X (Site COCs)			X (Site COCs)		
SI-02	Surface sample (0-2 inches)	Surface sample (0-2 inches)	X (site COCs)	X (site COCs)	X (site COCs)			X (site COCs)		
	2-ft interval above the groundwater interface	2-ft interval above the groundwater interface	X (site COCs)	X (site COCs)	X (site COCs)			X (site COCs)		
	2-ft Interval exhibiting visual/olfactory evidence of contamination	Variable Depth above the groundwater interface	X (Site COCs)	X (Site COCs)	X (Site COCs)			X (Site COCs)		
SI-03	Surface sample (0-2 inches)	Surface sample (0-2 inches)	X (site COCs)	X (site COCs)	X (site COCs)			X (site COCs)		
	2-ft interval above the groundwater interface	2-ft interval above the groundwater interface	X (site COCs)	X (site COCs)	X (site COCs)			X (site COCs)		
	2-ft Interval exhibiting visual/olfactory evidence of contamination	Variable Depth above the groundwater interface	X (Site COCs)	X (Site COCs)	X (Site COCs)			X (Site COCs)		
SI-04	Surface sample (0-2 inches)	Surface sample (0-2 inches)	X (site COCs)	X (site COCs)	X (site COCs)			X (site COCs)		
	2-ft interval above the groundwater interface	2-ft interval above the groundwater interface	X (site COCs)	X (site COCs)	X (site COCs)			X (site COCs)		
	2-ft Interval exhibiting visual/olfactory evidence of contamination	Variable Depth above the groundwater interface	X (Site COCs)	X (Site COCs)	X (Site COCs)			X (Site COCs)		
SI-05	Surface sample (0-2 inches)	Surface sample (0-2 inches)	X (site COCs)	X (site COCs)	X (site COCs)			X (site COCs)		
	2-ft interval above the groundwater interface	2-ft interval above the groundwater interface	X (site COCs)	X (site COCs)	X (site COCs)			X (site COCs)		
	2-ft Interval exhibiting visual/olfactory evidence of contamination	Variable Depth above the groundwater interface	X (Site COCs)	X (Site COCs)	X (Site COCs)			X (Site COCs)		

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SI-06	Surface sample (0-2 inches)	Surface sample (0-2 inches)	X (site COCs)	X (site COCs)	X (site COCs)			X (site COCs)		
	2-ft interval above the groundwater interface	2-ft interval above the groundwater interface	X (site COCs)	X (site COCs)	X (site COCs)			X (site COCs)		
	2-ft Interval exhibiting visual/olfactory evidence of contamination	Variable Depth above the groundwater interface	X (Site COCs)	X (Site COCs)	X (Site COCs)			X (Site COCs)		
SI-07	Surface sample (0-2 inches)	Surface sample (0-2 inches)	X (site COCs)	X (site COCs)	X (site COCs)			X (site COCs)		
	2-ft interval above the groundwater interface	2-ft interval above the groundwater interface	X (site COCs)	X (site COCs)	X (site COCs)			X (site COCs)		
	2-ft Interval exhibiting visual/olfactory evidence of contamination	Variable Depth above the groundwater interface	X (Site COCs)	X (Site COCs)	X (Site COCs)			X (Site COCs)		
SI-08	Surface sample (0-2 inches)	Surface sample (0-2 inches)	X (site COCs)	X (site COCs)	X (site COCs)			X (site COCs)		
	2-ft interval above the groundwater interface	2-ft interval above the groundwater interface	X (site COCs)	X (site COCs)	X (site COCs)			X (site COCs)		
	2-ft Interval exhibiting visual/olfactory evidence of contamination	Variable Depth above the groundwater interface	X (Site COCs)	X (Site COCs)	X (Site COCs)			X (Site COCs)		
SI-09	Surface sample (0-2 inches)	Surface sample (0-2 inches)	X (site COCs)	X (site COCs)	X (site COCs)			X (site COCs)		
	2-ft interval above the groundwater interface	2-ft interval above the groundwater interface	X (site COCs)	X (site COCs)	X (site COCs)			X (site COCs)		
	2-ft Interval exhibiting visual/olfactory evidence of contamination	Variable Depth above the groundwater interface	X (Site COCs)	X (Site COCs)	X (Site COCs)			X (Site COCs)		
SI-10	Surface sample (0-2 inches)	Surface sample (0-2 inches)	X (site COCs)	X (site COCs)	X (site COCs)			X (site COCs)		
	2-ft interval above the groundwater interface	2-ft interval above the groundwater interface	X (site COCs)	X (site COCs)	X (site COCs)			X (site COCs)		
	2-ft Interval exhibiting visual/olfactory evidence of contamination	Variable Depth above the groundwater interface	X (Site COCs)	X (Site COCs)	X (Site COCs)			X (Site COCs)		
SI-11	Surface sample (0-2 inches)	Surface sample (0-2 inches)	X (site COCs)	X (site COCs)	X (site COCs)			X (site COCs)		
	2-ft interval above the groundwater interface	2-ft interval above the groundwater interface	X (site COCs)	X (site COCs)	X (site COCs)			X (site COCs)		
	2-ft Interval exhibiting visual/olfactory evidence of contamination	Variable Depth above the groundwater interface	X (Site COCs)	X (Site COCs)	X (Site COCs)			X (Site COCs)		
SI-12	Surface sample (0-2 inches)	Surface sample (0-2 inches)	X (site COCs)	X (site COCs)	X (site COCs)			X (site COCs)		
	2-ft interval above the groundwater interface	2-ft interval above the groundwater interface	X (site COCs)	X (site COCs)	X (site COCs)			X (site COCs)		
	2-ft Interval exhibiting visual/olfactory evidence of contamination	Variable Depth above the groundwater interface	X (Site COCs)	X (Site COCs)	X (Site COCs)			X (Site COCs)		

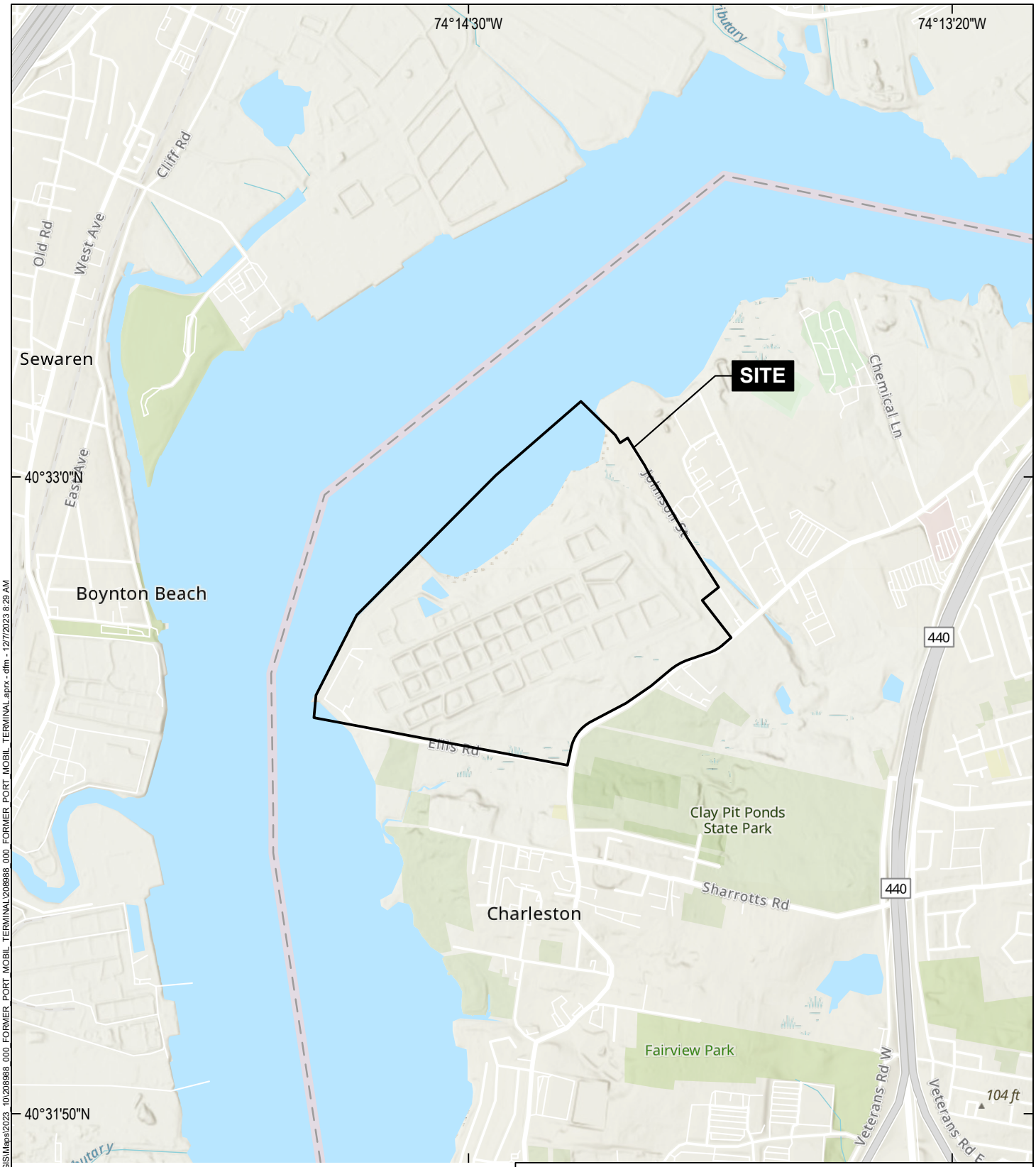
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SI-13	Surface sample (0-2 inches)	Surface sample (0-2 inches)	X (site COCs)	X (site COCs)	X (site COCs)			X (site COCs)		
	2-ft interval above the groundwater interface	2-ft interval above the groundwater interface	X (site COCs)	X (site COCs)	X (site COCs)			X (site COCs)		
	2-ft Interval exhibiting visual/olfactory evidence of contamination	Variable Depth above the groundwater interface	X (Site COCs)	X (Site COCs)	X (Site COCs)			X (Site COCs)		
SI-14	Surface sample (0-2 inches)	Surface sample (0-2 inches)	X (site COCs)	X (site COCs)	X (site COCs)			X (site COCs)		
	2-ft interval above the groundwater interface	2-ft interval above the groundwater interface	X (site COCs)	X (site COCs)	X (site COCs)			X (site COCs)		
	2-ft Interval exhibiting visual/olfactory evidence of contamination	Variable Depth above the groundwater interface	X (Site COCs)	X (Site COCs)	X (Site COCs)			X (Site COCs)		
SI-15	Surface sample (0-2 inches)	Surface sample (0-2 inches)	X (site COCs)	X (site COCs)	X (site COCs)			X (site COCs)		
	2-ft interval above the groundwater interface	2-ft interval above the groundwater interface	X (site COCs)	X (site COCs)	X (site COCs)			X (site COCs)		
	2-ft Interval exhibiting visual/olfactory evidence of contamination	Variable Depth above the groundwater interface	X (Site COCs)	X (Site COCs)	X (Site COCs)			X (Site COCs)		
SI-16	Surface sample (0-2 inches)	Surface sample (0-2 inches)	X (site COCs)	X (site COCs)	X (site COCs)			X (site COCs)		
	2-ft interval above the groundwater interface	2-ft interval above the groundwater interface	X (site COCs)	X (site COCs)	X (site COCs)			X (site COCs)		
	2-ft Interval exhibiting visual/olfactory evidence of contamination	Variable Depth above the groundwater interface	X (Site COCs)	X (Site COCs)	X (Site COCs)			X (Site COCs)		
GROUNDWATER										
MWSF-01	NA	Straddle water table	X	X	X	X	X	X	X	X
MWSF-02	NA	Straddle water table	X	X	X	X	X	X	X	X
MWSF-03	NA	Straddle water table	X	X	X	X	X	X	X	X
MWSF-04	NA	Straddle water table	X	X	X	X	X	X	X	X
MWSI-01	NA	Straddle water table	X	X	X	X	X	X	X	X
MWSI-02	NA	Straddle water table	X	X	X	X	X	X	X	X
MWSI-03	NA	Straddle water table	X	X	X	X	X	X	X	X
MWSI-04	NA	Straddle water table	X	X	X	X	X	X	X	X

Notes:
bgs: below grade surface
ft: feet
MW: Monitoring Well
PCBs: Polychlorinated biphenyls
PFAS: Per- and Polyfluoroalkyl Substances
PID: Photoionization Detector
SF: Solar Farm
SI: Surface Impoundment
SVOCs: Semivolatile Organic Compounds
VOCs: Volatile Organic Compounds

QA/QC samples include:
MS/MSD - 1 for every 20 samples
Trip Blanks - 1 per cooler per day of samples to be analyzed for VOCs
Field Blanks - 1 for every 20 samples
Duplicates - 1 for every 20 samples

FIGURES







MAP SOURCE: ESRI
SITE COORDINATES: 40°32'46"N, 74°14'21"W

HALEY ALDRICH

FORMER PORT MOBIL TERMINAL
STATEN ISLAND, NEWYORK

PROJECT LOCUS

APPROXIMATE SCALE: 1 IN = 2000 FT
SEPTEMBER 2026

FIGURE 1

GIS: \\haleyaldrich.com\share\CF\Projects\0208988\GIS Maps\2023_10\208988_000_FORMER_PORT_MOBIL_TERMINAL\208988_000_FORMER_PORT_MOBIL_TERMINAL_aprx - dfm - 12/7/2023 8:29 AM

ARTHUR KILL

OIL/WATER SEPARATOR

DRAVO BUILDING

MARINE WAREHOUSE AND OFFICE

OFFICE AND GARAGE

23 21 20 22 19 40 42 41 43 60 24/24A

53 54

2 4 6 8 10 12 14 16 18 1 3 5 7 9 11 13 15 17 48

58 59

61 62 44 45 49 50 51 52 55 56 57

LEGEND

- CONTAINMENT BERM
- STRUCTURES
- SURFACE IMPOUNDMENT
- OU-2 WETLAND AREA
- OU-2 AREA
- OU-2 TIDAL FLAT AREA
- PROJECT SITE BOUNDARY

NOTES
1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. ALL AREAS WITHIN THE SITE BOUNDARY, EXCLUDING THE OU-2 WETLANDS WITH ASSOCIATED BUFFERS, THE TIDAL FLAT AREAS, AND TIDAL ADJACENT AREAS, ARE CONSIDERED PART OF OU-1.
3. WETLAND BOUNDARY INCLUDES THE 100-FT WETLAND BUFFER AND TIDAL FLAT AREA BOUNDARY INCLUDES THE 150-FT TIDAL BUFFER.
4. # = TANK NUMBERS REPRESENT FORMER TANK LOCATIONS.
5. AERIAL IMAGERY SOURCE: NEARMAP, OCTOBER 4, 2025

0 450 900
SCALE IN FEET

HALEY ALDRICH

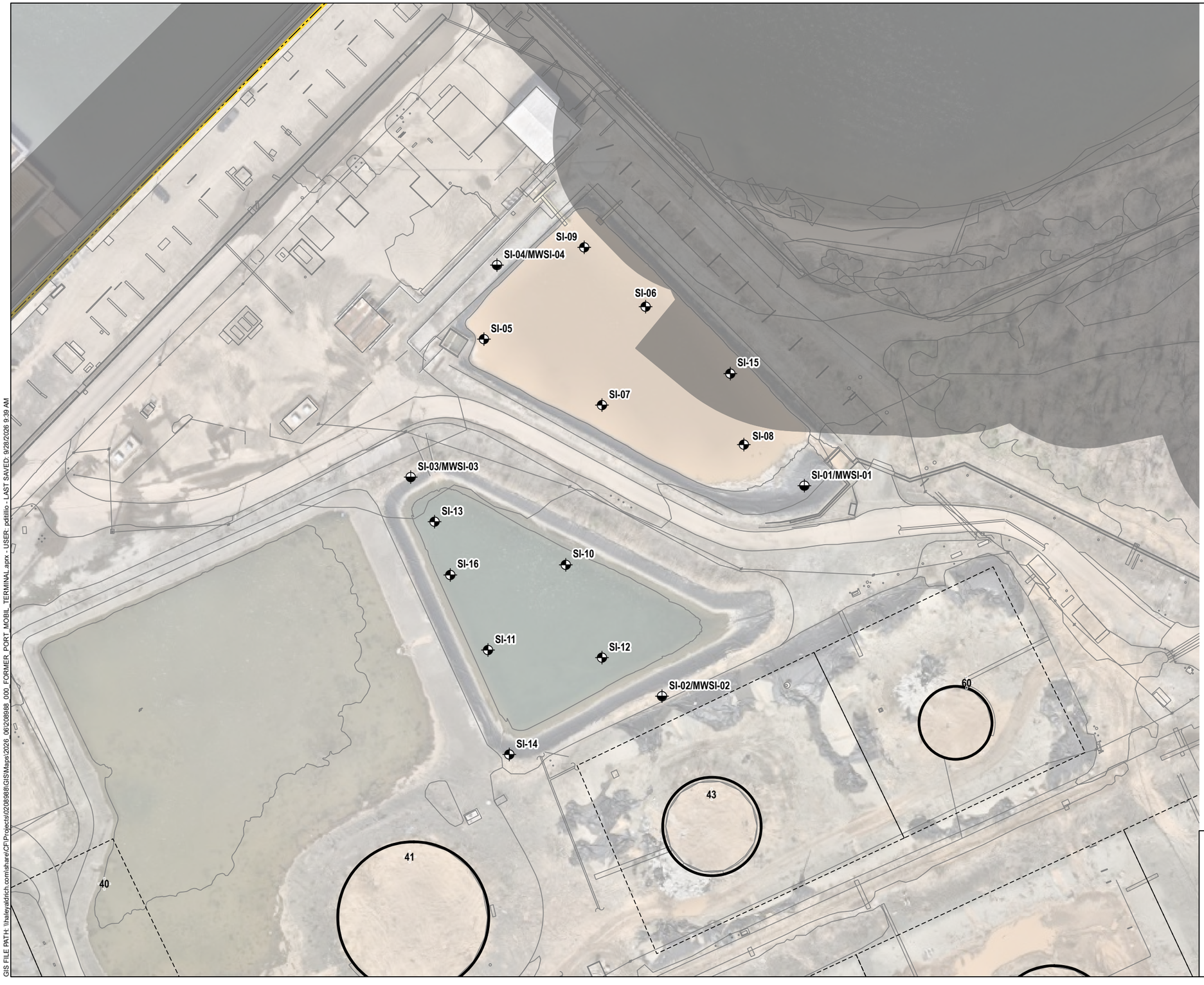
FORMER PORT MOBIL TERMINAL
STATEN ISLAND, NEW YORK

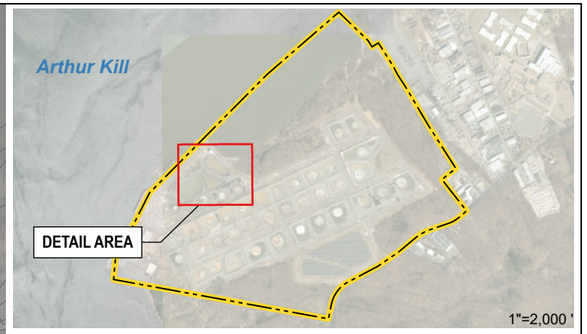
SITE PLAN

SEPTEMBER 2026

FIGURE 2

GIS FILE PATH: \\haleyaldrich.com\share\CF\Projects\0208988\GISMaps\2026_0120888_SOIL_GW_EXCEED_ILUSCO_POWSCO_SiteCOC.aprx - USER: pdilillo - LAST SAVED: 5/6/2026 1:20 PM





SITE MAP

LEGEND

- PROPOSED SOIL BORING
- PROPOSED SOIL BORING/PERMANENT MONITORING WELL
- CONTAINMENT BERM
- OU-2 AREA
- PROJECT SITE BOUNDARY

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. FINAL SURVEY KINDER MORGAN TERMINAL. DATED: MARCH 30, 2022. BOWMAN CONSULTING
3. AERIAL IMAGERY SOURCE: NEARMAP, APRIL 7, 2026

N

0 80 160

SCALE IN FEET

HALEY ALDRICH

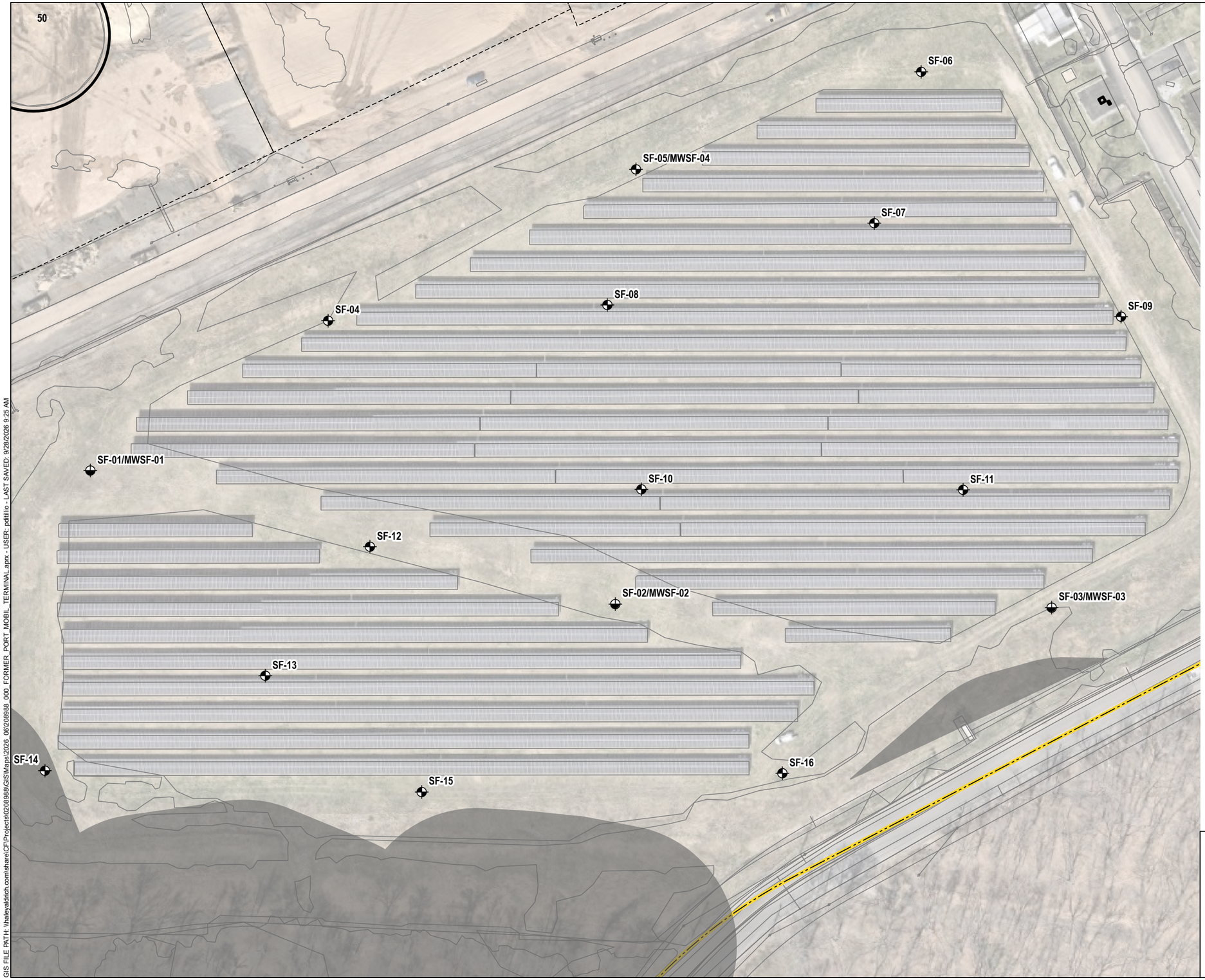
FORMER PORT MOBIL TERMINAL
STATEN ISLAND, NEWYORK

PROPOSED SAMPLE LOCATION PLAN – SURFACE IMPOUNDMENTS

SEPTEMBER 2026

FIGURE 3

GIS FILE PATH: \\haleyaldrich.com\share\CF\Projects\0208988\GIS\Maps\2026_0612089888_000_FORMER_PORT_MOBIL_TERMINAL.aprx - USER: pdilillo - LAST SAVED: 9/28/2026 9:39 AM





SITE MAP

LEGEND

- PROPOSED SOIL BORING
- PROPOSED SOIL BORING/PERMANENT MONITORING WELL
- CONTAINMENT BERM
- PROJECT SITE BOUNDARY

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. ASSESSOR PARCEL DATA SOURCE: ALAMEDA COUNTY
3. FINAL SURVEY KINDER MORGAN TERMINAL. DATED: MARCH 30, 2022. BOWMAN CONSULTING
4. AERIAL IMAGERY SOURCE: NEARMAP, 20 JUNE 2024

N

0 80 160
SCALE IN FEET

HALEY ALDRICH

FORMER PORT MOBIL TERMINAL
STATEN ISLAND, NEWYORK

PROPOSED SAMPLE LOCATION PLAN – SOLAR FARM

SEPTEMBER 2026

FIGURE 4

GIS FILE PATH: \\haleyaldrich.com\share\CF\Projects\02\06988\GIS\Maps\2026_06\206988_000_FORMER_PORT_MOBIL_TERMINAL.aprx - USER: pdilillo - LAST SAVED: 9/28/2026 9:25 AM

Arthur Kill

PRB-A
PRB-B
PRB-C
PRB-D
PRB-01
PRB-02
PRB-03
PRB-04
PRB-05
PRB-06
PRB-07
PRB-08
PRB-09
PRB-10
PRB-11
PRB-12
PRB-13
PRB-14
PRB-15
PRB-16
PRB-17
PRB-E
PRB-F
PRB-G
PRB-H
PRB-I
PRB-J
PRB-K
PRB-L

MARINE WAREHOUSE AND OFFICE

OFFICE AND GARAGE

OIL/WATER SEPARATOR

DRAVO BUILDING

AREA :AST-04

AREA :MW-101

AREA :AST-12

LEGEND

- SOIL BORING/COMPOSITE POINT
- CONTAINMENT BERM
- PERMEABLE REACTIVE BARRIER (PRB) WALL
- APPROXIMATE EXTENT OF LNAPL
- STRUCTURES
- SURFACE IMPOUNDMENT
- OU-2 AREA
- ISS AREA
- PROJECT SITE BOUNDARY

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. PROTECTION OF GROUNDWATER EXCEEDANCES ARE SHOWN FOR THE VADOSE ZONE ONLY.
3. LNAPL = LIGHT NON-AQUEOUS PHASE LIQUID
4. AERIAL IMAGERY SOURCE: NEARMAP, APRIL 9, 2025

0 150 300
SCALE IN FEET

HALEY ALDRICH

FORMER PORT MOBIL TERMINAL
STATEN ISLAND, NEWYORK

PRB WALL CONFIRMATION BORING LOCATION PLAN

SEPTEMBER 2026

FIGURE 5

GIS FILE PATH: \\haleyaldrich.com\share\CF\Projects\0208988\GIS\Maps\2025_04\208988_AA_RAWP_FIGURES.aprx - USER: pdilillo - LAST SAVED: 9/29/2026 4:10 PM

APPENDIX A
Field Sampling Plan

HALEY ALDRICH

www.haleyaldrich.com

FIELD SAMPLING PLAN
FORMER PORT MOBIL TERMINAL
STATEN ISLAND, NEW YORK

by
H & A of New York Engineering and Geology LLP
New York, New York

for
NP Staten Island Industrial, LLC
Kansas City, Missouri

File No. 0208988
September 2026

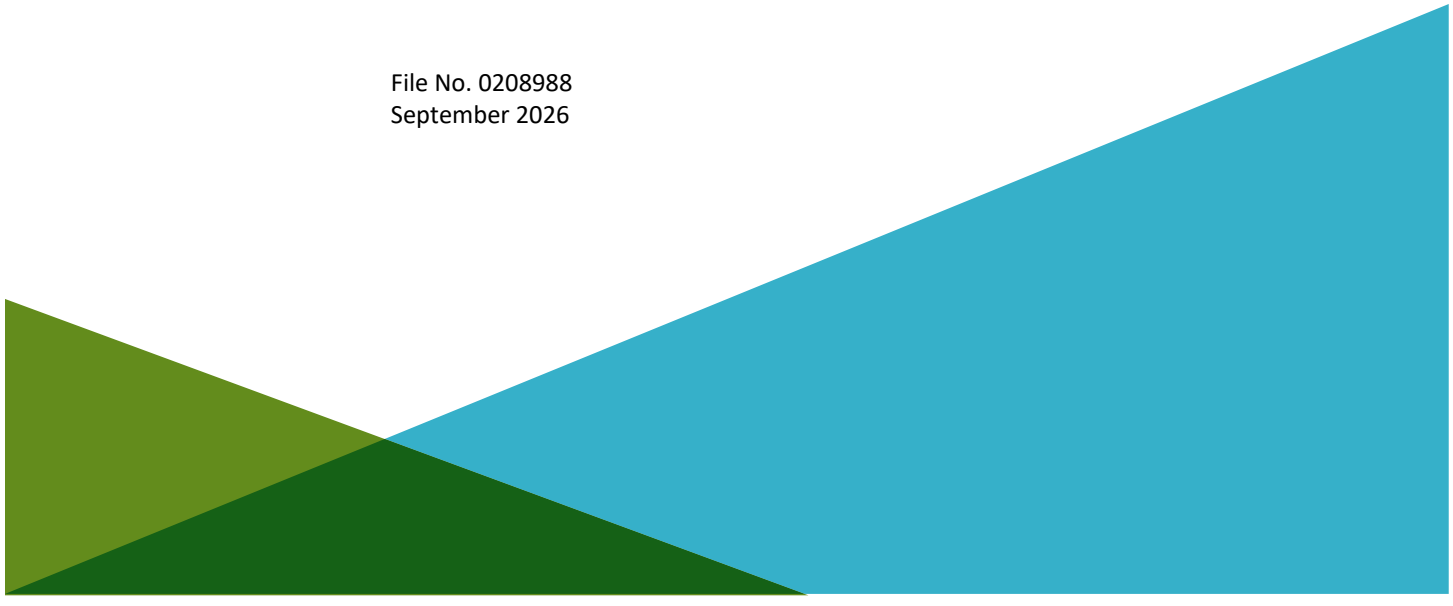


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A	Field Forms

1. Introduction

This Field Sampling Plan (FSP) has been prepared as a component of the Pre-Design Investigation Work Plan (PDIWP) for the subject site located at the Former Port Mobil Terminal in Staten Island, New York (the "Site"). This document was prepared to establish field procedures for field data collection to be performed in support of the PDIWP for the Site.

The PDIWP includes this FSP, a Quality Assurance Project Plan (QAPP), a Health and Safety Plan (HASP), and a Community Air Monitoring Plan (CAMP), which are included as part of this plan by reference.

The standard operating procedures (SOPs) included as components of this plan will provide the procedures necessary to meet the project objectives. The SOPs will be used as reference for the methods to be employed for field sample collection and handling and the management of field data collected in the execution of the approved PDIWP. The SOPs include numerous methods to execute the tasks of the PDIWP. The Project Manager will select the appropriate method as required by field conditions and/or the objective of the respective project task at the time of sample collection. Field procedures will be conducted in general accordance with the New York State Department of Conservation (NYSDEC) Technical Guidance for Site Investigation and Remediation (Division of Environmental Remediation [DER]-10) and the Sampling, Analysis, and Assessment of Per- and Polyfluoroalkyl Substances (PFAS) under the NYSDEC Part 375 Remedial Program when applicable.

2. Field Program

This FSP provides the general purpose of sampling as well as procedural information. The PDIWP contains the details on sampling and analysis (locations, depths, frequency, analyte lists, etc.).

The field program has been designed to acquire the necessary data to comply with the PDIWP, and includes the following tasks:

- Soil sampling;
- Groundwater sampling;
- Sampling of investigation-derived waste (IDW) as needed for disposal.

The purpose of the Pre-Design Investigation (PDI) is to investigate areas previously inaccessible and not investigated during the Remedial Investigation (RI) conducted by Weston Solutions, Inc. of New York (Weston) including the two surface impoundments on the northern portion of the Site and the solar farm on the southern portion of the Site. Soil and groundwater samples are proposed to be collected from the areas of the surface impoundments and the solar farm.

The SOPs presented herein may be changed as required, dependent on Site conditions or equipment limitations, at the time of sample collection. If the procedures employed differ from the SOP, the deviations will be documented in the associated sampling report.

3. Utility Clearance

Invasive remedial activities, such as excavation or remedial construction activities, require the location of underground utilities prior to initiating work. Such clearance is sound practice in that it minimizes the potential for damage to underground facilities, and more importantly, is protective of the health and safety of personnel. Under no circumstances will invasive activities be allowed to proceed without obtaining proper utility clearance from the appropriate public agencies and/or private entities. This clearance requirement applies to all work on both public and private properties, whether located in a dense urban area or a seemingly out-of-the-way rural location.

The drilling contractor performing the work will be responsible for obtaining utility clearance.

Utility clearance is required by law, and obtaining clearance includes contacting a public or private central clearance agency via a "One-Call" telephone service and providing the proposed exploration location information. It is important to note that public utility agencies may not, and usually do not, have information regarding utility locations on private property.

Before beginning subsurface work at any proposed exploration locations, it is critical that all readily available information on underground utilities and structures be obtained. This includes publicly available information as well as information in the possession of private landowners. Any drawings obtained must be reviewed in detail for information pertaining to underground utilities.

Using the information obtained, the Site should be viewed in detail for physical evidence of buried lines or structures, including pavement cuts and patches, variation in or lack of vegetation, variations in grading, etc. Care must also be taken to avoid overhead utilities as well. The presence of surface elements of buried utilities should be documented, such as manholes, gas or water service valves, catch basins, monuments, or other evidence.

Overhead utility lines must be considered when choosing exploration and excavation locations. Most states require a minimum of 10 feet (ft) of clearance between equipment and energized wires. Such separation requirements may also be voltage-based and may vary depending on state or municipality regulations. In evaluating clearance from overhead lines, the same restrictions may apply to "drops," or wires on a utility pole connecting overhead and underground lines.

Using the information obtained and observations made, proposed exploration or construction locations should be marked in the field. Marking locations can be accomplished using spray paint on the ground, stakes, or other means. All markings of proposed locations should be made in white, in accordance with the generally accepted universal color code for facilities identification (American Public Works Association [APWA] 4/99):

- White: Proposed Excavation or Drilling Location
- Pink: Temporary Survey Markings
- Red: Electrical Power Lines, Cables, Conduit, and Lighting Cables
- Yellow: Gas, Oil, Steam, Petroleum, or Gaseous Materials
- Orange: Communication, Alarm or Signal Lines, Cables or Conduits

- Blue: Potable Water
- Purple: Reclaimed Water, Irrigation and Slurry Lines
- Green: Sewers and Drain Lines

In order to effectively evaluate the proposed locations with these entities, detailed, accurate measurements between the proposed locations and existing surface features should be obtained. Such features can be buildings, street intersections, utility poles, guardrails, etc.

Obtaining the utility clearance generally involves the designated "One-Call" underground facilities protection organization for the area, the landowner, and one or both following entities and/or procedures:

- A third-party utility locator company to locate underground utilities outside of the public right-of-way; and/or,
- "Soft dig" excavation techniques to confirm or deny the presence of underground utilities in the area.

The proposed locations should be evaluated in consideration of information available for existing underground facilities. The detailed measurement information described above will be required by the "One-Call" agency. The owners of the applicable, participating underground utilities are obligated to mark their respective facilities at the Site in the colors described above. Utility stake-out activities will typically not commence for approximately 72 hours after the initial request is made.

The public and private utility entities generally only mark the locations of their respective underground facilities within public rights-of-way. Determination of the locations of these facilities on private property will be the responsibility of the property owner or Contractor. If available information does not contain sufficient detail to locate underground facilities with a reasonable amount of confidence, alternate measures may be appropriate, as described below. In some cases, the memory of a long-time employee of a facility on private property may be the best or only source of information. It is incumbent on the Consultant or Contractor to exercise caution and use good judgement when faced with uncertainty.

Note: It is important to note that not all utilities are participants in the "One-Call" agency or process. As such, inquiries must be made with the "One-Call" agency to determine which entities do not participate, so they can be contacted independently.

Most utility stakeouts have a limited time period for which they remain valid, typically two to three weeks. It is critical that this time period be considered to prevent expiration of clearance prior to completion of the invasive activities and the need to repeat the stake-out process.

Care must be exercised to document the receipt of notice from the involved agencies of the presence or absence of utilities in the vicinity of the proposed locations.

Most agencies will generally provide a telephone or fax communication indicating the lack of facilities in the project area. If contact is not made by all of the agencies identified by the "One-Call" process, do not assume that such utilities are not present. Re-contact the "One-Call" agency to determine the status.

For complicated sites with multiple proposed locations and multiple utilities, it is advisable to arrange an on-Site meeting with utility representatives. This will minimize the potential for miscommunication amongst the involved parties.

Completion of the utility stake-out process is not a guarantee that underground facilities will not be encountered in excavations or boreholes; in fact, most "One-Call" agencies and individual utilities do not offer guarantees, nor do they accept liability for damage that might occur. In areas outside the public right-of-way, a utility locating service may be utilized to locate underground utilities. It is advisable that any invasive activities proceed with extreme caution in the upper 4 to 5 ft in the event the clearance has failed to identify an existing facility. This may necessitate hand excavation or probing to confirm the potential presence of shallow utilities. If uncertainty exists for any given utility, extra activities can be initiated to solve utility clearance concerns. These options include:

- Screening the proposed work areas with utility locating devices, and/or hiring a utility locating service to perform this task.
- Hand digging, augering, or probing to expose or reveal shallow utilities and confirm presence and location. In northern climates, this may require advancing to below the frost line, typically at least 4 ft.
- Using "soft dig" techniques that utilize specialized tools and compressed air to excavate soils and locate utilities. This technique is effective in locating utilities to a depth of 4 to 5 ft.

Equipment/Materials:

- White Spray paint;
- Wooden stakes, painted white or containing white flagging;
- Color-code key; and,
- Available drawings.

4. Field Data Recording

This procedure describes the protocol for documenting the investigation activities in the field. Field data serves as the cornerstone for an environmental project, not only for site characterization but for additional phases of investigation or remedial design. Producing defensible data includes proper and appropriate recording of field data as it is obtained in a manner to preserve the information for future use. This procedure provides guidelines for accurate, thorough collection and preservation of written and electronic field data.

Field data to be recorded during the project generally includes, but is not limited to, the following:

- general field observations;
- numeric field measurements and instrument readings;
- quantity estimates;
- sample locations and corresponding sample numbers;
- relevant comments and details pertaining to the samples collected;
- documentation of activities, procedures, and progress achieved;
- contractor pay item quantities;
- weather conditions;
- a listing of personnel involved in Site-related activities;
- a log of conversations, Site meetings, and other communications; and,
- field decisions and pertinent information associated with the decisions.

4.1 Written Field Data

Written field data will be collected using a standardized, pre-printed field log form. In general, use of a field log form is preferable as it prompts field personnel to make appropriate observations and record data in a standardized format. This promotes completeness and consistency from one person to the next. Otherwise, electronic data collection using a handheld device produces equal completeness and consistency using a preformatted log form.

In the absence of an appropriate pre-printed form, the data should be recorded in an organized and structured manner in a dedicated project field log book. Log books must be hardcover, bound so that pages cannot be added or removed, and should be made from high-grade 50 percent rag paper with a water-resistant surface.

The following are guidelines for the use of field log forms and log books:

1. Information must be factual and complete.
2. All entries will be made in black indelible ink with a ballpoint pen and will be written legibly. Do not use “rollerball” or felt-tip-style pens, since the water-soluble ink can run or smear in the presence of moisture.

3. Field log forms should be consecutively numbered.
4. Each day's work must start a new form/page.
5. At the end of each day, the current log book page or forms must be signed and dated by the field personnel making the entries.
6. Make data entries immediately upon obtaining the data. Do not make temporary notes in other locations for later transfer; this only increases the potential for error or loss of data.
7. Entry errors are to be crossed out with a single line and initialed by the person making the correction.
8. Do not leave blanks on log forms, if no entry is applicable for a given data field, indicate so with "NA" or a dash ("--").
9. At the earliest practical time, photocopies or typed versions of log forms and log book pages should be made and placed in the project file as a backup in the event the book or forms are lost or damaged.
10. Log books should be dedicated to one project only, i.e., do not record data from multiple projects in one log book.

4.2 Electronic Data

Electronic data recording involves electronic measurement of field information through the use of monitoring instruments, sensors, gauges, and equipment controls. The following is a list of guidelines for proper recording and management of electronic field data:

1. Field data management should follow requirements of a project-specific data management plan (DMP), if applicable.
2. Use only instruments that have been calibrated in accordance with manufacturer's recommendations.
3. Usage of instruments, controls, and computers for the purpose of obtaining field data should only be performed by personnel properly trained and experienced in the use of the equipment and software.
4. Use only fully licensed software on personal computers and laptops.
5. Loss of electronic files may mean loss of irreplaceable data. Every effort should be made to back up electronic files obtained in the field as soon as practical. A backup file placed on the file server will minimize the potential for loss.
6. Electronic files, once transferred from field instruments or laptops to office computers, should be protected, if possible, to prevent unwanted or inadvertent manipulation or modification of data. Several levels of protection are usually available for spreadsheets, including making a file "read-only" or assigning a password to access the file.
7. Protect CDs from exposure to moisture, excessive heat or cold, magnetic fields, or other potentially damaging conditions.
8. Remote monitoring is often used to obtain stored electronic data from site environmental systems. A thorough discussion of this type of electronic field data recording is beyond the scope of this Section. Such on-site systems are generally capable of storing a limited amount of

data as a comma-delimited or spreadsheet file. Users must remotely access the monitoring equipment files via modem or other access and download the data. In order to minimize the potential for loss of data, access and downloading of data should be performed frequently enough to ensure the data storage capacity of the remote equipment is not exceeded.

Equipment/Materials:

- Appropriate field log forms, or iPad® or equivalent with preformatted log forms;
- Indelible ball point pen (do not use “rollerball” or felt-tip style pens);
- Straight edge;
- Pocket calculator; and,
- Laptop computer (if required).

5. Aquifer Characterization

This procedure describes the measurement of water levels in groundwater monitoring.

A synoptic gauging round will be completed to obtain water levels in monitoring wells. Water levels will be acquired in a manner that provides accurate data that can be used to calculate vertical and horizontal hydraulic gradients and other hydrogeologic parameters. Accuracy in obtaining the measurements is critical to ensure the usability of the data.

5.1 Procedure

In order to provide reliable data, water level monitoring events should be collected over as short a period of time as practical. Barometric pressure can affect groundwater levels, and therefore, observation of significant weather changes during the period of water level measurements must be noted. Rainfall events and groundwater pumping can also affect groundwater level measurements. Personnel collecting water level data must note if any of these controls are in effect during the groundwater level collection period. Due to possible changes during the groundwater level collection period, it is imperative that the time of data collection at each station be accurately recorded. Water levels will also be collected prior to any sample collection that day.

The depth to groundwater will be measured with an electronic depth-indicating probe. Prior to obtaining a measurement, a fixed reference point on the well casing will be established for each well to be measured. Unless otherwise established, the reference point is typically established and marked on the north side of the well casing. Do not use protective casings or flush-mounted road boxes as a reference, due to the potential for damage or settlement. The elevation of the reference point shall be obtained by accepted surveying methods, to the nearest 0.01 ft.

The water level probe will be lowered into the well until the meter indicates (via indicator light or tone) that the water has been reached. The probe will be raised above the water level and slowly lowered again until water is indicated. The cable will be held against the side of the inner protective casing at the point designated for water level measurements, and a depth reading will be taken. This procedure will be followed three times or until a consistent value is obtained. The value will be recorded to the nearest 0.01 ft on the Groundwater Level Monitoring Report form.

Upon completion, the probe will be raised to the surface and, together with the amount of cable that entered the well casing, will be decontaminated in accordance with the methods described in the Equipment Decontamination Procedure.

Equipment/Materials:

- Battery-operated, non-stretch electronic water level probe with permanent markings at 0.01-ft increments, such as the Solinst Model 101 or equivalent.
- The calibrated cable on the depth indicator will be checked against a surveyor's steel tape once per quarter. A new cable will be installed if the cable has changed by more than 0.01 percent (0.01 ft for a 100 ft cable). See also the Field Instruments – Use and Calibration Procedure.
- Groundwater Level Monitoring Report form.

6. Sample Collection for Laboratory Analysis

6.1 SOIL SAMPLE COLLECTION FOR LABORATORY ANALYSIS

The following procedure is an introduction to soil sampling techniques and an outline of field staff responsibilities. All samples will be collected with dedicated sampling equipment.

6.1.1 Preparatory Requirements

Prior to the beginning of any remedial investigation or remedial measures activities, staff must attend a project briefing for the purpose of reviewing the project work plan, Site and utility plans, drawings, applicable regulations, sampling location, depth, and criteria, Site contacts, and other related documents. Health and safety concerns will be documented in a Site-specific HASP.

A file folder for the field activities should be created and maintained such that all relevant documents and log forms likely to be useful for the completion of field activities by others are readily available in the event of personnel changes.

6.1.2 Soil Classification

The stratigraphic log is a factual description of the soil at the borehole location and is relied upon to interpret the soil characteristics and their influence and significance in the subsurface environment. The accuracy of the stratigraphic log is to be verified by the person responsible for interpreting subsurface conditions. An accurate description of the soil stratigraphy is essential for a reasonable understanding of the subsurface conditions. Confirmation of the field description by examination of representative soil samples by the project geologist, hydrogeologist, or geotechnical engineer (whenever practicable) is recommended.

The ability to describe and classify soil correctly is a skill that is learned from a person with experience and by systematic training and comparison of laboratory results to field descriptions.

6.1.2.1 Data Recording

Several methods for classifying and describing soils or unconsolidated sediments are in relatively widespread use. The Unified Soil Classification System (USCS) is the most common. With the USCS, a soil is first classified according to whether it is predominantly coarse-grained or fine-grained.

The description of fill soil is similar to that of natural undisturbed soil except that it is identified as fill and not classified by USCS group, relative density, or consistency. Those logging soils must attempt to distinguish between soils that have been placed (i.e., fill) and not naturally present or soils that have been naturally present but disturbed (i.e., disturbed native).

It is necessary to identify and group soil samples consistently to determine the subsurface pattern or changes and non-conformities in soil stratigraphy in the field at the time of drilling. The stratigraphy in each borehole during drilling is to be compared to the stratigraphy found at the previously completed

boreholes to ensure that patterns or changes in soil stratigraphy are noted and that consistent terminology is used.

Visual examination, physical observations, and manual tests (adapted from ASTM International [ASTM] D2488, visual-manual procedures) are used to classify and group soil samples in the field and are summarized in this subsection. ASTM D2488 should be reviewed for detailed explanations of the procedures. Visual-manual procedures used for soil identification and classification include:

- visual determination of grain size, soil gradation, and percentage fines;
- dry strength, dilatancy, toughness, and plasticity (thread or ribbon test) tests for identification of inorganic fine-grained soil (e.g., CL, CH, ML, or MH); and,
- soil compressive strength and consistency estimates based on thumb indent and pocket penetrometer (preferred) methods.

Soil characteristics like plasticity, strength, and dilatancy should be determined using the H & A of New York Engineering and Geology, LLP (Haley & Aldrich of New York) Soil Identification Field Form.

6.1.2.2 Field Sample Screening

Upon the collection of soil samples, the soil is screened with a photoionization detector (PID) for the presence of organic vapor. This is accomplished by running the PID across the soil sample. The highest reading and sustained readings are recorded.

Note: The PID measurement must be done upwind of the excavating equipment or any running engines so that exhaust fumes will not affect the measurements.

Another method of field screening is headspace measurements. This consists of placing a portion of the soil sample in a sealable glass jar, placing aluminum foil over the jar top, and tightening the lid. Alternatively, plastic sealable bags may be utilized for field screening in lieu of glass containers. The jar should only be partially filled. Shake the jar and set aside for at least 30 minutes. After the sample has equilibrated, the lid of the jar can be opened; the foil is punctured with the PID probe, and the air (headspace) above the soil sample is monitored. This headspace reading on the field form or in the field book is recorded. All headspace measurements must be completed under similar conditions to allow comparability of results. Soil classification and PID readings will be recorded in the daily field report.

Equipment/Materials:

- Pocket knife or small spatula;
- Small handheld lens;
- Stratigraphic Log (Overburden) (Form 2001);
- Tape measure; and,
- When sampling for PFAS, acceptable materials for sampling include stainless steel, high-density polyethylene (HDPE), polyvinyl chloride (PVC), silicone, acetate, and polypropylene.

6.1.3 Soil Sampling

Soil samples will be collected from acetate liners installed by a track-mounted direct-push drill rig (Geoprobe®) or sonic drill rig (as necessary) operated by a licensed operator. Soil samples will be collected using a stainless-steel trowel or sampling spoon into laboratory-provided sample containers. If it is necessary to relocate any proposed sampling location due to terrain, utilities, access, etc., the Project Manager must be notified, and an alternate location will be selected.

Prior to use and between each sampling location at an environmental site, the sampling equipment must be decontaminated. All decontamination must be conducted in accordance with the project-specific plans or the methods presented in SOP 7.0.

6.1.4 Sampling Techniques

The following procedure describes typical soil sample collection methods for submission of samples to a laboratory for chemical analysis. The primary goal of soil sampling is to collect representative samples for examination and chemical analysis (if required).

Environmental soil samples obtained for chemical analyses are collected with special attention given to the rationale behind determining the precise zone to sample, the specifics of the method of soil extraction, and the requisite decontamination procedures. Preservation, handling, and glassware for environmental soil samples vary considerably depending upon several factors, including the analytical method to be conducted and the analytical laboratory being used.

Soil sampling for PFAS will be performed in accordance with NYSDEC, DER, Sampling, Analysis, and Assessment of PFAS under NYSDEC Part 375 Remedial Program (April 2023).

6.1.4.1 Grab Versus Composite Samples

A grab sample is collected to identify and quantify conditions at a specific location or interval. The sample is comprised of the minimum amount of soil necessary to make up the volume of the sample dictated by the required sample analyses. Composite samples may be obtained from several locations or along a linear trend (in a test pit or excavation). Sampling may occur within or across stratification.

6.2 GROUNDWATER SAMPLE COLLECTION FOR LABORATORY ANALYSIS

The following section describes two techniques for groundwater sampling: "Low-Stress/Low-Flow Methods" and "Typical Sampling Methods."

"Low-Stress/Low-Flow" methods will be employed when collecting groundwater samples for the evaluation of volatile constituents (i.e., dissolved oxygen [DO]) or in fine-grained formations where sediment/colloid transport is possible. Analyses typically sensitive to colloidal transport issues include polychlorinated biphenyls (PCBs), polyaromatic hydrocarbons (PAHs), and metals.

The "Typical Sampling Methods" will be employed where the collection of parameters less sensitive to turbidity/sediment issues are being collected (general chemistry, pesticides, and other semi-volatile organic compounds [SVOCs]).

NOTE: If non-aqueous phase liquids (NAPL) (light or dense) are detected in a monitoring well, groundwater sample collection will not be conducted, and the Project Manager must be contacted to determine a course of action.

6.2.1 Preparatory Requirements

- Verify well identification and location using borehole log details and location layout figures. Note the condition of the well and record any necessary repair work required.
- Prior to opening the well cap, measure the breathing space above the well casing with a handheld organic vapor analyzer to establish baseline breathing space volatile organic compound (VOC) levels. Repeat this measurement once the well cap is opened. If either of these measurements exceeds the air quality criteria in the HASP, field personnel should adjust their personal protective equipment (PPE) accordingly.
- Prior to commencing the groundwater purging/sampling, a water level must be obtained to determine the well volume for hydraulic purposes. In some settings, it may be necessary to allow the water level time to equilibrate. This condition exists if a watertight seal exists at the well cap and the water level has fluctuated above the top of screen, creating a vacuum or pressurized area in this air space. Three water level checks will verify static water level conditions have been achieved.
- Calculate the volume of water in the well. Typically, overburden well volumes consider only the quantity of water standing in the well screen and riser; bedrock well volumes are calculated on the quantity of water within the open core hole and within the overburden casing.

6.2.2 Well Development

Well development is completed to remove fine-grained materials from the well but in such a manner as to not introduce fines from the formation into the sand pack. Well development continues until the well responds to water level changes in the formation (i.e., a good hydraulic connection is established between the well and formation) and the well produces clear, sediment-free water to the extent practical.

- Attach appropriate pump and lower tubing into well.
- Gauge well and calculate one well volume. Turn on pump. If well runs dry, shut off pump and allow to recover.
- Surging will be performed by raising and lowering the pump several times to pull fine-grained material from the well. Periodically measure turbidity level using a La Motte turbidity reader.
- The second and third steps will be repeated until turbidity is less than 50 nephelometric turbidity units (NTU) or when 10 well volumes have been removed.
- All water generated during cleaning and development procedures will be collected and contained on the Site in 55-gallon drums for future analysis and appropriate disposal.

Equipment:

- Appropriate health and safety equipment;
- Knife;

- Power source (generator);
- Field book ;
- Well Development Form (Form 3006);
- Well keys;
- Graduated pails;
- Pump and tubing;
- Cleaning supplies (including non-phosphate soap, buckets, brushes, laboratory-supplied distilled/deionized water, tap water, cleaning solvent, aluminum foil, plastic sheeting, etc.); and,
- Water level meter.

6.2.3 Well Purging and Stabilization Monitoring (Low-Stress/Low-Flow Method)

The preferred method for groundwater sampling will be the low-stress/low-flow method described below.

- Slowly lower the pump, safety cable, tubing, and electrical lines into the well to the depth specified by the project requirements. The pump intake must be at the midpoint of the well screen to prevent disturbance and resuspension of any sediment in the screen base.
- Before starting the pump, measure the water level again with the pump in the well leaving the water level measuring device in the well when completed.
- Purge the well at 100 to a maximum of 500 milliliters per minute (mL/min). During purging, the water level should be monitored approximately every five minutes, or as appropriate. A steady flow rate should be maintained that results in drawdown of 0.3 ft or less. The rate of pumping should not exceed the natural flow rate conditions of the well. Care should be taken to maintain pump suction and to avoid entrainment of air in the tubing. Record adjustments made to the pumping rates and water levels immediately after each adjustment.
- During the purging of the well, monitor and record the field indicator parameters (pH, temperature, conductivity, oxidation-reduction [redox] reaction potential [ORP], DO, and turbidity) approximately every five minutes. Stabilization is considered to be achieved when the final groundwater flow rate is achieved, and three consecutive readings for each parameter are within the following limits:
  - pH: 0.1 pH units of the average value of the three readings;
  - Temperature: 3 percent of the average value of the three readings;
  - Conductivity: 0.005 milliSiemen per centimeter (mS/cm) of the average value of the three readings for conductivity less than 1 mS/cm and 0.01 mS/cm of the average value of the three readings for conductivity greater than 1 mS/cm;
  - ORP: 10 millivolts (mV) of the average value of the three readings;
  - DO: 10 percent of the average value of the three readings; and
  - Turbidity: 10 percent of the average value of the three readings, or a final value of less than 50 NTU.
- The pump must not be removed from the well between purging and sampling.

6.2.4 Sampling Techniques

- If an alternate pump is utilized, the first pump discharge volumes should be discarded to allow the equipment a period of acclimation to the groundwater.
- Samples are collected directly from the pump with the groundwater being discharged directly into the appropriate sample container. Avoid handling the interior of the bottle or bottle cap and don new gloves for each well sampled to avoid contamination of the sample.
- Order of sample collection:
  - PFAS
  - VOCs
  - 1,4-dioxane
  - SVOCs
  - Total Analyte List (TAL) metals
  - PCBs, pesticides, and herbicides
- No sampling equipment components or sample containers should come in contact with aluminum foil, low-density polyethylene, glass, or polytetrafluoroethylene (PTFE, Teflon™) materials including plumber's tape and sample bottle cap liners with a PTFE layer.
- For low-stress/low-flow sampling, samples should be collected at a flow rate between 100 and 500 mL/min and such that drawdown of the water level within the well does not exceed the maximum allowable drawdown of 0.3 ft.
- The pumping rate used to collect a sample for VOC should not exceed 100 mL/min. Samples should be transferred directly to the final container of 40 mL glass vials completely full and topped with a Teflon™ cap. Once capped, the vial must be inverted and tapped to check for headspace/air presence (bubbles). If air is present, the sample will be discarded and recollected until free of air.
- Groundwater sampling for PFAS will be performed in accordance with NYSDEC, DER, Sampling, Analysis, and Assessment of PFAS under NYSDEC Part 375 Remedial Program (April 2023)
- All samples must be labeled with:
  - A unique sample number
  - Date and time
  - Parameters to be analyzed
  - Project Reference ID
  - Sampler's initials
- Labels should be written in indelible ink and secured to the bottle with clear tape.

Equipment/Materials:

- pH meter, conductivity meter, DO meter, ORP meter, nephelometer, temperature gauge;
- Field filtration units (if required);
- Purging/sampling equipment;

  - Peristaltic Pump;
- Water level probe;
- Sampling materials (containers, log book/forms, coolers, chain of custody);
- Work Plan;
- HASP; and,
- When sampling for PFAS, acceptable materials for sampling include stainless steel, HDPE, PVC, silicone, acetate, and polypropylene.

Note: Peristaltic pump use for VOC collection is not acceptable on NYSDEC/ U.S. Environmental Protection Agency (EPA)/ Resource Conservation and Recovery Act (RCRA) sites; this technique has gained acceptance in select areas where it is permissible to collect VOCs using a peristaltic pump at a low flow rate (e.g., Michigan).

Note: 1,4-dioxane and PFAS purge and sample techniques will be conducted following the NYSDEC guidance documents. Acceptable groundwater pumps include a stainless-steel inertia pump with HDPE tubing, a peristaltic pump equipped with HDPE tubing and silicone tubing, a stainless steel bailer with a stainless-steel ball or bladder pump (identified as PFAS-free) with HDPE tubing.

Field Notes:

- Field notes must document all the events, equipment used, and measurements collected during the sampling activities. Section 2.0 describes the data/recording procedure for field activities.
- The log book should document the following for each well sampled:
  - Identification of well;
  - Well depth;
  - Static water level depth and measurement technique;
  - Sounded well depth;
  - Presence of immiscible layers and detection/collection method;
  - Well yield – high or low;
  - Purge volume and pumping rate;
  - Time well purged;
  - Measured field parameters;
  - Purge/sampling device used;
  - Well sampling sequence;
  - Sampling appearance;
  - Sample odors;
  - Sample volume;
  - Types of sample containers and sample identification;
  - Preservative(s) used;
  - Parameters requested for analysis;
  - Field analysis data and method(s);

- Sample distribution and transporter;
- Laboratory shipped to;
- Chain of custody number for shipment to laboratory;
- Field observations on sampling event;
- Name collector(s);
- Climatic conditions including air temperature; and,
- Problems encountered and any deviations made from the established sampling protocol.

A standard log form for documentation and reporting groundwater purging and sampling events is presented on the Groundwater Sampling Record, Low Flow Groundwater Sampling Form, and Low Flow Monitored Natural Attenuation (MNA) Field Sampling Form. Refer to Appendix A for example field forms.

Groundwater/Decontamination Fluid Disposal:

- Groundwater disposal methods will vary on a case-by-case basis but may range from:
  - Off-Site treatment at private treatment/disposal facilities or public-owned treatment facilities
  - On-Site treatment
  - Direct discharge to the surrounding ground surface, allowing groundwater infiltration to the underlying subsurface regime
- Decontamination fluids should be segregated and collected separately from wash waters/groundwater containers.

6.3 SAMPLE HANDLING AND SHIPPING

Sample management is the continuous care given to each sample from the point of collection to receipt at the analytical laboratory. Good sample management ensures that samples are properly recorded, properly labeled, and not lost, broken, or exposed to conditions that may affect the sample's integrity.

All sample submissions must be accompanied by a chain of custody document to record sample collection and submission. Personnel performing sampling tasks must check the sample preparation and preservation requirements to ensure compliance with the QAPP.

The following sections provide the minimum standards for sample management.

6.3.1 Sample Handling

Prior to entering the field area where sampling is to be conducted, especially at sites with defined exclusion zones, the sampler should ensure that all materials necessary to complete the sampling are on hand. If samples must be maintained at a specified temperature after collection, dedicated coolers and ice must be available for use. Conversely, when sampling in cold weather, proper protection of water samples, trip blanks, and field blanks must be considered. Sample preservation will involve pH adjustment, cooling to 4 degrees Celsius, and sample filtration and preservation.

6.3.2 Sample Labeling

Samples must be properly labeled immediately upon collection.

Note that the data shown on the sample label is the minimum data required. The sample label data requirements are listed below for clarity.

- Project name
- Sample name/number/unique identifier
- Sampler's initials
- Date of sample collection
- Time of sample collection
- Analysis required
- Preservatives

To ensure that samples are not confused, a clear notation should be made on the container with a permanent marker. If the containers are too soiled for marking, the container can be put into a "zip lock" bag which can then be labeled.

All sample names will be as follows:

- Sample unique identifier: Enter the sample name or number. There should be no slashes, spaces, or periods in the date.
- Date: Enter the six-digit date when the sample was collected. Note that for one-digit days, months, and/or years, add zeros so that the format is MMDDYY (050210). There should be no slashes, dashes, or periods in the date.

The QA/QC samples will be numbered consecutively as collected with a sample name, date, and number of samples collected throughout the day (i.e., when multiple QA/QC samples are collected in one day).

Examples of this naming convention are as follows:

Sample Name:	Comments
TB-050202-0001	TRIP BLANK
TB-050202-0002	TRIP BLANK
FD-050202-0001	FIELD DUPLICATE
FD-050202-0002	FIELD DUPLICATE

NOTE: The QA/QC Sample number resets to 0001 EACH DAY, this will avoid having to look back to the previous day for the correct sequential number.

6.3.3 Field Code

The field code will be written in the "Comments" field on the chain of custody for every sample but will not be a part of the actual sample name. Enter the one/two-character code for the type of sample (must be in capitals):

N	Normal Field Sample
FD	Field Duplicate (note sample number [i.e., 0001] substituted for time)
TB	Trip Blank (note sample number [i.e., 0001] substituted for time)
EB	Equipment Blank (note sample number [i.e., 0001] substituted for time)
FB	Field Blank (note sample number [i.e., 0001] substituted for time)
KD	Known Duplicate
FS	Field Spike Sample
MS	Matrix Spike Sample (note on "Comments" field of chain of custody – laboratory to spike matrix)
MD	Matrix Spike Duplicate Sample (note on "Comments" field of chain of custody – laboratory to spike matrix
RM	Reference Material

The sample labeling – both chain and sample bottles must be exactly as detailed above. In addition, the Field Sample Key for each sample collected must be filled out.

6.3.4 Packaging

Sample container preparation and packing for shipment should be completed in a well-organized and clean area, free of any potential cross-contamination. The following is a list of standard guidelines which must be followed when packing samples for shipment.

- Double bag ice in "Zip Lock" bags.
- Double check to ensure trip and temperature blanks have been included for all shipments containing VOCs, or where otherwise specified in the QAPP.
- Enclose the chain of custody form in a "Zip Lock" bag.
- Ensure custody seals (two, minimum) are placed on each cooler. Coolers with hinged lids should have both seals placed on the opening edge of the lid. Coolers with "free" lids should have seals placed on opposite diagonal corners of the lid. Place clear tape over custody seals.
- Containers should be wiped clean of all debris/water using paper towels (paper towels must be disposed of with other contaminated materials).
- Clear, wide packing tape should be placed over the sample label for protection.
- Do not bulk pack. Each sample must be individually padded.
- Large glass containers (1 liter and up) require much more space between containers.
- Ice is not a packing material due to the reduction in volume when it melts.

Note: Never store sterile sample containers in enclosures containing equipment which use any form of fuel or volatile petroleum-based product. When conducting sampling in freezing conditions at sites without a heated storage area (free of potential cross-contaminants), unused trip blanks should be

isolated from coolers immediately after receipt. Trip blanks should be double bagged and kept from freezing.

6.3.5 Chain of Custody Records

Chain of custody forms will be completed for all samples collected. The form documents the transfer of sample containers. The chain of custody record, completed at the time of sampling, will contain, but not be limited to, the sample number, date and time of sampling, and the name of the sampler. The chain of custody document will be signed and dated by the sampler when transferring the samples.

Each sample cooler being shipped to the laboratory will contain a chain of custody form. The cooler will be sealed properly for shipment. The laboratory will maintain a copy for their records. One copy will be returned with the data deliverables package.

The following list provides guidance for the completion and handling of all chains of custody:

- Chains of custody used should be a Haley & Aldrich of New York standard form or supplied by the analytical laboratory.
- Chains of custody must be completed in black ball point ink only.
- Chains of custody must be completed neatly using printed text.
- If a simple mistake is made, cross out the error with a single line and initial and date the correction.
- Each separate sample entry must be sequentially numbered.
- If numerous repetitive entries must be made in the same column, place a continuous vertical arrow between the first entry and the next different entry.
- When more than one chain of custody form is used for a single shipment, each form must be consecutively numbered using the "Page ___ of ___" format.
- If necessary, place additional instructions directly onto the chain of custody in the Comment Section. Do not enclose separate instructions.
- Include a contact name and phone number on the chain of custody in case there is a problem with the shipment.
- Before using an acronym on a chain of custody, define clearly the full interpretation of your designation (i.e., PCBs).

6.3.6 Shipment

Prior to the start of the field sampling, the carrier should be contacted to determine if pickup will be at the field Site location. If pick-up is not available at the Site, the nearest pick-up or drop-off location should be determined. Sample shipments must not be left at unsecured drop locations.

Copies of all shipment manifests must be maintained in the field file.

7. Field Instruments – Use and Calibration

A significant number of field activities involve the usage of electronic instruments to monitor environmental conditions and for health and safety purposes. It is imperative the instruments are used and maintained properly to optimize their performance and minimize the potential for inaccuracies in the data obtained. This section provides guidance on the usage, maintenance, and calibration of electronic field equipment.

- All monitoring equipment will be in proper working order and operated in accordance with manufacturer's recommendations.
- Field personnel will be responsible for ensuring that the equipment is maintained and calibrated in the field in accordance with manufacturer's recommendations.
- Instruments will be operated only by personnel trained in the proper usage and calibration.
- Personnel must be aware of the range of conditions, such as temperature and humidity for instrument operation. Usage of instruments in conditions outside these ranges will only proceed with approval of the Project Manager and/or Health and Safety Officer as appropriate.
- Instruments that contain radioactive source material, such as x-ray fluorescence (XRF) analyzers or moisture-density gauges require specific transportation, handling, and usage procedures that are generally associated with a license from the Nuclear Regulatory Commission (NRC) or an NRC-Agreement State. Under no circumstance will the operation of such instruments be allowed on the Site unless by properly authorized and trained personnel, using the proper personal dosimetry badges or monitoring instruments.

7.1 GENERAL PROCEDURE DISCUSSION

Care must be taken to minimize the potential for transfer of contaminated materials to the ground or onto other materials. Regardless of the size or nature of the equipment being decontaminated, the process will utilize a series of steps that involve the removal of gross material (dirt, grease, oil, etc.), washing with a detergent, and multiple rinsing steps. In lieu of a series of washes and rinse steps, steam cleaning with low-volume, high-pressure equipment (i.e., steam cleaner) is acceptable.

Exploration equipment, and all monitoring equipment in contact with the sampling media must be decontaminated prior to initiating Site activities, in between exploration locations to minimize cross-contamination, and prior to mobilizing off Site after completion of Site work.

The following specific decontamination procedure is recommended for sampling equipment and tools:

- Brush loose soil off equipment;
- Wash equipment with laboratory-grade detergent (i.e., Alconox or equivalent);
- Rinse with tap water;
- Rinse equipment with distilled water;
- Allow water to evaporate before reusing equipment; and,
- Wrap equipment in aluminum foil when not being used.

7.2 DECONTAMINATION OF MONITORING EQUIPMENT

Because monitoring equipment is difficult to decontaminate, care should be exercised to prevent contamination. Sensitive monitoring instruments should be protected when they are at risk of exposure to contaminants. This may include enclosing them in plastic bags, allowing an opening for the sample intake. Ventilation ports should not be covered.

If contamination does occur, decontamination of the equipment will be required; however, immersion in decontamination fluids is not possible. As such, care must be taken to wipe the instruments down with detergent-wetted wipes or sponges, and then with de-ionized water-wetted wipes or sponges.

7.3 DISPOSAL OF WASH SOLUTIONS AND CONTAMINATED EQUIPMENT

All contaminated wash water, rinses, solids, and materials used in the decontamination process that cannot be effectively decontaminated (such as polyethylene sheeting) will be containerized and disposed of in accordance with applicable regulations. All containers will be labeled with an indelible marker as to contents and date of placement in the container, and any appropriate stickers required (such as PCBs). Storage of decontamination wastes on the Site will not exceed 90 days under any circumstances.

Equipment/Materials:

Decontamination equipment and solutions are generally selected based on ease of decontamination and disposability.

- Polyethylene sheeting;
- Metal racks to hold equipment;
- Soft-bristle scrub brushes or long-handle brushes for removing gross contamination and scrubbing with wash solutions;
- Large, galvanized wash tubs, stock tanks, or wading pools for wash and rinse solutions;
- Plastic buckets or garden sprayers for rinse solutions;
- Large plastic garbage cans or other similar containers lined with plastic bags can be used to store contaminated clothing;
- Contaminated liquids and solids should be segregated and containerized in New York State Department of Transportation (NYSDOT)-approved plastic or metal drums, appropriate for off-Site shipping/disposal if necessary.

8. Investigation-Derived Waste (IDW) Disposal

8.1 RATIONALE/ASSUMPTIONS

This procedure applies to the disposition of IDW, including soils and/or groundwater. IDW is dealt with using the following "Best Management Practices" and is not considered a listed waste due to the lack of generator knowledge concerning the chemical source, chemical origin, and timing of chemical introduction to the subsurface.

Consequently, waste sampling and characterization are performed to determine if the wastes exhibit a characteristic of hazardous waste. The disposal of soil cuttings, test pit soils, and/or purged groundwater will be reviewed on a case-by-case basis prior to initiation of field activities. Two scenarios typically exist:

- When no information is available in the area of activity or investigation, and impacted media/soils are identified. Activities such as new construction and /or maintenance below grade may encounter environmental conditions that were unknown.
- Disposal Required/Containerization Required – When sufficient Site information regarding the investigative Site conditions warrants that all materials handled will be contained and disposed of.

If a known listed hazardous and/or characteristically hazardous waste/contaminated environmental media is being handled, then handling must be performed in accordance with RCRA Subtitle C (reference 2, Part V, Section 1[a],[b],[c]).

The following outlines the waste characterization procedures to be employed when IDW disposal is required.

The following procedure describes the techniques for the characterization of IDW for disposal purposes. IDW may consist of soil cuttings (augering, boring, well installation soils, test pit soils), rock core or rock flour (from coring, reaming operations), groundwater (from well development, purging, and sampling activities), decontamination fluids, PPE, and disposal equipment (DE).

8.2 PROCEDURE

The procedures for handling and characterization of field activity-generated wastes are:

A.) Soil Cuttings - Soils removed from boring activities will be contained within an approved container, suitable for transportation and disposal.

- Once placed into the approved container, any free liquids (i.e., groundwater) will be removed for disposal as waste fluids or solidified within the approved container using a solidification agent such as Speedy Dri (or equivalent).
- Contained soils will be screened for the presence of VOCs using a PID; this data will be logged for future reference.
- Once screened, full, and closed; the container will be labeled and placed into the container storage area. At a minimum, the following information will be shown on each container

label: date of filling/generation, Site name, source of soils (i.e., borehole or well), and contact.

- Prior to container closure, representative samples from the containers will be collected for waste characterization purposes and submitted to the project laboratory.
- Typically, at a location where an undetermined Site-specific parameter group exists, sampling and analysis may consist of the full RCRA Waste Characterization (ignitability, corrosivity, reactivity, toxicity), or a subset of the above based upon data collected, historical information, and generator knowledge.

B.) Groundwater - purging, and sampling groundwater, which requires disposal, will be contained.

- Containment may be performed in 55-gallon drums, tanks suitable for temporary storage (i.e., Nalgene tanks 500 to 1,000 gallons) or if large volumes of groundwater are anticipated, a tanker trailer (5,000 to 10,000 gallons ±), or drilling "Frac" tanks may be utilized (20,000 gallons ±). In all cases, the container/tank used for groundwater storage must be clean before use such that cross-contamination does not occur.

C.) Decontamination Waters/Decontamination Fluids - Decontamination waters and/or fluids will be segregated, contained, and disposed of accordingly.

- Decontamination waters may be disposed of with the containerized groundwater once analytical results have been acquired.

D.) PPE/DE – A number of disposal options exist for spent PPE/DE generated from investigation tasks. The options typically employed are:

- Immediately disposed of within on-Site dumpster/municipal trash; or
- If known to be contaminated with RCRA hazardous waste, dispose off-Site at an RCRA Subtitle C facility.
- Spent Solvent/Acid Rinses - The need for sampling must be determined in consultation with the waste management organization handling the materials. If known that only the solvent and/or acids are present, then direct disposal/treatment using media-specific options may be possible without sampling (i.e., incineration).
- PPE/DE – Typically not sampled and included with the disposal of the solid wastes.

Equipment/Materials:

- Sample spoons, trier, auger;
- Sample mixing bowl;
- Sampling bailer, or pump;
- Sample glassware.

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APPENDIX A
Field Forms

EQUIPMENT CALIBRATION LOG

Project: _____

Location: _____

Model Name: _____

Model Number: _____ **Serial Number:** _____

Cal. Standards: _____

_____

_____

Instruments will be calibrated in accordance with manufacturer's recommendations at least once per day.

Date	Time	Calibration Satandard Solution	Calibration Result	Calibrated by

Other Comments: _____

_____

_____

_____

_____

_____

_____

_____

Groundwater Field Sampling Form

Location:

Job Number: _____
Well ID: _____
Field Sampling Crew: _____

Date: _____
Start Time: _____
Finished Time: _____

Initial Depth to Water: _____
Well Depth: _____
Depth to top of screen: _____
Depth to bottom of screen: _____
Depth of Pump Intake: _____

Purging Device: _____
Tubing present in well? _____
Tubing type: _____

Time Elapsed (24 hour)	Depth to Water (from casing)	Pump Setting (ml/min or gal/min)	Purge Rate (ml/min or gal/min)	Cumulative Purge Volume (liters or gallons)	Temperature (degrees Celsius)	pH	Conductivity us/cm	Dissolved Oxygen (mg/L)	Turbidity (NTU)	ORP/eH (mv)	Comments

Comments:

HALEY ALDRICH

SAMPLE IDENTIFICATION KEY

Page of

PROJECT _____ **H&A FILE NO.** _____

LOCATION _____ **PROJECT MGR.** _____

CLIENT _____

CONTRACTOR _____

Sample ID	Parent Sample ID	Location ID	Sample Date	Sample Time (military)	Sample Type Code	Filtered (Water Only T/D/N)	Composite Y/N	Soil Type	Depth To Top Of Sample	Depth To Bottom Of Sample	C.O.C. Number	Notes	Collected By

Notes:

Common Sample Type Codes:

N Normal Environmental Samp	WG Groundwater	WS Surface Water	SO Soil	GS Soil Gas	SE Sediment
WQ Water for Quality Control	FD Field Duplicate	EB Equipment Blank	TB Trip Blank	MS Matris Spike	MSD Matrix Spike Duplicate

see Memorandum dated 08/08/05 from Melanie Satanek "Sample Labeling for Submission to Analytical Laboratory" for less common codes

DAILY FIELD REPORT

Page of

Project		Report No.	
Location		Date	
Client		Page	of
Contractor		File No.	
Weather		Temperature	

Field Representative(s)	Time on site	Report/Travel/Other	Total hours

Distribution:

Haley & Aldrich, Inc.

GEOPROBE BORING REPORT

BORING NO.

Page 1 of

PROJECT
LOCATION
CLIENT
CONTRACTOR
DRILLER

PROJECT MGR.
FIELD REP.
DATE STARTED
DATE FINISHED

Elevation ft. Datum

Boring Location

Item	Casing	Sampler	Core Barrel
Type			
Inside Diameter (in.)			
Hammer Weight (lb.)			
Hammer Fall (in.)			

Rig Make & Model

☐ Truck ☐ Tripod ☐ Cat-Head
☐ ATV ☐ Geoprobe ☐ Winch
☐ Track ☐ Air Track ☐ Roller Bit
☐ Skid ☐ _____ ☐ Cutting Head

Hammer Type: ☐ Safety ☐ Doughnut ☐ Automatic

Drilling Mud: ☐ Bentonite ☐ Polymer ☐ None

Casing Advance: Type Method Depth

Drilling Notes:

Depth (ft.)	Casing Blows	Sampler Blows per 6 in.	Sample No. & Recovery (in.)	Sample Depth (ft)	Elev./ Depth (ft)	Visual-Manual Identification & Description (density/consistency, color, GROUP NAME & SYMBOL, maximum particle size*, structure, odor, moisture, optional descriptions, geologic interpretation)

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth in feet to: Bottom of Casing	Bottom of Hole	Water
Date					

Sample ID

O Open End Rod
T Thin Wall Tube
U Undisturbed Sample
S Split Spoon Sample
G Geoprobe

Summary

Overburden (Linear ft.) _____
Rock Cored (Linear ft.) _____
Number of Samples _____

BORING NO.

*NOTE: Maximum Particle Size is determined by direct observation within the limitations of sampler size.

NOTE: Soil descriptions based on a modified Burmister method of visual-manual identification

Form #3000

APPENDIX B
Quality Assurance Project Plan

HALEY ALDRICH

www.haleyaldrich.com

QUALITY ASSURANCE PROJECT PLAN
FORMER PORT MOBIL TERMINAL
STATEN ISLAND, NEW YORK

by
H & A of New York Engineering and Geology, LLP
New York, New York

for
NP Staten Island Industrial, LLC
Kansas City, Missouri

File No. 0208988
September 2026

Executive Summary

This Quality Assurance Project Plan outlines the scope of the quality assurance and quality control activities associated with the Site sampling activities associated with the Pre-Design Investigation Work Plan for the property located at the Former Port Mobil Terminal in Staten Island, New York (Site).

Protocols for sample collection, sample handling and storage, chain of custody procedures, and laboratory and field analyses are described herein or specifically referenced to related project documents.

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1. Project Description

This Quality Assurance Project Plan (QAPP) has been prepared as a component of the Pre-Design Investigation Work Plan (PDIWP) for the property located at the Former Port Mobil Terminal in Staten Island, New York (Site).

1.1 PROJECT OBJECTIVES

The primary objective for data collection activities is to collect sufficient data necessary to characterize the subsurface conditions at the Site and determine the nature and extent of contamination.

1.2 SITE DESCRIPTION AND HISTORY

The general Site description and Site history are provided in the Site Description and History Summary that accompanies the PDIWP.

1.3 LABORATORY PARAMETERS

The laboratory parameters for soil include:

- Target Compound List (TCL) volatile organic compounds (VOCs) using U.S. Environmental Protection Agency (EPA) Method 8260B;
- TCL semi-volatile organic compounds (SVOCs) using EPA Method 8270C;
- Total Analyte List (TAL) Metals using EPA Method 6010;
- TCL Pesticides using EPA Method 8081B;
- Polychlorinated biphenyls (PCBs) using EPA Method 8082;
- Per- and polyfluoroalkyl substances (PFAS) using EPA Method 1633; and,
- 1,4-dioxane using EPA method 8270.

The laboratory parameters for groundwater include:

- TCL VOCs using EPA Method 8260B;
- TCL SVOCs using EPA Method 8270C;
- Total Metals using EPA Methods 6010/7471;
- Dissolved Metals using EPA Methods 6010/7471;
- PCBs using EPA Method 8082;
- Pesticides by EPA Method 8081B;
- PFAS using EPA Method 1633; and,
- 1,4-dioxane using EPA Method 8270 SIM.

Note: PFAS will be collected in accordance with the New York State Department of Environmental Conservation (NYSDEC), Division of Environmental Remediation (DER), Sampling, Analysis and

Assessment of Per- and Polyfluoroalkyl Substances under NYSDEC Part 375 Remedial Program, April 2023.

During the collection of groundwater samples, pH, specific conductivity, temperature, dissolved oxygen (DO), and oxidation-reduction potential (ORP) will be measured until stabilized.

1.4 SAMPLING LOCATIONS

The PDIWP provides the locations of soil borings and groundwater monitoring wells that will be sampled (as applicable).

2. Project Organization and Responsibilities

This section defines the roles and responsibilities of the individuals who will perform the PDIWP monitoring activities. A New York State Department of Health (NYSDOH)-certified analytical laboratory will perform the analyses of environmental samples collected at the Site.

2.1 PROJECT TEAM

The following project personnel are anticipated for oversight of the PDIWP implementation. Project team resumes are included in Attachment A.

NYSDEC Case Manager	Rafi Alam
NYSDOH Case Manager	Stephen Lawrence
Qualified Environmental Professional (QEP)	Suzanne Bell, P.E.
Project Manager	Sarah Commisso
Haley & Aldrich of New York* Health & Safety Director	Brian Fitzpatrick, CHMM
Health & Safety Officer	Brian Ferguson
Quality Assurance Officer	Michael Boland
Third-Party Validator	Katherine Miller

**H & A of New York Engineering and Geology, LLP (Haley & Aldrich of New York)*

2.2 MANAGEMENT RESPONSIBILITIES

The Project Manager is responsible for managing the implementation of the PDIWP and monitoring and coordinating the collection of data. The Project Manager is responsible for technical quality control (QC) and project oversight. The Project Manager's responsibilities include the following:

- Acquire and apply technical and corporate resources as needed to ensure performance within budget and schedule restraints;
- Review work performed to ensure quality, responsiveness, and timeliness;
- Communicate with the client point of contact concerning the progress of the monitoring activities;
- Assure corrective actions are taken for deficiencies cited during audits of PDIWP monitoring activities; and,
- Assure compliance with the Site health and safety plan (HASP).

2.3 QUALITY ASSURANCE RESPONSIBILITIES

The Quality Assurance (QA) team will consist of a QA Officer and the Data Validation Staff. QA responsibilities are described as follows.

2.3.1 Quality Assurance Officer

The QA Officer reports directly to the Project Manager and will be responsible for overseeing the review of field and laboratory data. Additional responsibilities include the following:

- Assure the application and effectiveness of the QAPP by the analytical laboratory and the project staff;
- Provide input to the Project Manager as to corrective actions that may be required as a result of the above-mentioned evaluations; and,
- Prepare and/or review data validation and audit reports.

The QA Officer will be assisted by the Data Validation Staff in the evaluation and validation of field and laboratory-generated data.

2.3.2 Data Validation Staff

The Data Validation Staff will be independent of the laboratory and familiar with the analytical procedures performed. The validation will include a review of each validation criterion as prescribed by the guidelines presented in Section 9.2 of this document and be presented in a Data Usability Summary Report (DUSR) for submittal to the QA Officer.

2.4 LABORATORY RESPONSIBILITIES

The Environmental Laboratory Approval Program (ELAP)-approved laboratory to be used will be Alpha Analytical Inc. (Alpha), located in Westborough, Massachusetts. Laboratory services in support of the PDIWP monitoring include the following personnel.

2.4.1 Laboratory Project Manager

The Laboratory Project Manager will report directly to the QA Officer and Project Manager and will be responsible for ensuring all resources of the laboratory are available on an as-required basis. The Laboratory Project Manager will also be responsible for the approval of the final analytical reports.

2.4.2 Laboratory Operations Manager

The Laboratory Operations Manager will report to the Laboratory Project Manager and will be responsible for coordinating laboratory analysis, supervising in-house chain of custody reports, scheduling sample analyses, overseeing data review, and overseeing the preparation of analytical reports.

2.4.3 Laboratory QA Officer

The Laboratory QA Officer will have sole responsibility for the review and validation of the analytical laboratory data. The Laboratory QA Officer will provide Case Narrative descriptions of any data quality issues encountered during the analyses conducted by the laboratory. The QA Officer will also define appropriate QA procedures and oversee QA/QC documentation.

2.4.4 Laboratory Sample Custodian

The Laboratory Sample Custodian will report to the Laboratory Operations Manager and will be responsible for the following:

- Receive and inspect the incoming sample containers;
- Record the condition of the incoming sample containers;
- Sign appropriate documents;
- Verify chain of custody and its correctness;
- Notify the Project Manager and Operations Manager of sample receipt and inspection;
- Assign a unique identification number and enter each into the sample receiving log;
- Initiate transfer of samples to laboratory analytical sections; and,
- Control and monitor access/storage of samples and extracts.

2.4.5 Laboratory Technical Personnel

The Laboratory Technical Personnel will have the primary responsibility for the performance of sample analysis and the execution of the QA procedures developed to determine the data quality. These activities will include the proper preparation and analysis of the project samples in accordance with the laboratory's Quality Assurance Manual (QAM) and associated Standard Operating Procedures (SOPs).

2.5 FIELD RESPONSIBILITIES

2.5.1 Field Coordinator

The Field Coordinator is responsible for the overall operation of the field team and reports directly to the Project Manager. The Field Coordinator works with the project Health and Safety Officer (HSO) to conduct operations in compliance with the project HASP. The Field Coordinator will facilitate communication and coordinate efforts between the Project Manager and the field team members.

Other responsibilities include the following:

- Develop and implement field-related work plans, ensuring schedule compliance, and adhering to management-developed project requirements;
- Coordinate and manage field staff;
- Perform field system audits;
- Oversee QC for technical data provided by the field staff;
- Prepare and approve text and graphics required for field team efforts;
- Coordinate and oversee technical efforts of subcontractors assisting the field team;
- Identify problems in the field, resolve difficulties in consultation with the Project QA Officer and Project Manager, and implement and document corrective action procedures; and,
- Participate in preparation of the final reports.

2.5.2 Field Team Personnel

Field Team Personnel will be responsible for the following:

- Perform field activities as detailed in the PDIWP and in compliance with the Field Sampling Plan (FSP; Appendix A of the PDIWP) and QAPP.
- Immediately report any accidents and/or unsafe conditions to the Site HSO and take reasonable precautions to prevent injury.

3. Sampling Procedures

The FSP in Appendix A of the PDIWP provides the SOPs for sampling required by the PDIWP. Sampling will be conducted in general accordance with the NYSDEC Technical Guidance for Site Investigation and Remediation (DER-10) and the Sampling, Analysis, and Assessment of PFAS under NYSDEC Part 375 Remedial Program (April 2023) when applicable. Proposed sample locations are shown on Figure 2 of the PDIWP.

3.1 SAMPLE CONTAINERS

Sample containers for each sampling task will be provided by the laboratory performing the analysis. The containers will be cleaned by the manufacturer to meet or exceed the analyte specifications established in the EPA's "Specifications and Guidance for Obtaining Contaminant-Free Sample Containers," April 1992, OSWER Directive #9240.0-0.5A. Certificates of analysis for each lot of sample containers used will be maintained by the laboratory.

The appropriate sample containers, preservation method, maximum holding times, and handling requirements for each sampling task are provided in Table I.

3.2 SAMPLE LABELING

Each sample will be labeled with a unique sample identifier that will facilitate tracking and cross-referencing of sample information. Field blanks and field duplicate samples also will be numbered with a unique sample identifier to prevent analytical bias of field QC samples.

Refer to the FSP (Appendix A of the PDIWP) for the sample labeling procedures.

3.3 FIELD QC SAMPLE COLLECTION

3.3.1 Field Duplicate Sample Collection

3.3.1.1 Water Samples

Field duplicate samples will be collected by filling the first sample container to the proper level and sealing and then repeating for the second set of sample containers.

1. The samples are properly labeled as specified in Section 3.2.
2. Steps 1 through 4 are repeated for the bottles for each analysis. The samples are collected in order of decreasing analyte volatility as detailed in Section 3.3.1.
3. Chain of custody documents are executed.
4. The samples will be handled as specified in Table I.

3.3.1.2 Soil Samples

Soil field duplicates will be collected as specified in the following procedure:

1. Soils will be sampled directly from acetate liners.
2. Soil for VOC analysis will be removed from the sampling device as specified in the FSP provided as Appendix A of the PDIWP.
3. Soil for non-VOC analysis will be removed from the sampling device and collected into clean laboratory-provided containers.

3.4 GENERAL DECONTAMINATION PROCEDURES

Care must be taken to minimize the potential for the transfer of contaminated materials to the ground or onto other materials. Regardless of the size or nature of the equipment being decontaminated, the process will utilize a series of steps that involve removal of gross material (dirt, grease, oil, etc.), washing with a detergent, and multiple rinsing steps. In lieu of a series of wash and rinse steps, steam cleaning with low-volume, high-pressure equipment (i.e., steam cleaner) is acceptable.

Exploration equipment, and all monitoring equipment in contact with the sampling media, must be decontaminated prior to initiating Site activities, in between exploration locations to minimize cross-contamination, and prior to mobilizing off the Site after completion of Site work.

The following specific decontamination procedure is recommended for sampling equipment and tools:

- Brush loose soil off equipment;
- Wash equipment with laboratory-grade detergent (i.e., Alconox or equivalent);
- Rinse with tap water;
- Rinse equipment with distilled water;
- Allow water to evaporate before reusing equipment; and,
- Wrap equipment in aluminum foil when not being used.

4. Custody Procedures

Sample custody is addressed in three parts: field sample collection, laboratory analysis, and final project files. Custody of a sample begins when it is collected by or transferred to an individual and ends when that individual relinquishes or disposes of the sample.

A sample is under custody if:

1. The item is in actual possession of a person;
2. The item is in the view of the person after being in actual possession of the person;
3. The item was in actual possession and subsequently stored to prevent tampering; or,
4. The item is in a designated and identified secure area.

4.1 FIELD CUSTODY PROCEDURES

Field personnel will keep written records of field activities on applicable pre-printed field forms or in a bound field notebook to record data-collecting activities. These records will be written legibly in ink and will contain pertinent field data and observations. Entry errors or changes will be crossed out with a single line, dated, and initialed by the person making the correction. Field forms and notebooks will be periodically reviewed by the Field Coordinator.

The beginning of each entry in the logbook or preprinted field form will contain the following information:

- Date;
- Start time;
- Weather;
- Names of field personnel (including subcontractors);
- Level of personal protection used at the Site; and,
- Names of all visitors and the purpose of their visit.

For each measurement and sample collected, the following information will be recorded:

- Detailed description of sample location;
- Equipment used to collect the sample or make the measurement, and the date equipment was calibrated;
- Time sample was collected;
- Description of the sample conditions;
- Depth sample was collected (if applicable);
- Volume and number of containers filled with the sample; and,
- Sampler's identification.

4.1.1 Field Procedures

The following procedure describes the process to maintain the integrity of the samples:

- Upon collection, samples are placed in the proper containers. In general, samples collected for organic analysis will be placed in pre-cleaned glass containers and samples collected for inorganic analysis will be placed in pre-cleaned plastic (polyethylene) bottles. Refer to the FSP in Appendix A of the PDIWP for sample packaging procedures.
- Samples will be assigned a unique sample number and will be affixed to a sample label. Refer to the FSP in Appendix A of the PDIWP for sample labeling procedures.
- Samples will be properly and appropriately preserved by field personnel in order to minimize loss of the constituent(s) of interest due to physical, chemical, or biological mechanisms.
- Appropriate volumes will be collected to ensure that the appropriate reporting limits can be successfully achieved and that the required QC sample analyses can be performed.

4.1.2 Transfer of Custody and Shipment Procedures

- A chain of custody record will be completed at the time of sample collection and will accompany each shipment of project samples to the laboratory. The field personnel collecting the samples will be responsible for the custody of the samples until the samples are relinquished to the laboratory. Sample transfer will require the individuals relinquishing and receiving the samples to sign, date, and note the time of sample transfer on the chain of custody record.
- Samples will be shipped or delivered in a timely fashion to the laboratory so that holding times and/or analysis times as prescribed by the methodology can be met.
- Samples will be transported in containers (coolers) which will maintain the refrigeration temperature for those parameters for which refrigeration is required in the prescribed preservation protocols.
- Samples will be placed in an upright position and limited to one layer of samples per cooler. Additional bubble wrap or packaging material will be added to fill the cooler. Shipping containers will be secured with strapping tape and custody tape for shipment to the laboratory.
- When samples are split with the NYSDEC representatives, a separate chain of custody will be prepared and marked to indicate with whom the samples are shared. The person relinquishing the samples will require the representative's signature acknowledging sample receipt.
- If samples are sent by a commercial carrier, a bill of lading will be used. A copy of the bill of lading will be retained as part of the permanent record. Commercial carriers will not sign the custody record as long as the custody record is sealed inside the sample cooler and the custody tape remains intact.
- Samples will be picked up by a laboratory courier or transported to the laboratory the same day they are collected unless collected on a weekend or holiday. In these cases, the samples will be stored in a secure location until delivery to the laboratory. Additional ice will be added to the cooler as needed to maintain proper preservation temperatures.

4.2 LABORATORY CHAIN OF CUSTODY PROCEDURES

A Sample Custodian will be designated by the laboratory and will have the responsibility of receiving all incoming samples. Once received, the Custodian will document if the sample is received in good condition (i.e., unbroken, cooled, etc.) and that the associated paperwork, such as chain of custody forms, has been completed. The Custodian will sign the chain of custody forms.

The Custodian will also document if sufficient sample volume has been received to complete the analytical program. The Sample Custodian will then place the samples into secure, limited-access storage (refrigerated storage, if required). The Sample Custodian will assign a unique number to each incoming sample for use in the laboratory. The unique number will then be entered into the sample-receiving log with the verified time and date of receipt also noted.

Consistent with the analyses requested on the chain of custody form, analyses by the laboratory's analysts will begin in accordance with the appropriate methodologies. Samples will be removed from secure storage with internal chain of custody sign-out procedures followed.

4.3 STORAGE OF SAMPLES

Empty sample bottles will be returned to secure and limited-access storage after the available volume has been consumed by the analysis. Upon completion of the entire analytical work effort, samples will be disposed of by the Sample Custodian. The length of time that samples are held will be at least 30 days after reports have been submitted. Disposal of remaining samples will be completed in compliance with all federal, state, and local requirements.

4.4 Final Project Files Custody Procedures

The final project files will be the central repository for all documents with information relevant to sampling and analysis activities as described in this QAPP. The Haley & Aldrich of New York Project Manager will be the custodian of the project file. The project files, including all relevant records, reports, logs, field notebooks, pictures, subcontractor reports, and data reviews, will be maintained in a secured, limited-access area and under the custody of the Project Director or his designee.

The final project file will include the following:

- Project plans and drawings;
- Field data records;
- Sample identification documents and soil boring/monitoring well logs;
- All chain of custody documentation;
- Correspondence;
- References, literature;
- Laboratory data deliverables;
- Data validation and assessment reports;
- Progress reports, QA reports; and,

- A final report.

The laboratory will be responsible for maintaining analytical log books, laboratory data, and sample chain of custody documents. Raw laboratory data files and copies of hard copy reports will be inventoried and maintained by the laboratory for a period of six years, at which time the laboratory will contact the Haley & Aldrich of New York Project Manager regarding the disposition of the project-related files.

5. Calibration Procedures and Frequency

5.1 FIELD INSTRUMENT CALIBRATION PROCEDURES

Several field instruments will be used for both on-Site screening of samples and for health and safety monitoring, as described in the HASP. On-Site air monitoring for health and safety purposes may be accomplished using a vapor detection device, such as a photoionization detector (PID).

Field instruments will be calibrated at the beginning of each day and checked during field activities to verify performance. Instrument-specific calibration procedures will be performed in accordance with the instrument manufacturer's requirements.

5.2 LABORATORY INSTRUMENT CALIBRATION PROCEDURES

Reference materials of known purity and quality will be utilized for the analysis of environmental samples. The laboratory will carefully monitor the preparation and use of reference materials, including solutions, standards, and reagents, through well-documented procedures.

All solid chemicals and acids/bases used by the laboratory will be rated as "reagent grade" or better. All gases will be "high" purity or better. All Standard Reference Materials (SRMs) or Performance Evaluation (PE) materials will be obtained from approved vendors of the National Institute of Standards and Technology (NIST; formerly National Bureau of Standards), the EPA Environmental Monitoring Support Laboratories (EMSL), or reliable Cooperative Research and Development Agreement (CRADA)-certified commercial sources.

6. Analytical Procedures

Analytical procedures to be utilized for the analysis of environmental samples will be based on referenced EPA analytical protocols and/or project-specific SOP.

6.1 FIELD ANALYTICAL PROCEDURES

Field analytical procedures include the measurement of pH, temperature, ORP, DO, and specific conductivity during sampling of groundwater, and the qualitative measurement of VOC during the collection of soil samples.

6.2 LABORATORY ANALYTICAL PROCEDURES

Laboratory analyses will be based on the EPA methodology requirements promulgated in:

- "Test Methods for Evaluating Solid Waste," SW-846 EPA, Office of Solid Waste, and promulgated updates, 1986.

6.2.1 List of Project Target Compounds and Laboratory Detection Limits

The method detection limits (MDLs) studies are performed by the laboratories in accordance with the procedures established in the Code of Federal Register, Title 40, Part 136.

Laboratory parameters for soil samples are listed in the PDIWP. Laboratory parameters for disposal samples will be determined by the disposal facility after an approved facility has been determined.

6.2.2 List of Method-Specific QC Criteria

The laboratory SOPs include a section that presents the minimum QC requirements for the project analyses. Section 7.0 references the frequency of the associated QC samples for each sampling effort and matrix.

7. Internal QC Checks

This section presents the internal QC checks that will be employed for field and laboratory measurements.

7.1 FIELD QC

7.1.1 Field Blanks

Internal QC checks will include analysis of field blanks to validate equipment cleanliness. Whenever possible, dedicated equipment will be employed to reduce the possibility of cross-contamination of samples.

7.1.2 Trip Blanks

Trip blank samples will be prepared by the project laboratory using ASTM International (ASTM) Type II or equivalent water placed within pre-cleaned 40-milliliter (mL) VOC vials equipped with Teflon septa. Trip blanks will accompany each sample delivery group (SDG) of environmental samples collected for analysis of VOCs.

Trip blank samples will be placed in each cooler that stores and transports project samples that are to be analyzed for VOCs.

7.2 LABORATORY PROCEDURES

Procedures that contribute to the maintenance of overall laboratory QA/QC include appropriately cleaned sample containers, proper sample identification and logging, applicable sample preservation, storage, analysis within prescribed holding times, and use of controlled materials.

7.2.1 Field Duplicate Samples

The precision or reproducibility of the data generated will be monitored through the use of field duplicate samples. Field duplicate analysis will be performed at a frequency of one in 20 project samples.

Precision will be measured in terms of the absolute value of the relative percent difference (RPD) as expressed by the following equation:

$$RPD = [|R1-R2|/[(R1+R2)/2]] \; X \; 100\%$$

Acceptance criteria for duplicate analyses performed on solid matrices will be 100 percent and aqueous matrices will be 35 percent (or the absolute difference rule was satisfied if detects were less than five times the reporting limit [RL]). RPD values outside these limits will require an evaluation of the sampling and/or analysis procedures by the project QA Officer and/or laboratory QA Director. Corrective actions may include re-analysis of additional sample aliquots and/or qualification of the data for use.

7.2.2 Matrix Spike Samples

Ten percent of each project sample matrix for each analytical method performed will be spiked with known concentrations of the specific target compounds/analytes.

The amount of the compound recovered from the sample compared to the amount added will be expressed as a percent recovery. The percent recovery of an analyte is an indication of the accuracy of an analysis within the site-specific sample matrix. Percent recovery will be calculated for matrix spike and matrix spike duplicate (MS/MSD) samples using the following equation.

$$\%\ Recovery = \frac{Spiked\ Sample - Background}{Known\ Value\ of\ Spike} x100\%$$

If the QC value falls outside the control limits (upper control limit [UCL] or lower control limit [LCL]) due to sample matrix effects, the results will be reported with appropriate data qualifiers. To determine the effect a non-compliant MS recovery has on the reported results, the recovery data will be evaluated as part of the validation process.

7.2.3 Laboratory Control Sample (LCS) Analyses

The laboratory will perform LCS analyses prepared from SRMs. The SRMs will be supplied from an independent manufacturer and traceable to NIST materials with known concentrations of each target analyte to be determined by the analytical methods performed. In cases where an independently supplied SRM is not available, the LCS may be prepared by the laboratory from a reagent lot other than that used for instrument calibration.

The laboratory will evaluate LCS analyses in terms of percent recovery using the most recent laboratory-generated control limits.

LCS recoveries that do not meet acceptance criteria will be deemed invalid. Analysis of project samples will cease until an acceptable LCS analysis has been performed. If sample analysis is performed in association with an out-of-control LCS sample analysis, the data will be deemed invalid.

Corrective actions will be initiated by the Haley & Aldrich of New York QA Officer and/or Laboratory QA Officer to investigate the problem. After the problem has been identified and corrected, the solution will be noted in the instrument run log book and re-analysis of project samples will be performed, if possible.

The analytical anomaly will be noted in the SDG Case Narrative and reviewed by the Data Validator. The Data Validator will confirm that appropriate corrective actions were implemented and recommend the applicable use of the affected data.

7.2.4 Surrogate Compound/Internal Standard Recoveries

For VOCs, surrogates will be added to each sample prior to analysis to establish purge and trap efficiency. Quantitation will be accomplished via internal standardization techniques.

The recovery of surrogate compounds and internal standards will be monitored by laboratory personnel to assess possible Site-specific matrix effects on instrument performance.

For SVOC analyses, surrogates will be added to the raw sample to assess extraction efficiency. Internal standards will be added to all sample extracts and instrument calibration standards immediately before analysis for quantitation via internal standardization techniques.

Method-specific QC limits are provided in the attached laboratory method SOPs. Surrogate compound/internal standard recoveries that do not fall within accepted QC limits for the analytical methodology performed will have the analytical results flagged with data qualifiers as appropriate by the laboratory and will not be noted in the laboratory report Case Narrative.

To ascertain the effect non-compliant surrogate compound/internal standard recoveries may have on the reported results, the recovery data will be evaluated as part of the validation process. The Data Validator will provide recommendations for corrective actions, including but not limited to additional data qualification.

7.2.5 Calibration Verification (CV) Standards

CV standards will be utilized to confirm instrument calibrations and performance throughout the analytical process. CV standards will be prepared as prescribed by the respective analytical protocols. Continuing calibration will be verified by compliance with method-specific criteria prior to additional analysis of project samples.

Non-compliant analysis of CV standards will require immediate corrective action by the project laboratory QA Officer and/or designated personnel. Corrective action may include a re-analysis of each affected project sample, a detailed description of the problem, the corrective action undertaken, the person who performed the action, and the resolution of the problem.

7.2.6 Laboratory Method Blank Analyses

Method blank sample analysis will be performed as part of each analytical batch for each methodology performed. If target compounds are detected in the method blank samples, the reported results will be flagged by the laboratory in accordance with SOPs. The Data Validator will provide recommendations for corrective actions, including but not limited to additional data qualification.

8. Data Quality Objectives (DQOs)

Sampling that will be performed as described in the PDIWP is designed to produce data of the quality necessary to achieve the minimum standard requirements of the field and laboratory analytical objectives described below. These data are being obtained with the primary objective of assessing levels of contaminants of concern associated with the Site.

The overall project DQO is to implement procedures for field data collection, sample collection, handling, laboratory analysis, and reporting that achieve the project objectives. The following section is a general discussion of the criteria that will be used to measure the achievement of the project DQO.

8.1 PRECISION

8.1.1 Definition

Precision is defined as a quantitative measure of the degree to which two or more measurements are in agreement. Precision will be determined by collecting and analyzing field duplicate samples and by creating and analyzing laboratory duplicates from one or more of the field samples. The overall precision of measurement data is a mixture of sampling and analytical factors. The analytical results from the field duplicate samples will provide data on sampling precision. The results from duplicate samples created by the laboratory will provide data on analytical precision. The measurement of precision will be stated in terms of RPD. RPD is defined as the absolute difference of duplicate measurements divided by the mean of these analyses normalized to a percentage.

8.1.2 Field Precision Sample Objectives

Field precision will be assessed through the collection and measurement of field duplicate samples at a rate of one duplicate per 20 investigative samples. The RPD criteria for the project field duplicate samples will be +/- 100 percent for soil and +/- 35 percent for groundwater for parameters of analysis detected at concentrations greater than five times the laboratory RL.

8.1.3 Laboratory Precision Sample Objectives

Laboratory precision will be assessed through the analysis of LCS and laboratory control duplicate samples (LCDS), including MS/MSD samples for groundwater and soil samples.

8.2 ACCURACY

8.2.1 Definition

Accuracy relates to the bias in a measurement system. Bias is the difference between the observed and the "true" value. Sources of error are the sampling process, field contamination, preservation techniques, sample handling, sample matrix, sample preparation, and analytical procedure limitations.

8.2.2 Field Accuracy Objectives

Sampling bias will be assessed by evaluating the results of field equipment rinse and trip blanks. Equipment rinse and trip blanks will be collected as appropriate based on sampling and analytical methods for each sampling effort.

If non-dedicated sampling equipment is used, equipment rinse blanks will be collected by passing ASTM Type II water over and/or through the respective sampling equipment utilized during each sampling effort. One equipment rinse blank will be collected for each type of non-dedicated sampling equipment used for the sampling effort. Equipment rinse blanks will be analyzed for each target parameter for the respective sampling effort for which environmental media have been collected. (Note: If dedicated or disposable sampling equipment is used, equipment rinse samples will not be collected as part of that field effort.)

Trip blank samples will be prepared by the laboratory and provided with each shipping container that includes containers for the collection of groundwater samples for the analysis of VOCs. Trip blank samples will be analyzed for each VOC for which groundwater samples have been collected for analysis.

8.3 LABORATORY ACCURACY OBJECTIVES

Analytical bias will be assessed through the use of LCS and Site-specific MS sample analyses. LCS analyses will be performed with each analytical batch of project samples to determine the accuracy of the analytical system.

One set of MS/MSD analyses will be performed with each batch of 20 project samples collected for analysis to assess the accuracy of the identification and quantification of analytes within the Site-specific sample matrices. Additional sample volume will be collected at sample locations selected for the preparation of MS/MSD samples so that the standard laboratory RLs are achieved.

The accuracy of analyses that include a sample extraction procedure will be evaluated through the use of system monitoring or surrogate compounds. Surrogate compounds will be added to each sample, standard, blank, and QC sample prior to sample preparation and analysis. Surrogate compound percent recoveries will provide information on the effect of the sample matrix on the accuracy of the analyses.

8.4 REPRESENTATIVENESS

8.4.1 Definition

Representativeness expresses the degree to which sample data represent a characteristic of a population, a parameter variation at a sampling point, or an environmental condition. Representativeness is a qualitative parameter that is dependent upon the design of the sampling program. The representativeness criterion is satisfied through the proper selection of sampling locations, the quantity of samples, and the use of appropriate procedures to collect and analyze the samples.

8.4.2 Measures to Ensure Representativeness of Field Data

Representativeness will be addressed by prescribing sampling techniques and the rationale used to select sampling locations. Sampling locations may be biased (based on existing data, instrument surveys, observations, etc.) or unbiased (completely random or stratified-random approaches).

8.5 COMPLETENESS

8.5.1 Definition

Completeness is a measure of the amount of valid (usable) data obtained from a measuring system compared to the total amount anticipated to be obtained. The completeness goal for all data uses is that a sufficient amount of valid data be generated so that determinations can be made related to the intended data use with a sufficient degree of confidence. Valid data is determined by independent confirmation of compliance with method-specific and project-specific DQOs. The calculation of data set completeness will be performed by the following equation.

$$\frac{Number\ of\ Valid\ Sample\ Results}{Total\ Number\ of\ Samples\ Planned}\ X\ 100 = \%\ Complete$$

8.5.2 Field Completeness Objectives

Completeness is a measure of the amount of valid measurements obtained from measurements taken in this project versus the number planned. The field completeness objective for this project will be greater than 90 percent.

8.5.3 Laboratory Completeness Objectives

Laboratory data completeness objective is a measure of the amount of valid data obtained from laboratory measurements. The evaluation of the data completeness will be performed at the conclusion of each sampling and analysis effort.

The completeness of the data generated will be determined by comparing the amount of valid data, based on independent validation, with the total laboratory data set. The completeness goal will be greater than 90 percent.

8.6 COMPARABILITY

8.6.1 Definition

Comparability is a qualitative parameter expressing the confidence with which one data set can be compared to another.

8.6.2 Measures to Ensure Comparability of Laboratory Data

Comparability of laboratory data will be measured from the analysis of SRM obtained from either EPA CRADA suppliers or the NIST. The reported analytical data will also be presented in standard units of

mass of contaminant within a known volume of environmental media. The standard units for various sample matrices are as follows:

- Solid Matrices – micrograms per kilogram (µg/kg) for PFAS analyses, milligrams per kilogram (mg/kg) of media (Dry Weight).
- Aqueous Matrices – nanograms per liter (ng/L) for PFAS analyses, micrograms per liter (µg/L) of media for organic analyses, and milligrams per liter (mg/L) for inorganic analyses.

8.7 LEVEL OF QUALITY CONTROL EFFORT

If non-dedicated sampling equipment is used, equipment rinse blanks will be prepared by field personnel and submitted for analysis of target parameters. Equipment rinse blank samples will be analyzed to check for potential cross-contamination between sampling locations that may be introduced during the investigation. One equipment rinse blank will be collected per sampling event to the extent that non-dedicated sampling equipment is used.

If necessary, a separate equipment rinse blank sample will be collected for PFAS. (Note: If dedicated or disposable sampling equipment is used, equipment rinse samples will not be collected as part of that field effort.)

Trip blanks will be used to assess the potential for contamination during sample storage and shipment. Trip blanks will be provided with the sample containers to be used for the collection of groundwater samples for the analysis of VOCs. Trip blanks will be preserved and handled in the same manner as the project samples. One trip blank will be included along with each shipping container containing project samples to be analyzed for VOCs.

Method blank samples will be prepared by the laboratory and analyzed concurrently with all project samples to assess potential contamination introduced during the analytical process.

Field duplicate samples will be collected and analyzed to determine sampling and analytical reproducibility. One field duplicate will be collected for every 20 or fewer investigative samples collected for off-Site laboratory analysis.

MS will provide information to assess the precision and accuracy of the analysis of the target parameters within the environmental media collected. One MS/MSD will be collected for every 20 or fewer investigative samples per sample matrix.

(Note: Soil MS/MSD samples require triple sample volume for VOCs only. Aqueous MS/MSD samples require triple the normal sample volume for VOC analysis and double the volume for the remaining parameters.)

9. Data Reduction, Validation, and Reporting

Data generated by the laboratory operation will be reduced and validated prior to reporting in accordance with the following procedures.

9.1 DATA REDUCTION

9.1.1 Field Data Reduction Procedures

Field data reduction procedures will be minimal in scope compared to those implemented in the laboratory setting. The pH, conductivity, temperature, turbidity, DO, ORP, and breathing zone VOC readings collected in the field will be generated from direct-read instruments. The data will be written into field log books immediately after measurements are taken. If errors are made, data will be legibly crossed out, initialed and dated by the field member, and corrected in a space adjacent to the original entry.

9.1.2 Laboratory Data Reduction Procedures

Laboratory data reduction procedures are provided by the appropriate chapter of EPA's "Test Methods for Evaluating Solid Waste," SW-846, Third Edition. Errors will be noted; corrections made with the original notations crossed out legibly. Analytical results for soil samples will be calculated and reported on a dry weight basis.

9.1.3 Quality Control Data

QC data (e.g., laboratory duplicates, surrogates, MS, and MSD) will be compared to the method acceptance criteria. Data determined to be acceptable will be entered into the laboratory information management system.

Unacceptable data will be appropriately qualified in the project report. Case Narratives will be prepared which will include information concerning data that fell outside acceptance limits and any other anomalous conditions encountered during sample analysis.

9.2 DATA VALIDATION

Data validation procedures of the analytical data will be performed by the Haley & Aldrich of New York QA Officer or designee using the following documents as guidance for the review process:

- "U.S. EPA National Functional Guidelines for Organic Data Review," "Analysis of Volatile Organic Compounds in Air Contained in Canisters by Method TO-15," "Sampling, Analysis, and Assessment of Per- and Polyfluoroalkyl Substances Under NYSDEC's Part 375 Remedial Programs," and the "U.S. EPA National Functional Guidelines for Inorganic Data Review."
- The specific data qualifiers used will be applied to the reported results as presented and defined in the EPA National Functional Guidelines. Validation will be performed by qualified personnel at the direction of the Haley & Aldrich of New York QA Officer. Tier 1 data validation (the equivalent of EPA's Stage 2A validation) will be performed to evaluate data quality.

- The completeness of each data package will be evaluated by the Data Validator. Completeness checks will be administered on all data to determine that the deliverables are consistent with the NYSDEC Analytical Services Protocol (ASP) Category A and Category B data package requirements. The validator will determine whether the required items are present and request copies of missing deliverables (if necessary) from the laboratory.

9.3 DATA REPORTING

Data reporting procedures will be carried out for field and laboratory operations as indicated below.

- Field Data Reporting: Field data reporting will be conducted principally through the transmission of report sheets containing tabulated results of measurements made in the field and documentation of field calibration activities.
- Laboratory Data Reporting: The laboratory data reporting package will enable data validation based on the protocols described above. The final laboratory data report format will include the QA/QC sample analysis deliverables to enable the development of a DUSR based on NYSDEC DER-10 Appendix 2B.

10. Performance and System Audits

A performance audit is an independent quantitative comparison with data routinely obtained in the field or the laboratory. Performance audits include two separate, independent parts: internal and external audits.

10.1 FIELD PERFORMANCE AND SYSTEM AUDITS

10.1.1 Internal Field Audit Responsibilities

Internal audits of field activities will be initiated at the discretion of the Project Manager and will include the review of sampling and field measurements. The audits will verify that all procedures are being followed. Internal field audits will be conducted periodically during the project. The audits will include examination of the following:

- Field sampling records, screening results, instrument operating records;
- Sample collection;
- Handling and packaging in compliance with procedures;
- Maintenance of QA procedures; and,
- Chain of custody reports.

10.1.2 External Field Audit Responsibilities

External audits may be conducted by the Project Coordinator at any time during the field operations. These audits may or may not be announced and are at the discretion of the NYSDEC. The external field audits can include (but are not limited to) the following:

- Sampling equipment decontamination procedures;
- Sample bottle preparation procedures;
- Sampling procedures;
- Examination of HASPs;
- Procedures for verification of field duplicates; and,
- Field screening practices.

10.2 LABORATORY PERFORMANCE AND SYSTEM AUDITS

10.2.1 Internal Laboratory Audit Responsibilities

The laboratory system audits are typically conducted by the laboratory QA Officer or designee on an annual basis. The system audit will include an examination of laboratory documentation, including sample receiving logs, sample storage, chain of custody procedures, sample preparation and analysis, and instrument operating records.

At the conclusion of internal system audits, reports will be provided to the laboratory's operating divisions for appropriate comment and remedial/corrective action where necessary. Records of audits and corrective actions will be maintained by the Laboratory QA Officer.

10.2.2 External Laboratory Audit Responsibilities

External audits will be conducted as required by the NYSDOH or designee. External audits may include any of the following:

- Review of laboratory analytical procedures;
- Laboratory on-site visits; and,
- Submission of performance evaluation samples for analysis.

Failure of any of the above audit procedures can lead to laboratory decertification. An audit may consist of, but is not limited to:

- Sample receipt procedures;
- Custody, sample security, and log-in procedures;
- Review of instrument calibration logs;
- Review of QA procedures;
- Review of log books;
- Review of analytical SOPs; and,
- Personnel interviews.

A review of a data package from samples recently analyzed by the laboratory can include (but not be limited to) the following:

- Comparison of resulting data to the SOP or method;
- Verification of initial and continuing calibrations within control limits;
- Verification of surrogate recoveries and instrument timing results;
- Review of extended quantitation reports for comparisons of library spectra to instrument spectra, where applicable; and,
- Assurance that samples are run within holding times.

11. Preventive Maintenance

11.1 FIELD INSTRUMENT PREVENTIVE MAINTENANCE

The field equipment preventive maintenance program is designed to ensure the effective completion of the sampling effort and to minimize equipment downtime. Program implementation is concentrated in three areas:

- Maintenance responsibilities;
- Maintenance schedules; and,
- Inventory of critical spare parts and equipment.

The maintenance responsibilities for field equipment will be assigned to the task leaders in charge of specific field operations. Field personnel will be responsible for daily field checks and calibrations and for reporting any problems with the equipment. The maintenance schedule will follow the manufacturer's recommendations. In addition, the field personnel will be responsible for determining that an inventory of spare parts will be maintained with the field equipment. The inventory will primarily contain parts that are subject to frequent failure, have limited useful lifetimes, and/or cannot be obtained in a timely manner.

11.2 LABORATORY INSTRUMENT PREVENTIVE MAINTENANCE

Analytical instruments at the laboratory will undergo routine and/or preventive maintenance. The extent of the preventive maintenance will be a function of the complexity of the equipment.

Generally, annual preventive maintenance service will involve cleaning, adjusting, inspecting, and testing procedures designed to deduce instrument failure and/or extend useful instrument life. Between visits, routine operator maintenance and cleaning will be performed according to manufacturer's specifications by laboratory personnel.

12. Specific Routine Procedures Used to Assess Data Precision, Accuracy, and Completeness

12.1 FIELD MEASUREMENTS

Field-generated information will be reviewed by the Field Coordinator and typically includes evaluation of bound log books/forms, data entry, and calculation checks. Field data will be assessed by the Project Coordinator who will review the field results for compliance with the established QC criteria that are specified in Sections 7.0 and 8.0 of this QAPP. The accuracy of pH and specific conductance will be assessed using daily instrument calibration, calibration checks, and blank data. Accuracy will be measured by determining the percent recovery (% R) of calibration check standards. Precision of the pH and specific conductance measurements will be assessed on the basis of the reproducibility of duplicate readings of a field sample and will be measured by determining the RPD. Accuracy and precision of the soil VOC screening will be determined using duplicate readings of calibration checks. Field data completeness will be calculated using the following equation:

$$Completeness = \frac{Valid\ (usable)\ Data\ Obtained}{Total\ Data\ Planned} \ X\ 100$$

12.2 LABORATORY DATA

Laboratory data will be assessed by the Haley & Aldrich of New York QA Officer or designee who will review the laboratory results for compliance with the established QC criteria that are specified in Sections 7.0 and 8.0 of this QAPP.

13. QA Reports

Critically important to the successful implementation of the QAPP is a reporting system that provides the means by which the program can be reviewed, problems identified, and programmatic changes made to improve the plan.

QA reports to management can include:

- Audit reports, internal and external audits, with responses;
- Performance evaluation sample results, internal and external sources; and,
- Daily QA/QC exception reports/corrective actions.

QA/QC corrective action reports will be prepared by the Haley & Aldrich of New York QA Officer when appropriate and presented to the project and/or laboratory management personnel so that performance criteria can be monitored for all analyses from each analytical department. The updated trend/QA charts prepared by the laboratory QA personnel will be distributed and reviewed by various levels of laboratory management.

References

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3. New York State Department of Environmental Conservation. 2023. Sampling, Analysis, and Assessment of Per- and Polyfluoroalkyl Substances (PFAS) under NYSDEC Part 375 Remedial Program. Division of Environmental Remediation. April.

4. U.S. Environmental Protection Agency. 1986. Test Methods for Evaluating Solid Waste. SW-846. Office of Solid Waste. November. Updatedy.

5. U.S. Environmental Protection Agency. 1991. Preparation Aids for the Development of Category I Quality Assurance Project Plans. EPA/600/8-91/003. Risk Reduction Engineering Laboratory, Office of Research and Development. Cincinnati, Ohio. February.

6. U.S. Environmental Protection Agency. 1992. Specifications and Guidance for Contaminant-Free Sample Containers. OSWER Directive 9240.0-05A. April.

7. U.S. Environmental Protection Agency. 1993. Data Quality Objectives Process for Superfund: Interim Final Guidance. EPA/540/R-93/071. Office of Solid Waste and Emergency Response. September.

8. U.S. Environmental Protection Agency. 1999. EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations. EPA QA/R-5. Interim Final. November.

9. U.S. Environmental Protection Agency. n.d. U.S. EPA National Functional Guidelines for Organic Data Review. EPA 540/R-2017-002.

10. U.S. Environmental Protection Agency. n.d. U.S. EPA National Functional Guidelines for Organic Data Review. EPA 540/R-2017-001.

TABLE

TABLE I
SUMMARY OF ANALYSIS METHOD, PRESERVATION METHOD, HOLDING TIME, SAMPLE SIZE REQUIREMENTS AND SAMPLE CONTAINERS
FORMER PORT MOBIL TERMINAL
STATEN ISLAND, NEW YORK

Analysis/Method	Sample Type	Preservation	Holding Time	Volume/Weight	Container
Volatile Organic Compounds/8260C/5035	Soil	1 - 1 Vial MeOH/2 Vial Water, Cool, 4 ± 2 °C	14 days[1]	120 mL	3 - 40ml glass vials
Semi-volatile Organic Compounds/8270D	Soil	Cool, 4 ± 2 °C	14 days	250 mL	1 - 8 oz Glass
Metals/6010C	Soil	Cool, 4 ± 2 °C	180 days	60 mL	1 - 2 oz Glass
Polychlorinated Biphenyls/8082A	Soil	Cool, 4 ± 2 °C	14 days	250 mL	1 - 8 oz Glass
Pesticides (8081B)	Soil	Cool, 4 ± 2 °C	14 days	250 mL	1 - 8 oz Glass
PFAS 1633	Soil	Cool, 4 ± 2 °C	14 days	250 mL	1 - 8 oz Glass
1,4-Dioxane 8270	Soil	Cool, 4 ± 2 °C	14 days	250 mL	1 - 8 oz Glass
Volatile Organic Compounds/8260B	Groundwater	HCl, Cool, 4 ± 2 °C	14 days	120 mL	3 - 40ml glass vials
Semi-volatile Organic Compounds/8270C	Groundwater	Cool, 4 ± 2 °C	7 days	500 mL	2 - 250 mL amber glass
TAL Metals 6010/7471	Groundwater	HNO_3Cool, 4 ± 2 °C	180 days	500 mL	1 - 500 mL plastic bottle
Polychlorinated Biphenyls/8082	Groundwater	Cool, 4 ± 2 °C	365 days	2000 mL	2 - 1000 mL amber glass
Pesticides & Herbicides (8081B and 8151A)	Groundwater	Cool, 4 ± 2 °C	7 days	3000 mL	2 - 500 mL amber glass 2 - 1000 mL amber glass
PFAS 1633	Groundwater	H2O Cool, 4 ± 2 °C	14 days	500 mL	2 - teflon free 250 ml plastic containers
1,4-Dioxane 8270D	Groundwater	Cool, 4 ± 2 °C	7 days	500 mL	1 - 500 mL plastic bottle

Notes:
1. Terracores and encores must be frozen within 48 hours of collection
2. Refer to text for additional information.

ATTACHMENT A
Project Team Resumes

SUZANNE M. BELL, P.E.

Senior Project Manager

EDUCATION

B.S., Biosystems Engineering, University of Arizona

PROFESSIONAL REGISTRATIONS

AZ: Environmental Engineer (Reg. No. 61995)
NY: Professional Engineer (Reg No. 106301)

SPECIAL STUDIES AND COURSES

40-Hour OSHA Hazardous Waste and Operations Emergency Response Training (29 CFR 1910.120 and 40 CFR 265.16)
8-Hour HAZWOPER Refresher Course

Suzanne is a senior project manager with over 15 years of experience in the environmental consulting industry. She has worked on soil and groundwater environmental investigations, remediation projects, and prepared reports for private, industrial, and government clients. Her technical experience includes remediation systems; soil and groundwater feasibility studies; Phase I site investigations; environmental file review and historical research; stormwater assessments and Stormwater Pollution Prevention Plan (SWPPP) preparation; reclamation planning for the sand and gravel mining industry; air permitting; and data interpretation.

RELEVANT PROJECT EXPERIENCE

Waterfront Property Management, 89-91 Gerry Street and 93 Gerry Street, Brooklyn, New York. Suzanne served as project manager for execution of Remedial Action Work Plans at the former Just4Wheels Site and Just4Wheels Site 2 under the New York State Brownfield Cleanup Program (NYSBCP). Responsible for remedial oversight of excavation and removal of non-hazardous and hazardous soil, endpoint sample collection, air monitoring, dewatering system installation support, communication with soil brokerage firm and environmental laboratory, and preparation of Daily Field Reports (DFRs) and the Final Engineering Report (FER).

Multiple Clients, Remedial Investigation Work Plans and BCP Applications, New York City, New York. As project manager and engineer, Suzanne has prepared NYSBCP Applications and Remedial Investigation Work Plans for the New York State Department of Environmental Conservation (NYSDEC) for sites within the New York City boroughs.

Excavation Oversight and Community Air Monitoring Plan (CAMP) Monitoring, Various Sites, New York City, New York. Suzanne has served as project manager for projects under the New York City Office of Environmental Remediation (NYCOER) program and NYSBCP. Her responsibilities included managing excavation oversight, air monitoring, and logging trucks for off-site disposal.

Aerospace Manufacturing Facility, Feasibility Study and Remedial Action Plan, Chula Vista, California. Suzanne co-authored feasibility studies for soil and groundwater impacted by chlorinated solvents, metals, and polychlorinated biphenyls (PCBs). She screened ex-situ and in-situ remedial alternatives for effectiveness, implementability, and protectiveness of human health. She also assessed alternative cleanup levels for technical and economic feasibility of achieving background concentrations in accordance with State Water Resources Control Board Resolution 92-49. Additionally, she evaluated groundwater remedial alternatives, including bioremediation, monitored natural attenuation (MNA), pump and treat, chemical oxidation, chemical reduction, and engineering and institutional controls. Lastly, she prepared engineering cost estimates and conceptual designs. Assisted with the preparation of remedial action plans: a bioremediation remedy and MNA program for groundwater, and excavation of contaminated soil.

Aerospace Manufacturing Facility, Groundwater Remediation and Bioremediation Pilot Test, Riverside, California. Suzanne assisted with data analysis and reporting for the bioremediation pilot test study for groundwater impacted by chlorinated solvents, hexavalent chromium, and 1,4-dioxane. She evaluated site data for trends indicative of MNA using statistical analysis.

Goodyear Tire & Rubber Company, Phoenix Goodyear Airport South Superfund Site, Goodyear, Arizona. Suzanne prepared reports and performed data analysis related to the groundwater monitoring program and operation and maintenance of groundwater treatment systems. Currently, two groundwater extraction and remediation systems are capable of treating more than 1 million gallons per day (MGD) of groundwater contaminated with trichloroethylene. The upper groundwater zone is treated with an air stripper, while the lower zone is treated with granulated activated carbon. Treated groundwater is reinjected into their respective zones.

Soil and Groundwater Remediation Systems, Arizona. Suzanne performed operation, maintenance, and sampling activities for two soil vapor extraction systems to remove tetrachloroethylene from subsurface soils at two different dry-cleaning facilities. She prepared soil vapor extraction granular activated carbon (GAC) system test reports in accordance with Maricopa County Air Quality Department Permits.

ASTM Phase I Environmental Site Assessments (ESAs), Arizona. Suzanne assisted with ASTM Phase I ESAs at various industrial facilities in central and southern Arizona. She evaluated site conditions and regulatory implications as they related to the owner's or potential buyer's property development plans.

Phoenix-Goodyear Airport-North Superfund Site, Focused Feasibility Study, Goodyear, Arizona. Suzanne was a member of the team that prepared a source area remediation-focused feasibility study report. She evaluated several technologies and alternatives to treat groundwater contaminated with trichloroethylene (TCE) and perchlorate. She analyzed remedial alternatives, including in-well air stripping, a hydraulic barrier, nano- and macro-scale zero-valent iron, anaerobic reductive dechlorination, in-situ chemical oxidation (permanganate), and electrical resistive heating. She prepared cost estimates, conceptual designs, remediation technology summaries, and sustainability evaluations of the alternatives.

Enhanced In-Situ Bioremediation (EISB) and Chemical Reduction Using a Nanoscale, Zero-Valent Metallic Alloy to Treat Co-disposed Chloroethanes and Chloroethenes in Groundwater, Manufacturing Facility, Canton, Massachusetts. Suzanne performed data analysis and prepared status reports on the effectiveness of EISB in treating chlorinated solvents in shallow groundwater. She reported on the performance monitoring results for the permeable reactive barrier in deep zone groundwater.

Hayden Facilities RI/FS, ASARCO LLC, Hayden, Arizona. Suzanne served as Quality Assurance Officer for the air monitoring program at a copper smelting facility. She developed site-specific data validation procedures according to U.S. Environmental Protection Agency (EPA) guidelines for several analytical methods.

Market Evaluation for Nanoscale Zero-Valent Iron, Stamford, Connecticut. Suzanne used the EPA CERCLIS Public Access Database and select State databases to estimate the market size for potential use of nanoscale zero-valent iron (nZVI) as a remediation technology. She compiled competing vendor information and quotes to estimate the average cost of similar products. She utilized the U.S. Patent and Trademark Office database to analyze competing technologies.

AZPDES and NPDES Permits, Arizona. Suzanne prepared Arizona Pollutant Discharge Elimination System (AZPDES) and National Pollutant Discharge Elimination System (NPDES) permit renewal applications for a copper mining facility in Southern Arizona, which included updates to the facility's SWPPP and Quality Assurance (QA) Manual.

Spill Prevention, Control and Countermeasure Plans, Aggregate Mining Facilities, Arizona. Suzanne assisted with a Spill Prevention, Control, and Countermeasure (SPCC) Plan for aggregate mining facilities in Arizona. She performed site visits, evaluated fuel and oil tanks and secondary containment areas, assisted with calculations to verify compliance, and prepared reports.

Copper Mining Facility, Miami, Arizona. Suzanne assisted with Toxic Release Inventory (TRI) and Toxic Substances Control Act (TSCA) reporting, both submitted to the EPA.

SWPPP, Franciscan Friars of California, Gila County, Arizona. Suzanne updated the SWPPP for construction activities related to the closure of a historic Gibson Copper Mine, authorized under the AZPDES "General Permit for Discharge from Construction Activities to Waters of the United States." The Former Gibson Mine is a small, historic copper mine, located approximately 7 miles southwest of Miami, Arizona, in Gila County. Construction activities covered under the updated SWPPP consisted of the excavation, hauling, and removal of approximately 80,000 tons of soil cover from the Mineral Creek side of the site to mine-scarred areas on the Pinto Creek side of the site. Also included was final grading of the site, which consisted of re-contouring and re-defining any portion of the drainages that were on site, and revegetation.

SWPPP, Vulcan Materials Company, Western Division, Arizona. Suzanne prepared SWPPP for 11 aggregate mining facilities in Arizona. Performed site visits, analyzed stormwater flows, prepared reports, and completed Notices of Intent for the Arizona Department of Environmental Quality under a Multi-Sector General Permit.

Uranium Enrichment Facility, Lea County, New Mexico. Suzanne prepared quarterly and annual groundwater monitoring reports, semi-annual radioactive effluent release reports, and radiological environmental monitoring program reports in accordance with New Mexico Environment Department regulations and the Nuclear Regulatory Commission. Performed quarterly data validation on a variety of matrices and analytical methods. She prepared site-specific environmental monitoring procedures, which included field sampling techniques; data collection, management, and validation; and an air modeling software package.

Rocket Testing and Research Facility, Western U.S. Suzanne analyzed and evaluated groundwater quality data, prepared reports, and managed data for this Resource Conservation and Recovery Act (RCRA) site. Assisted with management of sampling, analysis, and reporting of constituents of concern for fractured sandstone bedrock aquifer impacted by chlorinated solvents and emergent chemicals 1,4-dioxane, perchlorate, and n-nitrosodimethylamine (NDMA). Performed data validation of water quality data according to EPA National Functional Guidelines. Queried data from client environmental data management system and prepared summary tables, concentration plots, and water level hydrographs using Microsoft Excel programs. She prepared a quarterly analytical schedule using an Access database application, updated the site-specific Health and Safety Plan (HASP), and participated in lean training, which reduced the cost of groundwater monitoring tasks by 25 percent.

Federal Superfund Site, Eastern Massachusetts. Suzanne performed data validation and quality assurance/quality control (QA/QC) of soil and groundwater data according to EPA National Functional Guidelines. She performed third-party database updates.

Great Western Bank, Cortaro Ranch Property, Marana, Arizona. For site characterization of undeveloped land, Suzanne performed surficial soil sampling, analytical laboratory coordination, data analysis, and report preparation.

Twin Buttes Properties, Inc., Southern Arizona. Suzanne assisted with report and analytical table preparation for the characterization and analysis of current and historical hydrologic conditions at an inactive mine site near Sahuarita, Arizona, in support of regulatory compliance.

Skyworks Solutions, Inc. Site, Newbury Park, California. Suzanne assisted with report and analytical table preparation for a subsurface investigation characterizing the lateral and vertical extent of soil and groundwater impacts from known releases of TCE, 1,4-dioxane, and other organic compounds.

PUBLICATIONS

"Mixed Redox Catalytic Destruction of Chlorinated Solvents in Soils and Groundwater," with S. Gao, E. Rupp, M. Willinger, T. Foley, B. Barbaris, A.E., Saez, R.G. Arnold and E. Betterton. In Environmental Challenges In The Pacific Basin, 2008; Annals of the New York Academy of Sciences, Vol. 1140, pp 435-445. PMID: 18991945

INVITED LECTURER OR SPEAKER

"Catalytic Destruction of Perchloroethylene," with E. Betterton, R. Arnold and Eduardo Saez, Presenter - NASA Space Grant Student Symposium, Phoenix, Arizona. April 2007.

SARAH COMMISSO, GIT

Assistant Project Manager

EDUCATION

B.S., Geological Sciences with a minor in Chemistry, State University of New York-Binghamton

PROFESSIONAL REGISTRATIONS

2021/ NY: Geologist in Training (GIT) Certification

SPECIAL STUDIES AND COURSES

40-Hour OSHA Hazardous Waste Operations and Emergency Response Training (29 CFR 1910.120)
8-Hour OSHA HAZWOPER Refresher Training
10-Hour OSHA Construction Safety Training
8-Hour DOT Hazmat Employee & RCRA Hazardous Waste Generator Training

Sarah is a geologist with experience in soil, groundwater, and soil vapor investigation, and preparation of technical reports. She also has extensive experience with conducting Phase I Environmental Site Assessments (ESAs) and Phase II Environmental Site Investigations (ESIs), site characterization, and hazardous materials analysis. She has performed soil, groundwater, and soil vapor sampling events, geotechnical drilling projects, and has drafted site investigation plans and reports.

RELEVANT PROJECT EXPERIENCE

Environmental Experience

Madison Realty Capital, New York State Superfund Site, Former NuHart Plastics Site, New York State Superfund Site (NuHart West) and Brownfield Cleanup Program (BCP) Site (NuHart East), Brooklyn, New York. Sarah served as a staff geologist for the preparation of offsite investigation reports, Resource Conservation and Recovery Act (RCRA) Closure Work Plan, execution of the RCRA Closure, preparation of the BCP Application (NuHart East), 30% Remedial Design, preparation of all BCP related work plans (NuHart East), coordination to vest the Site for 421-a and all community outreach programs for a former plasticizer facility with on- and off-site pollutant concerns. She was responsible for assisting in the remedial cost and alternative analysis with the client to bring the site to a certificate of completion. NuHart is a high-profile site that requires coordination with the New York State Department of Environmental Conservation (NYSDEC), the New York City Office of Environmental Remediation (NYCOER), local regulatory agencies, community stakeholders, and local elected officials.

The Jay Group, Speedway Portfolio, Multiple Boroughs, New York. As staff geologist, Sarah was responsible for the expedited due diligence during the acquisition of five former Speedway Sites of Phase I ESAs and Limited Phase II ESIs, preparation of the BCP Applications, Remedial Investigation Work Plans, Interim Remedial Measure Work Plans and Air/Noise Remedial Action Work Plans (NYCOER). Four of the sites were accepted into the NYSDEC BCP with one currently pursuing the program pending the acquisition. Remedial investigations for compliance with the BCP have been completed and the Remedial Investigation Reports are being drafted.

JCS Realty, 40 Bruckner Boulevard, Bronx, New York. As staff geologist, Sarah was responsible for the due diligence during acquisition, preparation of the BCP Application, Change of Use Documents, Brownfield Cleanup Agreement (BCA) Amendments, remedial investigation, and remedial action design (BCP and NYCOER) for the former Mill Sanitary Wiping Cloth Site under the New York State BCP (NYSBCP) and NYCOER E-Designation Programs (Air/Noise). The site has a footprint of 45,000 square feet (sq ft) with a planned development of a 12-story mixed-use building with approximately 480 units which include affordable housing.

Toldos Yehuda, Former Techtronics Site (8 Walworth Street), Brooklyn, New York. Sarah served as staff geologist for the remedial investigation, remedial action design, and remedial action implementation for the former Techtronics Site under the NYSBCP as a participant where trichloroethene (TCE) and tetrachloroethene (PCE) were encountered in soil and groundwater. Successfully delineated the vertical and lateral extents of the plumes which were identified as an upgradient, on-site. For this site, we have designed source removal to 20 feet (ft) below ground surface, zero valent Iron (ZVI) reactive barrier wall, in situ ZVI injections sitewide, and a vertical vapor mitigation system. The site is currently in the remedial implementation phase.

Waterfront Management of NY, 590-594 Myrtle Avenue, Brooklyn, New York. As lead field geologist, Sarah was responsible for the oversight of the excavation and remediation of the property under the NYCOER. During remediation, Sarah observed and documented the excavation and proper disposal of on-site soil required for the installation of foundation elements. In addition, she oversaw the proper cleaning and removal of three underground storage tanks (USTs) encountered during site-wide excavation. After excavation was complete, she inspected the installation of a sub-slab vapor barrier and conducted the community air monitoring program during the course of remedial action.

Madison Realty Capital, 644 East 14th Street, New York, New York. Sarah is the lead drafter of the Remedial Investigation Work Plan and the Remedial Investigation Report for the site, which is enrolled in the NYSDEC BCP. She coordinated field staff and subcontractors for the execution of the Remedial Investigation Work Plan which included installation of soil borings, groundwater monitoring wells, and soil vapor points, and sampling of each.

Madison Realty Capital, River North, Staten Island, New York. Sarah coordinates field staff and subcontractors for the execution of the remedial investigation at this approximately 2-acre site enrolled in the NYSDEC BCP. The remedial investigation involved the installation of approximately 50 soil borings, 20 soil vapor points, including soil borings extending to bedrock.

Oxford Property Group, Naval Yard Phase I Portfolio. Sarah conducted two of five Phase I ESAs for Oxford Property Group in the Philadelphia Naval Yard as part of due diligence for potential acquisition of the properties. Each property was approximately 8 acres in size and developed with active life sciences facilities. Sarah conducted site reconnaissance of the properties and reviewed historical site documentation to identify recognized environmental conditions (RECs) at each site.

Target, Multiple Locations, New York and New Jersey. Sarah conducted Phase I ESAs as part of due diligence for the potential acquisition of properties by Target in Jersey City, performed oversight of upgrades and construction at various Target stores in Brooklyn, Queens, Long Island, and Jersey City, including methane monitoring, air monitoring, collection of endpoint soil samples, and groundwater sampling. Sarah performed all oversight work in accordance with the site-specific Soil Materials Management Plan.

BCP Applications and Remedial Investigation Work Plans for NYSDEC. Sarah has completed writing several BCP Applications for various clients in New York State. In writing the applications, Sarah reviews previous subsurface investigations of the site, and historical information to help get underutilized and abandoned contaminated properties into the BCP to be remediated and redeveloped under NYSDEC. After completing the application, she prepares a Remedial Investigation Work Plan to strategically investigate site contamination so proper remedial action can take place.

Excavation Oversight and Community Air Monitoring Plan (CAMP) Monitoring, Various Sites, Bronx and Brooklyn, New York. Sarah served as field geologist for several projects under the NYCOER program and NYSBCP. Her responsibilities included performing excavation oversight, air monitoring, vapor barrier installation oversight, and logging trucks for off-site disposal.

Multiple Clients, Phase I ESAs and Due Diligence, Multiple Locations in New York, New Jersey, Pennsylvania, and Massachusetts. Sarah conducted Phase I ESAs, for buyers on a variety of properties, including commercial, industrial, and residential sites in New York, New Jersey, Pennsylvania, and Massachusetts. She has experience conducting site reconnaissance and reviewing historical site documentation to identify RECs at the sites.

Multiple Clients, Phase II, Multiple Locations, New York. As field geologist, Sarah conducted Phase II ESAs on a variety of different sites. She assisted with the development of sampling plans primarily based on previous environmental investigations and due diligence. Primary responsibilities for Phase II investigations included oversight of the installation of test borings and/or test pits, the installation of groundwater monitoring wells, and soil vapor points.

Geotechnical Engineering Experience

Smithsonian Institution Revitalization of the Historic Core, Washington, D.C. Sarah supported a team providing geotechnical engineering services for the renovation of several Smithsonian Institution buildings adjacent to the National Mall. Sarah was responsible for the oversight of geotechnical borings using hollow stem augur and mud rotary techniques as well as rock coring operations. Sarah classified soil samples using the Unified Soil Classification System, analyzed bedrock samples, and analyzed the geology of the Washington D.C. area.

Parcel B Development, Washington, D.C. Sarah was the lead field geologist for the geotechnical investigation for the development of the Parcel B Site adjacent to the D.C. United Stadium in Washington D.C. Sarah was responsible for the oversight of geotechnical borings using hollow stem auger and mud rotary techniques. She observed and coordinated pressure meter testing of several borings and observed the installation of several groundwater monitoring wells to investigate impacted groundwater on the property. Additionally, based on her soil classifications in the field, she drafted boring logs and analyzed subsurface conditions at the site.

MICHAEL J. BOLAND, E.I.T.

Assistant Project Manager | Mechanical Engineer

EDUCATION

BS, Mechanical Engineering, Binghamton University

PROFESSIONAL REGISTRATIONS

2022 FE Mechanical Engineer in Training (EIT) (NCEES ID No. 22-997-05)

SPECIAL STUDIES AND COURSES

40-Hour OSHA Hazardous Waste Operations and Emergency Response Training (29 CFR 1910.120)
30-Hour OSHA Construction Safety and Health
10-Hour OSHA Construction Safety and Health
8-Hour DOT Hazmat & RCRA Hazardous Waste Generator Training (49 CFR 172.704 / 40 CFR 262.34 & 265.16)

Michael is an engineer with over five years of experience in construction project management and will focus his time at Haley & Aldrich serving the Building & Infrastructure markets. He is skilled in building materials fabrication management, field operations oversight, quantity take-offs and submittal/RFI tracking methods. His current assignment is the NuHart Superfund site in Brooklyn, New York. Primary responsibilities include contractor oversight and logistics coordination for environmental remediation efforts within the designated area of concern.

RELEVANT PROJECT EXPERIENCE

Airports

Port Authority of New York & New Jersey, LaGuardia Airport Terminal B Replacement, East Elmhurst, New York. Michael served as a project engineer for the general contractor's structural steel operations. His roles included steel fabrication coordination between designers and detailers for several structures comprising the new airport such as both pedestrian bridges and the central hall western connection building. He managed shop drawing submission processing for official engineer approval. Once fabricated, he assisted with material delivery logistics, on-site installation sequencing and tracking of productivity rates. He has participated in scheduling and commercial forecasting efforts throughout the project life cycle. Additionally, he has experience interfacing with client representatives both in field settings and in formal progress update meetings.

Bridges

New York State DOT Region 11, Gowanus Expressway, Brooklyn, New York. Michael acted as an assistant superintendent for the contractor's self-performed structural steel removal and installation operations. He calculated and tracked physical quantities such as weight, square-footage and lengths of certain materials. All work performed under his supervision was carried out by local union ironworkers and teamsters.

New York State DOT Region 10, Fire Island Inlet Bridge, Gilgo-Oak Beach-Captree, New York. Michael acted as the on-site environmental, health and safety engineer for the start up of the project. He conducted general safety orientations and emergency response trainings for workers employed on the project. His responsibilities also included the maintenance of competent person status logs and material safety data sheets.

New York City DOT, Manhattan Bridge, Manhattan, New York. Michael was part of the team that developed the contractor's estimate for the initial bid-phase of the project. He performed quantity take-offs and solicited quotes from potential subcontractors and vendors capable of fulfilling certain work scopes. His specific roles included calculating tonnage values for the existing steel gusset plates and establishing cost metrics for the revised traffic marking configurations required as per contract drawings.

New York City DOT, Madison Avenue Movable Bridge, Bronx, New York. Michael served as the field engineer primarily responsible for managing the painting subcontractor on the project. He coordinated dry ice blasting efforts along the roller track assembly at the center pier of the bridge, as well as lead-based paint coating removals at the side rest piers. His responsibilities included ensuring workers abided by the proper PPE, debris containment and waste storage regulations. He also oversaw the identification, collection and transportation of EPA designated universal waste discovered at locations throughout the project site.

Miscellaneous

Port Authority of New York and New Jersey, 5kV Switchgear & Platform Replacement, Fort Lee, New Jersey. Michael served as the project engineer responsible for coordinating efforts between several subcontractors performing different scopes of work required for the replacement of the 5 kilovolt switchgears located within both towers of the George Washington Bridge. These scopes of work included fiberglass shelter fabrication, temporary access platform installation and electrical component submittals. He maintained time and material tracking systems in agreement with the client for the purpose of monthly payment requisitions.

NuHart Superfund Site

New York State Department of Environmental Conservation, Brooklyn, New York. Michael served as the project engineer responsible for implementing the Resource Conservation and Recovery Act (RCRA) Closure for the on-site NuHart factory. The RCRA Closure efforts were required by the NYSDEC Superfund program prior to approving the factory buildings for demolition. Michael worked with various environmental contractors, chemical analysis laboratories and waste disposal services to complete this phase of the remediation. Michael oversaw the demolition of the previously existing buildings as well as subsurface excavation of approximately 57,000 tons of soil/fill material to facilitate construction of the new residential/commercial buildings. Michael also worked closely with H&A's professional engineer of record and the NYSDEC to implement in-situ stabilization (ISS) of hazardous materials encountered at the bottom development depth of the excavation. The final stage of the remediation include installing an automated LNAPL Recovery System; the design for which Michael was heavily involved in developing and coordinating.

BRIAN A. FERGUSON

Senior Engineer

EDUCATION

M. S. Geotechnical Engineering, Tufts University, Medford, Massachusetts; 2012
B. S. Civil Engineering, State University of New York - Environmental, Science, and Forestry, Syracuse, New York; 2000
Ass. Science Degree in Applied Science and Technology (Nuclear Engineering), Thomas A. Edison State College, Trenton, New Jersey; 2000

PROFESSIONAL SOCIETIES

Order of the Engineer – 2000
Boston Society of Civil Engineers (BSCE)
American Society of Civil Engineers (ASCE)

SPECIAL STUDIES AND COURSES

American Concrete Institute – Certified Field Technician Certified Grade 1
Radiation Safety and Operations of Nuclear Testing Equipment – Troxler
40-Hour OSHA Hazardous Waste Operations Training (+ 8-Hour annual refresher)
10-Hour OSHA Construction training
Confined Space Entry Training
16-Hour Asbestos Operations and Maintenance

Mr. Ferguson has over six years of experience serving as project engineer on a variety of real estate development projects. His project experience has included monitoring field investigations and performing construction oversight, performing due diligence and engineering analyses, performing geotechnical analyses and developing geotechnical recommendations, and preparing geotechnical reports and project specifications.

In addition to providing engineering design support, Mr. Ferguson has managed and participated in a number of field service activities. Field work has included construction monitoring and documentation of contractors' deep and shallow foundation related construction, including slurry walls, caissons, pile driving, pile cap installation, earthwork, backfilling and compaction, installation of soldier pile and wood lagging support systems, installation of tie backs, reading inclinometers, conducting in-place field unit weight tests, tie-back load testing, seismograph installation, monitoring, and evaluating, and preparation of footing bearing surfaces. Other responsibilities have included site development activities, including placement of utilities and subgrade preparation for roads; observations and testing to determine that work is completed in compliance with contract documents; on-site soil management; sampling of soil and groundwater for chemical laboratory testing and conducting in situ field screening; maintenance of job records including pile driving logs, results of field density tests, records of caisson and footing installations; preparation of daily field reports; in contact with key personnel; and resolution of field related problems.

RELEVANT PROJECT EXPERIENCE

St. Elizabeths Hostpital – West Campus Forensic Evaluations, Washington, D.C. Project Engineer for forensic evaluations on the adaptive reuse of former hospital buildings. Responsibilities included coordination of a field exploration program, including test borings and test pits to obtain subsurface information for project design and construction, overseeing multiple field personnel, subcontractors, assisting with project management, reviewing subcontractors invoices, reviewing and summarizing subsurface data and writing data reports.

TUFTS University, New Central Energy Plant, Medford, MA. Project engineer for a new Central Energy Plant that will house new co-generation steam boilers, centralized chilled water and electrical transformer switchgear that is planned to occupy approximately 20,000 square feet across two or three levels. Responsibilities included coordination of construction monitoring, observing SOE and footing installation, assisting with project management,

reviewing weekly field construction reports, reviewing and responding to geotechnical design submittals and attending project meetings.

Lahey Hospital and Medical Center – Stilts Infill Project, Burlington, MA Project Engineer for an addition to the existing Stilts building on the Lahey campus. Responsibilities included coordination and overseeing geotechnical and environmental subsurface investigations, coordination of construction monitoring, observing footing installation, assisting with project management, reviewing weekly field construction reports, reviewing and responding to geotechnical design submittals and attending project meetings.

Gloucester Beauport Hotel, Gloucester, MA Project engineer for a four story hotel with a seawall constructed adjacent to tidal beach. Responsibilities included coordination and overseeing geotechnical and environmental subsurface investigations, coordination of construction monitoring, assisting with project management, reviewing weekly field construction reports, reviewing and responding to geotechnical design submittals and attending project meetings, design and implementation of a sub-slab gas mitigation system.

275 Wyman Street, New Office Building, Waltham, MA. Project engineer for a new office building and parking garage founded on a shallow foundation system. Responsibilities included preparing proposals, assisting with management and planning of a subsurface investigation program, summarizing subsurface data and reviewing geotechnical test boring logs, coordination of construction monitoring and instrumentation monitoring programs, reviewing weekly field construction reports, reviewing and responding to specialty geotechnical design submittals and RFIs by others and attending project meetings.

Suffolk University - 20 Somerset Street, Boston, MA Project engineer for design of 8-story academic building with two levels of below grade finished space. Responsibilities included coordination of construction monitoring, observing SOE and footing installation, assisting with project management, reviewing weekly field construction reports, reviewing and responding to geotechnical design submittals and attending project meetings.

Worcester State University, New Student Housing, Worcester, MA Project engineer for design and construction of a 7-story residence/dining hall with a single level basement and a major site retaining wall structure. Responsibilities included overseeing geotechnical subsurface investigations, provided foundation recommendations and specifications, and prepared a retaining wall contract document. Responsibilities included coordination of construction monitoring, excavation and construction of footings, and soil reuse and management, assisting with project management, reviewing weekly field construction reports, reviewing and responding to geotechnical design submittals and attending project meetings.

University of Massachusetts Boston, General Academic Building No.1, Boston, MA. Project engineer responsible for assisting project manager in preliminary foundation engineering recommendations and construction considerations for a new academic building on a part of Columbia Point, a historic landfill area. Assisted in design phase services that included preparing foundation support design recommendations including the use of high allowable stresses for 190-ft long end-bearing H-piles and application of Slickcoat coating to address downdrag concerns and reduce foundation costs.

Waltham Watch Factory, Waltham, MA project engineer for redevelopment of former watch factory. Responsibilities included construction oversight of new precast parking garage, utilitiy upgrades, soil remediation and management, installation of gas mitigation systems, assisting with project management, reviewing weekly field construction reports, reviewing and responding to geotechnical design submittals and attending project meetings.

Massachusetts Green High Performance Computing Center, Holyoke, MA. Project engineer for 60,000 sq. ft high level computing center and associated support utilities. Redevelopment of the site included recycling 50,000 cy of construction debris into the site fills at this historic site along the Connecticut River. Responsibilities included coordinating geotechnical and environmental field investigations, coordination of construction monitoring, seismic analysis, reviewing weekly field construction reports, reviewing and responding to geotechnical design submittals and attending project meetings.

The Shops at Riverwood, Hyde Park, MA. The project consisted of the redevelopment of a colonial era paper mill. The multi-building complex was demolished and the concrete and brick from the previous buildings were recycled. The project involved crushing 50,000 cy of brick and concrete and placement of excavated soils and recycled brick and concrete as compacted fill materials to support proposed buildings, pavement areas, and achieve 5 to 9 ft. raises in grade. Field Representative was responsible for management and reuse of brick and concrete stockpiles, in-place density testing, coordination of test pits, installation of soldier pile and versa-lok walls, and backfilling of underground vaults. Remedial activities included: excavation of 5,000 cy of petroleum contaminated soils, on-site cement batching in a pug mill, and placement of compacted recycled materials in roadway areas; delineation, excavation and off-site disposal of TSCA-regulated PCB contaminated soils associated with historical Askarel transformers and dioxin-contaminated soils associated with historical bleaching operations; and disposition of 1,000 tons of paper mill sludge encountered within an abandoned granite-walled sluiceway structure. In addition, assisted with weekly project meetings, maintaining a record of material reuse, and providing weekly field reports.

Harvard Law School, Cambridge, MA. The Harvard Law School project is located on Massachusetts Avenue in Cambridge. The project consisted of a multistory building above ground with 5 levels below ground for a parking garage. Field Representative was responsible for overseeing the installation of slurry walls into bedrock and LBEs with three installation rigs while monitoring the removal of urban fill and transfer to several different receiving facilities from another portion of the site. The slurry walls were constructed into bedrock. Other Field Representative activities were: testing of the slurry, management of the excavated soils, and record keeping of the Contractor's obstruction and down time of the equipment. In addition, assisted with weekly project meetings, maintaining a record of obstruction and machine time, and providing weekly field reports.



BRIAN FITZPATRICK, CHMM

Corporate Director, Health and Safety

EDUCATION

M.P.A., Environmental Policy, Syracuse University
B.S., Environmental Science, University of Massachusetts-Amherst
A.S., Chemistry, Valley Forge Military Junior College
Commissioned Officer, United States Army

CERTIFICATIONS

Certified Hazardous Materials Manager (Reg. No. 13454)
Certified Department of Transportation Shipper
Certified International Air Transport Authority Shipper

PROFESSIONAL SOCIETIES

Alliance of Hazardous Materials Professionals
Academy of Certified Hazardous Materials Managers, New England Chapter

SPECIAL STUDIES AND COURSES

Department of Transportation
International Air Transport Authority
Incident Commander
Confined Space Entry and Rescue
Radiation Safety Officer
RCRA Hazardous Waste
Massachusetts Industrial Waste Water Operator Grade 2I (expired)

AWARDS

Presidents Club Award (one million hours worked without a recordable injury, Cabot Corporation
Chancellors Award for Excellence, Syracuse University

Brian has over 25 years of experience in developing, implementing, and managing a wide range of environmental, health, and safety (EH&S) solutions for a variety of clients. Brian has served as the Health and Safety Manager and Incident Commander at several research and development sites and has managed extensive programs to maintain and clean contaminated sites under Federal and State regulatory programs. He has provided expertise in managing EH&S programs as a consultant, and has actively developed, implemented, and managed these programs as an EH&S professional for various industries.

Brian is currently working as the Chief Health and Safety Officer for Haley & Aldrich, Inc. He, and his staff, are involved in every project Haley & Aldrich, Inc. undertakes. Brian is involved on several projects, directly overseeing the health and safety on the project site of our staff, our contractors, and the public. Brian also acts as support for our on-site health and safety staff on other larger construction and remediation projects.

Through Brian's leadership our safety culture and focus extend from the top of our organization to each and every Haley & Aldrich employee as well as subconsultants and subcontractors. Utilizing a Behavior Based Safety approach, Haley & Aldrich expects every project team member to play an important role in making our projects safe and has given authority to every Haley & Aldrich employee, subconsultant, and subcontractor to stop any activity at any time for health or safety concerns. Our record illustrates that our hard work is paying off. The company has gone 4 years without a lost time injury, and our TRIR and EMR have consistently improved each of the last 3 years.

RELEVANT PROJECT EXPERIENCE

Haley & Aldrich, Inc., Burlington, Massachusetts. As Chief Health and Safety Officer, Brian has led and facilitated the development and implementation of corporate health and safety (H&S) improvement plans to enhance compliance and improve H&S performance. In Brian's time with Haley & Aldrich, Inc., the company has realized dramatic improvement on H&S goals and in Key Performance Indicators. Brian is responsible for developing a risk competence culture, where our staff are empowered to look for and engage to address risk before anyone is injured. Brian oversees the development, implementation and continuous improvement of all H&S programs for the company. Additional responsibilities include:

- Developing a safety culture through incident reporting, root cause analysis, behavior-based safety, hazard recognition and risk assessment, communication, and developing leaders;
- Monitoring proposed and existing SH&E regulations and legislation to determine their impact on operations and to ensure continued compliance;
- Overseeing the safety, industrial hygiene, and toxicology programs for over 600 staff members engaged in remediation, construction, health and safety, consulting, and general office work across 28 offices in the United States and on assignment to international project sites;
- Continuously seeks to improve H&S performance as measured by the OSHA Incident Rating (IR) and Worker's Compensation Experience Modification Rating (EMR), as well as Leading Indicators developed with the management team; and
- Participating in the corporate audit program as an auditor or lead auditor;

Energy Client, California. As Chief Health and Safety Officer, Brian led and facilitated the Alliance Partnership Safety Council in 2017, is still an active contributor to the council, and hosts routine contractor safety forums for the client. Brian is actively involved in the development and implementation of program safety, health, and environmental (SH&E) plans to ensure safe operations on project sites. Brian developed permits and Health and Safety Plans for large projects and routinely audits the site safety. Additional responsibilities include:

- Driving reporting and behavior-based safety initiatives to support our internal safety culture and developing monthly summary reports to illustrate performance to our client.
- Develop, assess and continuously improve site safety plans and practices, including specific safety protocols for working safely over and around water.
- Worked as an extension of the client's organization to provide assurance that the remedy was completed safely and consistent with client-specific requirements.
- Support on-site safety personnel in ensuring the health and safety of the general public, our staff, and our sub-contracted employees.
- Audits and visits sites to ensure compliance with our internal policies and client-specific requirements.

Energy Client, Ohio. As Chief Health and Safety Officer, Brian supports the project team in developing and executing client and project specific health and safety measures, such as a site specific Health and Safety Plan, Job Hazard Analyses, Industrial Hygiene program, and site specific training. Brian also routinely visits the site to assess current practices and condition and to ensure continuous improvement. Additional responsibilities include:

- Develop, assess, and continuously improve site safety plans and practices, including specific safety protocols to comply with supplemental EH&S requirements such as the Duke Health and Safety Handbook, Environmental Supplemental, and EHS Keys to Life.
- Develop, assess, and continuously improve site safety plans and practices to address the risks associated with the work being performed on site, as well as the environmental conditions and simultaneous operations, including trenching and excavation, hot work, work over and near water, heavy equipment, HAZWOPER, etc.
- Worked as an extension of the client's organization to provide assurance that the remedy was completed safely and consistent with client-specific requirements.
- Support on-site safety personnel in ensuring the health and safety of the general public, our staff, and our sub-contracted employees.
- Audits and visits site to ensure compliance with our internal policies and client-specific requirements.

KATHERINE R. MILLER

Project Manager

EDUCATION

B.S., Chemistry, University of Arizona

SPECIAL STUDIES AND COURSES

40-Hour OSHA Hazardous Waste Operations and Emergency Response Training (29 CFR 1910.120 and 40 CFR 265.16)
8-Hour OSHA Refresher Training (29 CFR 1910.120)
Level IV Data Validation Training

AWARDS

Pinnacle Award, 2009
Pathfinder Award, 2014

In her 10 years at Haley & Aldrich, Katherine has worked on soil and groundwater environmental investigations and the preparation of environmental reports for private, industrial, and government-based project clients. She is a qualified Data Validator capable of performing various levels of validation on laboratory water quality data according to U.S. Environmental Protection Agency (EPA) National Functional Guidelines and to U.S. Department of Energy radiochemical guidelines. She also has experience designing and maintaining databases for project-specific needs.

Project management responsibilities for a $1.5 million per year stormwater project include preparation of subcontractor bids and contracts; preparation of cost estimates, proposals, and reports; coordination of field testing programs; and interpretation of chemical testing results. She has interacted with local regulatory agencies.

RELEVANT PROJECT EXPERIENCE

Confidential Aerospace Manufacturer, Groundwater Monitoring, Western U.S. Katherine served as project manager for the comprehensive stormwater management program. Responsibilities included project finance management and data management including quality assurance/quality control (QA/QC) and interpretation of chemical testing results. Evaluated QA/QC of groundwater quality data, prepared reports and managed data for the site. Performed data validation of quarterly water quality data from over 300 locations according to EPA National Functional Guidelines and to DOE radiochemical guidelines over a six-year period. Also, responsible for updating and maintaining the integrity of over 200,000 records during that time period. Assisted with management of sampling, analysis, and reporting of constituents of concern, ensured compliance with post-closure permit monitoring and reporting requirements, Data Management Plan, QAPP, and Environmental Data Management System, and ensured and maintained 100% compliance with the QAPP and Data Management Plan. Additionally, prepared groundwater data summaries for proposed extraction wells including comparisons to site NPDES outfall limits in support of Groundwater Interim Measures planning.

Asarco Hayden Plant Site, Hayden, Arizona. Katherine assisted with field preparation, QA/QC of analytical data, and data validation as part of the Remedial Investigation/Feasibility Work Plan including soil, sediment, air, process water, surface water, and stormwater.

Former MGP Site, California. Katherine assisted with report preparation, QA/QC of soil and/or groundwater quality data, and data validation for the investigation of three large former MGP sites in an urban, residential setting; includes over 200 residential properties.

General Manufacturing, Leitchfield, Kentucky. Katherine assisted with report preparation, QA/QC of soil and/or groundwater quality data, and data validation for a soil and groundwater RCRA site. Groundwater monitoring is conducted annually at more than 50 locations for volatile organic compounds (VOCs), including 1,4-dioxane and semi-volatile organic compound (SVOCs).

Skyworks Solutions, Inc., Newbury Park, California. Katherine assisted with report preparation, QA/QC of soil and/or groundwater quality data, and data validation at groundwater remediation site. She monitored for VOCs, including 1,4-dioxane, and inorganic chemicals, including hexavalent chromium.

Teledyne Scientific Company, Thousand Oaks, California. Katherine assisted with report preparation for this groundwater assessment site. Monitored natural attenuation has been instituted as the long-term site remedy.

Port of Redwood City, Permitting and Sediment Characterization, California. Katherine assisted with report preparation, QA/QC of sampling data, and data validation.

Kiewit Infrastructure West, Sediment Quality Study, California. Katherine assisted with report preparation, QA/QC of sampling data, and data validation.

Aeolian Yacht Harbor, Permitting, Eel Grass Conservation and Sediment Characterization, California. Katherine assisted with report preparation, QA/QC of sampling data, and data validation.

Marin County, Paradise Cay Permitting and Sediment Characterization, California. Katherine assisted with report preparation, QA/QC of sampling data, and data validation.

APPENDIX C
HDPE and LLDPE Geomembrane Liner Manufacturer Specifications

Guidelines for Installation of:

HDPE and LLDPE Geomembrane Installation Specification



International Association of Geosynthetic Installers

www.iagi.org

Revised November 1, 2015

Guidelines for Installation of:

HDPE and LLDPE Geomembrane Installation Specification



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Part 1 — GENERAL

1.01 Guideline Scope

A.

This specification includes furnishing and installing HDPE and LLDPE geomembranes with a formulated sheet density of 0.940 g/cc or greater associated with HDPE geomembranes and a formulated sheet density of 0.939 or less for LLDPE geomembranes. Geomembranes with both smooth and textured surfaces are included.

1.02 References

A. American Society for Testing and Materials (ASTM):

1. D 638, Standard Test Method for Tensile Properties of Plastics.
2. D 4439 Terminology for Geosynthetics.
3. D 751, Standard Test Methods for Coated Fabrics.
4. D 792, Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
5. D 1004, Standard Test Method for Initial Tear Resistance of Plastic Film and Sheeting.
6. D 1204, Standard Test Method for Linear Dimensional Changes of Non Rigid Thermoplastic Sheeting or Film at Elevated Temperature.
7. D 1238, Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer.
8. D 1505, Standard Test Method for Density of Plastics by Density-Gradient Technique.
9. D 1603, Standard Test Method for Carbon Black in Olefin Plastics.
10. D 3895, Test Method for Oxidative Induction Time of Polyolefins by Thermal Analysis.

11. D 4218, Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique.
12. D4437 – 08, Standard Practice for Non-destructive Testing (NDT) for Determining the Integrity of Seams Used in Joining Flexible Polymeric Sheet Geomembranes.
13. D 4833, Test Method for Index Puncture Resistance of Geotextiles, Geomembranes and Related Products.
14. D 5199, Standard Test Method for Measuring Nominal Thickness of Smooth Geomembranes.
15. D 5397, Standard Test Method for Evaluation of Stress Crack. Resistance of Polyolefins using Notched Constant Tensile Load Test.
16. D 5596, Standard Practice for Microscopical Examination of Pigment Dispersion in Plastic Compounds.
17. D 5641, Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber.
18. D 5721, Practice for Air-Oven Aging of Polyolefin Geomembranes.
19. D 5820, Test Method for Air Testing.
20. D 5885, Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by High Pressure Differential Scanning Calorimetry.
21. D 5994, Standard Test Method for Measuring Nominal Thickness of Textured Geomembranes.
22. D 6365, Standard Practice for the Nondestructive Testing of Geomembrane Seams using The Spark Test.
23. D5820-95, Pressurized Air Channel Test for Dual Seamed Geomembranes.
24. D 6392-08, Integrity of Non-reinforced Geomembrane Seams Produced Using Thermo-Fusion Methods.
25. D7002, Standard Practice for Electrical Leak Location on Exposed Geomembranes Using the Water Puddle Method.
26. D7007-15, Standard Practices for Electrical Methods for Locating Leaks in Geomembranes Covered with Water or Earthen Materials.

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27. ASTM D7466, Measurement of the Asperity Height of Textured Geomembranes Using a Depth Gage

B. Geosynthetic Research Institute (GRI)

1. GRI GM 9, Cold Weather Seaming of Geomembranes
2. GRI GM 10, The Stress Crack Resistance of HDPE Geomembrane Sheet
3. GRI GM 13, Test Properties, Testing Frequency for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes
4. GRI GM 14, Test Frequencies for Destructive Seam Testing Selecting, variable intervals for taking geomembrane destructive samples using the method of attributes.
5. GRI GM 17, Test Methods, Test Properties and Testing Frequency for Linear Low Density Polyethylene (LLDPE) Smooth and Textured Geomembranes
6. GRI GM 19, Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembranes.
7. GRI GM 20, Selecting Variable Intervals for Taking Geomembrane Destructive Seam Samples Using Control Charts.

1.03 Submittals

A. Submit under provisions of Section 1.03B an 1.03D

B. Submit the following to the Engineer or Owner, for review and approval, within a reasonable time so as to expedite shipment or installation of the Geomembrane:

1. Documentation of manufacturer's qualifications as specified in subsection 1.04A of this Section.
2. Manufacturer's Quality Control program manual or descriptive documentation.

3. A material properties sheet, including at a minimum all properties specified in GRI GM 13 or GRI GM 17, including test methods used.
4. Sample of the material.
5. Documentation of Installer's qualifications, as specified below and in subsection 1.04B of this Section.
   a. Submit a list of at least ten completed facilities. For each installation, provide: name and type of facility; its location; the date of installation; name and telephone number of contact at the facility; type and thickness of geomembrane and; surface area of the installed geomembrane.
   b. Submit resumes or qualifications of the Installation Supervisor, Master Seamer and IAGI Certified Welding Technicians (CWTs) to be assigned to this project.
   c. Quality Control Program.
6. Example Material Warranty and Liner Installation Warranty.

C. Shop Drawings

1. Submit copies of shop drawings for engineer's approval within a reasonable time so as not to delay the start of geomembrane installation. Shop drawings shall show the proposed panel layout identifying seams and details. Seams should generally follow the direction of the slope. Butt seams or roll-end seams should not occur on a slope unless approved by the Owner's Representative. Butt seams on a slope, if allowed, should be staggered.
2. Placement of geomembrane should not be allowed to proceed until Owner's Representative has received and approved the shop drawings.

D. Additional Submittals (In-Progress and at Completion)

1. Manufacturer's warranty (refer to subsection 1.07).
2. Geomembrane installation warranty (refer to subsection 1.08).

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3. Daily written acceptance of subgrade surface (refer to subsection 3.01.C).
4. Low-temperature seaming procedures if applicable (refer to subsection 3.03.A).
5. Prequalification test seam samples (refer to subsection 3.05.A.6).
6. Field seam non-destructive test results (refer to subsection 3.05.B.1).
7. Field seam destructive test results (refer to subsection 3.05.C.6).
8. Daily field installation reports (refer to subsection 3.05.G).
9. Installation record drawing, as discussed in subsection 3.05.

1.04 Quality Control

A. Manufacturer's Qualifications: The manufacturer of geomembrane of the type specified or similar product shall have at least five years experience in the manufacture of such geomembrane. In addition, the geomembrane manufacturer shall have manufactured at least 1,000,000 M^2 (10,000,000 FT^2) of the specified type of geomembrane or similar product during the last five years.

B. Installer's Qualifications

1. The Geomembrane Installer shall be the Manufacturer, approved Manufacturer's Installer or a contractor approved by the Owner's Representative to install the geomembrane.
2. The Geomembrane Installer shall have at least three years experience in the installation of the specified geomembrane or similar. The Geomembrane Installer shall have installed at least 10 projects involving a total of 500,000 M^2 (5,000,000 FT^2) of the specified type of geomembrane or similar during the last three years.

3. Installation shall be performed under the direction of a field Installation Supervisor who shall be responsible throughout the geomembrane installation, for geomembrane panel layout, seaming, patching, testing, repairs, and all other activities of the Geomembrane Installer. The Field Installation Supervisor shall have installed or supervised the installation and seaming of a minimum of 10 projects involving a total of 500,000 M^2 (5,000,000 FT^2) of geomembrane of the type specified or similar product.

4. Seaming shall be performed under the direction of a Master Seamer (who may also be the Field Installation Supervisor or Crew Foreman) who has seamed a minimum of 300,000 M^2 (3,000,000 FT^2) of geomembrane of the type specified or similar product, using the same type of seaming apparatus to be used in the current project. The Field Installation Supervisor and/or Master Seamer shall be present whenever seaming is performed.

5. All seaming, patching, other welding operations, and testing shall be performed by qualified technicians employed by the Geomembrane Installer.

1.05 Delivery, Storage and Handling

A. Each roll of geomembrane delivered to the site shall be labeled by the manufacturer. The label shall be firmly affixed and shall clearly state the manufacturer's name, product identification, material thickness, roll number, roll dimensions and roll weight.

B. Geomembrane shall be protected from mud, dirt, dust, puncture, cutting or any other damaging or deleterious conditions.

C. Rolls shall be stored away from high traffic areas. Continuously and uniformly support rolls on a smooth, level prepared surface.

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1.06 Project Conditions

A. Geomembrane should not be installed in the presence of standing water, while precipitation is occurring, during excessive winds, or when material temperatures are outside the limits specified in Section 3.03.

1.07 Material Warranty

A. As agreed by project participants.

1.08 Geomembrane Installation Warranty

A. The Geomembrane Installer shall guarantee the geomembrane installation against defects in the installation and workmanship for 1 year commencing with the date of final acceptance.

1.09 Geomembrane Pre-Construction Meeting

A. A geomembrane pre-construction meeting shall be held at the site prior to installation of the geomembrane. At a minimum, the meeting shall be attended by the Geomembrane Installer, Owner, Owner's representative (Engineer and/or CQA Firm), and the Earthwork Contractor.

B. Topics for this meeting shall include:

1. Health and Safety
2. Lines of authority and communication. Resolution of any project document ambiguity.

3. Methods for documenting, reporting and distributing documents and reports.
4. Procedures for packaging and storing archive samples.
5. Review of time schedule for all installation and testing.
6. Review of panel layout and numbering systems for panels and seams including details for marking on geomembrane.
7. Procedures and responsibilities for preparation and submission of as-built panel and seam drawings.
8. Temperature and weather limitations. Installation procedures for adverse weather conditions. Defining acceptable subgrade, geomembrane, or ambient moisture and temperature conditions for working during liner installation.
9. Subgrade conditions, dewatering responsibilities and subgrade maintenance plan.
10. Deployment techniques including allowable subgrade for the geomembrane.
11. Plan for controlling expansion/contraction and wrinkling of the geomembrane.
12. Covering of the geomembrane and cover soil placement.
13. Measurement and payment schedules.
14. Responsibilities of each party.

C. The meeting shall be documented by a person designated at the beginning of the meeting and minutes shall be transmitted to all parties.

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PART 2 - PRODUCTS

2.01 Source Quality Control

A. Manufacturing Quality Control

1. The test methods and frequencies used by the manufacturer for quality control/quality assurance of the above geomembrane prior to delivery, shall be in accordance with GRI GM 13 for HDPE geomembrane or GRI GM 17 for LLDPE geomembrane, or modified as required for project specific conditions.

2. The manufacturer's geomembrane quality control certifications, including results of quality control testing of the products, as specified in subsection 2.01.A.3 of this Section, must be supplied to the Owner's Representative to verify that the materials supplied for the project are in compliance with all product and or project specifications in this Section. The certification shall be signed by a responsible party employed by the manufacturer, such as the QA/QC Manager, Production Manager, or Technical Services Manager. Certifications shall include lot and roll numbers and corresponding shipping information.

3. The Manufacturer will provide Certification that the geomembrane and welding rod supplied for the project are made from the same material type and are compatible.

2.02 Geomembrane

A. The geomembrane shall consist of new, first quality products designed and manufactured specifically for the purpose of this work which shall have been satisfactorily demonstrated by prior testing to be suitable and durable for such purposes. The geomembrane rolls shall be seamless, high density polyethylene (HDPE - Formulated Sheet Density ≥ 0.940g/cc) or linear low density pol-

yethylene (LLDPE - Formulated Sheet Density ≤ 0.939 g/cc) containing no plasticizers, fillers or extenders and shall be free of holes, blisters or contaminants, and leak free verified by 100% in line spark or equivalent testing. The geomembrane shall be supplied as a continuous sheet with no factory seams in rolls. The geomembrane will meet the property requirements as shown in Table 1a or 2a (GRI GM 13) or Table 1a or 2a (GRI GM 17).

B. Material conformance testing by the Owner's Representative, if required, will be conducted using in-plant sampling or as specified for the project.

C. The geomembrane seams shall meet the property requirements as shown in Table 2, (Attachment B) or as required by project specifications.

Interesting Historical Fact:

Before Australia adopted the metric system, they used the term "thou" to mean thousandth of an inch instead of using the term "mil." So 30 mil geomembranes would be referred to as "30 thou." For clarification, the use of the term mil in this guideline means "thousandth of an inch."

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PART 3 - EXECUTION

3.01 Subgrade Preparation

A. The subgrade shall be prepared in accordance with the project specifications. The geomembrane subgrade shall be uniform and free of sharp or angular objects that may damage the geomembrane prior to installation of the geomembrane.

B. The Geomembrane Installer and Owner’s Representative shall inspect the surface to be covered with the geomembrane on each day's operations prior to placement of geomembrane to verify suitability.

C. The Geomembrane Installer and Owner’s Representative shall provide daily written acceptance for the surface to be covered by the geomembrane in that day's operations. The surface shall be maintained in a manner, during geomembrane installation, to ensure subgrade suitability.

D. All subgrade damaged by construction equipment and deemed unsuitable for geomembrane deployment shall be repaired prior to placement of the geomembrane. All repairs shall be approved by the Owner's Representative and the Geomembrane Installer. This damage, repair, and the responsibilities of the contractor and Geomembrane Installer shall be defined in the preconstruction meeting.

3.02 Geomembrane Placement

A. No geomembrane shall be deployed until the applicable certifications and quality control certificates listed in subsection 1.03 of this Section are submitted to and approved by the Owner's Representative within the timeframe specified in the contract documents. If the material does not meet project specifications it shall be removed from the work area.

B. The geomembrane shall be installed to the limits shown on the project drawings and essentially as shown on approved panel layout drawings.

C. No geomembrane material shall be unrolled and deployed if the material temperatures are lower than 0 degrees C (32 degrees F) unless otherwise approved by the Owner's Representative. The specified minimum temperature for material deployment may be adjusted by the Owner's Representative. Temperature limitations should be defined in the preconstruction meeting. Typically, only the quantity of geomembrane that will be anchored and seamed together in one day should be deployed.

D. No vehicular traffic shall travel on the geomembrane other than an approved low ground pressure vehicle or equivalent.

E. Sandbags or equivalent ballast shall be used as necessary to temporarily hold the geomembrane material in position under the foreseeable and reasonably expected wind conditions. Sand bag material shall be sufficiently close-knit to prevent soil fines from working through the bags and discharging on the geomembrane.

F. Geomembrane placement shall not be done if moisture prevents proper subgrade preparation, panel placement, or panel seaming. Moisture limitations should be defined in the preconstruction meeting.

G. Damaged panels or portions of the damaged panels which have been rejected shall be marked and their removal from the work area recorded.

H. The geomembrane shall not be allowed to "bridge over" voids or low areas in the subgrade. The geomembrane shall rest in intimate contact with the subgrade.

I. Wrinkles caused by panel placement or thermal expansion should be minimized in accordance with section 1.09 B11.

J. Considerations on site geometry: In general, seams shall be oriented parallel to the line of the maximum slope. In corners and odd shaped geometric loca-

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tions, the total length of field seams shall be minimized. Seams shall not be located at low points in the subgrade unless geometry requires seaming at such locations and if approved by the Owner's Representative.

K. Overlapping: The panels shall be overlapped prior to seaming to whatever extent is necessary to affect a good weld and allow for proper testing. In no case shall this overlap be less than 75 mm (3 in.).

3.03 Seaming Procedures

A. Cold weather installations should follow guidelines as outlined in GRI GM9.

B. No geomembrane material shall be seamed when liner temperatures are less than 0 degrees C (32 degrees F) unless the following conditions are complied with:

1. Seaming of the geomembrane at material temperatures below 0 degrees C (32 degrees F) is allowed if the Geomembrane Installer can demonstrate to the Owner's Representative, using pre-qualification test seams, that field seams comply with the project specifications, the safety of the crew is ensured, and geomembrane material can be fabricated (i.e. pipeboots, penetrations, repairs. etc.) at sub-freezing temperatures.

2. The Geomembrane Installer shall submit to the Owner's Representative for approval, detailed procedures for seaming at low temperatures, possibly including the following:
   a. Preheating of the geomembrane.
   b. The provision of a tent or other device if necessary to prevent heat losses during seaming and rapid heat losses subsequent to seaming.
   c. Number of test welds to determine appropriate seaming parameters.

C. No geomembrane material shall be seamed when the sheet temperature is above 75 degrees C (170 degrees F) as measured by an infrared thermometer or surface thermocouple unless otherwise approved by the Owner's Representative. This approval will be based on recommendations by the manufacturer and on a field demonstration by the Geomembrane Installer using prequalification test seams to demonstrate that seams comply with the specification.

D. Seaming shall primarily be performed using automatic fusion welding equipment and techniques. Extrusion welding shall be used where fusion welding is not possible such as at pipe penetrations, patches, repairs and short (less than a roll width) runs of seams.

E. Fishmouths or excessive wrinkles at the seam overlaps shall be minimized and when necessary cut along the ridge of the wrinkles back into the panel so as to effect a flat overlap. The cut shall be terminated with a keyhole cut (nominal 10 mm (1/2 in) diameter hole) so as to minimize crack/tear propagation. The overlay shall subsequently be seamed. The key hole cut shall be patched with an oval or round patch of the same base geomembrane material extending a minimum of 150 mm (6 in.) beyond the cut in all directions.

3.04 Pipe and Structure Penetration Sealing System

A. Provide penetration sealing system as shown in the Project Drawings.

B. Penetrations shall be constructed from the base geomembrane material, flat stock, prefabricated boots and accessories as shown on the Project Drawings. The pre-fabricated or field fabricated assembly shall be field welded to the geomembrane as shown on the Project Drawings so as to prevent leakage. This assembly shall be tested as outlined in section 3.05.B. Alternatively, where field non-destructive testing cannot be performed, attachments will be field spark tested by standard holiday leak detectors in accordance with ASTM

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6365.

C. Spark testing should be done in areas where both air pressure testing and vacuum testing are not possible.

1. Equipment for spark testing shall be comprised of but not limited to a hand held holiday spark tester and conductive wand that generates a high voltage.

2. The testing activities shall be performed by the Geomembrane Installer by placing an electrically conductive tape or wire beneath the seam prior to welding. A trial seam containing a non-welded segment shall be subject to a calibration test to ensure that such a defect (non-welded segment) will be identified under the planned machine settings and procedures. Upon completion of the weld, enable the spark tester and hold approximately 25mm (1 in) above the weld moving slowly over the entire length of the weld in accordance with ASTM 6365. If there is no spark the weld is considered to be leak free.

3. A spark indicates a hole in the seam. The faulty area shall be located, repaired and retested by the Geomembrane Installer.

4. Care should be taken if flammable gases are present in the area to be tested.

3.05 Field Quality Control

The Owner's Representative shall be notified prior to all pre-qualification and production welding and testing, or as agreed upon in the pre-construction meeting.

A. Prequalification Test Seams

1. Test seams shall prepare and tested by the Geomembrane Installer to verify that seaming parameters (speed, temperature and pressure of welding equipment) are adequate.

2. Test seams shall be made by each welding technician and tested in accordance with ASTM D 4437 at the beginning of each seaming period. Test seaming shall be performed under the same conditions and with the same equipment and operator combination as production seaming. The test seam shall be approximately 3.3 meters (10 feet) long for fusion welding and 1 meter (3 feet) long for extrusion welding with the seam centered lengthwise. At a minimum, tests seams should be made by each technician 1 time every 4–6 hours; additional tests may be required with changes in environmental conditions.

3. Two 25 mm (1 in) wide specimens shall be die-cut by the Geomembrane Installer from each end of the test seam. These specimens shall be tested by the Geomembrane Installer using a field tensiometer testing both tracks for peel strength and also for shear strength. Each specimen should fail in the parent material and not in the weld, “Film Tear Bond"(F.T.B. failure). Seam separation equal to or greater than 25% of the track width shall be considered a failing test.

4. The minimum acceptable seam strength values to be obtained for all specimens tested are listed in Subsection 3.05.C.4 of this Section. Four specimens shall pass and the fifth specimen must meet or exceed 80% of the required seam strength for the test seam to be a passing seam.

5. If a test seam fails, an additional test seam shall be immediately conducted. If the additional test seam fails, the seaming apparatus shall be rejected and not used for production seaming until the deficiencies are corrected and a successful test seam can be produced.

6. A sample from each test seam shall be labeled. The label shall indicate the date, geomembrane temperature, number of the seaming unit, technician performing the test seam and pass or fail description. The sample shall then be given to the Owner's Representative for archiving.

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B. Field Seam Non-destructive Testing

1. All field seams shall be non-destructively tested by the Geomembrane Installer over the full seam length before the seams are covered. Each seam shall be numbered or otherwise designated. The location, date, test unit, name of tester and outcome of all non-destructive testing shall be recorded and submitted to the Owner's Representative.

2. Testing should be done as the seaming work progresses, not at the completion of all field seaming, unless agreed to in advance by the Owner's Representative. All defects found during testing shall be numbered and marked immediately after detection. All defects found should be repaired, retested and remarked to indicate acceptable completion of the repair.

3. Non-destructive testing shall be performed using vacuum box, air pressure or spark testing equipment.

4. Non-destructive tests shall be performed by experienced technicians familiar with the specified test methods. The Geomembrane Installer shall demonstrate to the Owner's Representative all test methods to verify the test procedures are valid.

5. Extrusion seams shall be vacuum box tested by the Geomembrane Installer in accordance with ASTM D 4437 and ASTM D 5641 with the following equipment and procedures:

    a. Equipment for testing extrusion seams shall be comprised of but not limited to: a vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft rubber gasket attached to the base, port hole or valve assembly and a vacuum gauge; a vacuum pump assembly equipped with a pressure controller and pipe connections; a rubber pressure/vacuum hose with fittings and connec-

tions; a plastic bucket; wide paint brush or mop; and a soapy solution.

b. The vacuum pump shall be charged and the tank pressure adjusted to approximately 35 kPa (5 psig).

c. The Geomembrane Installer shall create a leak tight seal between the gasket and geomembrane interface by wetting a strip of geomembrane approximately 0.3m (12 in) by 1.2m (48 in) (length and width of box) with a soapy solution, placing the box over the wetted area, and then compressing the box against the geomembrane. The Geomembrane Installer shall then close the bleed valve, open the vacuum valve, maintain initial pressure of approximately 35 kPa (5 psig) for approximately five (5) seconds. The geomembrane should be continuously examined through the viewing window for the presence of soap bubbles, indicating a leak. If no bubbles appear after five (5) seconds, the area shall be considered leak free. The box shall be depressurized and moved over the next adjoining area with an appropriate overlap and the process repeated.

d. All areas where soap bubbles appear shall be marked, repaired and then retested.

e. At locations where seams cannot be nondestructively tested, such as pipe penetrations, alternate nondestructive spark testing (as outlined in section 3.04.B) or equivalent should be substituted.

f. All seams that are vacuum tested shall be marked with the date tested, the name of the technician performing the test and the results of the test.

6. Double Fusion seams with an enclosed channel shall be air pressure tested by the Geomembrane Installer in accordance with ASTM D 5820 and ASTM D 4437 and the following equipment and procedures:

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a. Equipment for testing double fusion seams shall be comprised of but not limited to: an air pump equipped with a pressure gauge capable of generating and sustaining a pressure of 210 kPa (30 psig), mounted on a cushion to protect the geomembrane; and a manometer equipped with a sharp hollow needle or other approved pressure feed device.

b. The testing activities shall be performed by the Geomembrane Installer. Both ends of the seam to be tested shall be sealed and a needle or other approved pressure feed device inserted into the tunnel created by the double wedge fusion weld. The air pump shall be adjusted to a pressure of 210 kPa (30 psig), and the valve closed. Allow two (2) minutes for the injected air to come to equilibrium in the channel, and sustain pressure for five (5) minutes. If pressure loss does not exceed 28 kPa (4 psig) after this five minute period the seam shall be considered leak tight. Release pressure from the opposite end verifying pressure drop on needle to ensure testing of the entire seam. The needle or other approved pressure feed device shall be removed and the feed hole sealed.

NOTE: Historically, destructive seam testing has been conducted every 150 lineal meters. (approximately 500 lineal feet). There is a movement toward doing less destructive testing mid field seam. The rationale behind this change is that when a hole is cut from a seam, it is repaired with a seam that is not as good as the original. There are several methods used within the industry to reduce the amount of destructive seam sampling done. One method involves the use of both destructive and non-destructive methods for testing seam integrity. First, the seam must be made with split-wedge welder and successfully air channel tested. Also a destructive seam sample is taken from the anchor trench and tested. If both tests are successful, then no destructive seams are taken from the field seam. If either test fails, then destructive sampling is conducted on the field seam. A second method is detailed in GRI's GM 14 guideline "Selecting Variable Intervals for Taking Geomembrane Destructive Seam Samples Using the Method of Attributes." A simplified explanation of this method is that good seaming performance is rewarded by extending the de-

c. If loss of pressure exceeds 28 kPa (4 psig) during the testing period or pressure does not stabilize, the faulty area shall be located, repaired and retested by the Geomembrane Installer.

d. Results of the pressure testing shall be recorded on the liner at the seam tested and on a pressure testing record.

C. Destructive Field Seam Testing

1. One destructive test sample per 150 linear m (500 linear ft) seam length or another predetermined length in accordance with GRI GM14 or GRI GM20 shall be taken by the Geomembrane Installer from a location specified by the Owner's Representative. The Geomembrane Installer shall not be informed in advance of the sample location. In order to obtain test results prior to completion of geomembrane installation, samples shall be cut by the Geomembrane Installer as directed by the Owner's Representative as seaming progresses.

2. All field samples shall be marked with their sample number and seam number. The sample number, date, time, location, and seam number shall be recorded. The Geomembrane Installer shall repair all holes in the geomembrane resulting from obtaining the seam samples. All patches shall be vacuum box tested or spark tested. If a patch cannot be permanently installed over the test location the same day of sample collection, a temporary patch shall be tack welded or hot air welded over the opening until a permanent patch can be affixed.

3. The destructive sample size shall be 300 mm (12 in) wide by 1 m (36 in) long with the seam centered lengthwise. The sample shall be cut into three equal sections and distributed as follows: one section given to the Owner's Representative as an archive sample; one section given to the Owner's Representative for laboratory testing as specified in paragraph 5 below; and one section retained by the Geomembrane Installer for field testing as specified in paragraph 4 below.

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4. For field testing, the Geomembrane Installer shall cut 10 identical 25 mm (1 in) wide replicate specimens from the sample. The Geomembrane Installer shall test five specimens for seam shear strength and five for peel strength. Peel tests will be performed on both inside and outside weld tracks. To be acceptable, 4 of 5 test specimens must pass the stated criteria in section 2.02 with less than 25% separation. The fifth specimen must meet or exceed 80% of the required seam strength.

5. If independent seam testing is required by the specifications it shall be conducted in accordance with ASTM 5820 or ASTM D4437.

6. Reports of the results of examinations and testing shall be prepared and submitted to the Owner's Representative.

7. For field seams, if a laboratory test fails, that shall be considered as an indicator of the possible inadequacy of the entire seamed length corresponding to the test sample. Additional destructive test portions shall then be taken by the Geomembrane Installer at locations indicated by the Engineer; typically 3 m (10 ft.) on either side of the failed sample and laboratory seam tests shall be performed. Passing tests shall be an indicator of adequate seams. Failing tests shall be an indicator of non-adequate seams and all seams represented by the destructive test location shall be repaired with a cap-strip extrusion welded to all sides of the capped area. All cap-strip seams shall be non-destructively vacuum box tested until adequacy of the seams is achieved. Cap strip seams exceeding 50 M in length (150 FT) shall be destructively tested.

D. Identification of Defects

1. Panels and seams shall be inspected by the Installer and Owner's Representative during and after panel deployment to identify all defects, including holes, blisters, undispersed raw materials and signs of contamination by foreign matter.

E. Evaluation of Defects: Each suspect location on the liner (both in geomembrane seam and non-seam areas) shall be non-destructively tested using one of the methods described in Section 3.05.B. Each location which fails non-destructive testing shall be marked, numbered, measured and posted on the daily "installation" drawings and subsequently repaired.

1. If a destructive sample fails the field or laboratory test, the Geomembrane Installer shall repair the seam between the two nearest passed locations on both sides of the failed destructive sample location.
2. Defective seams, tears or holes shall be repaired by re-seaming or applying an extrusion welded cap strip.
3. Reseaming may consist of either:
    a. Removing the defective weld area and rewelding the parent material using the original welding equipment; or
    b. Reseaming by extrusion welding along the overlap at the outside seam edge left by the fusion welding process.
4. Blisters, larger holes, and contamination by foreign matter shall be repaired by patches and/or extrusion weld beads as required. Each patch shall extend a minimum of 150 mm (6 in) beyond all edges of the defects.
5. All repairs shall be measured, located and recorded.

F. Verification of Repairs on Seams: Each repair shall be non-destructively tested using either vacuum box or spark testing methods. Tests which pass the non-destructive test shall be taken as an indication of a successful repair. Failed tests shall be reseamed and retested until a passing test results. The number, date, location, technician and test outcome of each patch shall be recorded.

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G. Daily Field Installation Reports: At the beginning of each day's work, the Installer shall provide the Engineer with daily reports for all work accomplished on the previous work day. Reports shall include the following:

1. Total amount and location of geomembrane placed;
2. Total length and location of seams completed, name of technicians doing seaming and welding unit numbers;
3. Drawings of the previous day's installed geomembrane showing panel numbers, seam numbers and locations of non-destructive and destructive testing;
4. Results of pre-qualification test seams;
5. Results of non-destructive testing; and
6. Results of vacuum testing of repairs.

H. Destructive test results shall be reported prior to covering of liner or within 48 hours.

3.06 Liner Acceptance

A. Geomembrane liner will be accepted by the Owner's Representative when:

1. The entire installation is finished or an agreed upon subsection of the installation is finished;
2. All Installer’s QC documentation is completed and submitted to the owner;
3. Verification of the adequacy of all field seams and repairs and associated geomembrane testing is complete.

3.07 Anchor Trench

A. Construct as specified on the project drawings.

3.08 Disposal of Scrap Materials

A. On completion of installation, the Geomembrane Installer shall dispose of all trash and scrap material in a location approved by the Owner, remove equipment used in connection with the work herein, and shall leave the premises in a neat acceptable manner. No scrap material shall be allowed to remain on the geomembrane surface.

PART 4 - MEASUREMENT AND PAYMENT

As per project specifications.

PART 5 - GSI GM13 SPECIFICATION

"This section shall include the current GSI GM13 manufacturer's specification or a revision of GSI GM13 specific to the unique project requirements and/or standards, as determined by the owner or owners' agent."

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Attachment A.

Table 1(a) – Seam Strength and related Properties of Thermally Bonded Smooth and Textured **Linear Low Density Polyethylene (LLDPE)** Geomembrane **(English Units)**

Geomembrane Nominal Thickness	**20 mils**	**30 mils**	**40 mils**	**50 mils**	**60 mils**	**80 mils**	**100 mils**	**120 mils**
Hot Wedge Seams [1]								
shear strength[2], lb/in.	**30**	**45**	**60**	**75**	**90**	**120**	**150**	**180**
shear elongation at break[3] , %	50	50	50	50	50	50	50	50
peel strength [2], lb/in.	**25**	**38**	**50**	**63**	**75**	**100**	**125**	**150**
peel separation, %	25	25	25	25	25	25	25	25
Extrusion Fillet Seams [1]								
shear strength[2], lb/in.	**30**	**45**	**60**	**75**	**90**	**120**	**150**	**180**
shear elongation at break[3] , %	50	50	50	50	50	50	50	50
peel strength [2], lb/in.	**22**	**34**	**44**	**57**	**66**	**88**	**114**	**136**
peel separation, %	25	25	25	25	25	25	25	25

Table 1(b) – Seam Strength and related Properties of Thermally Bonded Smooth and Textured **Linear Low Density Polyethylene (LLDPE)** Geomembrane **(S.I. Units)**

Geomembrane Nominal Thickness	**0.50 mm**	**0.75 mm**	**1.0 mm**	**1.25 mm**	**1.5 mm**	**2.0 mm**	**2.5 mm**	**3.0 mm**
Hot Wedge Seams [1]								
shear strength[2], N/25mm	**131**	**197**	**263**	**328**	**394**	**525**	**657**	**788**
shear elongation at break[3] , %	50	50	50	50	50	50	50	50
peel strength [2], N/25mm	**109**	**166**	**219**	**276**	**328**	**438**	**547**	**657**
peel separation, %	25	25	25	25	25	25	25	25
Extrusion Fillet Seams [1]								
shear strength[2], N/25mm	**131**	**197**	**263**	**328**	**394**	**525**	**657**	**788**
shear elongation at break[3] , %	50	50	50	50	50	50	50	50
peel strength [2], N/25mm	**95**	**150**	**190**	**250**	**290**	**385**	**500**	**595**
peel separation, %	25	25	25	25	25	25	25	25

Notes for Tables 1(a) and 1(b):

1. Also for hot air and ultrasonic seaming methods
2. Value listed for shear and peel strength are for 4 out of 5 test specimens; the 5th specimen can be low as 80% of the listed values
3. Elongation measurements should be omitted for field testing

Table 2(a) – Seam Strength and related Properties of Thermally Bonded Smooth and Textured **High Density Polyethylene (HDPE)** Geomembrane **(English Units)**

Geomembrane Nominal Thickness	30 mils	40 mils	50 mils	60 mils	80 mils	100 mils	120 mils
Hot Wedge Seams[1]							
Shear strength[2], lb/in.	**57**	**80**	**100**	**120**	**160**	**200**	**240**
Shear elongation at break[3], %	50	50	50	50	50	50	50
Peel strength[2], lb/in.	**45**	**60**	**76**	**91**	**121**	**151**	**181**
Peel separation, %	25	25	25	25	25	25	25
Extrusion Fillet Seams							
Shear strength[2], lb/in.	**57**	**80**	**100**	**120**	**160**	**200**	**240**
Shear elongation at break[3], %	50	50	50	50	50	50	50
Peel strength[2], lb/in.	**39**	52	**65**	**78**	**104**	**130**	**156**
Peel separation, %	25	25	25	25	25	25	25

Table 2(b) – Seam Strength and related Properties of Thermally Bonded Smooth and Textured **High Density Polyethylene (HDPE)** Geomembrane **(S.I. Units)**

Geomembrane Nominal Thickness	**0.75 mm**	**1.0 mm**	**1.25 mm**	**1.5 mm**	**2.0 mm**	**2.5 mm**	**3.0 mm**
Hot Wedge Seams [1]							
shear strength[2], N/25mm	**250**	**350**	**438**	**525**	**701**	**876**	**1050**
shear elongation at break[3] , %	50	50	50	50	50	50	50
peel strength [2], N/25mm	**197**	**263**	**333**	**398**	**530**	**661**	**793**
peel separation, %	25	25	25	25	25	25	25
Extrusion Fillet Seams [1]							
shear strength[2], N/25mm	**250**	**350**	**438**	**525**	**701**	**876**	**1050**
shear elongation at break[3] , %	50	50	50	50	50	50	50
peel strength [2], N/25mm	**170**	**225**	**285**	**340**	**455**	**570**	**680**
peel separation, %	25	25	25	25	25	25	25

Notes for Tables 1(a) and 1(b):

1. Also for hot air and ultrasonic seaming methods
2. Value listed for shear and peel strength are for 4 out of 5 test specimens; the 5th specimen can be low as 80% of the listed values
3. Elongation measurements should be omitted for field testing

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