Brownfield Cleanup Program

Remedial Investigation Work Plan

Clay Properties LLC

29 Clay Street

Brooklyn, NY 11222

Site No.: Not Assigned

Prepared for

Clay Properties LLC
134 North 4th Street
Brooklyn, NY 11249

Submitted to:

New York State Department of Environmental Conservation

Prepared by

Preferred Environmental Services

323 Merrick Avenue

North Merrick, New York 11566

February 2024

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CERTIFICATION

I, Victoria D. Whelan, certify that I am currently a Qualified Environmental Professional as defined in 6 New York Codes, Rules and Regulations (NYCRR) Part 375 and that this Remedial Investigation Work Plan (RIWP) was prepared in accordance with all applicable statutes and regulations and in substantial conformance with New York State Department of Environmental Conservation (NYSDEC) Division of Environmental Remediation (DER)-10 Technical Guidance for Site Investigation and Remediation.

Victoria D. Whelan, QEP, NYSPG

1.0 INTRODUCTION

The following Remedial Investigation Work Plan (RIWP) was prepared by Preferred Environmental Services (Preferred) on behalf of Clay Properties LLC, the Brownfield Cleanup Program (BCP) volunteer, relative to the necessary remediation of the real property located at 29 Clay Street, Brooklyn, New York, BCP Site (not assigned) (herein referred to as the 'Site' or 'Property'). This RIWP is based upon the guidelines set forth in Section 3 of the New York State Department of Environmental Conservations (NYSDEC) Draft Brownfield Cleanup Program Guide dated May 2004 and NYSDEC's DER-10 Technical Guidance for Site Investigations and Remediations. The proposed scope of work discussed in this RIWP will be conducted in accordance with the Quality Assurance Project Plan (Appendix A), the Health & Safety Plan (Appendix B) and the Community Air Monitoring Plan (Appendix C).

The Site has applied to the NYSDEC BCP in February 2024. Prior investigations indicate that the subsurface, including the soil, groundwater and soil vapor have been impacted by past usage of the Site. Based on the previous investigations for the purposes of developing this RIWP and the HASP, the contaminants of concern are Volatile Organic Compounds (VOCs). One previous study was completed:

1. Remedial Investigation Report, Clay Properties, Preferred Environmental March 2023.

The results of the March 2023 RIR will be included in the RIR for this scope of work.

The information collected from the previous investigations document that there is contamination of VOCs, at the Site. Due to the limited nature of the previous investigations Preferred has prepared this RIWP to fully identify the nature and extent of the impacted media beneath the Site.

The purpose of this RIWP is to outline the scope and protocol to be followed during the investigation of soil, groundwater, and soil vapor to:

1. Define the nature and extent of all contamination;
2. Identify contaminant source areas; and
3. Produce data of sufficient quantity and quality to support the development of a NYSDEC acceptable Remedial Action Work Plan.

2.0 PHYSICAL SITE CHARACTERISTICS

2.1 Site Description

The site is located at 29 Clay Street, Brooklyn, NY 11222. The site is comprised of one New York City Tax Lot (County: Brooklyn; Block 2482; Lot 53). The total area of the site is 9,415). The Site has frontage on Clay Street.

The site can be best described as a large vacant parcel that has the remains of the prior structures' foundation. The site is gated to avoid any trespassers entering the premises. The yard area does have storage trailers located within the gate. The use of the site will not interfere with the investigation or when the remediation commences.

The site is currently inactive and the current zoning designation is M1-2-R6. The Site is level and has no natural or artificial surface water bodies or impoundments. The depth to groundwater is between 6-8 feet below surface grade. A Topographic Map and a Property Location Map are included as Figures 1 and 2, respectively.

2.2 Site History

The site was utilized for various industrial and manufacturing operations including iron works, tin can storage facility, cotton batting company, paper storage warehouse, and "non-specific manufacturing use".

Sanborn History:

1887-1905: The Subject Property is developed with multiple structures identified as the Logan Iron Works, including a blacksmith shop, a flange shop and a boiler shop. Commercial Street and additional portions of the iron works are to the north, followed by a sugar refinery.

1916: The Subject Property is developed consistent with the 1905 map depictions; however, the buildings are now identified as a tin can storage facility.

1942-1951: The Subject Property has been redeveloped with a commercial/industrial building along Clay Street. These include a 2-story structure (west) occupied by a cotton batting

manufacturer. The structure layout appears to be consistent with the recently demolished building.

1965: The building is identified as occupied by non-specific manufacturing use

Summary of Historical Environmental Findings:

1. Depth to groundwater is shallow and between 6-8 feet below ground surface grade.
2. On-site groundwater flow is generally northwest.
3. Bedrock was not encountered during the investigation.
4. Soils encountered throughout the Subject Property consisted generally of brown fine grained sandy fill mixed with wood, gravel and/or brick fragments (consistent with historic fill material) from grade surface to a depth of approximately 4 ft bgs, Soil below 4 feet did have silty clay to the terminal drilling depth (10-15 ft bgs).
5. The known contaminants of concern are Volatile Organic Compounds, (VOCs). Soil results shows one VOC, Trichloroethylene was detected in two samples one sample SB-6 (0-2 ft) was above the NYSDEC Restricted Residential Soil Cleanup Objective (RRSCO) at 21 mg/kg and one sample was detected above the Unrestricted Use Soil Cleanup Objective (UUSCO) in SB-4 (0-2ft) at 10mg/kg.

   *SVOCs s*even (7) semi-volatile organic compounds, Benz(a)anthracene (maximum 15 mg/kg), Benzo(a)pyrene (maximum 13.1 mg/kg), Benzo(b)fluoranthene (maximum 12 mg/kg), Dibenzo (a,h)anthracene (maximum 3.270 mg/kg) Benzo(k)fluoranthene (maximum 10.9 mg/kg) Chrysene (maximum 13.9 mg/kg), Ideno(1, 2, 3-cd)pyrene(maximum 8.73 mg/kg) were detected above RRSCOs. SB-5 (0-2 ft), SB-7 (0-2 ft) and SB-8 (0-2 ft) had all seven compounds over their applicable RRSCO. Additionally, SB-8 (0-2 ft) also reported Phenol (maximum 0.459 mg/kg) over the Protection of Groundwater Standard. The elevated detections of SVOCs were not found in the deeper samples within the same boring. No other SVOCs were detected above UUSCOs in any other boring or sample.

   Total Metals - Seven (7) metals, Arsenic (maximum 23.2 mg/kg in SB-9 (0-2'), Barium (maximum 513 mg/kg in SB-7 (0-2'), Cadmium (maximum 6.14 mg/kg in SB-7 (0-2'), Copper (maximum 303

mg/kg in SB-7 (0-2'), Lead (maximum 6,870 mg/kg in SB-7 (0-2'), Manganese (maximum 3,260 mg/kg in SB-7 (0-2'), and mercury (maximum 4.280 mg/kg in SB-10 (0-2') were detected at or above their applicable RRSCO and/or the Protection of Groundwater SCO. The elevated detection of inorganic constituents are not detected at the deeper sample locations within the same boring. No metals were detected above RRSCOs any of the deeper samples.

*PFOA/PFAS T*hree (3) samples were analyzed for PFOA/PFAS, SB-4 (0-2'), SB-6 (4-6') and SB-10 (4-6'). No detections above UUSCOs were reported. *1,4 Dioxane- T*hree (3) samples were analyzed for 1,4-dioxane, SB-4 (0-2'), SB-6 (4-6') and SB-10 (4-6'). No detections above UUSCOs were reported.

6. Groundwater samples were collected, and results showed exceedances above groundwater standards for eight (8) compounds; 1,1,2-Trichloroethane 1.38 ug/L (GWQS 1 ug/L), 1,1-Dichloroethylene 11.2 ug/L (GWQS 5 ug/L), chloroform 12 ug/L (GWQS 7 ug/L), cis-1,2-Dichloroethylene 1,340 ug/L, (GWQS 5 ug/L), Tetrachloroethylene 6.28 ug/L, (GWQS 5 ug/L), trans-1,2-Dichloroethylene 42.6 ug/L (GWQS 5 ug/L), Trichloroethylene 6,370 ug/L (GWQS 5 ug/L), and Vinyl Chloride 60.4 ug/L(GWQS 2 ug/L).

7. Soil vapor samples showed the following:

Carbon Tetrachloride - the NYSDOH has established that 6 ug/m^3 as an immediate action level. SV-3 located on the Clay Street side of the property reported the maximum concentration of Carbon tetrachloride of 9.2 ug/m^3. The remaining soil vapor samples reported concentrations ranging from 0.36 ug/m^3 (Clay Street side) to 27 ug/m^3 (Commercial Street side).

cis-1,2-dichloroethene - the NYSDOH has established that 6 ug/m^3 as an immediate action level. SV-3 on the Clay Street side of the property has the maximum site detection of 120 ug/m^3. SV-1, SV-2, SV-3 and SV-4 all had results over the immediate action level.

Methylene chloride – the NYSDOH has established that 600 ug/m^3 as an immediate action level. Methylene chloride was detected in any of the Soil Vapor Samples at concentrations above laboratory detection limits and therefore below applicable the immediate action level.

Tetrachloroethylene (PCE) - the NYSDOH has established that 300 ug/m^3 as an immediate action level. PCE was detected in soil vapor samples collected across the Subject Property 9 Clay Street and commercial Street sides) ranging in concentration from 3.7 ug/m^3 to 4,500 ug/m^3 in the SV-2 sample collected form the Clay Street side of the Subject Property.

Trichloroethene (TCE) - the NYSDOH has established that 20 ug/m^3 is an immediate action level. TCE was detected across the property at ranges from 11 ug/m^3 to 740,000 ug/m^3 in the SV-2 sample collected form the Clay Street side of the Subject Property.

Vinyl Chloride – Vinyl Chloride was not detected in any of the samples across the Subject Property at concentrations above laboratory detection limits.

Previously collected samples will be included in the RIR. The data was collected with the necessary QA/QC. Previous sample results are summaries on Figures 3, 4, and 5.

2.3 Areas of Concern

Based on the site history and the findings of the previous studies, the Areas of Concern (AOCs) to be further investigated during the RI are as described below:

AOC-1 Historical Site Use

Information obtained from multiple historic sources revealed that the Subject Property was utilized as for various industrial/manufacturing operations from at least 1887. In addition, the Subject Property was identified on several regulatory agency databases related to hazardous waste generation with multiple RCRA and other agency violations. Given the length of time this facility operated, the lack of information regarding its operations and chemical/waste handling practices, there is a potential for historic operations to have impacted the subsurface.

Historic information also revealed that a number of the adjacent/surrounding properties were also historically utilized for various industrial/manufacturing uses, machine shops, iron works/foundries, service stations, garages/repair shops, and railroad/bus maintenance facilities. Further the southern and eastern adjacent properties are listed on multiple regulatory agency databases, including the NY SHWS and NY Brownfields, with documented impacts to the subsurface. As such, there is a potential for historic operations at these properties to have impacted the subsurface (soil vapor and/or groundwater quality).

AOC-2 – RI Findings

Information obtained from multiple historic sources revealed that the Subject Property was utilized as for various industrial/manufacturing operations from at least 1887. In addition, the Subject Property was identified on several regulatory agency

2.4 Surrounding Land Use

The Subject Property is located within densely developed mixed-use area. The following surrounding land uses were observed during the Phase I ESA site inspection:

North: Commercial Street and a 4-story residential building (74 Commercial Street), followed by a NYC Transit facility (65 Commercial Street), an undeveloped lot (33-35 Commercial Street) and a high-rise building under construction (1-3 Bell Slip).

South: Clay Street, followed by three 1-story industrial buildings (26-32 Clay Street), multi-family residences (38-46 Clay Street) and a mixed-use (residential (48 Clay Street).

East: An industrial building (6 Box Street) and a 7-story mixed-use (retail residential) building (1133 Manhattan Avenue, followed by two mixed-use buildings and Manhattan Avenue.

West: A contractor storage yard (56 Commercial Street) and a building supply warehouse (15 Clay Street), followed by three undeveloped parcels used as a storage yard, with the intersection of Clay and Commercial Streets beyond.

2.5 Hydrogeologic Setting

The Site is relatively flat and has no natural or artificial surface water bodies or impoundments. According to the most recent subsurface investigation conducted by Preferred, the depth to groundwater is approximately 6-feet below surface grade. It is anticipated that shallow groundwater flows to the northwest.

Underlying groundwater in this area of Brooklyn is not used for potable supply purposes. New York City currently utilizes upstate reservoirs for its potable water supply, therefore no potable water resources appear to be threatened by local groundwater contamination.

2.6 Proposed Redevelopment/Project Description

This project is to investigate and remediate the site through the NYSBCP. The gross area of the residential building on lot 53 will be approximately 63,600 square feet with 35 market rate residential condominiums (and 3 affordable housing units provided off-site) and parking approximately 1 foot below grade. The building will include a recreational space, gym and green roof.

3.0 REMEDIAL INVESTIGATION

3.1 Objectives

The objectives of the investigation phase of this project are to:

1. Determine the nature and extent of soil, groundwater and soil vapor at the Site; and,
2. Obtain the necessary information needed to design and implement a Remedial Action Work Plan (RAWP) for the Site.

The names, contact information and roles of personnel who will participate in the investigation are included in the QAPP – **Appendix A.**

3.2 Utility Clearance

A mark-out of underground utility lines will be performed prior to the start of fieldwork by calling the New York City One-Call Center. A utility mark-out verification reference number for the Site will be obtained and a record of the utilities will be kept (e.g., Con Ed, Cablevision, etc.).

3.3 Groundwater Monitoring Wells

3.3.1 Groundwater Monitoring Well Installation

A total of four (4) permanent groundwater monitoring well clusters will be installed throughout the Site. Each of the clusters will consist of two (2) monitoring wells. One 2-inch diameter monitoring well will be installed into the shallow groundwater and will be constructed with a 10-foot long 0.010-inch slotted well screen followed by a 3-foot riser. The second monitoring well will be screened from 16-21 feet below grade with a 0.010-inch slotted well screen followed by a 16- foot riser. The monitoring wells will be furnished with a flush-mount cap and a locking j-plug.

The following characteristics of each newly installed well will be recorded in the field log book:

- Date/time of construction
- Drilling method used
- Approximate well location
- Borehole diameter and well casing diameter
- Well depth
- Drilling and lithologic logs

- Casing materials
- Screen materials and design
- Casing and screen joint type
- Screen slot size/length
- Filter pack material/size
- Filter pack placement method
- Sealant materials

A minimum of 24 hours after installation, the monitoring wells will be developed by surging/bailing, using a centrifugal pump and dedicated polyethylene tubing, or by Waterra positive displacement pumps and dedicated polyethylene tubing, or other methods at the discretion of the Field Manager/Site Supervisor. The development water will be contained in a tank on site or in drums to be provided by Aarco Environmental Services Corp. (AARCO), the drilling subcontractor. Wells will be developed until turbidity is less than 50 Nephelometric Turbidity Units (NTUs) for three (3) successive reading and until water quality indicators stabilized within 10% for pH, temperature, and specific conductivity for three successive readings, or until at least three well volumes are purged. All monitoring well development will be overseen by a field geologist and the duration, method of development, and approximate volume of water removed will be recorded in the field book.

3.3.2 Well Survey

The monitoring wells will be surveyed. The elevations of the top of the well casings will be surveyed by a licensed surveyor to the nearest 0.01 of a foot. The depth to water will be measured and a water table elevation contour map will be prepared. The water table contour map will also include the horizontal direction of groundwater flow.

3.3.3 Groundwater Monitoring Well Sampling

Groundwater samples will be collected from the eight (8) newly installed groundwater monitoring wells. All monitoring wells will be sampling in accordance with EPA's Low-Flow (minimal drawdown) Groundwater Sampling procedures.

Two (2) weeks after well development, the eight (8) groundwater monitoring wells will be sampled. The following materials, as required, shall be available during groundwater sampling:

- Sample pump (peristaltic)
- Sample tubing
- Power source (i.e., generator, battery)
- Appropriate health and safety equipment as specified in the HASP
- Dedicated or disposable bailers
- New disposable polypropylene rope
- Buckets to measure purge water
- Water-level interface probe
- Conductivity/temperature meter
- pH meter
- Turbidity meter
- Appropriate water sample containers
- Appropriate blanks (trip blank supplied by the laboratory)
- Appropriate transport containers (coolers) with ice and appropriate labeling, packing, and shipping materials
- Groundwater sampling logs
- COC forms
- Indelible ink pens
- Site map with well locations

Prior to sampling, groundwater elevations will be measured at each monitoring well and the presence of light non-aqueous phase liquid (LNAPL) or DNAPL (if any) within the well will be evaluated. Depth to water and depth to bottom measurements of each well will be collected using a sonic interface probe and recorded on the sampling log sheet.

After groundwater elevations are measured and NAPLs are determined not to be present, groundwater will be purged from the wells. If NAPLs are determined present, then a groundwater sample will not be

collected, rather a representative NAPL sample may be collected (if required) using a peristaltic pump or other method determined by the Field Manager/Site Supervisor.

Tubing (for peristaltic pumps) will be lowered slowly into the well to a depth corresponding to the center of the saturated screen section of the well. Purging rates will not exceed 500 milliliters per minute. During well purging, monitor the field indicator parameters (turbidity, temperature, specific conductance, pH, dissolved oxygen [DO], and oxidation-reduction potential [ORP]) every three to five minutes (or as appropriate). The well is considered stabilized and ready for sample collection when the indicator parameters have stabilized (readings with 10% of prior reading for pH, conductivity, turbidity and DO and 10 +/- mV for ORP) for three consecutive readings. Readings will be recorded utilizing a Horiba multimeter with flow through cell or equivalent.

Groundwater samples will be collected directly from the decontaminated tubing into laboratory-issued bottleware. The vials will be filled completely and checked to ensure that no air bubbles are present. Samples will be packaged in laboratory-issued sample contained by Preferred personnel and stored on ice pending same day or overnight shipment to a New York State ELAP and Contract Laboratory Protocol (CLP)-Accredited laboratory subcontracted by Preferred. All samples will be uniquely identified, and all information associated with the samples will be recorded utilizing standard Chain-of-Custody (COC) sampling protocols. Sample containers will then be placed on ice until delivered to the laboratory.

Groundwater samples from each well will be analyzed for NYSDEC Full TCL/TAL List Volatile Organic Compounds (VOCs) by EPA Method 8260, Semi-Volatile Organic Compounds (SVOCs) by EPA Method 8270, Organochlorine Pesticides by USEPA Method 8081, Polychlorinated Byphenols (PCBs) by USEPA Method 8082, Chlorinated Herbicides by USEPA Method 8151 and Target Analyte list (TAL) Metals via EPA 6010/7471 Series, NYSDEC List 21 Perfluorinated compounds and 1,4-Dioxane. All analysis will be reported using NYSDEC ASP Category B deliverables.

During this round of sampling, the following samples will be collected for QA/QC purposes in accordance with the attached Quality Assurance Project Plan (QAPP) (Appendix A):

- 1 trip blank

- 1 field blank
- 1 duplicate sample
- 1 matrix spike and 1 matrix spike duplicate

The groundwater laboratory data will be reviewed by a qualified Data Validator and a Data Usability Summary Report (DUSR) will be prepared. The laboratory analytical results of the samples will be compared to NYSDEC TOGS groundwater standards and guidance values. Monitoring well installation logs will be generated and will be included as an Appendix in the Remedial Investigation Report. The logs will contain any local condition(s) that occurred during the sampling that may influence interpretation of the results (i.e., weather). Additionally, logs will include parameters recorded during low flow sampling, depth to water, depth to bottom, monitoring well screen information, and construction details. All purge water will be drummed and sampled for proper off-site disposal.

3.4 Soil Sampling

Eight (8) soil borings will be advanced at pre-specified locations to further characterize the soil to the groundwater interface. Utilizing the Geoprobe drilling system, continuous soil samples will be collected and screened from each boring at two-foot depth intervals.

One of Preferred's environmental professionals will oversee all soil boring activities; log (characterize) the shallow fill lithology and screen the subsurface earth materials (fill) samples with a PID. Organoleptic conditions will be noted for all samples.

A shallow soil sample will be collected from each boring at approximately 0-2 feet below grade and a second sample will be collected from the soil exhibiting the highest degree of impact based upon both a visual inspection and PID readings and/or the deepest sample above the groundwater interface.

Soil Samples will be submitted for laboratory analysis for NYSDEC Full TCL/TAL List Volatile Organic Compounds (VOCs) by EPA Method 8260, Semi-Volatile Organic Compounds (SVOCs) by EPA Method 8270, Organochlorine Pesticides by USEPA Method 8081, Polychlorinated Byphenols (PCBs) by USEPA Method 8082, Chlorinated Herbicides by USEPA Method 8151 and Target Analyte list (TAL) Metals via EPA 6010/7471 Series, NYSDEC List 21 Perfluorinated compounds and 1,4-Dioxane. All analysis will be reported using NYSDEC ASP Category B deliverables.

All on-site sampling equipment will be decontaminated between each use in the following manner: laboratory grade detergent and fresh water wash using scrub brush, followed by two fresh water rinses and a final air dry. Gloves worn for sample handling will be discarded between sample collections. Each sample will be placed in sterilized laboratory supplied containers. The sampled earth material will be settled and capped to insure that little or no headspace is present within the sample. Sample containers will then be placed on ice until delivered to the laboratory. All samples will be uniquely identified, and all information associated with the samples will be recorded utilizing standard chain-of-custody sampling protocols.

Following the completion of each boring, the boreholes will be backfilled with drill cuttings and then sealed with cement grout. Boring logs will be generated for each borehole.

During this round of sampling, the following samples will be collected for QA/QC purposes in accordance with the attached Quality Assurance Project Plan (QAPP) (Appendix A):

- 1 trip blank – per day
- 1 field blank/20 samples
- 1 duplicate sample/20 samples
- 1 matrix spike and 1 matrix spike duplicate/20 samples

The soil laboratory data will be reviewed by a qualified Data Validator and a Data Usability Summary Report (DUSR) will be prepared. The laboratory analytical results of the samples will be compared to NYSDEC Part 375 standards and guidance values. Soil boring installation logs will be generated and will be included as an Appendix in the Remedial Investigation Report. The logs will contain any local condition(s) that occurred during the sampling that may influence interpretation of the results (i.e., weather).

3.5 Soil Vapor Point Installation and Sampling

Three (3) soil vapor samples will be installed via a Geoprobe™ direct push technology throughout the Site in accordance with the NYSDOH "Guidance for Evaluating Soil Vapor Intrusion in the State of New York" dated October 2006.

A stainless steel screen connected to ¼-inch poly-tubing tubing will be advanced to two-feet above the groundwater interface, approximately 4 feet below surface grade and capped with a sample fitting to

allow for the collection of soil gas. The annual space around the stainless steel screen will be packed with coarse sand to one foot above the screen, creating a sampling zone of one foot six inches. A three (3) foot bentonite seal will then be emplaced above the sampling zone. The remainder of the borehole will be backfilled with clean fill.

One (1) soil gas sample will be collected from each soil vapor point at least 24-hours after installation in accordance with NYSDOH's "Guidance for Evaluating Soil Vapor Intrusion in the State of New York" dated October 2006. Concurrently one outdoor air sample will be collected.

Prior to sampling, one-to-three volumes of soil gas will be purged from the soil vapor point using a calibrated air sampling pump. A bucket will be placed over the sample assembly and helium gas will be used to enrich the atmosphere around the sample location in combination with real-time air monitoring (for helium) to verify that ambient air was not infiltrating the sampling assembly during purging and sampling.

Once confirmed that ambient air is not being drawn into the assembly, the soil vapor will be screened for the presence of VOCs using a photoionization detector (PID). After field screening is completed, the tubing will be connected to the SUMMA canister and a soil vapor sample will be collected. The SUMMA canister regulators for the soil vapor, indoor air and outdoor air samples will be set to restrict the sample collection to not exceed 0.2 liters per minute over an eight-hour time period. The canister will be submitted to a NYSDOH-certified laboratory for analysis of VOCs via EPA method TO-15 under chain-of-custody documentation.

During this round of sampling, the following samples will be collected for QA/QC purposes in accordance with the attached Quality Assurance Project Plan (QAPP) (Appendix A):

- 1 duplicate sample

Sampling activities a sample log sheet will be complete for each sample summarizing the following:

- sample identification;
- date and time of sample collection;
- sampling depth/height;
- identity of samplers;
- sampling methods and devices;

- purge volumes;
- volume of soil vapor extracted;
- if canisters used, the vacuum before and after samples collected;
- apparent moisture content (dry, moist, saturated, etc.) of the sampling zone, and
- chain of custody protocols and records used to track samples from sampling point to analysis.

Soil vapor point installation logs will be generated and will be included as an Appendix in the Remedial Investigation Report. The logs will contain any local condition(s) that occurred during the sampling that may influence interpretation of the results (i.e., weather).

The soil vapor laboratory data will be reviewed by a qualified data validator and a Data Usability Summary Report (DUSR) will be prepared in accordance with the QAPP.

3.6 Disposal

Waste generated from remedial investigation activities including. Soil boring installation, soil vapor point installation, monitoring wells installation and subsequent sampling will be placed in drums. Samples will be collected for proper off-site disposal. Manifest documenting proper disposal will be included in the Remedial Investigation Report. It should be noted that PCE and its degradation products are listed hazardous wastes. The Investigation Derived Waste (IDW) will be treated as hazardous unless a 'contained-in' determination from the NYSDEC is received.

3.7 Equipment Decontamination

An equipment decontamination area will be set up in a location close to, but segregated from, the work area. This decontamination area will be set up on top of a minimum 6-mil polyethylene liner (or equivalent quality plastic sheeting), and will include the following equipment: decontaminating cleaners and solutions, deionized water, sprayers, washing tubs, brushes and clean disposable latex and neoprene gloves. Gloves worn for sample handling will be discarded between sample collections.

All down-hole drilling equipment will be decontaminated upon arrival at the Site and between each use, e.g., augers, samplers, rods and plugs, etc. All re-usable sampling equipment, including bowls, trowels, and split-spoon samplers, etc. will be decontaminated with a three-step washing process that consists of a tap water rinse, an Alconox® and tap water wash, followed by a distilled water rinse. After each rinsing

process the equipment will be allowed to air dry. The submersible pump used for groundwater sample collection will be decontaminated between sample collection by passing the detergent and water mixture through the pump, followed by two fresh water rinses.

3.8 Sampling QA/QC Protocol

Field notes including observations of soil conditions, pertinent observations, diagrams (if appropriate) will be maintained, and appropriate photographs will be taken. A record of each sample, including any pertinent observations about the sample will be kept in a field notebook and/or appropriate logs and copies will be included in the Remedial Investigation Report.

3.9 Air Monitoring

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

- Most of the work area and the boring locations are paved with asphalt, gravel, or concrete; therefore, vehicle movement will not generate dust.
- Intrusive work is limited to boring. Sub-slab vapor point and well installation, which does not generate large volumes of soil cuttings or dust

3.9.1 Worker Air Monitoring

Air monitoring of the breathing zone will be performed periodically during drilling and sampling activities to document health and safety protection for the work team. VOCs will be monitored with a PID in accordance with the HASP (Appendix B). If air monitoring during intrusive operations identifies the presence of VOCs, the field engineer will follow the guidelines outlined in the HASP regarding action levels, permissible exposure, engineering controls, and personal protective equipment. If the VOC action level is exceeded, work will cease and the work location will be evacuated. Monitoring will continue until the levels drops to permissible limits, at which point, work will resume with continued monitoring. If high

levels persist, field activities will be halted and the work relocated to another area. If dust emissions are observed, work will stop and dust suppression measures (i.e., water spray) will be implemented.

3.9.2 Community Air Monitoring Plan

In addition to air monitoring in the worker breathing zone, community air monitoring will be performed in compliance with the NYSDOH Generic Community Air Monitoring Plan (CAMP) during all intrusive work for the duration of the investigation. The CAMP is included in Appendix C. The CAMP will consist of continuous monitoring for VOCs and dust emissions during ground intrusive activities (i.e., soil boring and monitoring well installation). Concentrations of VOCs and dust emissions will be measured at both the upwind (one) and downwind (one) CAMP stations before the start of the RI to establish background concentrations. During the RI, VOCs and dust emissions will be measured at the start of each workday, and at one-minute intervals throughout the day at the downwind perimeter of the work zone, which will be established at points on the site where the general public or site employees may be present. VOC Monitoring will be conducted with a PID equipped with a 10.6 eV lamp. VOC community air monitoring requirements will be conducted until it is determined that the site is not a source of organic vapors. Dust emissions will be monitored using real-time monitoring equipment capable of measuring particulate matter less than 10 micrometers in size (PM10) and capable of averaging a period of 15 minutes (or less) for comparison to the airborne particulate action level (e.g., DustTrak). If dust emissions are observed, work will stop and dust suppression measures will be used. The results will be presented in the daily reports (see DER-10 for details).

3.10 Health & Safety

A site-specific Health and Safety Plan (HASP) has been prepared for the field portion of the Remedial Investigation. The HASP will cover all activities in the investigation area as well as, emergency procedures and available emergency services in proximity to the Site. All proposed work discussed in the RIWP will be conducted in accordance with the HASP. The HASP is included as Appendix B.

3.11 Qualitative Human Health Exposure Assessment

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

3.12 Fish and Wildlife Resource Impact Analysis (FWRIA)

A Fish And Wildlife Resource Impact Study is not required for this site according to DER-10 Section 3.10.

4.0 REPORTING

4.1 Remedial Investigation Reporting

Following completion of the RI and receipt of analytical data, an RIR will be prepared. The report will include:

- A summary of the site history and previous investigations
- A description of site conditions
- Sampling methodology and field observations
- An evaluation of the results and findings
- Conclusions and recommendations for any further assessment (if warranted), and remedial action objectives

The report will summarize the nature and extent of contamination at each area of concern and identify unacceptable exposure pathways (as determined through a Qualitative Human Health Exposure Assessment).

The report will include soil boring and well construction logs, sampling logs, tabulated analytical results, figures, and laboratory data packages. The tabulated analytical results will be organized in table format and include sample location, media sampled, sample depth, field/laboratory identification numbers, analytical results and the applicable Standards, Criteria, and Guidance (SCGs) pertaining to the site and contaminants of concern for comparison. The report will include scaled figures showing the locations of soil borings, monitoring wells, and sub-slab vapor points, sample concentrations above SCGs for each media, groundwater elevation contours and flow direction, and, if appropriate, groundwater contaminant concentration contours.

4.2 Daily Reports

Daily reports will be submitted to NYSDEC and NYSDOH Project Managers by the end of each day following the reporting period and will include:

- An update of progress made during the reporting day
- Locations of work and quantities of material imported and exported from the site
- References to alpha-numeric map for site activities
- A summary of any and all complaints with relevant details (names, phone numbers)
- A summary of CAMP findings, including exceedances
- An explanation of notable site conditions.

Daily reports are not intended to be the mode of communication for notification to the NYSDEC of emergencies (accident, spill), requests for changes to the RIWP or other sensitive or time critical information. However, such conditions must also be included in the daily reports. Emergency conditions and changes to the RIWP will be addressed directly to NYSDEC Project Manager via personal communication.

Daily Reports will include a description of daily activities keyed to an alpha-numeric map for the site that identifies work areas. These reports will include a summary of CAMP results, odor and dust problems and corrective actions, and all complaints received from the public. The NYSDEC-assigned project number will appear on all reports.

4.3 Monthly Reports

Monthly reports will be submitted to NYSDEC and NYSDOH Project Managers by the 10th of each month and will include:

- Activities relative to the site during the previous reporting period and those anticipated for the next reporting period, including a quantitative presentation of work performed (i.e. tons of material exported and imported, etc.)
- Description of approved activity modifications, including changes of work scope and/or
- Schedule Sampling results received following internal data review and validation, as applicable
- An update of the remedial schedule including the percentage of project completion, unresolved delays encountered or anticipated that may affect the future schedule, and efforts made to mitigate such delays

5.0 COMMUNITY RELATIONS

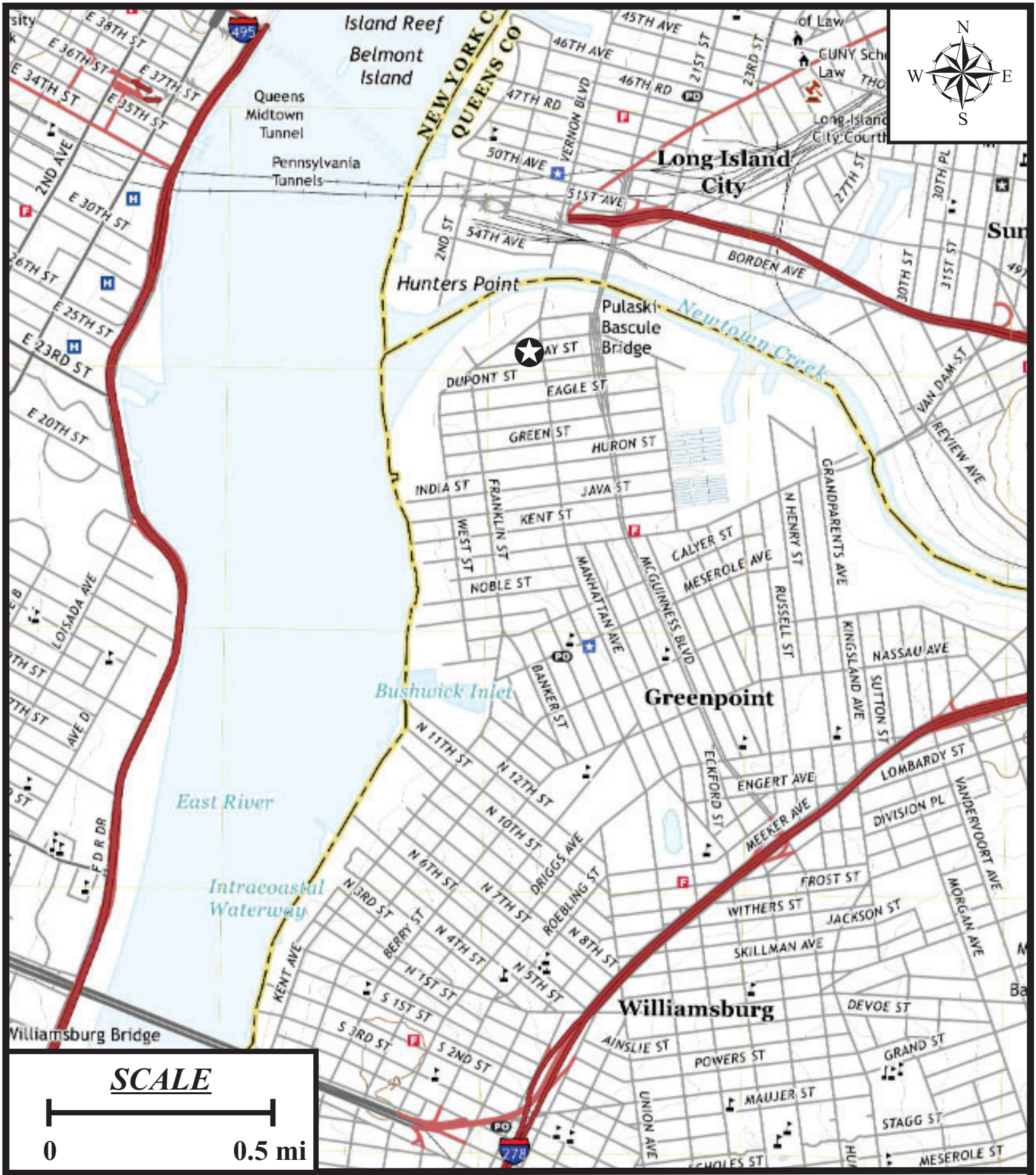
A detailed mailing list of contact list of near residents, businesses, public officials and citizens groups in included in the BCP Application. We will update this list as needed to include any other interested parties.

6.0 SCHEDULE

The following Schedule is provided for the BCP Project:

Event	Schedule
Remedial Investigation Work Plan and HASP	February 2024
Site Investigation Field Work	June 2024
Remedial Investigation Report/Remedial Action Work Plan	October 2024
45-Day Public Comment Period	December 2024
Implement RAWP	January 2025

Figures



SCALE

0 — 0.5 mi

Figure 1 - Topographic Map

PREFERRED ENVIRONMENTAL SERVICES

323 Merrick Avenue - North Merrick, New York 11566

Tel: (516) 546-1100 Fax : (516) 213-8156

-Approximate Location of Subject Property

Source: United States Geologic Survey Greenpoint Quadrangle

Site: Lot 53
29 Clay Street,
Brooklyn, New York

Date: February 2024

Figure 2 - Aerial Photograph

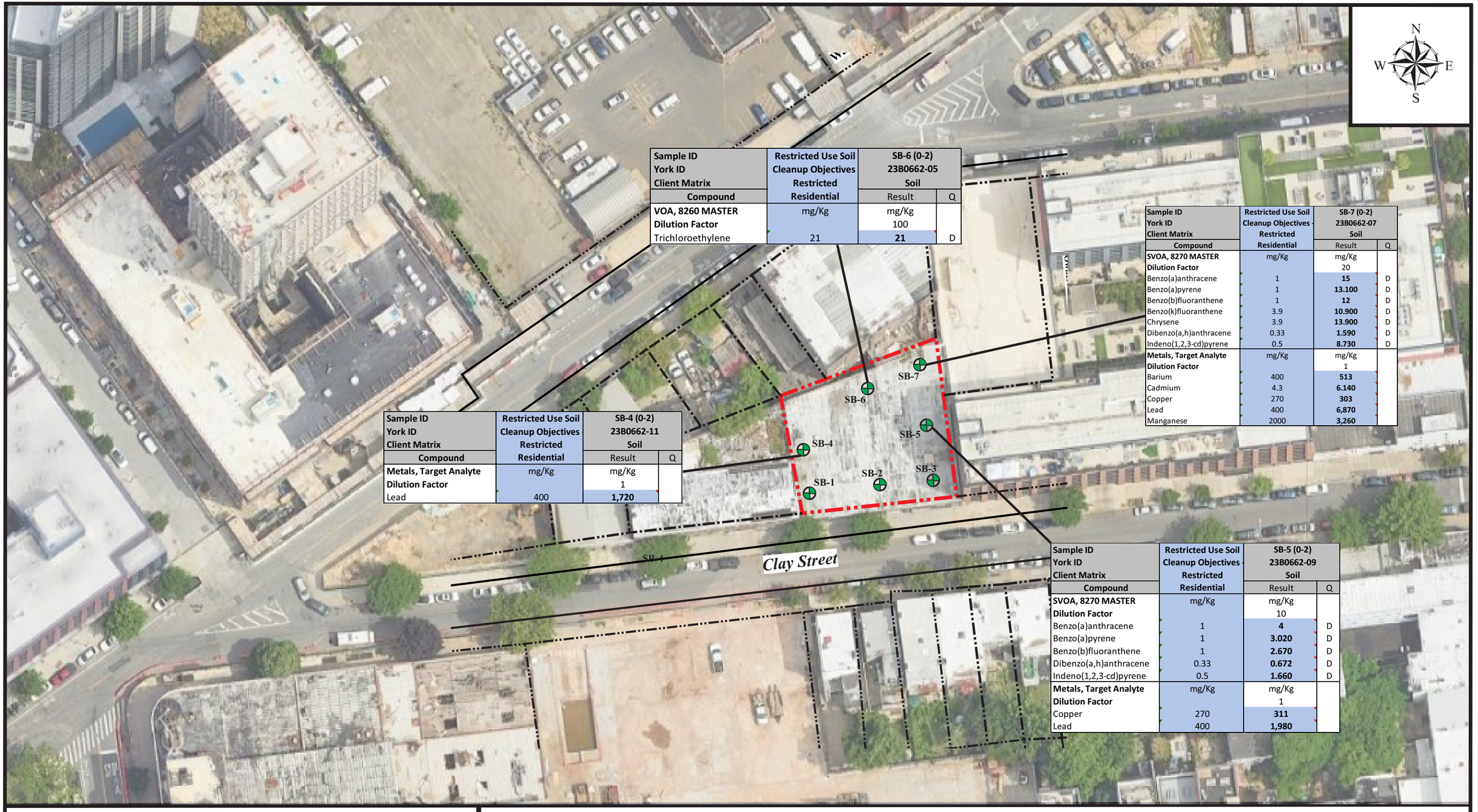
PREFERRED ENVIRONMENTAL SERVICES
323 Merrick Avenue - North Merrick, New York 11566
Tel: (516) 546-1100 Fax : (516) 213-8156

-Approximate Property Line

Source: Google Maps

Site: Lot 53
29 Clay Street,
Brooklyn, New York

Date: February 2024



Sample ID	Restricted Use Soil Cleanup Objectives - Restricted Residential	SB-6 (0-2) 23B0662-05 Soil	
York ID			
Client Matrix			
Compound		Result	Q
VOA, 8260 MASTER	mg/Kg	mg/Kg	
Dilution Factor		100	
Trichloroethylene	21	**21**	D

Sample ID	Restricted Use Soil Cleanup Objectives - Restricted Residential	SB-7 (0-2) 23B0662-07 Soil	
York ID			
Client Matrix			
Compound		Result	Q
SVOA, 8270 MASTER	mg/Kg	mg/Kg	
Dilution Factor		20	
Benzo(a)anthracene	1	**15**	D
Benzo(a)pyrene	1	**13.100**	D
Benzo(b)fluoranthene	1	**12**	D
Benzo(k)fluoranthene	3.9	**10.900**	D
Chrysene	3.9	**13.900**	D
Dibenzo(a,h)anthracene	0.33	**1.590**	D
Indeno(1,2,3-cd)pyrene	0.5	**8.730**	D
Metals, Target Analyte	mg/Kg	mg/Kg	
Dilution Factor		1	
Barium	400	**513**	
Cadmium	4.3	**6.140**	
Copper	270	**303**	
Lead	400	**6,870**	
Manganese	2000	**3,260**	

Sample ID	Restricted Use Soil Cleanup Objectives - Restricted Residential	SB-4 (0-2) 23B0662-11 Soil	
York ID			
Client Matrix			
Compound		Result	Q
Metals, Target Analyte	mg/Kg	mg/Kg	
Dilution Factor		1	
Lead	400	**1,720**	

Sample ID	Restricted Use Soil Cleanup Objectives - Restricted Residential	SB-5 (0-2) 23B0662-09 Soil	
York ID			
Client Matrix			
Compound		Result	Q
SVOA, 8270 MASTER	mg/Kg	mg/Kg	
Dilution Factor		10	
Benzo(a)anthracene	1	**4**	D
Benzo(a)pyrene	1	**3.020**	D
Benzo(b)fluoranthene	1	**2.670**	D
Dibenzo(a,h)anthracene	0.33	**0.672**	D
Indeno(1,2,3-cd)pyrene	0.5	**1.660**	D
Metals, Target Analyte	mg/Kg	mg/Kg	
Dilution Factor		1	
Copper	270	**311**	
Lead	400	**1,980**	

PREFERRED ENVIRONMENTAL SERVICES

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Figure 3 - Soil Over RRSCOs

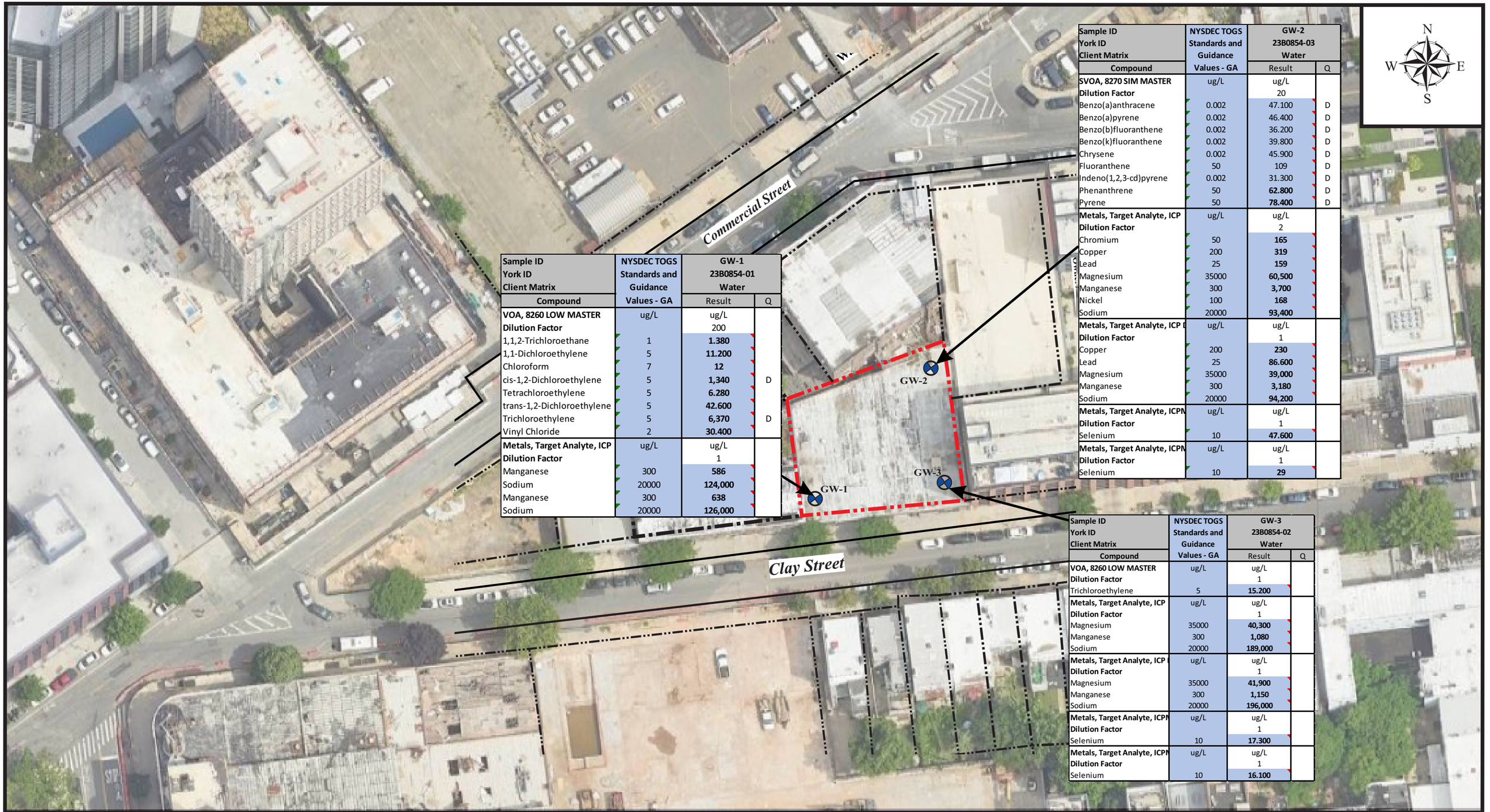
Location of Subject Property

SCALE

0 50 FT.

Site: Lot 53
29 Clay Street,
Brooklyn, New York

Date: February 2024



Sample ID York ID Client Matrix	NYSDEC TOGS Standards and Guidance Values - GA	GW-1 23B0854-01 Water	
Compound		Result	Q
VOA, 8260 LOW MASTER	ug/L	ug/L	
Dilution Factor		200	
1,1,2-Trichloroethane	1	**1.380**	
1,1-Dichloroethylene	5	**11.200**	
Chloroform	7	**12**	
cis-1,2-Dichloroethylene	5	**1,340**	D
Tetrachloroethylene	5	**6.280**	
trans-1,2-Dichloroethylene	5	**42.600**	
Trichloroethylene	5	**6,370**	D
Vinyl Chloride	2	**30.400**	
Metals, Target Analyte, ICP	ug/L	ug/L	
Dilution Factor		1	
Manganese	300	**586**	
Sodium	20000	**124,000**	
Manganese	300	**638**	
Sodium	20000	**126,000**	

Sample ID York ID Client Matrix	NYSDEC TOGS Standards and Guidance Values - GA	GW-2 23B0854-03 Water	
Compound		Result	Q
SVOA, 8270 SIM MASTER	ug/L	ug/L	
Dilution Factor		20	
Benzo(a)anthracene	0.002	47.100	D
Benzo(a)pyrene	0.002	46.400	D
Benzo(b)fluoranthene	0.002	36.200	D
Benzo(k)fluoranthene	0.002	39.800	D
Chrysene	0.002	45.900	D
Fluoranthene	50	109	D
Indeno(1,2,3-cd)pyrene	0.002	31.300	D
Phenanthrene	50	**62.800**	D
Pyrene	50	**78.400**	D
Metals, Target Analyte, ICP	ug/L	ug/L	
Dilution Factor		2	
Chromium	50	**165**	
Copper	200	**319**	
Lead	25	**159**	
Magnesium	35000	**60,500**	
Manganese	300	**3,700**	
Nickel	100	**168**	
Sodium	20000	**93,400**	
Metals, Target Analyte, ICP	ug/L	ug/L	
Dilution Factor		1	
Copper	200	**230**	
Lead	25	**86.600**	
Magnesium	35000	**39,000**	
Manganese	300	**3,180**	
Sodium	20000	**94,200**	
Metals, Target Analyte, ICPM	ug/L	ug/L	
Dilution Factor		1	
Selenium	10	**47.600**	
Metals, Target Analyte, ICPM	ug/L	ug/L	
Dilution Factor		1	
Selenium	10	**29**	

Sample ID York ID Client Matrix	NYSDEC TOGS Standards and Guidance Values - GA	GW-3 23B0854-02 Water	
Compound		Result	Q
VOA, 8260 LOW MASTER	ug/L	ug/L	
Dilution Factor		1	
Trichloroethylene	5	**15.200**	
Metals, Target Analyte, ICP	ug/L	ug/L	
Dilution Factor		1	
Magnesium	35000	**40,300**	
Manganese	300	**1,080**	
Sodium	20000	**189,000**	
Metals, Target Analyte, ICP	ug/L	ug/L	
Dilution Factor		1	
Magnesium	35000	**41,900**	
Manganese	300	**1,150**	
Sodium	20000	**196,000**	
Metals, Target Analyte, ICPM	ug/L	ug/L	
Dilution Factor		1	
Selenium	10	**17.300**	
Metals, Target Analyte, ICPM	ug/L	ug/L	
Dilution Factor		1	
Selenium	10	**16.100**	

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Figure 4 - Groundwater Sample Results Over Togs

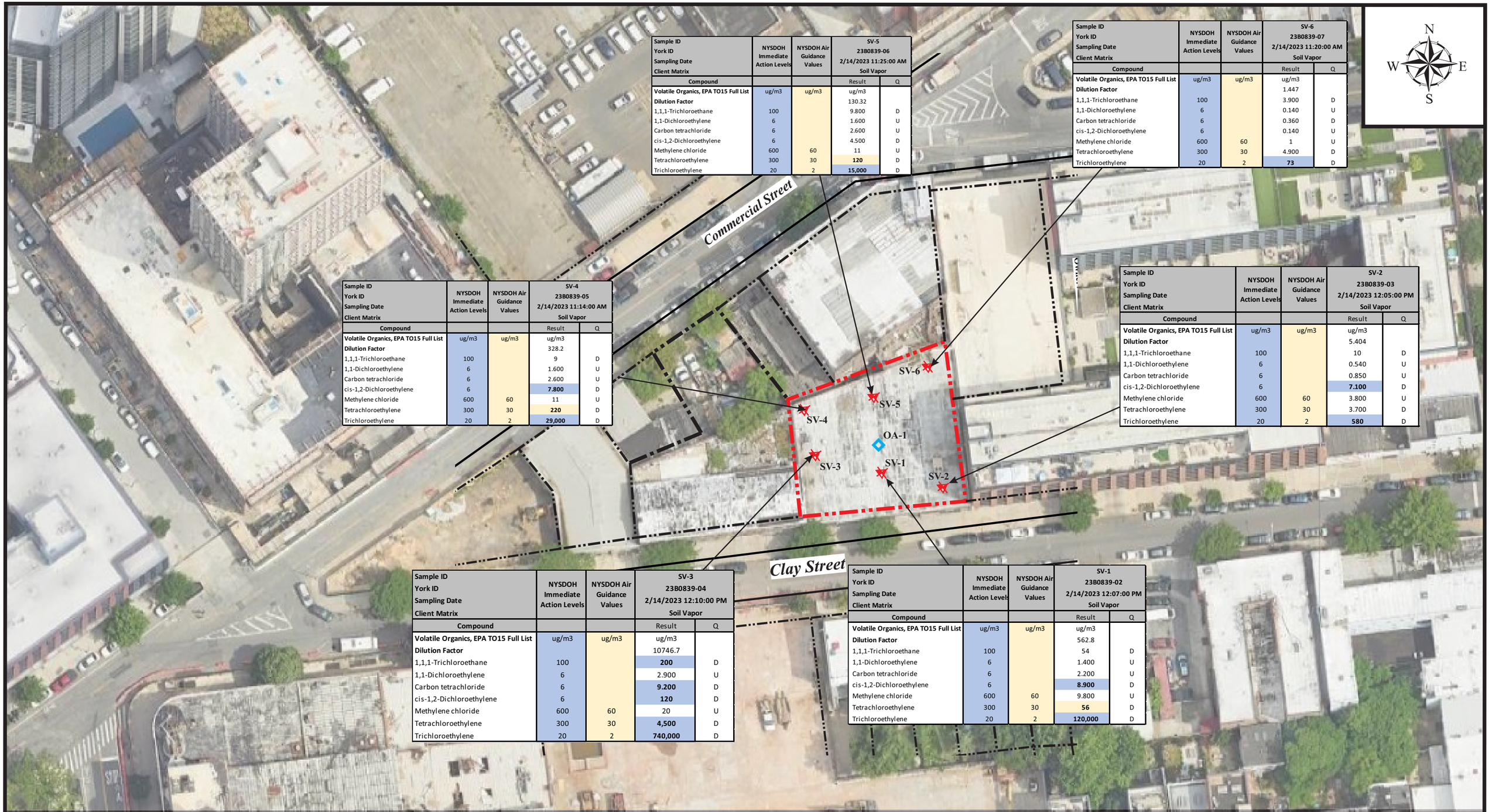
Location of Subject Property

SCALE

0 50 FT.

Site: Lot 53
29 Clay Street,
Brooklyn, New York

Date: February 2024



Sample ID	NYSDOH Immediate Action Levels	NYSDOH Air Guidance Values	SV-5
York ID			23B0839-06
Sampling Date			2/14/2023 11:25:00 AM
Client Matrix			Soil Vapor
Compound			Result / Q
Volatile Organics, EPA TO15 Full List	ug/m3	ug/m3	ug/m3
Dilution Factor			130.32
1,1,1-Trichloroethane	100		9.800 D
1,1-Dichloroethylene	6		1.600 U
Carbon tetrachloride	6		2.600 U
cis-1,2-Dichloroethylene	6		4.500 D
Methylene chloride	600	60	11 U
Tetrachloroethylene	300	30	**120** D
Trichloroethylene	20	2	**15,000** D

Sample ID	NYSDOH Immediate Action Levels	NYSDOH Air Guidance Values	SV-6
York ID			23B0839-07
Sampling Date			2/14/2023 11:20:00 AM
Client Matrix			Soil Vapor
Compound			Result / Q
Volatile Organics, EPA TO15 Full List	ug/m3	ug/m3	ug/m3
Dilution Factor			1.447
1,1,1-Trichloroethane	100		3.900 D
1,1-Dichloroethylene	6		0.140 U
Carbon tetrachloride	6		0.360 D
cis-1,2-Dichloroethylene	6		0.140 U
Methylene chloride	600	60	1 U
Tetrachloroethylene	300	30	4.900 D
Trichloroethylene	20	2	**73** D

Sample ID	NYSDOH Immediate Action Levels	NYSDOH Air Guidance Values	SV-4
York ID			23B0839-05
Sampling Date			2/14/2023 11:14:00 AM
Client Matrix			Soil Vapor
Compound			Result / Q
Volatile Organics, EPA TO15 Full List	ug/m3	ug/m3	ug/m3
Dilution Factor			328.2
1,1,1-Trichloroethane	100		9 D
1,1-Dichloroethylene	6		1.600 U
Carbon tetrachloride	6		2.600 U
cis-1,2-Dichloroethylene	6		**7.800** D
Methylene chloride	600	60	11 U
Tetrachloroethylene	300	30	**220** D
Trichloroethylene	20	2	**29,000** D

Sample ID	NYSDOH Immediate Action Levels	NYSDOH Air Guidance Values	SV-2
York ID			23B0839-03
Sampling Date			2/14/2023 12:05:00 PM
Client Matrix			Soil Vapor
Compound			Result / Q
Volatile Organics, EPA TO15 Full List	ug/m3	ug/m3	ug/m3
Dilution Factor			5.404
1,1,1-Trichloroethane	100		10 D
1,1-Dichloroethylene	6		0.540 U
Carbon tetrachloride	6		0.850 U
cis-1,2-Dichloroethylene	6		**7.100** D
Methylene chloride	600	60	3.800 U
Tetrachloroethylene	300	30	3.700 D
Trichloroethylene	20	2	**580** D

Sample ID	NYSDOH Immediate Action Levels	NYSDOH Air Guidance Values	SV-3
York ID			23B0839-04
Sampling Date			2/14/2023 12:10:00 PM
Client Matrix			Soil Vapor
Compound			Result / Q
Volatile Organics, EPA TO15 Full List	ug/m3	ug/m3	ug/m3
Dilution Factor			10746.7
1,1,1-Trichloroethane	100		**200** D
1,1-Dichloroethylene	6		2.900 U
Carbon tetrachloride	6		**9.200** D
cis-1,2-Dichloroethylene	6		**120** D
Methylene chloride	600	60	20 U
Tetrachloroethylene	300	30	**4,500** D
Trichloroethylene	20	2	**740,000** D

Sample ID	NYSDOH Immediate Action Levels	NYSDOH Air Guidance Values	SV-1
York ID			23B0839-02
Sampling Date			2/14/2023 12:07:00 PM
Client Matrix			Soil Vapor
Compound			Result / Q
Volatile Organics, EPA TO15 Full List	ug/m3	ug/m3	ug/m3
Dilution Factor			562.8
1,1,1-Trichloroethane	100		54 D
1,1-Dichloroethylene	6		1.400 U
Carbon tetrachloride	6		2.200 U
cis-1,2-Dichloroethylene	6		**8.900** D
Methylene chloride	600	60	9.800 U
Tetrachloroethylene	300	30	**56** D
Trichloroethylene	20	2	**120,000** D

PREFERRED ENVIRONMENTAL SERVICES

323 Merrick Avenue - North Merrick, New York 11566

Tel: (516) 546-1100 Fax : (516) 213-8156

Figure 5 – Soil Vapor Analytical Results

Location of Subject Property

SCALE

0 50 FT.

Site: Lot 53
29 Clay Street,
Brooklyn, New York

Date: February 2024

Commercial Street

Notes: Gray Sample locations are previously sampled locations

Proposed Soil Vapor

-Outdoor Air Sampling Location

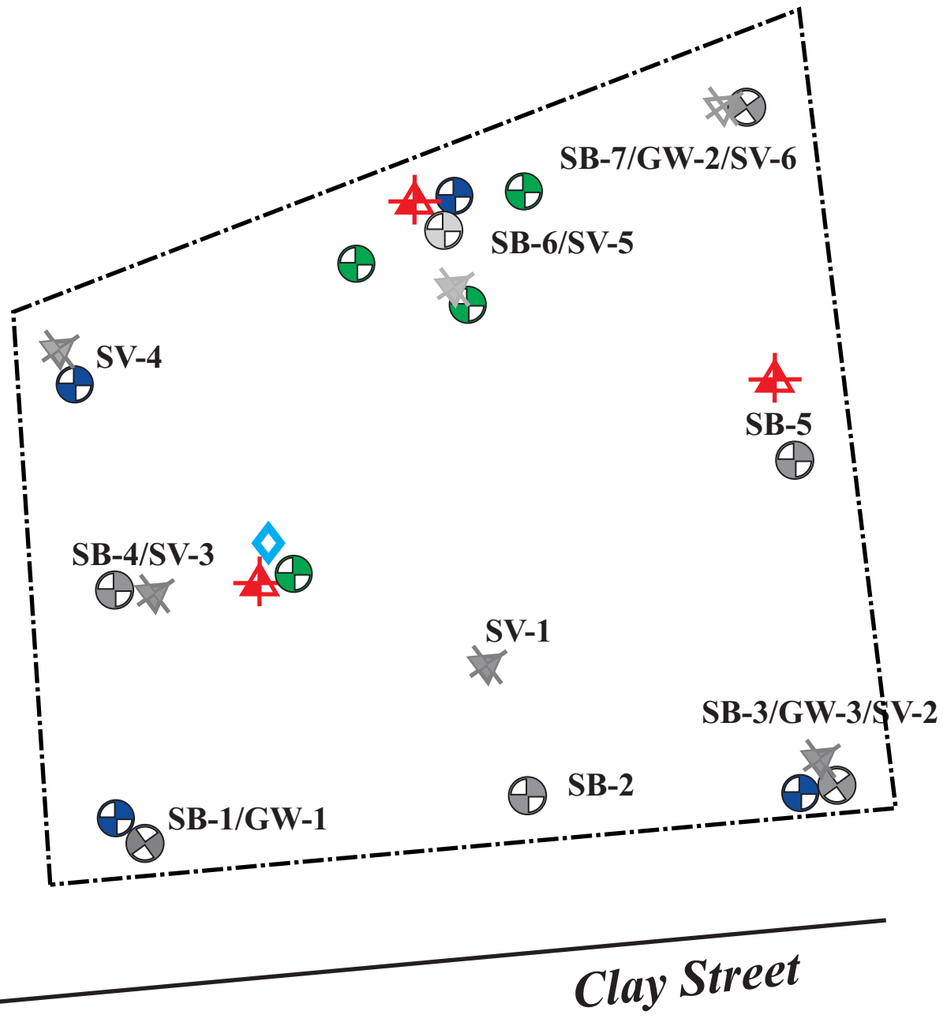
- Proposed Soil Sampling Location

-Proposed Monitoring Well Cluster and Soil Boring

N

W E

S



Clay Street

Scale:

0 25 FT.

Figure 6 - Proposed Sampling Locations

Site: Lot 53
29 Clay Street
Brooklyn, New York

Date: February 2024

PREFERRED ENVIRONMENTAL SERVICES

323 Merrick Avenue - North Merrick, New York 11566

Tel: (516) 546-1100 Fax : (516) 213-8156

Appendix A

Quality Assurance Project Plan

Quality Assurance Sampling and Analysis Plan

for

29 Clay Street

Brooklyn, NY 11222

BCP Site No. – Not Assigned

Prepared for

Clay Properties LLC

134 North 4th Street

Brooklyn, NY 11249

Submitted to:

New York State Department of Environmental Conservation

Prepared by

Preferred Environmental Services

323 Merrick Avenue, North Merrick, New York 11566

February 2024

Introduction

This Quality Assurance Project Plan (QAPP) presents the sampling and analytical methods and procedures that will be used during implementation of the Remedial Investigation Work Plan (RIWP) at 29 Clay Street, Brooklyn NY site. The QAPP is intended to be utilized in conjunction with the RIWP and Health and Safety Plan (HASP). The RIWP presents the site background and defines the field sampling program. The HASP provides a mechanism for establishing safe working conditions at the site. The HASP is provided in Appendix B of the RIWP.

This QAPP was prepared in a manner consistent with the following reference and guidance documents:

- United States Environmental Protection Agency's (USEPA's) "Test Methods for Evaluating Solid Waste, SW-846" (USEPA, 1996).

- The USEPA's guidance document entitled "EPA Requirements for Quality Assurance Project Plans for Environmental Operations, "EPA-QA/R-5 (USEPA, 2001), which replaces QAMS-005/80 "Interim Guidance and Specifications for Preparing Quality Assurance Project Plans" (USEPA, 1980).

- The National Enforcement Investigations Center (NEIC) Policies and Procedures Manual (USEPA, 1991).

1.0 Project Organization and Responsibilities

1.1 Project Organization

The RIWP for the project, will be implemented by Preferred Environmental Services and its subcontractors identified below, collectively referred to as the project team. A detailed description of the responsibilities of each member of the project team is presented in Section 2.2.

1.1.1 Overall Project Management

Preferred Environmental Services (Preferred), on behalf of the property owner, has overall technical responsibility for the implementation of the RIWP. Preferred personnel will conduct the tasks and subtasks presented in Section 3 and will be responsible for assembling resultant investigation data, and preparing the RIWP Report. A listing of project management personnel and their responsibilities is provided below.

Name	Title	Company/Organization	Phone #	Responsibility/Role
Victoria Whelan, NYS P.G.	Senior Associate/Geologist	Preferred Environmental Services	516 546 1100	Senior Project Manager
William Schlageter, P.G.	Vice President	Preferred Environmental Services	516 546 1100	Quality Assurance Manager
Donald Tesoriero	Project Manager	Preferred Environmental Services	516 546 1100	Field Task Manager
Christopher Zweier	Environmental Scientist	Preferred Environmental Services	516 546 1100	Health and Safety Officer
Sarah Widomski	QA Manager	York Analytical Laboratories, Inc.	203 325 - 1371	Laboratory Project Manager
Nancy Weaver	Third Party Validator	Environmental Data Services, Inc.	561-475-2000	Validator
Marc Morgenstern	Drilling Supervisor	Coastal Environmental Solutions	516-587-9570	Drilling

1.2 Team Member Responsibilities

This section of the QAPP discusses the responsibilities and duties of the project team members.

1.2.1 Preferred Environmental Services

Project Manager

- Management and coordination of all aspects of the project as defined in the RIWP with an emphasis on adhering to the project objectives
- Reviews SC Report and all documents prepared by Preferred
- Assures corrective actions are taken for deficiencies cited during audits of the SC activities

Field Task Manager

- Oversight of investigation Activities
- Reduction of field data calibration and maintenance
- Review of the field instrumentation, maintenance, and calibration to maintain quality data
- Preparation of draft reports and other key documents
- Maintenance of field files of notebooks and logs, and calculations
- Instruction of Subcontractors
- Coordination of field and laboratory schedules
- Calibrate, operate, and maintain field equipment
- Reduce field data
- Maintain sample custody
- Prepare field records and logs

Quality Assurance Manager

- Review laboratory data packages
- Oversee and interface with the analytical laboratories
- Coordinate field QA/QC activities with task managers, including audits of SC activities, concentrating on field analytical measurements and practices to meet Data Quality Objectives
- Review field reports
- Review audit reports
- Prepare QA/QC report which includes an evaluation of field and laboratory data

1.2.2 York Analytical Laboratories Inc. and ELAP approved Laboratory

- Perform sample analysis
- Supply sample containers and shipping cartons
- Maintain laboratory custody of samples
- Strictly adhere to laboratory protocols

Laboratory Project Manager

- Serve as primary communication link between Preferred and laboratory staff
- Monitor workloads and ensure availability of resources
- Oversee preparation of analytical reports
- Supervise in-house chain-of-custody

Quality Assurance Officer

- Supervise technical staff in QA/QC procedures
- Conduct audits of all laboratory activities

1.2.3 Environmental Data Services Inc. – Third Party Validator

- Conduct a third-party review of the laboratory procedures and results
- Provide a Data Usability Report

1.2.4 Coastal Environmental Solutions

- Performance of monitoring well and soil boring installations in accordance with the RIWP
- Decontamination of drilling and sampling equipment

2.0 Project Background

The following summarizes background information for the site. Additional information can be found in the RIWP.

2.1 Site Description and History

2.1.1 Site Description

The site is currently unoccupied. 29 Clay Street is vacant, there are no structures on-site. There is the remains of the concrete slab from the old building. Operations ceased in 2022. The RIWP is part of an on-going investigation/remediation associated with Brownfield Cleanup Program(BCP).

2.2 RIWP Objectives

The overall objectives of the RIWP are to:

1. Define the nature and extent of all contamination;
2. Identify contaminant source areas;
3. Produce data of sufficient quantity and quality to support the development of a NYSDEC acceptable Remedial Action Work Plan.

3.0 Project Description

This section presents a description of the investigation activities to be conducted during the implementation of the RIWP. Sampling activities associated with the RIWP will be conducted under the following tasks:

- Groundwater Investigation
- Soil Investigation
- Soil Vapor Intrusion Study

Sampling protocols to be followed during the investigation activities are detailed in the RIWP. Table 1 presents a list of the constituents that will be analyzed for samples collected as part of the investigation. Health and Safety protocols to be followed by field personnel during completion of the investigation activities are discussed in the Health and Safety Plan (HASP). A detailed description can be found in the associated RIWP.

4.0 Quality Objectives and Criteria for Measurement Data

The DQO process, as described in the USEPA QA/G-5 QAPP instructions document (USEPA, 2002b), is intended to provide a "logical framework" for planning field investigations. The following section addresses, in turn, each of the seven sequential steps in the USEPA QA/G-5 QAPP DQO process.

Data quality objectives (DQOs) are qualitative and quantitative statements that specify the quality of the data required to support decisions made during site-related activities and are based on the end uses of the data to be collected. Preliminary DQOs were identified to ensure that the data generated during field investigations will be of adequate quality and sufficient quantity to form a sound basis for decision making relative to the above objectives. Data quality objectives have been specified for each data collection activity or investigation. The DQOs presented herein address investigation efforts only and do not cover health and safety issues, which are addressed in detail in the HASP for this project.

For this project, data reporting requirements have been defined as follows: Level 3 – Full Reporting: Full "CLP-type" reporting is used for those analyses that, based on intended data use, require full documentation. This reporting level would include ASP Superfund and Category B reporting.

The analytical methods to be used during the RIWP implementation will be USEPA SW-846 methods with New York State Department of Environmental Conservation (NYSDEC) Analytical Services Protocol (ASP) Revision 2005, QA/QC requirements and Category B reporting deliverables.

To obtain information necessary to meet the SC objectives stated above in Section 2.3, the following task will be performed (Note: Only subtasks that require collection and analysis of environmental samples or collecting field measurements are listed below. Refer to the RIWP for a description of the tasks and subtasks.):

- Soil, Groundwater and Soil Vapor Sampling

A description of the DQOs for the implementation of the RIWP is presented below.

4.1 DQOs for Sampling

The site characterization samples will be submitted for laboratory analysis for the following:

- TAL VOCs by Method 8260
- TAL SVOCs by Method 8270
- Organochlorine Pesticides by USEPA Method 8081
- Polychlorinated Byphenols (PCBs) by USEPA Method 8082
- Chlorinated Herbicides by USEPA Method 8151; and
- TAL Metals via EPA 6010/7471 Series.
- NYSDEC List 21 Perfluorinated compounds by 537; and
- 1,4-Dioxane by 8270D SIM (RL 20.00 ug/kg soil and 0.300 ug/L water)

The number of soil samples that will be collected, including QA/QC samples, is summarized in **Table 1**. **Table 2** presents the parameters, containers, preservation methods and holding times. **Appendix B** includes the parameters for each compound lists, MDLs and RLs.

5.0 Special Training Requirements/Certification

Compliant with the Occupational Safety and Health Administration's (OSHA's) final rule, "Hazardous Waste Operations and Emergency Response," 29 CFR§1910.120(e), all personnel performing remedial activities at the site will have completed the requirements for OSHA 40-hour Hazardous Waste Operations and Emergency Response training.

6.0 Documentation and Records

6.1 General

Samples of the various media will be collected as described in the RIWP. Detailed descriptions of the documentation and reporting requirements are presented below.

6.2 Field Documentation

Field personnel will provide comprehensive documentation covering all aspects of field sampling, field analysis, and sample chain-of-custody. This documentation constitutes of a record that allows reconstruction of all field events to aid in the data review and interpretation process. All documents, records, and information relating to the performance of the field work will be retained in the project file. The various forms of documentation to be maintained throughout the action include:

- Daily Production Documentation – A field notebook consisting of a waterproof, bound notebook that will contain a record of all activities performed at the site.

- Sampling Information – Detailed notes will be made as to the exact site of sampling, physical observations, and weather conditions (as appropriate).

- Sample Chain-of-Custody – Chain-of-custody (COC) forms will provide the record of responsibility for sample collection, transport, and submittal to the laboratory. The original COC form will accompany the samples to the laboratory, and copies will be forwarded to the project files. A sample COC form is included in **Appendix A**. Persons will have custody of samples when the samples are in their physical possession, in their view after being in their possession, or in their physical possession and secured so they cannot be tampered with. In addition, when samples are secured in a restricted area accessible only to authorized personnel, they will be deemed to be in the custody of such authorized personnel.

- Field Equipment, Calibration, and Maintenance Logs – To document the calibration and maintenance of field instrumentation, calibration and maintenance logs will be maintained for each piece of field equipment that is not factory-calibrated.

6.3 Laboratory Documentation

6.3.1 Laboratory Project Files

The laboratory will establish a file for all pertinent data. The file will include all correspondence, faxed information, phone logs, and COC forms. The laboratory will retain all project files and data packages for a period of 5 years.

6.3.2 Laboratory Logbooks

Workbooks, bench sheets, instrument logbooks, and instrument printouts will be used to trace the history of samples through the analytical process and document and relate important aspects of the work, including the associated quality controls. As such, all logbooks, bench sheets, instrument logs, and instrument printouts will be part of the permanent record of the laboratory.

Each page or entry will be dated and initialed by the analyst at the time of entry. Errors in entry will be crossed out in indelible ink with a single stroke, corrected without the use of whiteout or by obliterating or writing directly over the erroneous entry, and initialed and dated by the individual making the correction. Pages of logbooks that are not used will be completed by lining out unused portions.

Information regarding the sample, analytical procedures performed, and the results of the testing will be recorded on laboratory forms or personal notebook pages by the analyst. These notes will be dated and will also identify the analyst, the instrument used, and the instrument conditions. Laboratory notebooks will be periodically reviewed by the laboratory group leaders for accuracy, completeness, and compliance to this QAPP. All entries and calculations will be verified by the laboratory group leader. If all entries on the pages are correct, then the laboratory group leader will initial and date the pages. Corrective action will be taken for incorrect entries before the laboratory group leader signs.

6.3.3 Electronic File Storage

All electronic files will be maintained on Preferred's company network server for 5 years.

6.4 Data Reporting Requirements

6.4.1 Field Data Reporting

Information collected in the field through visual observation, manual measurement, and/or field instrumentation will be recorded in field notebooks or data sheets and/or on forms. Such data will be reviewed by the appropriate Task Manager for adherence to the Work Plan and for consistency. Concerns identified as a result of this review will be discussed with the field personnel, corrected if possible, and, as necessary, incorporated into the data evaluation process.

Where appropriate, field data forms and calculations will be processed and included in appendices to a Site Action Report (when generated). The original field logs, documents, and data reductions will be kept in the project file at the Preferred office in Merrick, New York.

6.4.2 Laboratory Data Reporting

The laboratory is responsible for preparing ASP Category B data packages. All data reports for all parameters will include, at a minimum, the following items:

Narrative: Summary of activities that took place during the course of sample analysis, including the following information:

- Laboratory name and address
- Date of sample receipt
- Cross reference of laboratory identification number to contractor sample identification
- Analytical methods used
- Deviations from specified protocol
- Corrective actions taken

Included with the narrative will be any sample handling documents, including field and internal COC forms, air bills, and shipping tags.

Analytical Results: Reported according to analysis type and including the following information, as acceptable:

- Sample ID
- Laboratory ID
- Date of collection
- Date of receipt
- Date of extraction
- Date of analysis
- Detection limits

Sample results on the report forms will be collected for dilutions. Soil samples will be reported on a dry weight basis. Unless otherwise specified, results will be reported uncorrected for blank contamination.

The data analyses will be expanded to include all supporting documentation necessary to provide a Category B package. This additional documentation will include, but is not limited to, all raw data required to recalculate any result, including printouts, chromatograms, and quantitation reports.

6.5 Project File

Reports (including QA reports) will be filed with correspondence. Analytical laboratory documentation when received) and field data will be filed with notes and data. Filed materials may be removed and signed out by authorized personnel on a temporary basis only.

7.0 Sampling Process Design

Information regarding the sampling design and rationale and associated sampling locations can be found in the RIWP.

8.0 Sampling Method Requirements

The RIWP contains the procedures that will be followed to collect groundwater, air and macro core samples; perform field measurements; and handle, package, and ship collected samples. Sampling for PFAS will be in accordance with the EPA specific guidance for PFAS sampling included in **Appendix C**.

9.0 Sample Handling and Custody Requirements

9.1 Sample Containers and Preservation

Appropriate sample containers, preservation methods, and laboratory holding times for the samples are shown in **Table 2**.

The analytical laboratory will supply appropriate sample containers and preservatives, as necessary. The bottles will be purchased pre-cleaned to USEPA Office of Solid Waste and Emergency Response (OSWER) Directive 9240.05A requirements. The field personnel will be responsible for properly labeling containers and preserving samples (as appropriate).

9.2 Packing, Handling, and Shipping Requirements

Sample packaging and shipment procedures are designed to insure that the samples will arrive at the laboratory, with the COC, intact. Samples will be packaged for shipment as outlined below:

- Ensure that all sample containers have the sample labels securely affixed to the container.
- Check the caps on the sample containers to ensure that they are properly sealed.
- Complete the COC form with the required sampling information and ensure the recorded information matches the sample labels. NOTE: If the designated sampler relinquishes the samples to other sampling or field personnel for packing or other purposes, the sampler will complete the COC prior to this transfer. The appropriate personnel will sign and date the COC form to document the sample custody transfer.
- Ice layer.
- Place the sealed sample containers into the cooler.
- Place ice in plastic bags and seal. Place loosely in the cooler.
- Place COC forms in a plastic bag and seal.
- Close the lid of the cooler, lock, and secure with duct tape.

• Wrap strapping tape around both ends of the cooler at least twice.

All samples will be packaged by the field personnel and transported as low concentration environmental samples. The samples will be hand-delivered or by courier within 48 hours of the time of collection. All shipments will be accompanied by the COC form identifying the contents. The original form will company the shipment; copies will be retained by the sampler for the sampling office records. If the samples are sent by common carrier, a bill of lading should be used. Receipts or bills of lading will be retained as part

of the permanent project documentation. Commercial carriers are not required to sign off on the COC form, as long as the forms are sealed inside the sample cooler and the custody seals remain intact.

Sample custody seals and packing materials for filled sample containers will be provided by the analytical laboratory. The filled, labeled, and sealed containers will be placed in a cooler on ice and carefully packed to eliminate the possibility of container breakage. Trip blank(s) of analyte-free water will be provided by the laboratory and included in each cooler containing aqueous samples to be analyzed for VOCs.

9.3 Field Custody Procedures

The objective of field sample custody is to assure that samples are not tampered with from the time of sample collection through the time of transport to the analytical laboratory. Persons will have "custody of samples" when the samples are in their physical possession, in their view after being in their possession, or in the physical possession and secured so they cannot be tampered with. In addition, when samples are secured in a restricted area accessible only to authorized personnel, they will be deemed to be in the custody of such authorized personnel.

Field custody documentation consists of both field logbooks and field COC forms.

9.3.1 Field Logbooks

Field logbooks will provide the means of recording data collecting activities performed. As such, entries will be described in as much detail as possible so that persons going to the site could reconstruct a particular situation without reliance on memory. Field logbooks will be bound field survey books or notebooks. Logbooks will be assigned to field personnel, but will be stored in a secure location when not in use. Each logbook will be identified by the project-specific document number. The title page of each logbook will contain the following:

- Person to whom the logbook is assigned
- Logbook number
- Project name
- Project start date
- End date

Entries into the logbook will contain a variety of information. At the beginning of each entry, the date, start time, weather, names of all sampling team members present, level of personal protection being used, and the signature of the person making the entry will be entered. The names of visitors to the site, field sampling or investigation team personnel, and the purpose of their visit will also be recorded in the field logbook.

Measurements made and samples collected will be recorded. All entries will be made in ink, and no erasures will be made. If an incorrect entry is made, the information will be crossed out with a single strike mark. Whenever a sample is collected or a measurement is made, a detailed description of the location of the station shall be recorded. The number of the photographs taken of the station, if any, will also be noted. All equipment used to make measurements will be identified, along with the date of calibration.

The equipment used to collect samples will be noted, along with the time of sampling, sample description, depth at which the sample was collected, volume, and number of containers. Sample identification numbers will be assigned prior to sample collection.

Field duplicate samples, which will receive an entirely separate sample identification number, will be noted under sample description.

9.3.2 Sample Labeling

Preprinted sample labels will be affixed to sample bottles prior to delivery at the sampling site. The following information is required in each sample label.

- Project
- Date collected
- Location
- Sample number

9.3.3 Field Chain-of-Custody Forms

Completed COC forms will be required for all samples to be analyzed. COC forms will be initiated by the sampling crew in the field. The COC forms will contain the sample's unique identification number, sample date and time, sample description, sample type, preservation (if any), and analyses required. The original COC form will accompany the samples to the laboratory. Copies of the COC will be made prior to shipment (or multiple copy forms used) for field documentation. The COC forms will remain with the samples at all times. The samples and signed COC forms will remain in the possession of the sampling crew until the samples are delivered to the express carrier (e.g., Federal Express) or hand delivered to a mobile or permanent laboratory, or placed in secure storage.

Sample labels will be completed for each sample using waterproof ink, unless prohibited by weather conditions. The labels will include sample information, such as: sample number and location, type of sample, date and time of sampling, sampler's name or initials, preservation, and analyses to be performed. The completed sample labels will be affixed to each sample bottle. Whenever samples are co-located with a source or government agency, a separate Sample Receipt will be prepared for those samples and marked to indicate with whom the samples are being co-located. The person relinquishing the samples to the facility or agency should request the representative's signature, acknowledging sample receipt. If the representative is unavailable or refuses, this is noted in the "Received By" space.

9.4 Management of Investigation-Derived Materials and Wastes

Disposable equipment, debris, and decontamination rinsate (e.g., tap and distilled water containing small amounts of solvent) will be containerized during the sampling events and labeled for appropriate disposal.

9.5 Laboratory Procedures

9.5.1 General

Laboratory specific Standard Operating Procedure for PFAS is included in Appendix D.

Upon sample receipt, laboratory personnel will be responsible for sample custody. A field chain-of-custody form will accompany all samples requiring laboratory analysis. Samples will be kept secured in the laboratory until all stages of analysis are complete. All laboratory personnel having samples in their custody will be responsible for maintaining sample integrity.

9.5.2 Sample Receipt and Storage

Upon sample receipt, the laboratory sample custodian will verify the package seal, open the package, verify the sample integrity, and compare the contents against the field chain-of-custody. If a sample container is broken, the sample is in an inappropriate container, has not been preserved by appropriate means, or if there is a discrepancy between the chain-of-custody and the sample shipment, Preferred will be notified. The laboratory sample custodian will then log the samples in, assign a unique laboratory identification number to each, and label the sample bottle with the laboratory identification number. The project name, field sample code, date sampled, date received, analysis required, storage location and date, and action for final disposition will be recorded in the laboratory information management system. If the sample container is broken, the sample is in an inappropriate container, or has not been preserved by appropriate means, Preferred will be notified.

9.5.3 Sample Chain-of-Custody and Documentation

Laboratory chain-of-custody and documentation will follow industry procedures.

9.5.4 Sample Analysis

Analysis of an acceptable sample will be initiated by worksheets that contain all pertinent information for analysis. The analyst will sign and date the laboratory COC form when removing the samples from storage.

Samples will be organized into sample delivery groups (SDGs) by the laboratory. An SDG may contain up to 20 field samples (field duplicates, trip blanks, and rinse blanks are considered field samples for the purposes of SDG assignment). All field samples assigned to a single SDG shall be received by the laboratory over a maximum of 7 calendar days, and must be processed through the laboratory (preparation, analysis, and reporting) as a group. Every SDG must include a minimum of one site-specific matrix/matrix spike duplicate (MS/MSD) pair, which shall be received by the laboratory at the start of the SDG assignment.

Each SDG will be self-contained for all of the required quality control samples. All parameters within an SDG will be extracted and analyzed together in the laboratory. At no time will the laboratory be allowed to run any sample (including QC samples) at an earlier or later time than the rest of the SDG. These rules for analysis will ensure that the QC samples for an SDG are applicable to the field samples of the same SDG and that the best possible comparisons can be made.

9.5.5 Sample Storage Following Analysis

The remaining samples will be maintained by the laboratory for 1 month after the final report is delivered to Preferred. After this period, the samples will be disposed of in accordance with applicable rules and regulations.

10.0 Analytical Procedures

10.1 Field Analytical Procedures

Field analytical procedures will include the measurement of VOCs utilizing a Photo-Ionization Detector (PID) and groundwater quality parameters utilizing a Horiba.

10.2 Laboratory Analytical Procedures

Laboratory analytical requirements presented in the sub-sections below include a general summary of requirements, specifics related to each sample medium to be analyzed, and details of the methods to be used for this project. SW-846 methods with NYSDEC, ASP, 2005 Revision, QA/QC and reporting deliverables requirements will be used for all analytes.

10.2.1 Investigation Sample Matrices

10.2.1.1 Surface Soils

Analyses in this category will relate to soil and sediments samples. Analyses will be performed following the methods listed in **Table 1**. Results will be reported as dry weight, in units presented in **Table 2**. Moisture content will be reported separately.

10.2.3 Analytical Requirements

The primary sources to describe the analytical methods to be used during the investigation are provided in USEPA SW-846 Test Methods for Evaluating Solid Waste, Third Edition and USEPA Methods for Chemical Analysis of Water and Waste with NYSDEC ASP 2005 Revision, QA/QC and reporting deliverables requirements.

Detailed information regarding quality control procedures including matrix spike, matrix spike duplicates, matrix spike blanks, and surrogate recoveries is provided in NYSDEC, ASP 2005 Revision.

11.0 Quality Control Requirements

11.1 Quality Assurance Indicators

The overall quality assurance objective for this QAPP is to develop and implement procedures for sampling, chain-of-custody, laboratory analysis, instrument calibration, data reduction and reporting, internal quality control, audits, preventive maintenance, and corrective action such that valid data will be generated. These procedures are presented or referenced in the following sections of the QAPP. Specific QC checks are discussed in Section 11.2.

Quality assurance indicators are generally defined in terms of five parameters:

1. Representativeness
2. Comparability
3. Completeness
4. Precision
5. Accuracy

Each parameter is defined below. Specific objectives for the site actions are set forth in other sections of this QAPP, as referenced below.

11.1.1 Representativeness

Representativeness is the degree to which sampling data accurately and precisely represent site conditions, and is dependent on sampling and analytical variability. The investigation has been designed to assess the presence of the constituents at the time of sampling. The Work Plan presents the rationale for sample quantities and location. The use of the prescribed field and laboratory analytical methods with associated holding times and preservation requirements are intended to provide representative data.

11.1.2 Comparability

Comparability is the degree of confidence with which one data set can be compared to another. Comparability between this investigation, and to the extent possible, with existing data will be maintained through consistent sampling and analytical methodology set forth in the FSP and this QAPP, SW-846 analytical methods with NYSDEC ASP Revision 2005 QA/QC requirements and Category B reporting deliverables, and through use of QA/QC procedures and appropriately trained personnel.

11.1.3 Completeness

Completeness is defined as a measure of the amount of valid data obtained from an event and/or investigation compared to the amount that was expected to be obtained under normal conditions. This will be determined upon assessment of the analytical results, as discussed in Section 11.6.

11.1.4 Precision

Precision is the measure of reproducibility of sample results. The goal is to maintain a level of analytical precision consistent with the project objectives. To maximize precision, sampling and analytical

procedures will be followed. All work for this investigation will adhere to established protocols presented in the RIWP.

Checks for analytical precision will include the analysis of matrix spike duplicates, laboratory duplicates and field duplicates. Checks for field measurement precision will include obtaining duplicate field measurements. Further discussion of precision QC checks is provided in Section 11.4.

11.1.5 Accuracy

Accuracy is the deviation of a measurement from the true value of a known standard. Both field and analytical accuracy will be monitored through initial and continuing calibration of instruments. In addition, internal standards, matrix spikes, blank spikes, and surrogates (system monitoring compounds) will be used to assess the accuracy of the laboratory analytical data. Further discussion of these QC samples is provided in Section 11.4.

11.2 Field Quality Control Checks

11.2.1 Field Measurements

To verify the quality of data using field instrumentation, duplicate measurements will be obtained and reported for all field analytical measurements.

11.2.2 Sample Containers

Certified-clean sample containers in accordance with Exhibit I of the NYSDEC ASP Revision 2005 (Eagle Picher pre-cleaned containers or equivalent) will be supplied by the laboratory.

11.2.3 Field Duplicates

Field duplicates will be collected for soil samples to check reproducibility of the sampling methods. Soil sample field duplicates will be analyzed at a 5 percent frequency (every 20 samples). Table 1 provides an estimated number of field duplicates for each applicable parameter and matrix.

11.2.4 Rinse Blanks

Rinse blanks are used to monitor the cleanliness of the sampling equipment and the effectiveness of the cleaning procedures. Rinse blanks will be prepared and submitted for analysis at a frequency of one per day (when sample equipment cleaning occurs) or once for every 20 samples collected, whichever is less. Rinse blanks will be prepared by filling sample containers with analyte-free water (supplied by the laboratory) which has been routed through a cleaned sampling device. When dedicated sampling devices are used or sample containers are used to collect the samples, rinse blanks will not be necessary. Table 1 provides an estimated number of rinse blanks collected during the investigation.

11.2.5 Trip Blanks

Trip blanks will be used to assess whether site samples have been exposed to onsite related volatile constituents during storage and transport. Trip blanks will be analyzed at a frequency of once per day, per cooler containing soil samples to be analyzed for volatile organic constituents. A trip blank will consist of a container filled with analyte-free water (supplied by the laboratory) which remains unopened with field

samples throughout the sampling event. Trip blanks will only be analyzed for aqueous volatile organic constituents. Table 1 provides an estimated number of trip blanks collected for each matrix and parameter during the investigation.

11.3 Analytical Laboratory Quality Control Checks

Internal quality control procedures are specified in the analytical methods. These specifications include the types of QC checks required (method blanks, reagent/preparation blanks, matrix spike and matrix spike duplicates (MS/MSD), calibration standards, internal standards, surrogate standards, the specific calibration check standards, laboratory duplicate/replicate analysis), compounds and concentrations to be used, and the QC acceptance criteria.

11.3.1 Method Blanks

Method blanks will serve as a measure of contamination attributable to a variety of sources including glassware, reagents, and instrumentation. The method blank will be initiated at the beginning of an analytical procedure and is carried through the entire process.

11.3.2 Matrix Spike/Matrix Spike Duplicates

The MS will serve as a measure of method accuracy in a given matrix. The MS and the MSD together will serve as a measure of method precision.

11.3.3 Surrogate Spikes

Surrogate spikes are organic compounds that have similar properties to those being tested. They will serve as indicators of method performance and accuracy in organic analyses.

11.3.4 Laboratory Duplicates

Laboratory duplicates will serve to the measure method precision in inorganic and supplemental analyses. instrument set-up, and the premises inherent in quantitation. Reference standards will be analyzed at the frequencies specified within the analytical methods.

11.4 Data Precision Assessment Procedures

Field precision is difficult to measure because of temporal variations in field parameters. However, precision will be controlled through the use of experienced field personnel, properly calibrated meters, and duplicate field measurements. Field duplicates will be used to assess precision for the entire measurement system including sampling, handling, shipping, storage, preparation, and analysis.

Laboratory data precision for organic analyses will be monitored through the use of MSD, laboratory duplicate, and field duplicates as identified in Table 1. The precision of data will be measured by calculation of the relative percent differences (RPDs) of duplicate sample sets. The RPD can be calculated by the following equation:

$$RPD = \frac{(A-B)}{(A+B)/2} \times 100$$

Where:

A = Analytical result from one of two duplicate measurements.

B = Analytical result from the second measurement.

Precision objectives for matrix spike duplicate and laboratory duplicate analyses are identified in the NYSDEC ASP Revision 2005.

11.5 Data Accuracy Assessment Procedures

The accuracy of field measurements will be controlled by experienced field personnel, properly calibrated field meters, and adherence to established protocols. The accuracy of field meters will be assessed by review of calibration and maintenance logs. Laboratory accuracy will be assessed via the use of matrix spikes, surrogate spikes, and internal standards. Where available and appropriate, QA performance standards will be analyzed periodically to assess laboratory accuracy. Accuracy will be calculated as a percent recovery as follows:

$$Accuracy = \frac{A-X}{B} \times 100$$

Where:

A = Value measured in spiked sample or standard. X = Value measured in original sample. B = True value of amount added to sample or true value of standard.

This formula is derived under the assumption of constant accuracy over the original and spiked measurements. If any accuracy calculated by this formula is outside of the acceptable levels, data will be evaluated to determine whether the deviation represents unacceptable accuracy, or variable, but acceptable accuracy. Accuracy objectives for matrix spike recoveries and surrogate recovery objectives are identified in the NYSDEC ASP, 2005 Revision.

11.6 Data Completeness Assessment Procedures

Completeness of a field or laboratory data set will be calculated by comparing the number of samples collected or analyzed to the proposed number.

$$\text{Completeness} = \frac{\text{No. Valid Samples Collected or Analyzed}}{\text{No. Proposed Samples Collected or Analyzed}} \times 100$$

As general guidelines, overall project completeness is expected to be at least 90 percent. The assessment of completeness will require professional judgment to determine data usability for intended purposes.

12.0 Instrument/Equipment Testing, Inspection, and Maintenance Requirements

Preventive maintenance schedules have been developed for both field and laboratory instruments. A summary of the maintenance activities to be performed is presented below.

12.1 Field Instruments and Equipment

Prior to any field sampling, each piece of field equipment will be inspected to assure it is operational. If the equipment is not operational, it must be serviced prior to use. All meters which require charging or batteries will be fully charged or have fresh batteries. If instrument servicing is required, it is the responsibility of the Field Activities Task Manager to follow the maintenance schedule and arrange for prompt service. Field instrumentation to be used in this study includes a Photo-Ionization Detector (PID).

A logbook will be kept for each field instrument. Each logbook contains records of operation, maintenance, calibration, and any problems and repairs. The Field Activities Task Manager will review calibration and maintenance logs.

Field equipment returned from a site will be inspected to confirm it is in working order. This inspection will be recorded in the logbook or field notebooks as appropriate. It will also be the obligation of the last user to record any equipment problems in the logbook. Non-operational field equipment will be either repaired or replaced. Appropriate spare parts will be made available for field meters. A summary of preventive maintenance requirements for field instruments, and details regarding field equipment maintenance, operation, and calibration, are provided in the FSP.

12.2 Laboratory Instruments and Equipment

12.2.1 General

Only qualified personnel will service instruments and equipment. Repairs, adjustments, and calibrations are documented in the appropriate logbook or data sheet.

12.2.2 Instrument Maintenance

Preventive maintenance of laboratory equipment will follow the guidelines recommended by the manufacturer. A malfunctioning instrument will be repaired by inhouse staff or through a service call by the manufacturer as appropriate. The laboratory will maintain a sufficient supply of spare parts for its instruments to minimize downtime. Whenever possible, backup instrumentation will be retained.

Whenever practical, analytical equipment will be maintained under a service contract. The contract allows for preventative system maintenance and repair on an "as-needed" basis. The laboratory has sufficiently trained staff to allow for the day-to-day maintenance of equipment.

12.2.3 Equipment Monitoring

On a daily basis, the operation of balances, incubators, ovens, refrigerators, and water purification systems will be checked and documented. Any discrepancies will be immediately reported to the appropriate laboratory personnel for resolution.

13.0 Instrument Calibration and Frequency

13.1 Field Equipment Calibration Procedures and Frequency

Field equipment operation, calibration, and maintenance procedures are provided in the FSP section of the RIWP.

13.2 Laboratory Equipment Calibration Procedures and Frequency

Instrument calibration will follow the specifications provided by the instrument manufacturer or specific analytical method used. Equipment calibration procedures will follow guidelines presented in NYSDEC ASP 2005 Rev, Exhibit E.

14.0 Inspection/Acceptance Requirements for Supplies and Consumables

The laboratory shall inspect/test all supplies and consumables prior to use with SC samples. Documentation shall be maintained for all associated testing and analyses.

15.0 Data Acquisition Requirements for Non-direct Measurements

At this point in time, historical data generated by outside parties is not anticipated to be used directly in completing the investigation. However, historical data will be used as guidance in determining sampling locations for the investigation.

Prior to their use, historic data sets have been reviewed according to the procedures identified in subsequent sections of this QAPP to determine the appropriate uses of such data. The extent to which these data can be validated will be determined by the analytical level and QC data available. The evaluation of historic data for investigation purposes requires the following:

- Identification of analytical levels
- Evaluation of QC data, when available
- Development of conclusions regarding the acceptability of the data for intended uses

Acceptability of historic data for intended uses will be determined by application of these procedures and professional judgment. If the historic data quality cannot be determined, its use will be limited to general trend evaluations.

16.0 Data Management

The purpose of the data management is to ensure that all of the necessary data are accurate and readily accessible to meet the analytical and reporting objectives of the project. The field investigations will encompass a large number of samples and a variety of sample matrices and analytes from a large geographic area. From the large amount of resulting data, the need arises for a structured, comprehensive, and efficient program for management of data.

The data management program established for the project includes field documentation and sample QA/QC procedures, methods for tracking and managing the data, and a system for filing all site-related information. More specifically, data management procedures will be employed to efficiently process the information collected such that the data are readily accessible and accurate. These procedures are described in detail in the following section.

The data management plan has five elements:

1. Sample designation system
2. Field activities
3. Sample tracking and management
4. Data management system
5. Document control and inventory

16.1 Sample Designation System

A concise and easily understandable sample designation system is an important part of the project sampling activities. It provides a unique sample number that will facilitate both sample tracking and easy re-sampling of select locations to evaluate data gaps, if necessary. The sample designation system to be employed during the sampling activities will be consistent, yet flexible enough to accommodate unforeseen sampling events or conditions. A combination of letters and numbers will be used to yield a unique sample number for each field sample collected.

16.2 Field Activities

Field activities designed to gather the information necessary to make decisions regarding the off-site areas require consistent documentation and accurate record keeping. During site activities, standardized procedures will be used for documentation of field activities, data security, and QA. These procedures are described in further detail in the following subsections.

16.2.1 Field Documentation

Complete and accurate record keeping is a critical component of the field investigation activities. When interpreting analytical results and identifying data trends, investigators realize that field notes are an important part of the review and validation process. To ensure that all aspects of the field investigation are thoroughly documented, several different information records, each with its own specific reporting requirements, will be maintained, including:

- Field logs

- Instrument calibration records
- Chain-of-custody forms

A description of each of these types of field documentation is provided below.

Field Logs

The personnel performing the field activities will keep field logs that detail all observations and measurements made during the investigation. Data will be recorded directly into site-dedicated, bound notebooks, with each entry dated and signed. To ensure at any future date that notebook pages are not missing, each page will be sequentially numbered. Erroneous entries will be corrected by crossing out the original entry initialing it, and then documenting the proper information.

Instrument Calibration Records

As part of data quality assurance procedures, field monitoring and detection equipment will be routinely calibrated. Instrument calibration ensures that equipment used is of the proper type, range, accuracy, and precision to provide data compatible with the specified requirements and desired results. Calibration procedures for the various types of field instrumentation are described in Section 13.1. In order to demonstrate that established calibration procedures have been followed, calibration records will be prepared and maintained to include, as appropriate, the following:

- Calibration date and time
- Type and identification number of equipment
- Calibration frequency and acceptable tolerances
- Identification of individual(s) performing calibration
- Reference standards used
- Calibration data
- Information on calibration success or failure

The calibration record will serve as a written account of monitoring or detection equipment QA. All erratic behavior or failures of field equipment will be subsequently recorded in the calibration log.

Chain-of-Custody Forms

COC forms are used as a means of documenting and tracking sample possession from time of collection to the time of disposal. A COC form will accompany each field sample collected, and one copy of the form will be filed in the field office. All field personnel will be briefed on the proper use of the COC procedure.

16.2.2 Data Security

Measures will be taken during the field investigation to ensure that samples and records are not lost, damaged, or altered. When not in use, all field notebooks will be stored at the field office in a locked cabinet. Access to these files will be limited to the field personnel who utilize them.

16.3 Sample Management and Tracking

A record of all field documentation, as well as analytical and QA/QC results, will be maintained to ensure the validity of data used in the site analysis. To effectively execute such documentation, carefully constructed sample tracking and data management procedures will be used throughout the sampling program.

Sample tracking will begin with the completion of COC forms, as described in Section 9.3.3. On a daily basis, the completed COC forms associated with samples collected that day will be faxed from the project office to the QAM. Copies of all completed COC forms will be maintained in the field office. On the following day, the QAM will telephone the laboratory to verify receipt of samples.

When analytical data are received from the laboratory, the QAM will review the incoming analytical data packages against the information on the COCs to confirm that the correct analyses were performed for each sample and that results for all samples submitted for analysis were received. Any discrepancies noted will be promptly followed-up by the QAM.

16.4 Data Management System

In addition to the sample tracking system, a data management system may be implemented. The central focus of the data management system will be the development of a personal computer-based project database. The project database, to be maintained by the Database Administrator, will combine pertinent geographical, field, and analytical data. Information that will be used to populate the database will be derived from three primary sources: sample locations, field observations, and analytical results. Each of these sources is discussed in the following sections.

16.4.1 Computer Hardware

If required, the database will be constructed on Pentium®-based personal computer work stations connected through a Novell network server. The Novell network will provide access to various hardware peripherals, such as laser printers, backup storage devices, image scanners, modems, etc. Computer hardware will be upgraded to industrial and corporate standards, as necessary, in the future.

16.4.2 Computer Software

The database will running in a Windows operating system.

16.4.3 Analytical Results

Analytical results provided by the laboratory will generally be available in both a digital and a hard copy format. Upon receipt of each analytical package, the original COC form will be placed in the project files. The data packages will be examined to ensure that the correct analyses were performed for each sample submitted and that all of the analyses requested on the COC form were performed. If discrepancies are noted, the QAM will be notified and will promptly follow up with the laboratory to resolve any issues.

Digital files will be used to populate the appropriate database tables. The format of the table will specify one data record for each constituent for each sample analyzed. Specific fields include:

- sample identification number
- date sampled
- date analyzed
- parameter name
- analytical result
- units
- detection limit
- qualifier(s)

The individual EDDs, supplied by the laboratory in either an ASCII comma separated value (CSV) format or in a Microsoft Excel worksheet, will be loaded into the appropriate database table. Any analytical data that cannot be provided by the laboratory in electronic format will be entered manually.

After entry into the database, the EDD data will be compared to the field information previously entered into the database to confirm that all requested analytical data have been received.

16.5 Document Control and Inventory

Preferred maintains project files in its Merrick, New York office. Each client project is assigned a file/job number. Each file is then broken down into the following subfiles:

- #1- Administrative - all agreements and contracts involving the off-site investigations
- #2- Correspondence - all external correspondence, including report comments, all internal and external memoranda
- #3 Field Work Documentation – notes, photographs, logs and data from field, activities
- # 4 Reporting – reports, laboratory data, figures etc.

Originals, when possible, are placed in the files. These are the central files and will serve as the site-specific files for the investigations.

17.0 Assessment and Response Actions

Performance and systems audits will be completed in the field and the laboratory during the SC as described below.

17.1 Field Audits

The following field performance and systems audits will be completed during this project.

17.1.1 Performance Audits

The Project Manager will monitor field performance. Field performance audit summaries will contain an evaluation of field measurements and field meter calibrations to verify that measurements are taken according to established protocols.

The Quality Assurance Manager will review all field reports and communicate concerns to the Project Manager, as appropriate. In addition, the Quality Assurance Manager will review the rinse and trip blank data to identify potential deficiencies in field sampling and cleaning procedures.

17.1.2 Internal Systems Audits

A field internal systems audit is a qualitative evaluation of all components of field QA/QC. The systems audit compares scheduled QA/QC activities from this document with actual QA/QC activities completed. The Project Manager will periodically confirm that work is being performed consistent with the RIWP, and the HASP.

17.2 Laboratory Audits

The laboratory will perform internal audits consistent with NYSDEC ASP, 2005 Revision. In addition to the laboratory's internal audits and participation in state and federal certification programs, the laboratory sections at the laboratory are audited by representatives of the regulatory agency issuing certification. Audits are usually conducted on an annual basis and focus on laboratory conformance to the specific program protocols for which the laboratory is seeking certification. The auditor reviews sample handling and tracking documentation, analytical methodologies, analytical supportive documentation, and final reports. The audit findings are formally documented and submitted to the laboratory for corrective action, if necessary.

17.3 Corrective Action

Corrective actions are required when field or analytical data are not within the objectives specified in this QAPPor the Work Plan. Corrective actions include procedures to promptly investigate, document, evaluate, and correct data collection and/or analytical procedures. Field and laboratory corrective action procedures are described below.

17.3.1 Field Procedures

When conducting field work, if a condition is noted that would have an adverse effect on data quality, corrective action will be taken so as not to repeat this condition. Condition identification, cause, and corrective action implemented will be documented on a Corrective Action Report Form and reported to the Project Manager.

Examples of situations that would require corrective actions are provided below:

1. Protocols as defined by this QAPP or the RIWP have not been followed.
2. Equipment is not in proper working order or properly calibrated.
3. QC requirements have not been met.
4. Issues resulting from performance or systems audits.

Project personnel will continuously monitor ongoing work performance in the normal course of daily responsibilities.

17.3.2 Laboratory Procedures

In the laboratory, when a condition is noted to have an adverse effect on data quality, corrective action will be taken so as not to repeat this condition. Condition identification, cause, and corrective action to be taken will be documented, and reported to the Project Manager.

Corrective action may be initiated, at a minimum, under the following conditions:

1. Specific laboratory analytical protocols have not been followed.
2. Predetermined data acceptance standards are not obtained.
3. Equipment is not in proper working order or calibrated.
4. Sample and test results are not completely traceable.
5. QC requirements have not been met.
6. Issues resulting from performance or systems audits.

Laboratory personnel will continuously monitor ongoing work performance in the normal course of daily responsibilities.

18.0 Reports to Management

18.1 Internal Reporting

The analytical laboratory will submit analytical reports to Preferred for review. Supporting data (i.e., historic data, related field or laboratory data) will also be reviewed to evaluate data quality, as appropriate. The Quality Assurance Manager will incorporate results of the data review into a summary report (if required).

18.2 Reporting

Upon sample transport to the laboratory, a copy of the chain-of-custody will be forwarded to National Fuel. Upon receipt of the ASP - Category B Data Package from the laboratory, the Quality Assurance Manager will determine if the data package has met the required data quality objectives. The analytical data package will also be incorporated into the Report.

19.0 Data Review and Verification

After field and laboratory data are obtained, these data will be subject to:

1. Reduction or manipulation of the data mathematically or otherwise into meaningful and useful forms
2. Organization, interpretation, and reporting of the data

19.1 Field Data Reduction, Validation, and Reporting

19.1.1 Field Data Reduction

Information that is collected in the field through visual observation, manual measurement and/or field instrumentation will be recorded in field notebooks, log sheets, and/or other appropriate forms. Such data will be reviewed by the Project Manager for adherence to the Work Plan and consistency of data. Any concerns identified as a result of this review will be discussed with the field personnel, corrected if possible, and as necessary incorporated into the data evaluation process.

19.1.1.1 Task 1 – Soil Investigation

The specific data reduction activity that will be performed during Task 1 is:

- Mapping of areas impacted with targeted CVOCs based on findings of the soil-boring program

19.1.2 Field Data Reporting

Where appropriate, field data forms and calculations will be processed and included in appendices to the Report. The original field logs, documents, and data reductions will be kept in the project.

19.2 Laboratory Data Reduction, Review, and Reporting

19.2.1 Laboratory Data Reduction

Laboratory analytical data will be directly transferred from the instrument to the computer or the data reporting form (as applicable). Calculation of sample concentrations will be performed using the appropriate regression analysis program, response factors, and dilution factors (where applicable).

19.2.2 Laboratory Data Review

All data will be subject to multi-level review by the laboratory. The group leader will review all data reports prior to release for final data report generation, and the laboratory director will review a cross section of the final data reports. All final data reports are reviewed by the laboratory QAM prior to shipment to Preferred.

If discrepancies or deficiencies exist in the analytical results, then corrective action will be taken, as discussed in Section 17. Deficiencies discovered as a result of internal data review, as well as the corrective actions to be used to rectify the situation, will be documented on a Corrective Action Form. This form will be submitted to the Preferred Project Manager.

20.0 Reconciliation with User Requirements

The data results will be examined to determine the performance that was achieved for each data usability criteria. The performance will then be compared with the project objectives. Of particular note will be samples at or near action levels. All deviations from objectives will be noted. Additional action may be warranted when performance does not meet performance objectives for critical data. Action options may include any or all of the following:

- Retrieval of missing information
- Request for additional explanation or clarification
- Reanalysis of sample from extract (when appropriate)
- Recalculation or reinterpretation of results by the laboratory

These actions may improve the data quality, reduce uncertainty, and may eliminate the need to qualify or reject data. If these actions do not improve the data quality to an acceptable level, the following actions may be taken:

- Extrapolation of missing data from existing data points
- Use of historical data
- Evaluation of the critical/non-critical nature of the sample

If the data gap cannot be resolved by these actions, an evaluation of the data bias and potential for false negatives and positives can be performed. If the resultant uncertainty level is unacceptable, then the following action may be taken:

- Additional sample collection and analysis

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Table 1
Environmental and Quality Control Sample Analyses

		QA/QC Samples					
Laboratory Parameter	**# of Proposed Samples**	**Field Blank***	**Trip Blank**	**Duplicate**	**MS**	**MSD**	**Total # of Samples**
Soils							
VOCs	16	2	2	1	1	1	23
SVOCs	16	2	2	1	1	1	23
Metals	16	2	2	1	1	1	23
PCBs	16	2	2	1	1	1	23
Pesticides	16	2	2	1	1	1	23
Perfluorinated Compounds	16	2	2	1	1	1	23
1-4, Dioxane	16	2	2	1	1	1	23
Groundwater							
VOCs	8	1	2	1	1	1	14
SVOCs	8	1	2	1	1	1	14
Metals	8	1	2	1	1	1	14
PCBs	8	1	2	1	1	1	14
Pesticides	8	1	2	1	1	1	14
Perfluorinated Compounds	8	1	2	1	1	1	14
1-4, Dioxane	8	1	2	1	1	1	14
Soil Vapor/Indoor Air/Outdoor Air							
VOCs	4	0	0	1	0	0	5
* Will be collected 1 per day per matrix							

Table 2

Sample Containers, Preservation Methods, and Holding Times Requirements

Parameter	Method	Container	Preservation	Maximum Holding Time
Soil Samples				
VOCs	8260C	Terra Core	methanol, deionized water 4 degrees C	14 days
SVOCs	8270	1 8 (oz) glass jar	Cool 4 degress C	7 days
Pesticides/PCBs	8081/8082	1 8 (oz) glass jar	Cool 4 degress C	7 days
Metals	6010	1 8 (oz) glass jar	Cool 4 degress C	14 days
PFAS	537	250 mL Plastic	Cool 4 degress C	40 days
1,4 -Dioxane	8270D SIM	250 mL	Cool 4 degress C	28 days
Groundwater Samples				
VOCs	8260C	Two 40 mil vials	HCL to pH<2	14 days
SVOCs	8270	250 mil glass	Cool 4 degress C	7 days
Pesticides/PCBs	8081/8082	250 mil glass	Cool 4 degress C	7 days
TAL Metals (unfiltered)	6010C	250 mil plastic	HNO3	14 days
TAL Metals (filtered)	6010C	250 mil plastic	HNO3	14 days
PFAS	537	250 mil HDPE Plastic	Cool 4 degress C	40 days
1,4-Dioxane	8270D SIM	500 mil Glass Amber	Cool 4 degress C	28 Days
VOCs	TO-15	6-liter SUMMA Canister	NA	30 Days

Appendix A

Resumes

QUALITY SYSTEMS MANUAL

FOR ENVIRONMENTAL ANALYTICAL SERVICES

Version 2.9
Effective Date July 1, 2021

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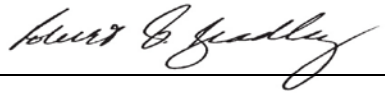
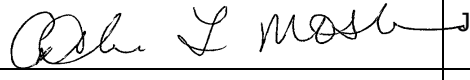
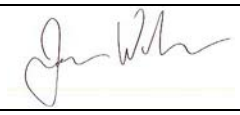
Name	Title	Signature	Date
Robert Q. Bradley	Chief Technology Officer		July 1, 2021
Cassie Mosher	Laboratory Manager-CT		July 1, 2021
Taylor Pasquence	Laboratory Manager-NY		July 1, 2021
Jon Walsh	QA Officer/Technical Director-NY		July 1, 2021
Sarah Widomski	QA Officer-CT		July 1, 2021

TABLE OF CONTENTS QUALITY SYSTEMS MANUAL

PREFACE TO THE QUALITY SYSTEMS MANUAL

Purpose

The purpose of this document is to provide implementation guidance on the establishment and management of quality systems for York Analytical Laboratories, Inc. and is based on The National Environmental Laboratory Accreditation Institute (TNI) Quality System requirements,

Background

To be accredited by various States and certain other programs under the auspices of TNI and ISO the following are relevant:

1. The National Environmental Laboratory Accreditation Conference (TNI). Accredited laboratories shall have a comprehensive quality system in place, the requirements for which are outlined in The NELAC Institute (TNI) 2016 Volume 1: Management and Technical Requirements for Laboratories Performing Environmental Analysis (EL-V1-2016). This manual was written with guidance primarily from Volume 1: Modules 2, 3, 4, 5, and 7.

   Additional information may be found at:
   - http://www.nelac-institute.org/

2. ISO/IEC 17025:2005 General Requirements for the Competence of Testing and Calibration Laboratories is for use by laboratories in developing their management system for quality, administrative and technical operations. Laboratory customers, regulatory authorities and accreditation bodies may also use it in confirming or recognizing the competence of laboratories.

   Additional information may be found at:
   - http://www.iso.org/iso/home.html

Project Specific Requirements

Project-specific requirements or regulations may supersede requirements contained in this manual. The laboratory bears the responsibility for meeting all **State requirements**. Nothing in this document relieves the laboratory from complying with contract requirements, or with **Federal, State, and/or local regulations**.

Results and Benefits

- **Standardization of Processes** – Because this manual provides the laboratory with a comprehensive set of requirements that meet the needs of many clients, as well as the NELAP, the laboratory may use it to create a standardized quality system. Ultimately, this standardization saves laboratory resources by establishing one set of consistent requirements for all environmental work. Primarily, the laboratory bears the responsibility for meeting all State requirements as outlined in their respective certification programs.
- **Deterrence of Improper, Unethical, or Illegal Actions** – Improper, unethical, or illegal activities committed by only a few laboratories have implications throughout the industry, with negative impacts on all laboratories. This manual establishes a minimum threshold program for all laboratories to use to deter and detect improper, unethical, or illegal actions.
- **Foundations for the Future** – A standardized approach to quality systems, shared by laboratories and The NELAC Institute, paves the way for the standardization of other processes. For example, this manual might serve as a platform for a standardized strategy for Performance Based Measurement System (PBMS) implementation.

Document Format

This YORK Quality Systems Manual (QSM) is designed to implement the TNI 2016 (EL-V1-2016) standards along with the ISO/IEC 17025:2005 standards.

The section numbering has been changed from that of these standards as the manual is meant to be a stand-alone document. Therefore the numbering in this document is not consistent with the numbering in the above-mentioned standards; however, all required elements are covered, herein.

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ACROYNM LIST

°C: Degrees Celsius
ANSI/ASQC: American National Standards Institute / American Society for Quality Control
ASTM: American Society for Testing and Materials
CAS: Chemical Abstract Service
CCV: Continuing calibration verification
CFR: Code of Federal Regulations
COC: Chain of Custody
CV: Coefficient of Variation
DO: Dissolved Oxygen
DOC: Demonstration of Capability **DQOs:** Data Quality Objectives
EPA: Environmental Protection Agency
g/L: Grams per Liter
GC/MS: Gas Chromatography / Mass Spectrometry
ICP-MS: Inductively Coupled Plasma / Mass Spectrometer
ICV: Initial Calibration Verification
ID: Identifier
IDOC: Initial Demonstration of Capability

ISO/IEC: International Standards Organization / International Electrotechnical Commission
LCS: Laboratory Control Sample
LCSD: Laboratory Control Sample Duplicate
LOD: Limit of Detection
LOQ: Limit of Quantitation
MDL: Method Detection Limit **ME:** Marginal Exceedance **mg/kg:** Milligrams per Kilogram **MS:** Matrix Spike
MSD: Matrix Spike Duplicate
NELAC: National Environmental Laboratory Accreditation Conference **NELAP:** National Environmental Laboratory Accreditation Program **NIST:** National Institute of Standards and Technology
OSHA: Occupational Safety and Health Administration **PBMS:** Performance Based Measurement System
PC: Personal Computer
PCBs: Polychlorinated Biphenyls
PT: Proficiency Testing
QA: Quality Assurance
QAPP: Quality Assurance Project Plan
QSM: Quality Systems Manual
QC: Quality Control
RL: Reporting Limit
RPD: Relative Percent Difference **RSD:** Relative Standard Deviation **SD:** Serial Dilutions
SOP: Standard Operating Procedure
TNI: The NELAC Institute **TSS:** Total Suspended Solids **UV:** Ultraviolet
VOC: Volatile Organic Compound

QUALITY SYSTEMS

Quality Systems include all quality assurance (QA) policies and quality control (QC) procedures that are delineated in a Quality Systems Manual (QSM) and followed to ensure and document the quality of the analytical data. York Analytical Laboratories, Inc. (YORK), accredited under the National Environmental Laboratory Accreditation Program (NELAP), assures implementation of all QA policies and the applicable QC procedures specified in this Manual. The QA policies, which establish essential QC procedures, are applicable to all areas of YORK, regardless of size and complexity.

The intent of this document is to provide sufficient detail about quality management requirements so that all accrediting authorities evaluate laboratories consistently and uniformly.

The NELAC Institute (TNI) is committed to the use of Performance Based Measurement Systems (PBMS) in environmental testing and provides the foundation for PBMS implementation in these standards. While this standard may not currently satisfy all the anticipated needs of PBMS, NELAC will address future needs within the context of State statutory and regulatory requirements and the finalized EPA implementation plans for PBMS.

Chapter 5 is organized according to the structure of ISO/IEC 17025, 2005. Where necessary specific areas within this Chapter deemed may contain more information than specified by ISO/IEC 17025.

All items identified in this QSM shall be available for on-site inspection or data audit.

1.0 SCOPE

a) This QSM sets the general requirements that YORK must successfully demonstrate to be recognized as competent to perform specific environmental analyses.

b) This QSM includes additional requirements and information for assessing competence or for determining compliance by the organization or accrediting authority that grants approval.

If more stringent standards or requirements are included in a mandated test method or by regulation, the laboratory demonstrates that such requirements are met. If it is not clear which requirements are more stringent, the standard from the method or regulation is to be followed.

c) YORK uses this QSM in the development and implementation of its quality systems. Accreditation authorities use this NELAC based standard to assess the competence of environmental laboratories.

2.0 REFERENCES

See Appendix A.

3.0 DEFINITIONS

The relevant definitions from ISO/IEC Guide 2, ANSI/ASQC E-4, 1994, the EPA "Glossary of Quality Assurance Terms and Acronyms," and the *International vocabulary of basic and general terms in metrology (VIM*) are applicable. The most relevant is quoted in Appendix A, Glossary, of Chapter 1 of NELAC, together with further definitions applicable for the purposes of this Standard.

4.0 ORGANIZATION AND MANAGEMENT

4.1 Legal Definition of Laboratory

YORK is legally definable as evidenced by its business license, and current Certifications by the States of Connecticut and New York Depts. of Heath Environmental Laboratory Accreditation Program (ELAP) certifications and the NJDEP and PADEP ELAP certifications. York is organized and operates in such a way that its facilities meet the requirements of the NELAC/TNI Standard. Refer to the presentations of the Organization and QA responsibility as shown in Figures 1 and 2, respectively. Current Certifications are detailed as follows: State of Connecticut Department of Health (CTDOH) Certification no. PH-0723 and PH-0721, New York State Department of Health (NYSDOH) Certifications no. 10854 and 12058 State of New Jersey Dept. of Environmental Protection (NJDEP) Certification nos. CT-005 and NY-037 and State of Pennsylvania DEP Registration No. 68-04440. York's EPA registration ID is CT-005.

4.2 Organization

York Analytical Laboratories Inc.:

a) Has a managerial staff with the authority and resources necessary to discharge their duties;

b) Has processes to ensure that its personnel are free from any commercial, financial and other undue pressure that adversely affect the quality of their work;

c) Is organized in such a way that confidence in its independence of judgment and integrity is maintained at all times;

d) Specifies and documents the responsibility, authority, and interrelationship of all personnel who manage, perform or verify work affecting the quality of calibrations and tests;

Such documentation includes:

1) A clear description of the lines of responsibility in the laboratory, and is proportioned such that adequate supervision is ensured, and

2) Job descriptions for all positions.

e) Provides supervision by persons familiar with the calibration or test methods and procedures, the

objective of the calibration or test, and the assessment of the results.

The ratio of supervisory to non-supervisory personnel ensures adequate supervision and adherence to laboratory procedures and accepted techniques.

f) Has technical directors who have overall responsibility for the technical operations of YORK facilities.

The technical director certifies that personnel who perform the tests for which the laboratory is accredited have the appropriate educational and/or technical background. Such certification is documented.

The technical director meets the requirements specified in the Accreditation Process. (See NELAC Section 4.1.1.1.)

g) Has a Quality Assurance Officer (QAO) who has responsibility for the quality system and its implementation.

The quality assurance officer has direct access to the technical director and to the highest level of management at which decisions are made regarding laboratory policy or resources.

The quality assurance officer (and/or designees):

1) Serves as the focal point for QA/QC activities, and is responsible for the oversight and/or review of quality control data;
2) Has functions independent from laboratory operations for which she/he has quality assurance oversight;
3) Is able to evaluate data objectively and perform assessments without outside (e.g., managerial) influence;
4) Has documented training and/or experience in QA/QC procedures and is knowledgeable in the quality system, as defined under NELAC;
5) Has a general knowledge of the analytical test methods for which data review is performed;
6) Arranges for and conducts internal audits as per YORK QSM section 5.3 annually; and
7) Notifies YORK management of deficiencies in the quality system and monitors corrective action.

h) Nominates, by way of the “Alternates List,” deputies in case of absence of the Technical Director and/or the Quality Assurance Director;

i) YORK makes every effort to ensure the protection of its clients' information as confidential and proprietary.

ii) YORK is sensitive to the fact that much of the analytical work performed for clientele may be subject to litigation processes. YORK, therefore, holds all information in strict confidence with laboratory release only to the client.
iii) Information released to entities other than the client is performed only upon written request from the client.
iv) Due to the investigative nature of most site assessments, analytical information may become available to regulatory agencies or other evaluating entities during site assessment of the laboratory for the specific purpose of attaining laboratory certifications, accreditations, or evaluation of laboratory qualification for future work. During these occurrences, the laboratory will make every effort to maintain the confidence of client specific information.

j) For purposes of qualifying for and maintaining accreditation, participates in a proficiency test program as outlined in Chapter 2 of NELAC. Results of YORK’s performance in rounds of proficiency testing are available by request.

5.1 QUALITY SYSTEM – ESTABLISHMENT, AUDITS, ESSENTIAL QUALITY CONTROLS, AND DATA VERIFICATION

5.2 Establishment

YORK establishes and maintains quality systems based on the required elements contained in this Manual and appropriate to the type, range and volume of environmental testing activities it undertakes.

a) The elements of this quality system are documented in this quality manual.

b) The quality documentation is available for use by all laboratory personnel.

c) The laboratory defines and documents its policies and objectives for, and its commitment to accepted laboratory practices and quality of testing services.

d) The laboratory management ensures that these policies and objectives are documented in the quality manual and are communicated to, understood and implemented by all laboratory personnel concerned.

i. All staff members are given access to a controlled copy of the Quality Systems Manual (QSM) for review at the commencement of employment. However, the individual Standard Operating Procedures are the training documents that have precedence. The QSM is provided as a general overview.

ii. A controlled copy of the quality manual is also available in each department.

e) The quality manual is maintained current under the responsibility of the quality assurance department. This manual is reviewed on an annual basis or more frequently, and revised as necessary.

5.3 Quality Systems Manual (QSM) Elements

This Quality Systems Manual (QSM) and related quality documentation state YORK's policies and operational procedures established in order to meet the requirements of this Standard.

This manual lists on the title page: a document title; the laboratory's full name and address; the name, address, and telephone number of individuals responsible for the laboratory and the effective date of the version.

This quality manual and related quality documentation also contains:

a) A quality ***policy statement***, including objectives and commitments, by top management;

i. York Analytical Laboratories, Inc. (YORK) is committed to providing quality environmental analytical services. To ensure the production of scientifically sound, legally defensible data of known and documented quality, an extensive Quality Assurance program has been developed and implemented. This document, YORK's Quality Systems Manual for Environmental Analytical Services, presents an overview of the essential elements of our Quality Assurance program. YORK has modeled this systems manual after EPA guidelines as outlined in "Guidance for Quality Assurance Project Plans (EPA QA/G-5)", Office of Monitoring Systems and Quality Assurance, Office of Research and Development, U.S. EPA, EPA/240-R-02/009 December 2002.

ii. YORK's QA Program is monitored at the Corporate, Divisional, and Group levels, and relies on clearly defined objectives, well-documented procedures, a comprehensive quality assurance/quality control system, and management support for its effectiveness.

iii. This QA Program Systems Manual is designed to control and monitor the quality of data generated at YORK. The essential elements described herein are geared toward generating data that is in compliance with federal regulatory requirements specified under the Clean Water Act, the Safe Drinking Water Act, the Resource Conservation and Recovery Act, the Comprehensive Environmental Response, Compensation, and Liability Act, Clean Air Act and applicable amendments, and state and equivalents. Although the quality control requirements of these various programs are not completely consistent, each of the programs base data quality judgments on the following three types

of information, the operational elements of each being described elsewhere in this manual.

⇨ Data which indicates the overall qualifications of the laboratory to perform environmental analyses;
⇨ Data which measures the laboratory's daily performance using a specific method; and
⇨ Data which measures the effect of a specific matrix on the performance of a method.

iv. It is important to note that the QA guidelines presented herein will always apply unless adherence to specific Quality Assurance Project Plans (QAPPs) or client and/or regulatory agency specific requirements are directed. In these cases, the elements contained within specified direction or documentation shall supersede that contained in this document.

v. This manual is a living document subject to periodic modifications to comply with regulatory changes and technological advancements. All previous versions of this document are obsolete. Users are urged to contact YORK to verify the current revision of this document.

b) The organization and management structure of the laboratory, its place in any parent organization and relevant organizational charts;

See Figures 1 and 2- Organizational Charts.

The relationship between management, technical operations, support services and the quality system;

c) Procedures to ensure that all records required under the NELAP are retained, as well as procedures for control and maintenance of documentation through a document control system which ensures that all standard operating procedures, manuals, or documents clearly indicate the time period during which the procedure or document was in force;

i. Ensuring a quality work product in the environmental laboratory not only requires adherence to the quality issues discussed in the previous sections, but also requires the ability to effectively archive, restore, and protect the records that are generated.

ii. Procedures are in place to ensure that all records are retained. In addition, a documentation control system is employed to clearly indicate the time period during which a standard operating procedure, manual, or document was in force. These procedures are outlined in the laboratory standard operating procedure SOP-T002.

iii. All laboratory logbooks, instrument response printouts, completed analytical reports, chain-of-custodies, and laboratory support documentation are stored for a minimum of five years. Project specific data are stored in sequentially numbered project files and include copies of the applicable laboratory logbooks, instrument response printouts, completed analytical reports, chain-of-custodies, and any other pertinent supporting documentation.

iv. When complete, the project specific data are high speed optically scanned and transformed into digital CD media. Additional copies of these records are created at the time of scanning and are stored off-site for protection of the data. These records are stored for a minimum of five years.

v. Access to all systems is limited by use of log-in and password protection and is maintained by York's IT Manager.

vi. There are four forms of electronic data that are generated in the laboratory. Refer to Table 1 – Data Archiving Schedule below for a synopsis of general data archiving schedules.

vii. All electronic records are stored for a minimum of five years.

TABLE 1 – DATA ARCHIVING SCHEDULE

LIMS Database	
Backup frequency:	Hourly
Backup media:	Virtual Machine/Hard Disk

Backup software:	MS SQL Server Backup
Onsite copy:	Redundancy by using mirrored hard drive
Offsite copy:	Hourly to Cloud

Instrument Data

Backup frequency:	Real time back-up to VM then Daily
Backup media:	Hard Disk-File server-VM
Backup software:	Win Backup
Backup versions kept:	All versions-changes only archived
Offsite copy:	One to Cloud/Daily

d) Job Descriptions, Roles and Responsibilities

In order for the Quality Assurance Program to function properly, all members of the staff must clearly understand and meet their individual responsibilities as they relate to their job function and the quality program as a whole.

The responsibility for quality lies with every employee at YORK. As such, all employees have access to the Quality Assurance Manual and are responsible for knowing the content of this manual and upholding the standards therein. Each employee is expected to conduct themselves in accordance with the procedures in this manual and the laboratory's SOPs.

The following descriptions define the primary roles and their relationship to the Quality Assurance Program. Members of the key staff include the following:

- Management (e.g., President, CTO, Managers);
- Technical managers (e.g., Technical Directors, Group Leaders);
- Quality Assurance Officer and Data Quality Managers;
- Support systems and administrative managers (e.g., IT manager, Facilities manager, project managers, client services); and
- Other staff

In these positions, members of the key staff are responsible for assuring compliance with the National Environmental Laboratory Accreditation Program (NELAP), California Environmental Laboratory Accreditation Program (ELAP), State and Federal Agencies, and ISO 17025:2005 Standard requirements. In these roles, key personnel may set or enforce quality policies, monitor compliance, initiate corrective actions, interface with laboratory, client, and regulatory personnel, and provide general program oversight.

President and Chief technology Officer:

YORK's Top Management which represents YORK to the various York facilities and Client entities.

- ⇨ Ensures that YORK's financial and production performance meets assigned metrics.
- ⇨ Determines need for capital and employee resources and allocates as appropriate.
- ⇨ Serves as the legal representative for YORK.
- ⇨ Responsible for yearly budget and overruns.
- ⇨ Point persons for major new initiatives
- ⇨ Manages Laboratory Managers, Technical Directors, QAO and support personnel

Laboratory Technical Directors:

YORK's Laboratory Technical Directors are the final authorities on all issues dealing with data quality and have the authority to require that procedures be amended or discontinued, or analytical results voided or repeated. They also have the authority to recommend suspension or termination of employees on the grounds of non-compliance with QA/QC procedures. In addition, Technical Directors:

- ⇨ Ensure that YORK remains current with all regulations which affect operations and disseminate all such changes in regulatory requirements to the QA Officer, and Group Leaders;
- ⇨ The Laboratory Manager may also act in the Technical Director capacity if the Technical Director is absent for a period of time exceeding 15 consecutive calendar days, providing they meet the qualifications of the Technical Director to temporarily perform this function. If the absence exceeds 35 consecutive calendar days, the primary accrediting authority will be notified in writing;
- ⇨ Ensure that all analysts and supervisors have the appropriate education and training to properly carry out the duties assigned to them and ensures that this training has been documented;
- ⇨ Ensures that personnel are free from any commercial, financial and other undue pressures which might adversely affect the quality of their work;
- ⇨ Oversees the development and implementation of the QA Program which assures that all data generated will be scientifically sound, legally defensible, and of known quality;
- ⇨ In conjunction with the QA Officer, conduct annual reviews of the QA Program;
- ⇨ Oversees the implementation of new and revised QA procedures to improve data quality;
- ⇨ Ensures that appropriate corrective actions are taken to address analyses Identified as requiring such actions by internal and external performance or procedural audits. Procedures that do not meet the standards set forth in the QAM or laboratory SOPs may be temporarily suspended by the Laboratory Manager and Technical Director;
- ⇨ Reviews and approves all SOPs prior to their implementation and ensures all approved SOPs are implemented and adhered to;
- ⇨ Assists the QA Officer with all laboratory accreditation efforts as necessary

Laboratory Managers:

The Laboratory Managers direct log-in and the analytical production sections of the laboratories. They report directly to the Chief Technology Officer and assist in determining the most efficient instrument utilization. More specifically, they:

- ⇨ Evaluate the level of internal/external non-conformances for all departments;
- ⇨ Continuously evaluate production capacity and improves capacity utilization;
- ⇨ Continuously evaluate turnaround time and addresses any problems that may hinder meeting the required and committed turnaround time from the various departments;
- ⇨ Develop and improve the training of all analysts in cooperation with the Chief Technology Officer, Laboratory Directors, QA Officers and Group Leaders, and in compliance with regulatory requirements;
- ⇨ Ensure that scheduled instrument maintenance is completed;
- ⇨ Are responsible for efficient utilization of supplies;
- ⇨ Constantly monitor and modify the processing of samples through the departments; and
- ⇨ Maintain sufficient personnel, equipment and supplies to achieve production goals.

The Laboratory Managers report to the Chief Technology Officer and are responsible for all laboratory, client, and project technical issues. More specifically, they:

- ⇨ For major projects and/or clients, act as a technical resource for the client and the laboratory in matters of method selection or QC criteria.
- ⇨ Company-wide, maintain all training-related documentation in a single secure location. Develops training guides and other training documentation as needed;
- ⇨ Interface directly with Project Management staff in response to questions pre-release or from the client post-release. Determine root cause and interface with QA Officer to prevent recurrences;
- ⇨ Interface directly with clients, or other client representatives in matters related to technical data quality requests, when required
- ⇨ Provide support to Business Development through the review of QAPPs, and work plans. Provide comment and alternative solutions if unable to meet specific requirements;
- ⇨ Support QA and Operations with SOP revisions, where needed;
- ⇨ Perform full QA reviews and/or data validation where required;
- ⇨ Provide technical solutions to QA with regard to laboratory procedures, data quality issues, possible solutions, and appropriate corrective actions;
- ⇨ Provide technical opinions and support to Operations with regard to current procedures or new method development;

- ⇨ Interface with QA staff as necessary to ensure continuous improvement in all areas of YORK's operations.
- ⇨ Provide LIMS input; and

Quality Assurance Officer:

The Quality Assurance Officer (QAO) has full authority through the Chief Technology Officer in all matters relating to quality assurance and quality control systems. The QAO can make recommendations to the Chief Technology Officer and/or Laboratory Managers/Directors regarding the suspension analytical activities or the suspension or termination of employees on the grounds of non-compliance with QA/QC systems or procedures. An alternate QA Officer is always assigned. In the absence of the primary designate, the alternate will act in the QAO's capacity with the full authority of the position as allowed by YORK governing documents. In addition, the QAO performs the following:

- ⇨ Oversight and monitoring of and compliance with YORK's QA program;
- ⇨ Ensuring continuous improvement in all aspects of YORK's QA program such as:
  - o accreditations/certifications;
  - o analytical method management;
  - o internal and external audits;
  - o documentation;
  - o training;
  - o proficiency evaluation studies;
- ⇨ Ensuring YORK's QA program remains up-to-date consistent with current regulatory requirements and YORK's QA policies;
- ⇨ Supervision and direction of all QA staff; and
- ⇨ Provide assistance to responses for data validation inquiries
- ⇨ Serving as a technical resource for analytical chemistry or QA matters;
- ⇨ Provide support and oversight to QA staff with regard to external audit responses. Provide input on, and define appropriate corrective actions for the laboratory. Document corrective action responses, and monitor the required audit response time frames, as needed.
- ⇨ Oversees in-house training on quality assurance and control.
- ⇨ Provides Ethics training to all relevant personnel

- ⇨ Maintains and updates the QAM on an annual basis;
- ⇨ Implements YORK's QA Program;
- ⇨ Monitors the QA Program within the laboratory to ensure complete compliance with its objectives, QC procedures, holding times, and compliance with client or project spYorkfic data quality objectives;
- ⇨ Distributes performance evaluation (PE) samples on a routine basis to ensure the production of data that meets the objectives of its QA Program;
- ⇨ Maintains all SOPs used at YORK;
- ⇨ Maintains records and archives of all PE results, audit comments, and customer inquiries concerning the QA program;
- ⇨ Performs statistical analyses of QC data and establish controls that accurately reflect the performance of the laboratory;
- ⇨ Conducts periodic performance and system audits to ensure compliance with the elements of YORK's QA Program;
- ⇨ Prescribes and monitors corrective action;
- ⇨ Serves as in-house client representative on all project inquiries involving data quality issues;
- ⇨ Coordinates data review process to ensure that thorough reviews are conducted on all project files;
- ⇨ Develops revisions to existing SOPs;
- ⇨ Reports the status of in-house QA/QC to the Chief Technology Officer;
- ⇨ Maintains records and archives of all QA/QC data including but not limited to method detection limit (MDL) studies, IDOCs, DOCs and completed log books; and
- ⇨ Conducts and/or otherwise ensures that an adequate level of QA/QC training is conducted within the laboratory

Director of Project Management/Client Services:

The Director of Project Management reports to the President and serves as the interface between the laboratory's technical departments and the laboratory's clients. The staff consists of the Project Management team, and satellite office/remote personnel. With the overall goal of total client satisfaction, the functions of this position are outlined below:

- ⇨ Technical training and growth of the Project Management team;
- ⇨ Business liaison for the Project Management team;
- ⇨ Human resource management of the Project Management team;
- ⇨ Responsible for the review and negotiation of client contracts and terms and conditions;
- ⇨ Responsible for establishing standard and custom fee schedules for the laboratory;
- ⇨ Responsible for preparation of proposals and quotes for clients and client prospects;
- ⇨ Accountable for response to client inquiries concerning sample status;
- ⇨ Responsible for assistance to clients regarding the resolution of problems concerning Chains-of-Custody;
- ⇨ Ensuring that client specifications, when known, are met by communicating project and quality assurance requirements to the laboratory;
- ⇨ Notifying the department managers of incoming projects and sample delivery schedules;
- ⇨ Accountable to clients for communicating sample progress in with agreed-upon due dates;
- ⇨ Responsible for discussing with client any project-related problems, resolving service issues, and coordinating technical details with the laboratory staff;
- ⇨ Responsible for staff familiarization with specific quotes, sample log-in review, and final report completeness; and
- ⇨ Ensure that all non-conformance conditions are reported to the QA Officer, Lab Manager, and/or Laboratory Director via the Corrective Action process.

Group Leaders:

The Group Leaders report directly to the Lab Managers. They have the authority to accept or reject data based on pre-defined QC criteria. In addition, with the approval of the QA Officer, the Group Leaders may accept data that falls outside of normal QC limits if, in his or her professional judgment, there are technical justifications for the acceptance of such data. The circumstances must be well documented and any need for corrective action identified must be defined and initiated. The authority of the Group Leaders in QC related matters results directly from the QA Officer. The Group Leaders also:

- ⇨ Monitoring the validity of the analyses performed and data generated in the laboratory. This activity begins with insuring data quality, analyzing internal and external non-conformances to identify root cause issues and implementing the resulting corrective and preventive actions, facilitating the data review process and providing technical and troubleshooting expertise on routine and unusual or complex problems;
- ⇨ Providing training and development programs to applicable laboratory staff as new hires and, subsequently, on a scheduled basis; and
- ⇨ Coordinates audit responses with Laboratory Managers and QA Officer.
- ⇨ Actively support the implementation of YORK's QA Program;
- ⇨ Ensure that their employees are in full compliance with YORK's QA Program;
- ⇨ Maintain accurate SOPs (by reviewing and implementing updates) and enforce routine compliance with SOPs;
- ⇨ Conduct technical training of new staff and when modifications are made to existing procedures;
- ⇨ Maintain a work environment which emphasizes the importance of data quality;
- ⇨ Ensure all logbooks are current, reviewed and properly labeled or archived;
- ⇨ Ensure that all non-conformance conditions are reported to the QA Officer, Lab Manager, and/or Technical Director via Corrective Action reports;
- ⇨ Provide guidance to analysts in resolving problems encountered daily during sample prep/analysis in conjunction with the Technical Director, Lab Manager, and/or QAO . Each is responsible for 100% of the data review and documentation, nonconformance issues, and the timely and accurate completion of performance evaluation samples and MDLs, for his/her department;
- ⇨ Encourage the development of analysts to become cross-trained in various methods and/or operate multiple instruments efficiently while performing maintenance and using appropriate documentation techniques;
- ⇨ Ensure that preventive maintenance is performed on instrumentation as detailed in the QA

Manual or SOPs. He or she is responsible for developing and implementing a system for preventive maintenance, troubleshooting, and repairing or arranging for repair of instruments;
- ⇨ Provide written responses to external and internal audit issues; and
- ⇨ Provide support to all levels of YORK Management.

Sample Control Group:

The Sample Control Group reports to the Laboratory Manager. The responsibilities are outlined below:

- ⇨ Conduct the receipt, handling, labeling and proper storage of samples in compliance with laboratory procedures and policies;
- ⇨ Oversee the training of Sample Control Technicians regarding the above items;
- ⇨ Direct the logging of incoming samples into the Element LIMS and ensure the verification of data entry from login;
- ⇨ Acts as a liaison between Project Managers and Analytical departments in respect to handling rush orders and resolving inconsistencies and problems with chain-of-custody forms, and routing of subcontracted analyses; and
- ⇨ Oversees the handling of samples in accordance with the Waste Disposal SOP
- ⇨ Supervise the recording of the transfer of samples from refrigerated conditions to ambient conditions;
- ⇨ Coordinate the collection of waste throughout the laboratory that will be disposed of through "Lab Packs";
- ⇨ Coordinate and supervise Hazardous Waste Technician(s);
- ⇨ Dispose of solid waste to an assigned locations;
- ⇨ Supervise the disposal of soils into appropriate drums;.
- ⇨ Prepare and discharge treated wastewater to the sewer system;
- ⇨ Maintain Uniform Hazardous Waste Manifest files;
- ⇨ Prepare weekly sample disposal schedules;
- ⇨ Coordinate and schedule waste pick-up;
- ⇨ Check all waste containers for appropriate labels; and
- ⇨ Maintain safe housekeeping and practices.

Laboratory Analysts

Laboratory analysts are responsible for conducting analysis and performing all tasks assigned to them by the group leader or supervisor. The responsibilities of the analysts are listed below:

- ⇨ Perform analyses by adhering to analytical and quality control protocols prescribed by current SOPs, this QA Manual, the Data Integrity Policy, and project-specific QA plans honestly, accurately, timely, safely, and in the most cost-effective manner.
- ⇨ Document standard and sample preparation, instrument calibration and maintenance, data calculations, sample matrix effects, and any observed non-conformance on work sheets, bench sheets, preparation logbook, and/or a Non-Conformance report;
- ⇨ Report all non-conformance situations, instrument problems, matrix problems and QC failures, which might affect the reliability of the data, to the Group Leader and/or the QA Officer;
- ⇨ Perform 100% review of the data generated prior to entering and submitting for secondary level review; and
- ⇨ Work cohesively as a team in their department to achieve the goals of accurate results, optimum turnaround time, cost effectiveness, cleanliness, complete documentation, and personal knowledge of environmental analysis.

Project Managers/Client Services:

The Project Managers report to the Director of Project Management and/or Business Development Director. These personnel in turn report directly to the President. Typical responsibilities include:

- ⇨ Serving as the laboratories' primary point of contact for assigned clients;
- ⇨ Working with laboratory chemists to resolve questions on data;
- ⇨ Scheduling of courier deliveries and pick-ups;
- ⇨ Tracking the progress of all laboratory production efforts;

- ⇨ Advising clients of any scheduling conflicts, possible delays, or other problems which may arise;
- ⇨ Resolving any questions or issues that clients may have with regard to our services, especially our reports;

- ⇨ Preparation or directing preparation of bottle kits for use by clients in their sampling efforts;
- ⇨ Reviewing of reports/EDDs (Electronic Data Deliverables) as necessary prior to release;
- ⇨ Invoice review prior to release to client;
- ⇨ Serving as back-up contact person for other Project Managers in the event of his/her absence;
- ⇨ Coordination of all subcontracting efforts for projects assigned;
- ⇨ Preparation and implementation of program QAPPs (Quality Assurance Project Plans), if needed;

Health and Safety Manager:

The Health and Safety Manager (EHS) reports to the Laboratory Manager and ensures that systems are maintained for the safe operation of the laboratory. The EHS Manager is responsible for:

- ⇨ Conducting ongoing, necessary safety training and conducting new employee safety orientations;
- ⇨ Assisting in developing and maintaining the Chemical Hygiene/Safety Manual;
- ⇨ Oversees the inspection and maintenance of general safety equipment – fire extinguishers, safety showers, eyewash fountains, etc. and ensure prompt repairs as needed; and
- ⇨ Completes accident reports, follows up on root causes and defines corrective actions.

Education and Experience

YORK makes every effort to hire analytical staff that possess a college degree (AS, BA, BS) in an applied science with some chemistry in the curriculum. Exceptions are made based upon experience and an individual's ability to learn as there are many in the industry that are more than competent, experts perhaps, who have not earned a college degree.

Selection of qualified individuals for employment begins with documentation of minimum education, training, and experience prerequisites needed to perform the prescribed task. Experience and specialized training may be accepted in lieu of a college degree (basic lab skills such as using a balance, aseptic or quantitation techniques, etc. are also considered).

Included in Table 1.0 below are the basic job titles and personnel responsibilities for anyone who manages, performs or verifies work affecting the quality of the laboratory's environmental sample testing. Minimum education and training requirements are summarized as well.

When an analyst does not meet these minimum requirements, they can perform a task under the direct supervision of a qualified analyst, peer reviewer or Group Leader, and are considered an analyst in training. The person supervising an analyst in training is directly accountable for the quality of the analytical data and must review and approve data and associated corrective actions.

Table 1.0 Minimum Education/Experience requirements for each York position

Position	General Duties	Minimum Education Requirements	Minimum Experience Requirements
Sr. Scientist/Technical Director/Chief Tech. Officer	Responsible for technical aspects of the laboratory operations and related SOPs, training and troubleshooting. Provide Client technical support	B.S. in Chemistry	Ten years hands-on lab experience with GC, GCMS, ICP, AAS, IC and wet chem procedures for the analysis of environmental samples. A minimum of two year front line supervisory experience
Laboratory Manager	Responsible for Lab operations, including all lab disciplines.	B.S. in one of the physical sciences or A.S. plus 10 years' experience	Two years hands-on laboratory experience at the bench and management levels. Familiarity with licensing requirements.
QA/QC Officer	Responsible for overseeing the QA aspects of data. Also provides for review of data	B.S. in one of the physical sciences or A.S. plus 10 years' experience	Four years hands-on lab experience demonstrated familiarity with QA principles and practices in analytical

	packages and internal audits/training.		laboratory.
Data Quality Manager	Responsible for second level review of Lab data for all disciplines	B.S. in one of the physical sciences or A.S. plus 5 years' experience	5 years' experience in lab operations with all major disciplines including intimate knowledge of lab instrumentation and related software. Familiar with data review and data validation guidelines.
Group Leader GC/MS	Responsible for all technical efforts of the GC/MS labs.	B.S. in one of the physical sciences	Four years hands-on GC and/or GC/MS experience with environmental methods. Capable of troubleshooting instrumentation, and interpretation of GCMS data. Also experienced in data package preparation and review.
GC/MS Analyst	Responsible for GC/MS sample/data analysis, reduction and reporting.	B.S. in one of the physical sciences	One year of experience in operating and maintaining GC/MS systems, one year interpreting MS data or one external MS interpretation course.
GC/MS Operator	Responsible for operating subsampling systems and GC/MS systems.	A.S. or B. in a science discipline	Six months experience in operating GC/MS systems. Internal training and certification require.
GC Analyst	Responsible for analysis of samples for Pesticides, PCBs, herbicides and special analytes by GC techniques.	A.S. or B.S. in a science discipline	Five years of hands-on experience with analysis using capillary GC with flame ionization electron capture, flame photometric and thermal conductivity detectors. Also, experience interpreting GC data for pesticide, PCBs, herbicides and other environmental contaminants.
Group Leader Metals	Responsible for all sample preparation and analysis for metals.	B.S. in a science discipline	Five years of hands-on experience with ICP, GFAAS and CVAA. Minimum of three years of experience with environmental sample prep and analysis for all metals including mercury.
Metals Technician	Responsible for sample preparation for metals analysis, including Hg.	High school diploma	Six months experience in laboratory procedures
Group Leader-Wet Chemistry	Responsible for all wet chemistry analyses, Ion Chromatography and TCLP extractions/preparation.	B.S. in a science discipline or A.S.	Two years of hands-on environmental laboratory experience with Wet Chem procedures , Ion Chromatography and TCLP extractions
Lab Technician-Wet Chemistry	Responsible for wet chem analyses and TCLP extractions	A.S. or B.S. in a science discipline	Six months hands-on experience with Wet chem procedures and TLP extractions. In lieu of educational requirement, a High school diploma with one year experience in wet chem procedures is acceptable.
Ion Chromatography Analyst	Responsible for all anion and cation analysts by IC.	B.S. in a science discipline	Six months hands-on experience with IC procedures, including data interpretation, review and reporting.
Group Leader-Organic Extractions	Responsible for all organic extractions for BNAs, Pest/PCB, Herbicides and other target compounds	A.S. or B.S. in a science discipline	Two years of experience of environmental sample for target organics compounds. In lieu of the education requirement, a high school diploma and four years of experience in education including one year of supervisory experience will suffice.
Extractions Technician	Responsible for extraction/concentration of environmental samples for BNAs, PCB/Pests, and herbicides	A.S. or B.S. in a science discipline	Six months of experience in extraction/concentration techniques. In lieu of a degree, a high school diploma and one year of experience in laboratory procedures will suffice.
Sample Manager	Reportable for all sample receipts, chain-of-custody, and log-in.	A.S. or B.S. in a science discipline	Three years of experience in an environmental laboratory or A.M.B. + one year experience

Sample Custodian	Assist Sample Manager with log-in duties and sample disposal	High School Diploma	One year of general laboratory experience or environmental industry experience.
System Manager	Responsible for the management of all computing systems including hardware, software, documentation, archive procedures and LIMS management.	Outsourced to Corcystems, Inc.	Three years of experience in hardware troubleshooting, system design/build, software installation and maintenance.
Client Services Managers/Project Mgrs.	Responsible for all client interface from both technical and scheduling perspective	B.S. in a science discipline	Five years laboratory analysis experience and/or three years of sales experience in environmental business.

e) Identification of the laboratory's approved signatories; at a minimum, the title page of the quality manual has the signed and dated concurrence (with appropriate titles) of all responsible parties including the QA Manager, Operations, QA, Technical, Laboratory and Operations Directors.

f) The laboratory's procedures for achieving traceability of measurements;

g) A list of all test methods under which the laboratory performs its accredited testing may be found in the Index of Standard Operating Procedures, a separate document.

h) Mechanisms for ensuring that the laboratory reviews all new work to ensure that it has the appropriate facilities and resources before commencing such work;

i) Reference to the calibration and/or verification test procedures used;

Calibration procedures and verification of acceptability for each set of required calibrations are defined in Section 13 (Calibration) and Section 12 (Quality Control) of each standard operating procedure.

j) Procedures for handling samples received;

The generation of quality analytical data begins with the collection of the sample and, therefore, the integrity of the sample collection process is of importance to YORK. Samples must be collected in such a way that foreign material is not introduced into the samples and that analytes of interest do not escape from the samples or degrade prior to their analysis. To ensure sample integrity and representativeness, the following items must be considered:

- ⇨ Samples must be collected in appropriate containers. In general, glass containers are used for organic analytes except for PFAS (HDPE or PP) and polyethylene for inorganic/metal analytes;
- ⇨ Only new sample containers which are certified and documented clean by the vendor in shall be provided by YORK for sample collection;
- ⇨ Certain extremely hazardous samples or samples that have the potential to become extremely hazardous will not be accepted. These include (but are not limited to)

1. Radioactive samples that significantly exceed background levels
2. Biohazardous samples (medical wastes, body fluids, etc.)
3. Explosive samples in pure form (gunpowder, ammunition, flares, etc.)
4. Neurological or other toxic agents (Sarin, Anthrax, Ricin, etc.)
5. Drum samples which are concentrated acids, organic solvents or know oxidizers
6. Unknowns with no historical information on character of the material

YORK's chain-of-custody document is used to forward samples from the client to the laboratory. As the basic elements of most all chain-of-custody (COC) documents are similar, clientele may choose to use their own chain-of-custody document to forward samples to YORK, however York prefers use of its COC.

Any discrepancies in the COC must be documented on the Sample Receipt Form and resolved prior to analysis of samples.

Upon receipt by YORK, samples proceed through an orderly processing sequence designed to ensure continuous integrity of both the sample and its documentation from sample receipt through its analysis

and beyond.

All coolers that are received by the Sample Control Group undergo a preliminary examination in accordance with the Sample Receipt checklist in Element. Specifically, each sample is carefully examined for label identification, proper container (type and volume), chemical preservation when applicable, container condition, and chain-of-custody documentation consistency with sample labels. Discrepancies are noted in Element on both the Sample Receipt Form and, if possible, discussed with the client by Project Management. If this is not possible, the discrepancies are communicated to the client for resolution prior to the completion of the log-in process. The temperature of the cooler is measured and, with other observations, are recorded on the COC and in Element (temperature).

During the log-in process each sample is assigned a unique laboratory identification number through a computerized Laboratory Information Management System (LIMS), which stores all essential project information. YORK maintains multiple security levels of access into LIMS to prevent unauthorized tampering/release of sample and project information.

Once all analyses for a sample have been completed and the sample container is returned to its designated location where, it shall remain in refrigerated storage for a period not less than 14 days following sample receipt unless the client requests return/forwarding of the sample. Following the 14-day refrigerated storage period, the samples are placed into ambient storage for another period not less than 16 days after which the samples are bulked into drums for later disposal. Samples are retained for 30 days in total unless other arrangements pre-empt this.

k) Reference to the major equipment and reference measurement standards used as well as the facilities and services used by the laboratory in conducting tests;

A list of major equipment is kept up-to-date on the List of Major Assets, reference Appendix G. This, as well as a list of reference measurement standards and their certificates of calibration, is maintained by the QA Officer or the respective departments. In general, all calibrations and references should be traceable to NIST

l) Reference to procedures for calibration, verification and maintenance of equipment; Laboratory SOPs are available to staff for calibration, verification and maintenance of equipment. In general,

m) Reference to verification practices which may include inter-laboratory comparisons, proficiency testing programs, use of reference materials and internal quality control schemes;

Instrument calibration is required to ensure that the analytical system is operating correctly and functioning at the proper sensitivity such that required reporting limits can be met. Each instrument is calibrated with standard solutions appropriate to the type of instrument and the linear range established for the analytical method. The manufacturer's guidelines, the analytical method, and/or the requirements of special contracts determine the frequency of calibration and the concentration of calibration standards, whichever is most applicable. The following are very general guidelines and are not meant to be all-inclusive. Detailed calibration procedures are specified in the SOP for each method performed.

Gas Chromatography/Mass Spectroscopy (GC/MS): Each day prior to analysis of samples, all GC/MS instruments are tuned with 4-bromofluorobenzene (BFB) for VOCs and decafluorotriphenylphosphine (DFTPP) for SVOCs in accordance with the tuning criteria specified in the applicable methods. Samples are not analyzed until the method-specific tuning requirements have been met. These have been eliminated in newer versions SW846 methods of 8260D and 8270E. Tuning is only required upon performance of an initial calibration.

After the tuning criteria are met, the instrument is then calibrated for all target analytes and an initial multipoint calibration curve established. The calibration curve is then validated by the analysis of a second source standard, referred to as the initial calibration verification (ICV). Alternatively, the previous calibration curve may be used if validated by a continuing calibration verification (CCV) standard. All target analytes are represented in the calibration. For the initial calibration to be deemed acceptable, 80% of the target compounds must show average Response factor RSDs <20% or for regressions >0.990 and must be re-evaluated and meet the acceptance criteria, at a minimum, every twelve (12) hours thereafter.

Non-GC/MS Chromatography: The field of chromatography involves a variety of instrumentation and detectors. While calibration standards and control criteria vary depending upon the type of system and analytical methodology required for a specific analysis, the general principles of calibration apply uniformly. Each chromatographic system is calibrated prior to sample analysis. An initial multipoint calibration curve is generated using all target analytes. All target analytes must meet the acceptance criteria for the calibration to be deemed acceptable. The calibration curve is then validated by the analysis of a second source standard, referred to as the initial calibration verification (ICV). The continued validity of the initial multipoint calibration is verified every 12 hours using continuing calibration verification (CCV) standard containing all target analytes. If the CCV fails to meet the acceptance criteria, the system is re-calibrated and all samples analyzed since the last acceptable CCV must be re-analyzed.

Inductively Coupled Plasma Emission Spectroscopy: Initial calibration consists of a calibration blank (CB) plus one calibration standard. The calibration is verified by the re-analysis of the standard and initial calibration verification (ICV) standard. If the standard and the ICV fail to meet the acceptance criteria, the initial calibration is considered invalid and is re-performed.

Continuing calibration verification (CCV) consists of a mid-concentration standard plus a calibration blank (CB) analyzed every 10 samples and at the end of the sequence. If the CCV and/or CB fail to meet the acceptance criteria, the instrument must be re-calibrated and all samples analyzed since the previous acceptable CCV and/or CB must be re-analyzed.

ICP/MS Spectroscopy: Each day prior to the analysis of samples, all ICP/MS instruments undergo mass calibration and resolution checks prior to initial calibration. Initial calibration consists of a calibration blank (CB) and at least three calibration standards. The calibration is verified by the re-analysis of the standard and initial calibration verification (ICV) standards. If the standard and the ICV fail to meet the acceptance criteria, the initial calibration is considered invalid and is re-performed.

Continuing calibration verification (CCV) consists of a mid-concentration standard plus a calibration blank (CB) analyzed every 10 samples and at the end of the sequence. If the CCV and/or CB fail to meet the acceptance criteria, the instrument must be re-calibrated and all samples analyzed since the previous acceptable CCV and/or CB must be re-analyzed.

Cold Vapor Atomic Absorption Spectroscopy: Initial calibration consists of a calibration blank plus a series of at least 5 standards. The calibration curve is then validated by the analysis of a second source standard, referred to as the initial calibration verification (ICV). Continuing calibration verification (CCV) consists of midpoint calibration standard plus a continuing calibration blank (CCB) analyzed every 10 samples and at the end of the sequence. If the CCV and/or CCB fail to meet the acceptance criteria, the instrument must be re-calibrated and all samples analyzed since the previous acceptable CCV and/or CCB must be re-analyzed. If the calibration blanks contain target analyte concentrations exceeding the acceptance limits, the cause must be determined and corrected.

General Inorganic Analyses: General inorganic (non-metal) analyses involve a variety of instrumental and wet chemistry techniques. While calibration procedures vary depending on the type of instrumentation and methodology, the general principles of calibration apply universally. Each system or method is initially calibrated using standards prior to analyses being conducted with continual verification that the calibration remains acceptable throughout analytical processing. If continuing calibration verification fails to meet the acceptance criteria, the instrument must be re-calibrated and all samples analyzed since the previous acceptable CCV must be re-analyzed.

PERIODIC CALIBRATION

Periodic calibration shall be performed for instrumentation such as balances, thermometers, ovens, and furnaces that are required in analytical methods, but which are not routinely calibrated as part of the analytical procedure. Documentation of calibration is kept for each instrumentation item.

Calibration requirements are determined within the York laboratory depending upon the instrumentation used and its operating function. Following are brief example discussions for

the calibration of balances and thermometers with examples of calibration data sheets to serve as a guideline for the preparation of laboratory- specific procedures.

Balances (Example Procedure)

All balances are verified by using weights traceable to the National Bureau of Standards (NIST) on use. Calibration weights shall be Class S or better and shall be recertified every year. If balances are calibrated by an external agency, verification of their weights shall be provided.

Calibration of balances shall be over the range in which they are most commonly used. The weighs used for calibration of each balance shall be 0.5g, 2.0g, 10.0g, 20.0g, and 100g. Acceptance for balances which are direct reading to 0.01 gram shall be ± 0.01g, to 0.0001g shall be ± 0.007g, and to 0.00001g shall be ± 0.0007g.

Thermometers (Example Procedure)

Certified, or reference, thermometers shall be maintained for use in calibrating working thermometers including other temperature measurement devices such as thermocouples, probes and infrared temperature sensors. Reference thermometers shall be provided with NIST traceability for initial calibration and shall be recertified every year with instrumentation directly traceable to the NIST. Working thermometers shall be compared with reference thermometers every 12 months. In addition, working thermometers shall be visually inspected by laboratory personnel prior to use.

Calibration temperatures and acceptance criteria shall be based upon the working range of the thermometer and the accuracy required for its use.

n) Procedures to be followed for feedback and corrective action whenever testing discrepancies are detected, or departures from documented policies and procedures occur;

o) The laboratory management arrangements for permitting exceptions and departures from documented policies and procedures or from standard specifications;

YORK's SOPs are in substantial conformity with their corresponding published method references. Departure from approved SOPs shall be approved if necessary or appropriate due to the nature or composition of the sample or otherwise based on the reasonable judgment of YORK's Laboratory Manager, Technical Director, or QA Officer.

Departures shall be made on a case-by-case basis consistent with recognized standards of the industry. In no case shall significant departures be approved without written communication between Cleint Services and the affected client.

p) Procedures for dealing with complaints;

Procedures for dealing with complaints may be found in the SOP, Handling of Inquiries and Complaints.

q) Procedures for protecting confidentiality and proprietary rights;

YORK is sensitive to the fact that some of the analytical work performed for clients may be subject to litigation. YORK, therefore, holds all information in strict confidence with laboratory release only to the client or designee. Information released to entities other than the client is performed only upon written (facsimile or e-mail) request from the client.

Due to the investigative nature of most site assessments, analytical information may become available to regulatory agencies or other evaluating entities during site assessment of the laboratory for the specific purpose of attaining laboratory certifications, accreditations, or evaluation of laboratory qualification for future work. During these occurrences, the laboratory will make its best effort to maintain the confidence

of client specific information.

r) Procedures for audits;

YORK participates in a wide variety of system and performance audits conducted by various state agencies, as well as through its major clients. These audits are conducted to verify that analytical data produced conforms to industry standards on a routine basis.

A System Audit is a qualitative evaluation of the measurement systems utilized at YORK, specifically, that YORK has, in place, the necessary facilities, staff, procedures, equipment, and instrumentation to generate acceptable data. This type of audit typically involves an on-site inspection of the laboratory facility, operations, and interview of personnel by the auditing agency.

A Performance Audit verifies the ability of YORK to correctly identify and quantitate compounds in blind check samples. This type of audit normally is conducted by the auditing agency through laboratory participation in round robin Performance Evaluation (PE) programs. Examples of current PE program involvement include those offered by commercial suppliers like ERA (WS/WP/SOIL and DMR-QA), or other inter-laboratory studies not required for certification but done to ensure laboratory performance, as well as programs administered by major clients.

Outliers in required PE samples will be investigated and corrective actions documented using the Corrective/Preventive Action Record.

Should the result of any audit detect a significant error, which has been identified to adversely affect released data, the situation shall be thoroughly investigated. Corrective measures shall be enacted to include system re-evaluation, the determined effect on released data and client notification, as necessary. These measures shall be documented using the Corrective/Preventive Action Record.

s) Processes/procedures for establishing that personnel are adequately experienced in the duties they are expected to carry out and are receiving any needed training;

Quality control begins prior to sample(s) receipt at the laboratory. The selection of well qualified personnel, based upon education and/or experience is the first step in successful laboratory management. A thorough screening of job applicants and selection of the best candidate to fulfill a well-defined need is as important an aspect of a successful QA/QC program as a careful review of analytical data.

Employee training and approval procedures used at YORK are detailed in the SOP on Employee Training, and includes but is not limited to the following:

- ⇨ A thorough understanding of the applicable regulatory method and YORK SOP;
- ⇨ A review of YORK's QA Program Manual and thorough understanding of the specifics contained therein that are directly related to the analysis to be performed;
- ⇨ Instruction by the applicable Group Leader or Tech. Director on all aspects of the analytical procedure;
- ⇨ Performance of analyses under supervision of experienced laboratory personnel, which shall include analysis of blind QC check samples, when deemed appropriate;
- ⇨ Participation in in-house seminars on analytical methodologies and procedures;
- ⇨ Participation in job related seminars outside of the laboratory; and

t) Ethics policy statement developed by the laboratory and processes/procedures for educating and training personnel in their ethical and legal responsibilities including the potential punishments and penalties for improper, unethical, or illegal actions;

A vital part of YORK’s analytical laboratory services is their Laboratory Ethics Training Program. An effective program starts with an Ethics Policy Statement that is supported by all staff, and is reinforced with initial and ongoing ethics training.

“It shall be the policy of YORK to conduct all business with integrity and in an ethical manner. It is a basic and expected responsibility of each staff member and manager to hold to the highest ethical standard of

professional conduct in the performance of all duties."

A proactive ethics training program is the most effective means of deterring and detecting improper, unethical, or illegal actions in the laboratory. There are six facets to the program: (1) clearly define improper, unethical, and illegal actions; (2) outline elements of prevention and detection programs for

improper, unethical, or illegal actions; and (3) identify examples of inappropriate (i.e., potentially fraudulent) laboratory practices; (4) Annual Ethics and Data Integrity Training to be documented and maintained in the personnel file of each employee., (5) Documented training on new revisions of the Quality Systems Manual (QSM) and for new employees as needed. (6) Signed Ethics and Data Integrity Agreement (to be completed for new employees and annually thereafter).

Definition of Improper, Unethical, and Illegal Actions

Improper actions are defined as deviations from contract-specified or method-specified York analytical practices and may be intentional or unintentional.

Unethical or illegal actions are defined as the deliberate falsification of analytical or quality assurance results, where failed method or contractual requirements are made to appear acceptable.

Prevention of laboratory improper, unethical, or illegal actions begins with a zero-tolerance philosophy established by management. Improper, unethical, or illegal actions are detected through the implementation of oversight protocols.

Prevention and Detection Program for Improper, Unethical, or Illegal Actions

YORK management has implemented a variety of proactive measures to promote prevention and detection of improper, unethical, or illegal activities. The following components constitute the basic program:

- ⇨ Data Integrity Standard Operating Procedure
- ⇨ Data Integrity Documentation Procedures
- ⇨ An Ethics and Data Integrity Agreement that is read and signed by all personnel;
- ⇨ Initial and annual ethics training;
- ⇨ Internal audits;
- ⇨ Analyst documentation on certain types of manual integration changes to data;
- ⇨ Active use of electronic audit functions when they are available in the instrument software; and
- ⇨ A "no-fault" policy that encourages laboratory personnel to come forward and report fraudulent activities directly to the QA Officer.

A proactive, "beyond the basics" approach to the prevention of improper, unethical, or illegal actions are a necessary part of laboratory management. As such, in addition to the requirements above, YORK has a designated ombudsman (Data Quality Manager) to whom laboratory personnel can report improper, unethical, or illegal practices, or provide routine communication of training, lectures, and changes in policy intended to reduce improper, unethical, or illegal actions.

Examples of Improper, Unethical, or Illegal Practices

Documentation that clearly shows how all analytical values were obtained are maintained by YORK and supplied to the data user as needed. To avoid miscommunication, YORK clearly documents all errors, mistakes, and basis for manual integrations within the project file and case narrative as applicable. Notification is also made to the appropriate supervisor so that appropriate corrective actions can be initiated. Gross deviations from specified procedures are investigated for potential improper, unethical, or illegal actions, and findings of fraud are fully investigated by senior management. Examples of improper, unethical, or illegal practices are identified below:

- ⇨ Improper use of manual integrations to meet calibration or method QC criteria (for example, peak shaving or peak enhancement are considered improper, unethical, or illegal actions if performed solely to meet QC requirements);
- ⇨ Intentional misrepresentation of the date or time of analysis (for example, intentionally resetting a computer system's or instrument's date and/or time to make it appear that a time/date requirement was met);

- ⇨ Falsification of results to meet method requirements;
- ⇨ Reporting of results without analyses to support (i.e., dry-labbing);
- ⇨ Selective exclusion of data to meet QC criteria (for example, initial calibration points dropped without technical or statistical justification);
- ⇨ Misrepresentation of laboratory performance by presenting calibration data or QC limits within data reports that are not linked to the data set reported, or QC control limits presented within QAPP that are not indicative of historical laboratory performance or used for batch control;
- ⇨ Notation of matrix inference as basis for exceeding acceptance limits (typically without implementing corrective actions) in interference-free matrices (for example, method blanks or laboratory control samples);
- ⇨ Unwarranted manipulation of computer software (for example, improper background subtraction to meet ion abundance criteria for GC/MS tuning, chromatographic baseline manipulations);
- ⇨ Misrepresentation of QC samples (for example, adding surrogates after sample extraction, omitting sample preparation steps for QC samples, over- or under-spiking); and
- ⇨ Reporting of results from the analysis of one sample for those of another.

v) Reference to procedures for reporting analytical results;

Standard operating procedures pertaining to the reporting of results are available to all laboratory personnel and are included in the specific SOP for each procedure.

All analytical data generated within YORK is thoroughly checked for accuracy and completeness. The data validation process consists of data generation, reduction, and two levels of review as described below.

The analyst generating the analytical data has the primary responsibility for its correctness and completeness. All data is generated and reduced following protocols specified in the appropriate SOPs. Each analyst reviews the quality of his or her work based upon an established set of guidelines specified in the SOPs or as detailed by project requirements. The analyst reviews the data to ensure that:

- ⇨ Holding times have not been exceeded;
- ⇨ Sample preparation information is correct and complete;
- ⇨ Analysis information is correct and complete;
- ⇨ The appropriate procedures were employed;
- ⇨ Analytical results are correct and complete;
- ⇨ All associated QC is within established control limits and, if not, out-of-control forms are completed thoroughly explaining the cause and corrective action taken;
- ⇨ Any special sample preparation and analytical requirements have been met; and
- ⇨ Documentation is complete, i.e., all anomalies in the preparation and analysis have been documented; out-of-control forms, if required, are complete, etc.

This initial review step, performed by the analyst, is designated as primary review. The Data Quality Manager then conducts an independent check equivalent to that of the primary review and are designed to ensure that:

- ⇨ Calibration data is scientifically sound, appropriate to the method, and completely documented;
- ⇨ QC data is within established guidelines or reported with appropriate clarification/qualification;
- ⇨ Qualitative identification of sample components is correct;
- ⇨ Quantitative results are correct;
- ⇨ Documentation is complete and any anomalies properly addressed and documented;
- ⇨ The data is ready for incorporation into the final report package; and
- ⇨ The data package is complete and ready for release.

A significant component of the secondary review is the documentation of any errors that have been identified and corrected during the review process. YORK believes that the data package that is submitted for a secondary review should be free from errors. Errors that are discovered are documented and formally transmitted to the appropriate Group Leader. The cause of the errors is then addressed by additional training or clarification of procedures (SOP revisions) to ensure that similar errors do not recur and high quality data will be generated.

These procedures are done electronically. Once set to Reviewed in Element LIMS, this constitutes

approval for data release and generation of analytical report.

During both of the QC review processes, 100% of the raw data associated with the entire project is available to the reviewer.

Following draft report generation, the report is reviewed by the Project Manager to ensure that the data set and quality control data are complete and meet the specific requirements of the project. When available, the data are also evaluated against historical site information. Once all requested analytical work has been verified as complete, a final report is generated and electronically signed by the Laboratory Manager.

Following approval for release, the Quality Assurance Manager or other qualified personnel may review 10% of the project files back to the raw data as an additional check, if a situation so warrants.

A variety of reporting formats, from Portable Document File (PDF), normal reports to computerized data tables (Execl and special EDDs) to complex reports discussing regulatory issues are available. In general, YORK reports contain the following information.

Analytical Data

Analytical data is reported by sample identification (both client and laboratory) and test. Pertinent information including date(s) sampled, received, prepared, and analyzed; any required data qualifiers are included on each results page. The reporting limit for each method analyte is also listed. Additional data may include Method Detection Limits (MDLs) and any dilution factors used.

QC Data

A QC Summary is provided with each QA Summary report when requested. Unless otherwise specified in a QAPP or requested by the client, QC Summaries include results for method blanks, blank spikes, site-specific matrix spikes, matrix spike duplicates, and surrogate spikes. The effective control limits for the reported QC values are also provided on the QC Summary as well as explanations for any QC outliers. Case Narratives may be included as appropriate.

As required for the project, data reports from “results only” through “full ASP-B like” will be generated and provided. Numerous custom EDD formats are also provided as needed including EquIS, NYSDEC EquIS, Giskey and numerous other formats.

Methodology

References for the preparative and analytical methodology employed is included on all preliminary or final analytical reports.

Signatory

Final reports are ready for release to the client following review and approval by the Laboratory Manager, as evidenced by his/her signature on the final report.

Preliminary Data

Upon client request, preliminary data shall be released prior to completion of a full QC review. Preliminary data is subject to change pending QC review and, therefore, shall be clearly marked as “DRAFT”. This qualification is provided as notification to the client that the data review process has not been completed yet and that the data is subject to possible modification resulting therefrom.

Revised Data

Analytical reports that have been revised for any reason from the original sent report shall be noted as being revised with a report note, case narrative or indication as to the reason for the revision.

Formatting

At a minimum, an analytical report shall consist of the Report Cover Page, Analytical Results, Footnotes/Comments Page, and COC. Paginated reports shall be employed for all reports. All reports are bookmarked for ease of navigation. York offers approximately forty different reporting formats from a simple report (Results only) to a complex validation ready deliverable, along with various Electronic Data Deliverables (EDDs). All data are posted to our website for client access through our DataPort access portal.

Figure 1. Company Organizational Chart

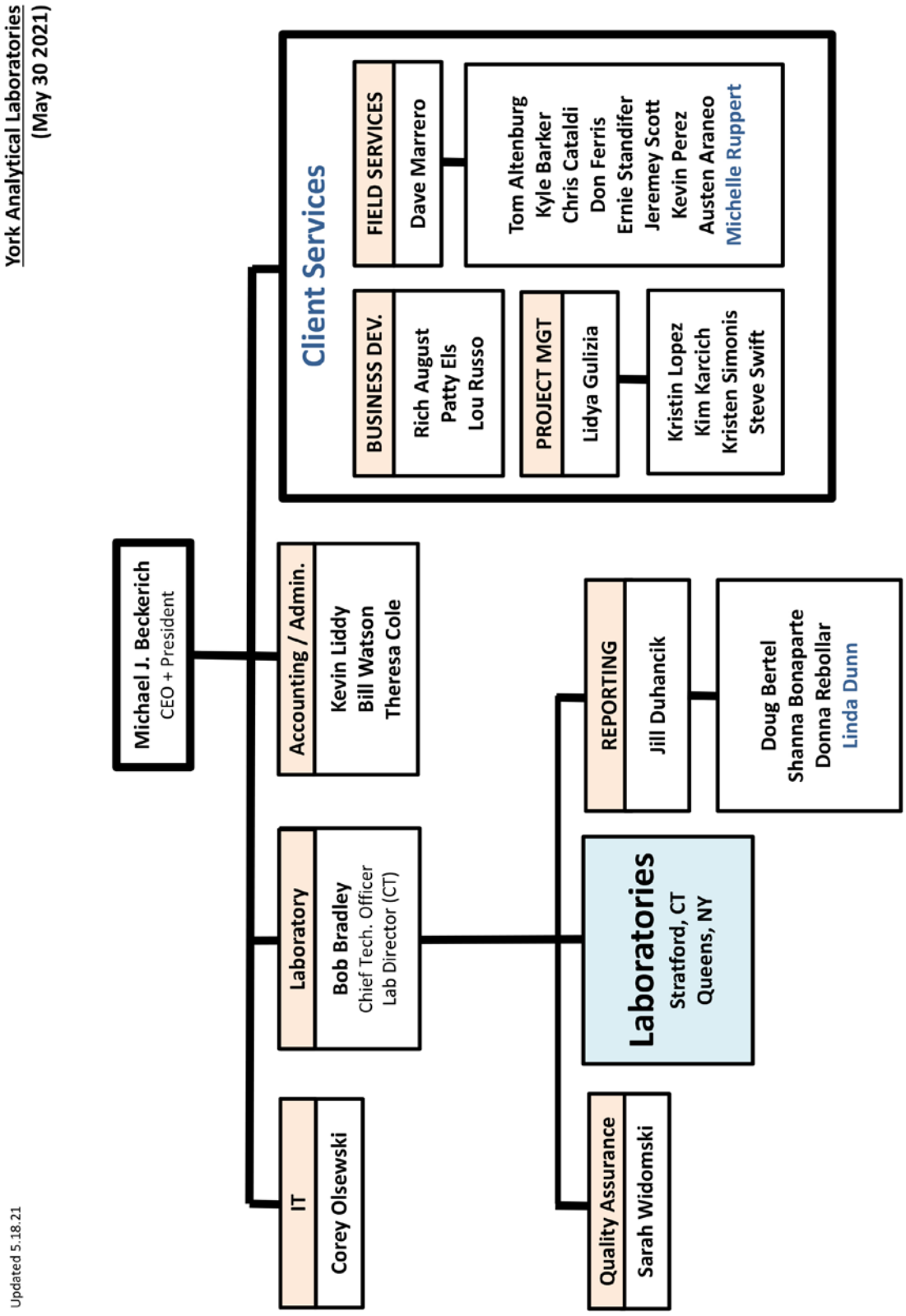
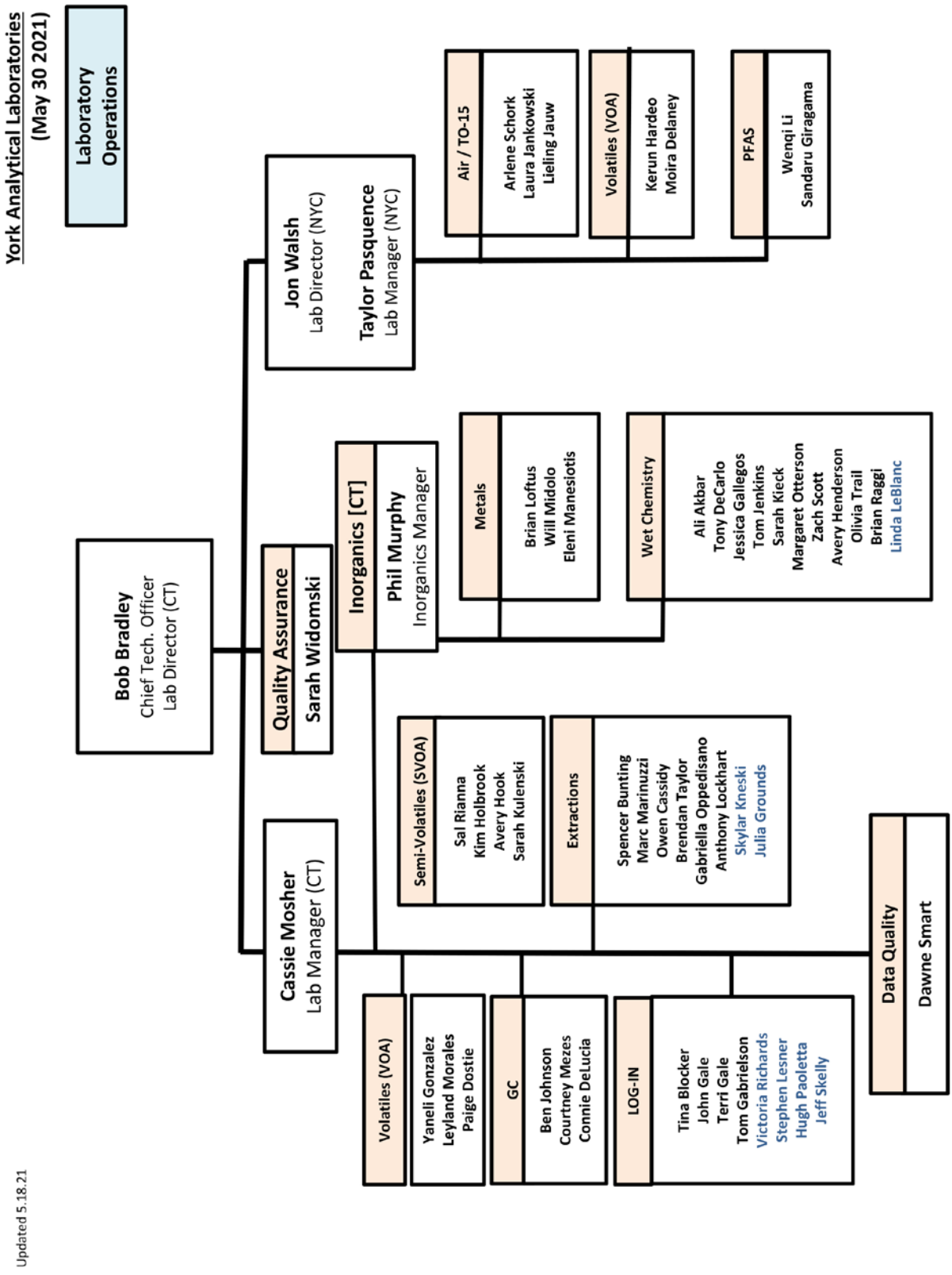


Figure 2. Laboratory Functional Organizational Chart



5.4 Audits

5.4.1 Internal Audits

The laboratory arranges comprehensive annual internal audits to verify that its operations continue to comply with the requirements of the laboratory's quality system. The Quality Assurance Officer or designee plans and organizes audits as required by a predetermined schedule and requested by management. The internal audits

also serve the purpose of ensuring that SOPs meet the requirements of the reference methods and their updates.

The QAO or other qualified personnel, independent of the activity to be audited, will carry out such audits following the procedures in the SOP, Internal Audit Procedures.

Personnel do not audit their own activities except when it can be demonstrated that an effective audit will be carried out.

Where the audit findings cast doubt on the correctness or validity of the laboratory's calibrations or test results, the laboratory takes immediate corrective actions and where deemed relevant notifies, in writing, any client whose work was involved.

i. List of available qualified personnel for internal audits include:
   - QA Officer
   - Lab Manager or Technical Director
   - QA Assistant
   - Group Leader (For departments other than their own)
   - Any Senior Chemist (With training in proper internal auditing procedures) not working in the area to be audited

ii. The minimum qualifications for an internal auditor shall be:
   - Education: A Bachelors (BS) Degree in an applied science with 12-16 semester hours in chemistry.
   - Experience: Two years' experience in an instrumental analytical technique for environmental analysis of representative environmental samples. Training to the most current revision of the SOP on Internal Audits.
   - Any outside audit findings will also be included in the Internal Audits.

5.4.2 Management Review

YORK management conducts an annual review of its quality system and its testing and calibration activities to ensure its continuing suitability and effectiveness and to introduce any necessary changes or improvements in the quality system and laboratory operations.

This review takes account of reports from managerial and supervisory personnel, the outcome of recent internal audits, assessments by external bodies, the results of inter-laboratory comparisons or proficiency tests, any changes in the volume and type of work undertaken, feedback from clients, senior lab personnel, corrective actions, and other relevant factors.

The laboratory shall have a procedure for review by management, and maintain records of review findings and actions.

5.4.3 Audit Review

All audit and review findings and any corrective actions that arise from them are documented. The laboratory management ensures that these actions are discharged within the agreed time frame as indicated in the quality manual and/or SOPs. Specific Audit checklists are employee for each discipline/method.

5.4.4 Performance Audits

In addition to periodic audits, the laboratory ensures the quality of results provided to clients by implementing checks to monitor the quality of the laboratory's analytical activities. Examples of such checks are:

a) Internal quality control procedures using statistical techniques (see Section 5.4 below);-Control charts

b) Participation in proficiency testing or other inter-laboratory comparisons;

c) Use of certified reference materials and/or in-house quality control using secondary reference materials as specified in YORK QSM Section 5.4;

d) Replicate testing using the same or different test methods;

g) Re-testing of retained samples;

h) Correlation of results for different but related analysis of a sample (for example, total phosphorus should be greater than or equal to ortho-phosphate).

5.4.5 Corrective / Preventive Actions

a) In addition to providing acceptance criteria and specific protocols for corrective/preventive actions in, the laboratory implements general procedures to be followed to determine when departures from documented policies, procedures and quality control have occurred. These procedures include but are not limited to the following:

   1) Identify the individual(s) responsible for assessing each QC data type;

   2) Identify the individual(s) responsible for initiating and/or recommending corrective/preventive actions;

   3) Define how the analyst shall treat a data set if the associated QC measurements are unacceptable;

   4) Specify how out-of-control situations and subsequent corrective actions are to be documented; and

   5) Specify procedures for management (including the QA officer) to review corrective/preventive action reports.

b) To the extent possible, sample results are reported only if all quality control measures are acceptable. If a quality control measure is found to be out of control, and the data are to be reported, all samples associated with the failed quality control measure are reported with the appropriate data qualifier(s).

5.4 Essential Quality Control Procedures

These general quality control principles apply, where applicable, to all testing at YORK. The manner in which each is implemented is dependent on the types of tests performed by the laboratory and is further described in specific SOPs for each test. The standards for any given test type assure that the applicable principles are addressed:

a) All laboratories have detailed written protocols in place to monitor the following quality controls:

   1) Positive and negative controls (blanks, spikes, reference materials, etc.) to monitor tests;

   2) Tests to define the variability and/or repeatability of the laboratory results such as replicates;

   3) Measures to assure the accuracy of the test method including calibration and/or continuing calibrations, use of certified reference materials, proficiency test samples, or other measures;

   4) Measures to evaluate test method capability, such as detection limits and quantitation limits or range of applicability such as linearity;

   5) Selection of appropriate formulae to reduce raw data to final results such as regression analysis, comparison to internal/external standard calculations, and statistical analyses;

6) Selection and use of reagents and standards of appropriate quality as define din the SOPs;

7) Measures to assure the selectivity of the test for its intended purpose; and

8) Measures to assure constant and consistent test conditions (both instrumental and environmental) where required by the test method, such as temperature, humidity, or specific instrument conditions.

b) All quality control measures are assessed and evaluated on an on-going basis, and quality control acceptance criteria are used to determine the usability of the data.

c) The laboratory has procedures for the development of acceptance/rejection criteria where no method or regulatory criteria exist.

d) The quality control protocols specified in the method manual (YORK QSM Section 10.1.2) is followed. YORK ensures that the essential standards outlined in NELAC 5, Appendix D, or mandated methods or regulations (whichever are more stringent) are incorporated into the SOP/method manuals. When it is not apparent which is more stringent the QC in the mandated method or regulations is to be followed.

The essential quality control measures for testing are found in Appendix D.

6.1 PERSONNEL

6.2 General Requirements for Laboratory Staff

YORK's testing departments have a sufficient level of personnel with the necessary education, training, technical knowledge and experience to perform the assigned functions.

All personnel are responsible for complying with all quality assurance/quality control requirements that pertain to their organizational/technical function. Each technical staff member must have a combination of experience and education to adequately demonstrate a specific knowledge of their particular function and a general knowledge of laboratory operations, test methods, quality assurance/quality control procedures and records management.

6.3 Laboratory Management Responsibilities

In addition to YORK QSM Section 4.2.d, the laboratory management:

a) Defines the minimum level of qualification, experience and skills necessary for all positions in the laboratory. In addition to education and/or experience, basic laboratory skills such as using a balance and quantitative techniques, are considered.

b) Ensures that all technical laboratory staff members demonstrate capability in the activities for which they are responsible. Such demonstration is documented (See Appendix C). Note: In departments with specialized "work cells" (a well-defined group of analysts that together perform the method analysis), the group as a unit meets the above criteria and this demonstration is fully documented.

c) Ensures that the training of each member of the technical staff is kept up-to-date (on-going) by the following:

1) Keeping evidence on file that demonstrates that each employee has read, understood, and is using the latest version of the laboratory's in-house quality documentation that relates to his/her job responsibilities.

2) Documenting training courses or workshops on specific equipment, analytical techniques, or laboratory procedures.

3) Documenting employee attendance at training courses on ethical and legal responsibilities including

the potential punishments and penalties for improper, unethical or illegal actions. Keeping on file evidence that demonstrates that each employee has read, acknowledges, and understands their personal ethical and legal responsibilities including the potential punishments and penalties for improper, unethical or illegal actions.

4) Maintains up-to-date analyst training records that contain a certification that technical personnel have read, understood and agreed to perform the most recent version of the test method (the approved method or SOP as defined by the laboratory document control system, YORK QSM Section 5.2.d) and documentation of continued proficiency by at least one of the following once per year:

   i. Acceptable performance of a blind sample (single blind to the analyst);

   ii. Another demonstration of capability;

   iii. Successful analysis of a blind performance sample on a similar test method using the same technology (e.g., GC/MS volatiles by purge and trap for Methods 524.2, 624, or 5035/8260) would only require documentation for one of the test methods;

   iv. At least four consecutive laboratory control samples with acceptable levels of precision and accuracy;

   v. If subsections i-iv cannot be performed, analysis of authentic samples with results statistically indistinguishable from those obtained by another trained analyst.

d) Documents all analytical and operational activities of the laboratory;

e) Supervises all personnel employed by the laboratory with the exception of the QA Officer;

f) Ensures that all sample acceptance criteria (YORK QSM Section 11.0) are verified and that samples are logged into the sample tracking system and properly labeled and stored.

g) Documents the quality of all data reported by the laboratory.

h) In conjunction with the QA Officer, develops a proactive program for the prevention and detection of improper, unethical, or illegal actions. Components of this program could include: internal proficiency testing (single and double blind); post-analysis electronic audits; effective reward program to improve employee vigilance and co-monitoring; and separate SOPs identifying appropriate and inappropriate laboratory and instrument manipulation practices.

6.2.1 Ownership Transfer / Out of Business

a) In the event that the laboratory transfers ownership or goes out of business, YORK will ensure that the records are maintained or transferred according to client instruction.

b) Upon ownership transfer, record retention requirements shall be addressed in the ownership transfer agreement and the responsibility for maintaining archives will be clearly established. In cases of bankruptcy, appropriate regulatory and state legal requirements concerning laboratory records will be followed.

c) In the event that the laboratory goes out of business, all records will revert to the control of the client or regulatory agency, as applicable. As much notice as possible will be given to clients and the accrediting bodies who have worked with the laboratory during the previous 5 years of such action.

6.3 Personnel Records

Records on the relevant qualifications, training, skills and experience of the technical personnel are maintained by the laboratory, including records on demonstrated proficiency for each laboratory test method, such as the criteria outlined in YORK QSM Section 10.5 for analysis.

7.1 PHYSICAL FACILITIES – ACCOMMODATION AND ENVIRONMENT

7.2 Environment

a) Laboratory accommodations, test areas, energy sources, lighting, heating and ventilation are such that they facilitate proper performance of tests.

b) The environment in which these activities are undertaken does not invalidate the results or adversely affect the required accuracy of the measurements. Particular care shall be taken when such activities are undertaken at sites other than the permanent laboratory premises.

c) The laboratory shall provide for the effective monitoring, control and recording of environmental conditions as appropriate. Such environmental conditions may include dust, electromagnetic interference, humidity, main voltage, temperature, and sound and vibration levels.

d) In instances where monitoring or control of any of the above-mentioned items is specified in a test method or by regulation, the laboratory meets and documents adherence to the laboratory facility requirements.

7.3 Work Areas

a) There is effective separation between neighboring areas when the activities therein are incompatible including volatile organic chemicals handling areas.

b) Access to and use of all areas affecting the quality of these activities are defined and controlled.

c) Adequate measures are taken to ensure good housekeeping in the laboratory and to ensure that any contamination does not adversely affect data quality.

d) Workspaces are available to ensure an unencumbered work area. Work areas include:

1) Access and entryways to the laboratory;

2) Sample receipt areas;

3) Sample storage areas;

4) Chemical and waste storage areas; and

5) Data handling and storage areas.

8.0 EQUIPMENT AND REFERENCE MATERIALS

a) YORK is furnished with all items of equipment (including reference materials) required for the correct performance of tests for which accreditation is maintained. Note that YORK does not use equipment outside its permanent control.

b) All equipment is properly maintained, inspected, and cleaned. Maintenance procedures are documented.

c) Any equipment item that has been subjected to overloading or mishandling, or that gives suspect results, or has been shown by verification or otherwise to be defective, is taken out of service, clearly identified and wherever possible stored at a specified place until it has been repaired and shown by calibration, verification or test to perform satisfactorily. The laboratory shall examine the effect of this defect on previous calibrations or tests.

d) When appropriate, each item of equipment, including reference materials, is labeled, marked, or otherwise identified to indicate its calibration status.

e) Records are maintained of each major item of equipment and all reference materials significant to the tests performed. These records include documentation on all routine and non-routine maintenance activities in assigned log books and reference material verifications.

The records include:

1) The name of the item of equipment;
2) The manufacturer's name, type identification, and serial number or other unique identification;
3) Date received and date placed in service (if available);
4) Current location, where appropriate;
5) If available, condition when received (e.g., new, used, reconditioned);
6) Copy of the manufacturer's instructions, where available;
7) Dates and results of calibrations and/or verifications and date of the next calibration and/or verification;
8) Details of maintenance carried out to date and planned for the future; and
9) History of any damage, malfunction, modification or repair.

9.1 MEASUREMENT TRACEABILITY AND CALIBRATION

9.2 General Requirements

All measuring operations and testing equipment having an effect on the accuracy or validity of tests are calibrated and/or verified before being put into service and on a continuing basis. The laboratory has an established program for the calibration and verification of its measuring and test equipment. This includes balances, thermometers and control standards.

9.3 Traceability of Calibration

a) The overall program of calibration and/or verification and validation of equipment is designed and operated so as to ensure that measurements made by the laboratory are traceable to national standards of measurement.

b) Calibration certificates indicate the traceability to national standards of measurement and provide the measurement results and associated uncertainty of measurement and/or a statement of compliance with an identified metrological specification. The laboratory maintains records of all such certification in the QA office.

c) Where traceability to national standards of measurement is not applicable, the laboratory provides satisfactory evidence of correlation of results, for example, by participation in a suitable program of inter-laboratory comparisons, proficiency testing, or independent analysis.

9.4 Reference Standards

a) Reference standards of measurement held by the laboratory (such as Class S or equivalent weights, or N I S T traceable thermometers) are used for calibration only and for no other purpose, unless it can be demonstrated that their performance as reference standards has not been invalidated. A body that can provide traceability calibrates reference standards of measurement. Where possible, this traceability is to a national standard of measurement.

b) There is a program of calibration and verification for reference standards.

   i. Two weeks prior to their date of calibration expiration, individual thermometers are removed from service and replaced by newly calibrated units from the supplier.

   ii. YORK keeps two sets of Class S weights on hand for use in the laboratory. One set is used for daily calibration checks, and the second set is kept for back up use should the first set be damaged, lost or otherwise compromised. The second set of weights is also place in service when the daily use set is shipped off site for recalibration.

   iii. Analytical balances are serviced and calibrated on a routine, annual schedule by an outside vendor.

c) Where relevant, reference standards and measuring and testing equipment are subjected to in-service checks between calibrations and verifications. Reference materials are traceable. Where possible, traceability is to national or international standards of measurement, or to national or international

standard reference materials.

d) NIST-Traceable Weights and Thermometers

i. Reference standards of measurement shall be used for the purposes of calibration only. NIST traceable thermometers and NIST-traceable weights shall not be used for routine testing. If NIST traceable reference sources are used for routine testing they shall not be used for calibration purposes unless it can be shown that their performance as reference standards would not be invalidated.

ii. For NIST-traceable weights and thermometers, YORK requires that all calibrations be conducted by a calibration laboratory accredited by ACLASS, A2LA or other recognized accrediting body.

a. The calibration laboratory must hold proper accreditation for the services rendered. Prior to use, QA verifies that the selected vendor holds the appropriate scope of accreditation for the services required.

b. The calibration certificate or report supplied by the calibration laboratory must contain a traceability statement, the conditions under which the calibrations were made, a compliance statement with an identified metrological specification and the pertinent clauses when applicable, and a clearly identified record of the quantities and functional test results before and after re-calibration.

c. The certificate and scope of accreditation is kept on file at the laboratory and is reviewed yearly.

iii. If significant amendments are made to a calibration certificate, it must have its own unique report identifier and must reference the one it is replacing. The piece of equipment must be identified in the amended report using its unique serial number or other laboratory defined identifier. The amended report is maintained with the original calibration report.

iv. Laboratory balances are recalibrated annually by an external, certified vendor that is certified to ISO 17025 / ISO 9001 standards for calibration. Prior to use, QA verifies that the selected vendor holds the appropriate scope of accreditation for the services required. This service is documented on each balance with a signed and dated certification sticker.

v. NIST mercury thermometers are sent out for recalibration every five years, or are replaced. All working mercury thermometers are calibrated annually against a NIST-traceable reference thermometer. All digital temperature measuring devices (min/max thermometers, IR guns) are calibrated quarterly. Equipment that does not meet acceptance criteria is removed from service and repaired or replaced. Calibration reports are maintained by the QA Officer.

vi. Balance calibrations and temperature readings of ovens, refrigerators, and incubators are checked on each day of use. Min/Max thermometers are used for refrigerators and freezers to continually monitor temperature performance.

e) Traceable Reference Standards and Materials

i. Reference standards and materials are traceable to certified reference materials, where available. Commercially prepared standard materials are purchased from vendors accredited by A2LA, NVLAP (National Voluntary Lab Accreditation Program) or other recognized vendor, and come with a Certificate of Analysis that documents the purity of the standard and expiration date, if assigned. If a standard cannot be purchased from a vendor that supplies a Certificate of Analysis, the purity of the standard is documented by analysis against a known reference.

ii. Analytical reagents must be at a minimum the purity required by or stated in the test method. Commercial materials that are purchased for the preparation of calibration, verification or spiking solutions, are usually accompanied by an assay certificate or the purity is noted on the label. If

the purity is ≥96%, the weight provided by the vendor may be used without correction. If the purity is <96%, a correction will be made to solution concentrations prepared from that material.

iii. The receipt of all reference standards and materials, including received date and expiration date, is documented by the laboratory at the time of receipt, in chemical receiving logbooks. All documentation received with the reference standard or material (Certificate of Analysis or Purity Certificates) is retained by the laboratory. To prevent contamination and/or deterioration in quality, all standards and materials are handled and stored according to the method or manufacturer's requirements.

iv. Preparation of standard or reference materials are documented in SOPs and in Element LIMS by department. These records show the traceability to the purchased standards or materials, and include the method of preparation, date of preparation, expiration date, and preparer's initials, at a minimum.

v. All standards, reference, primary and working, whether purchased from a commercial vendor or prepared by the laboratory, must be checked regularly to ensure that the variability of the standard from the 'true' value does not exceed method requirements. Calibration standards are checked by comparison with a standard from a second source, usually another manufacturer and vendor. In cases where a second manufacturer is not available, a different lot, with vendor certification, may be used as a second source.

vi. Quality control (QC) criteria for primary and second source standards are defined in laboratory SOPs and/or in Element LIMS. In most cases, the analysis of an Initial Calibration Verification (ICV) is used as the second source verification of a primary calibration source.

9.5 Calibration

Calibration requirements are divided into two parts: (1) requirements for analytical support equipment, and (2) requirements for instrument calibration. In addition, the requirements for instrument calibration are divided into initial calibration and second source or initial calibration verification, and continuing calibration verification.

9.4.1 Support Equipment

These standards apply to all devices that may not be the actual test instrument, but are necessary to support laboratory operations. These include but are not limited to: balances, ovens, refrigerators, freezers, incubators, water baths, thermometers, and volumetric dispensing devices (such as Eppendorf®, or automatic dilutor/dispensing devices) if quantitative results are dependent on their accuracy, as in standard preparation and dispensing or dilution into a specified volume.

a) All support equipment is maintained in proper working order. The records of all repair and maintenance activities, including service calls is kept.

b) All support equipment is calibrated or verified at least annually, using NIST traceable references when available, over the entire range of use. The results of such calibration are within the specifications required of the application for which this equipment is used or:

   1) The item is removed from service until repaired; or

   2) The laboratory maintains records of established correction factors to correct all measurements.

c) Raw data records are retained to document equipment performance.

d) Prior to use on each working day, balances, ovens, refrigerators, freezers, and water baths are checked in the expected use range, with NIST traceable calibrated references. The acceptability for use or continued use is according to the needs of the analysis or application for which the equipment is being used.

e) Mechanical volumetric dispensing devices including burettes (except Class A glassware) are checked for accuracy on at least a quarterly use basis. Glass microliter syringes are to be considered Class A

glassware, and come with a certificate from the manufacturer attesting to established accuracy or the accuracy is initially demonstrated and documented by the laboratory.

9.4.2 Instrument Calibration

This manual specifies the essential elements that define the procedures and documentation for initial instrument calibration and continuing instrument calibration verification to ensure that the data are of known quality and be appropriate for a given regulation. This manual does not specify detailed procedural steps ("how to") for calibration, but establishes the essential elements for selection of the appropriate technique(s). This approach allows flexibility and permits the employment of a wide variety of analytical procedures and statistical approaches currently applicable for calibration. If more stringent standards or requirements are included in a mandated test method or by regulation, the laboratory demonstrates that such requirements are met. If it is not apparent which standard is more stringent, then the requirements of the regulation or mandated test method are to be followed.

Note: In the following sections, initial instrument calibration is directly used for quantitation and continuing instrument calibration verification is used to confirm the continued validity of the initial calibration, unless otherwise stipulated by the analytical method.

9.4.2.1 Initial Instrument Calibrations

The following items are essential elements of initial instrument calibration:

a) The details of the initial instrument calibration procedures including calculations, integrations, acceptance criteria and associated statistics are included or referenced in the test method SOP. When initial instrument calibration procedures are referenced in the test method, the referenced material is retained by the laboratory and is available for review.

b) Sufficient raw data records are retained to permit reconstruction of the initial instrument calibration, e.g., calibration date, test method, instrument, analysis date, each analyte name, analyst's initials or signature; concentration and response, calibration curve or response factor; or unique equation or coefficient used to reduce instrument responses to concentration.

c) Sample results are quantitated from the initial instrument calibration and may not be quantitated from any continuing instrument calibration verification unless specifically stated in a mandated test method.

d) All initial instrument calibrations are verified with a standard obtained from a second manufacturer or lot. Traceability shall be to a national standard, when available.

e) Criteria for the acceptance of an initial instrument calibration is established, e.g., correlation coefficient or relative percent difference. The criteria used are appropriate to the calibration technique employed.

f) Results of samples not bracketed by initial calibration standards (within calibration range) are reported as having less certainty, e.g., defined qualifiers or flags or explained in the case narrative. As determined by the method, the lowest calibration standard is at or above the method detection limit and at or below the reporting limit.

g) If the initial instrument calibration results are outside established acceptance criteria, corrective actions are performed. Data associated with an unacceptable initial instrument calibration is not reported.

h) Calibration standards include concentrations at or below the regulatory limits/Action levels where technologically feasible.

i) If a reference or mandated method does not specify the number of calibration standards, the minimum number is two for ICP metals and a minimum of 5 for all other calibrations. The laboratory's standard operating procedure defines the number of points for establishing the initial instrument calibration.

9.4.2.2 Continuing Instrument Calibration Verification

When an initial instrument calibration is not performed on the day of analysis, the validity of the initial

calibration is verified prior to sample analyses by analyzing continuing calibration verification standards with each analytical batch. The following items are essential elements of continuing calibration verification:

a) The details of the continuing calibration procedure, calculations and associated statistics are included or referenced in the test method SOP.

b) A continuing calibration verification standard (s) must be analyzed at the beginning and end of each analytical batch, and where required by method or project, at a specific frequency, every 10 or 20 samples or 12 hours, within the batch.

c) Sufficient raw data electronic records must be retained to permit reconstruction of the continuing calibration verification, e.g., test method, instrument, analysis date, each analyte name, concentration and response, calibration curve or response factor, or unique equations or coefficients used to convert instrument responses into concentrations. Continuing calibration verification records must explicitly connect the continuing calibration verification data to the initial calibration.

d) Criteria for the acceptance of a continuing calibration verification must be established, e.g., relative percent difference or Percent Drift.

e) If the continuing calibration verification results obtained are outside established acceptance criteria, corrective actions must be performed. If routine corrective action procedures fail to produce a second (consecutive and immediate) calibration verification within acceptance criteria, then the laboratory shall demonstrate performance after corrective action with two consecutive successful calibration verifications, or a new instrument calibration must be performed. If the laboratory has not demonstrated acceptable performance, sample analyses shall not occur until a new initial calibration curve is established and verified.

   As an exception, sample data associated with an unacceptable continuing calibration verification may be reported as qualified data under the following specific conditions:

   i. When the acceptance criteria for the continuing calibration verification are exceeded high, i.e., high bias and there are associated samples that are non-detects, then those non-detects may be reported. Otherwise the samples affected by the unacceptable calibration verification are reanalyzed after a new calibration curve has been established, evaluated and accepted.

   ii. When the acceptance criteria for the continuing calibration verification are exceeded low, i.e., low bias, those sample results may be reported if they exceed a maximum regulatory limit/action level. Otherwise the samples affected by the unacceptable verification are reanalyzed after a new calibration curve has been established, evaluated and accepted.

10.1 TEST METHODS AND STANDARD OPERATING PROCEDURES

10.2 Methods Documentation

a) The laboratory has documented instructions on the use and operation of all relevant equipment, on the handling and preparation of samples and for calibration and/or testing, where the absence of such instructions could jeopardize the calibrations or tests.

b) All instructions, standards, manuals, and reference data relevant to the work of the laboratory are maintained up-to-date and be readily available to the staff.

10.1.1 Standard Operating Procedures (SOPs) Administrative

YORK maintains standard operating procedures that accurately reflect all phases of current laboratory activities such as instrument operation, assessing data integrity, corrective actions, handling customer complaints, reporting of test results, etc.

a) These documents, for example, may be equipment manuals provided by the manufacturer or internally

written documents.

b) The test methods may be copies of published methods as long as any changes or selected options in the methods are documented and included in the SOP (See 10.1.2.)

c) Copies of all SOPs are accessible to all personnel.

d) The SOPs are organized.

e) Each SOP clearly indicates the effective date of the document, the revision number and the signatures of the approving authorities.

10.1.2 Standard Operating Procedures (SOPs) Analytical

a) The laboratory has and maintains SOPs for each accredited analyte or test method.

b) This SOP may consist of copies of published or referenced test methods or standard operating procedures that have been written by the laboratory. In cases where modifications to the published method have been made by the laboratory or where the referenced test method is ambiguous or provides insufficient detail, these changes or clarifications are clearly described. Each test method includes or references where applicable:

1) Identification of the test method;
2) Applicable matrix or matrices;
3) Detection limit;
4) Scope and application, including components to be analyzed;
5) Summary of the test method;
6) Definitions;
7) Interferences;
8) Safety;
9) Equipment and supplies;
10) Reagents and standards;
11) Sample collection, preservation, shipment, and storage;
12) Quality control;
13) Calibration and standardization;
14) Procedure;
15) Calculations;
16) Method performance;
17) Pollution prevention;
18) Data assessment and acceptance criteria for quality control measures;
19) Corrective actions for out-of-control data;
20) Contingencies for handling out-of-control or unacceptable data;
21) Waste management;
22) References; and
23) Any tables, diagrams, flowcharts, and validation data.
24) Modifications
25) Revision History

10.2 Exceptionally Permitting Departures from Documented Policies / Procedures

a) If it is necessary to depart from a documented procedure or policy due to circumstances outside of YORK's control or due to conditions encountered while preparing or analyzing a sample, the following will be documented.

1) The nature of the exception
2) How the data or procedure may be impacted
3) Any Corrective Action that may be needed.
4) Any approval from a client that may be required.
5) Approval by management to report or proceed with the exception.
6) A Case Narrative with the Final Report explaining the exception.

10.3 Test Methods

The laboratory uses appropriate test methods and procedures for all tests and related activities within its responsibility (including, as applicable, sample collection, sample handling, transport and storage, sample preparation and sample analysis). The method and procedures shall be consistent with the accuracy required, and with any standard specifications relevant to the calibrations or tests concerned.

a) When the use of specific test methods for a sample analysis is mandated or requested, only those methods are used.

b) Where test methods are employed that are not required, as in the Performance Based Measurement System approach, the methods are fully documented and validated (see YORKQSM Section 10.1.2 and Appendix C), and are available to the client and other recipients of the relevant reports.

10.4 Test Method Assessment

The laboratory will periodically conduct a Test Method Assessment on the analytical methods in use. These assessments are typically done during annual internal audit activities. The purpose is to evaluate the compliance between bench performance of the method versus the current YORK Standard Operating Procedure versus the promulgated or published method. Discrepancies will need to be addressed and resolved. Note that some methods are totally prescriptive while others may contain prescriptive aspects, and still others are performance based. In many cases, modifications to the published method may be required due to circumstances outside the laboratories' control.

10.5 Demonstration of Capability

a) Prior to acceptance and initiation of any test method, satisfactory demonstration of method capability is required. This demonstration does not test the performance of the method in real world samples, but in the applicable and available clean matrix (sample of a matrix is which no target analytes or interferences are present at concentrations that impact the results of a specific test method), e.g., water, solids and air. In addition, for analytes that do not lend themselves to spiking, the demonstration of capability may be performed using quality control samples.

b) Continuing demonstration of method performance, per the quality control requirements is required annually as DOCs.

c) In all cases, the appropriate forms, such as the Certification Statement, is completed and retained by the laboratory to be made available upon request. The laboratory retains all associated supporting data necessary to reproduce the analytical results summarized in the Certification Statement.

d) Demonstration of capability is completed each time there is a significant change in instrument type, personnel, or test method.

e) In departments with specialized "work cell(s)" (a group consisting of analysts with specifically defined tasks that together perform the test method), the group as a unit must meet the above criteria and this demonstration of capability is fully documented.

f) When a work cell is employed, and the members of the cell change, the new employee(s) must work with an experienced analyst in that area of the work cell where they are employed. This new work cell must demonstrate acceptable performance through acceptable continuing performance checks such as laboratory control samples). Such performance is documented and the four preparation batches following the change in personnel must not result in the failure of any batch acceptance criteria, e.g., method blank and laboratory control sample, or the demonstration of capability must be repeated. In addition, if the entire work cell is changed or replaced, the new work cell must perform the demonstration of capability.

g) Performance of the work cell is linked to the training records of the individual members of the work cell (See YORK QSM Section 6.2).

10.6 Sample Aliquots

Where sampling (as in obtaining sample aliquots from a submitted sample) is carried out as part of the test method, the laboratory shall use documented procedures and appropriate techniques to obtain representative subsamples.

10.7 Data Verification

Calculations and data transfers are subject to appropriate checks.

a) The laboratory has Standard Operating Procedures that ensure that the reported data are free from transcription and calculation errors.

b) The laboratory has Standard Operating Procedures that ensure that all quality control measures are reviewed, and evaluated before data are reported. Refer to internal Quality Control Checks, Project Management and Analytical Report Review

c) The laboratory has Standard Operating Procedures that address manual calculations including manual integrations. Refer to appropriate SOPs.

10.8 Documentation and Labeling of Standards and Reagents

Documented procedures exist for the purchase, receipt and storage of consumable materials used for the technical operations of the laboratory. Most records are electronically documented in Element LIMS whilke oters may be log book entries with references.

a) The laboratory retains records for all standards, reagents and media including the manufacturer/vendor, the manufacturer's Certificate of Analysis or purity (if supplied), the date of receipt, recommended storage conditions, and an expiration date after which the material is not used, unless the laboratory verifies its suitability for testing use.

b) Original containers (such as those provided by the manufacturer or vendor) are labeled with an expiration date.

c) Records are maintained on reagent and standard preparation. These records indicate traceability to purchased stocks or neat compounds, reference to the method of preparation, date of preparation, expiration date and preparer's initials.

d) All containers of prepared reagents and standards bear a unique identifier and expiration date and are linked to the documentation requirements in YORKQSM Section 10.8.c above.

10.9 Computers and Electronic Data Related Requirements

Where computers, automated equipment, or microprocessors are used for the capture, processing, manipulation, recording, reporting, storage or retrieval of test data, YORK ensures that:

a) All requirements of the NELAC Standard (i.e., Chapter 5 of NELAC) are met;

b) Computer software is tested and documented to be adequate for use, e.g., internal audits, personnel training, focus point of QA and QC;

c) Procedures are established and implemented for protecting the integrity of data. Such procedures include, but are not limited to, integrity of data entry or capture, data storage, data transmission and data processing;

d) Computer and automated equipment are maintained to ensure proper functioning and provided with the environmental and operating conditions necessary to maintain the integrity of calibration and test data; and,

e) It establishes and implements appropriate procedures for the maintenance of security of data including the prevention of unauthorized access to, and the unauthorized amendment of, computer records.

11.1 SAMPLE HANDLING, SAMPLE ACCEPTANCE POLICY AND SAMPLE RECEIPT

While YORK does not have control of field sampling activities, the following are essential to ensure the validity of the laboratory's data.

11.2 Sample Tracking

a) The laboratory has a documented system for uniquely identifying the items to be tested, to ensure that there can be no confusion regarding the identity of such items at any time. This system includes identification for all samples, subsamples and subsequent extracts and/or digestates. The laboratory assigns a unique identification (ID) code to each sample container received in the laboratory. (The use of container shape, size, or other physical characteristic, such as amber glass, or purple top, is not an acceptable means of identifying the sample.)

b) This laboratory code is maintained as an unequivocal link with the unique field ID code assigned each container.

c) The laboratory ID code is placed on the sample container as a durable label.

d) The laboratory ID code is entered into the laboratory records (see YORKQSM Section 11.3.d) and is the link that associates the sample with related laboratory activities such as sample preparation or calibration.

e) In cases where the sample collector and analyst is the same individual or the laboratory pre-assigns numbers to sample containers, the laboratory ID code may be the same as the field ID code.

11.3 Sample Acceptance Policy

The laboratory has a written sample acceptance policy that clearly outlines the circumstances under which samples are accepted or rejected. Data from any samples that do not meet the following criteria are flagged in an unambiguous manner, and the nature of the variation is clearly defined. The sample acceptance policy is available to sample collection personnel and includes, but is not limited to, the following areas of concern:

a) Proper, full, and complete documentation, that includes sample identification, the location, date and time of collection, collector's name, preservation type, sample type and any special remarks concerning the sample;
b) Proper sample labeling that includes a unique identification and a labeling system for the samples with requirements concerning the durability of the labels (water resistant) and the use of indelible ink;
c) Use of appropriate sample containers;
d) Adherence to specified holding times;
e) Adequate sample volume. Sufficient sample volume must be available to perform the necessary tests; and,
f) Procedures to be used when samples show signs of damage, contamination or inadequate preservation.
g) Samples are NOT accepted if classified as extremely hazardous, such as drum waste or neat chemicals.

11.4 Sample Acceptance Policy (Posted)

This sample acceptance policy outlines the circumstances in which received samples are accepted or rejected by York Analytical Laboratories, Inc. (YORK). If any of the below criteria are not met, it may

delay YORK's processing of samples, possibly compromising "short" holding time analyses. Where received samples do not meet these criteria, YORK will contact the client.

If immediate client contact cannot be made, and hold times are not an issue, samples will be appropriately stored until the situation is clarified with the client. If a delay in sample processing will result in missed holding times, and YORK deems there is sufficient information provided on the Chain-of-Custody (COC), the lab will proceed with sample log-in and processing; however, YORK will not assume any liability for samples processed under these circumstances.

Data from samples that do not meet the sample acceptance criteria are flagged and/or addressed in a case narrative, with the nature of the deviation clearly defined. Samples must have written authorization to proceed if not in compliance with this guidance.

1. Complete COC with the following information:

   Unique sample identification, date and time of collection, sample matrix, analysis requested, sampler's name, preservation type (if applicable), client name and address, any additional comments, signature of relinquishing party and date and time that samples were relinquished.

2. Sample temperature upon receipt of >0°C to 6°C, as applicable to the method.

   In the event that samples are collected on the same day that they are received by the laboratory, they are deemed acceptable if they are received on ice and the cooling process has begun.

3. Sample containers and preservatives must be appropriate for the test and method being requested on the COC.

4. Sample labels must include a unique identification written with indelible ink on water resistant labels that correspond with the COC.

5. Adequate sample volume must be provided for the analyses requested on the COC, and containers for volatile analyses must be free of headspace. This includes Tedlar bags and Summa canisters.

6. Sufficient holding time available to perform the analyses requested:

   Samples shall be received at the laboratory within 48 hours of sampling, or with at least 1/2 of the holding time left for the analysis, whichever is less. YORK always makes a best effort to ensure that holding times are not exceeded under these circumstances. In the event that a preparation or analysis is performed outside of the associated holding time, the client will be notified and the data will be qualified in the report.

7. Coolers and samples must be received in good condition, with no obvious signs of damage or tampering.

8. Please note, mixed waste, or samples classified as extremely hazardous are **NOT** accepted.

If you require additional information or clarification, please do not hesitate to contact YORK, or your Project Manager at (203) 325-1371.

11.5 Sample Receipt Protocols

a) Upon receipt, the condition of the sample, including any abnormalities or departures from standard condition as prescribed in the relevant test method, is recorded**.** All items specified in YORKQSM Section 11.2 above are checked.

   1) All samples that require cold temperature preservation are considered acceptable if the arrival temperature is within 2°C of the required temperature or the method-specified range. For samples with a specified temperature of 4°C, samples with a temperature ranging from just above the freezing temperature of water to 6°C shall be acceptable. Samples that are hand delivered to the laboratory immediately after collection may not meet these criteria. In these cases, the samples shall be considered acceptable if there is evidence that the chilling process has begun, such as arrival on ice.

2) The laboratory shall implement procedures for checking chemical preservation using readily available techniques, such as pH or free chlorine, prior to or during sample preparation or analysis.

Certain measurements, such a pH, are performed and recorded just prior to analysis.

Field filtration for dissolved metals may also be required. If there is no documentation of field filtration on the Chain of Custody when required, the Project Manager is notified and the client asked. If samples are not field filtered, they are sent to the lab for filtration within 24 or 48 hours depending on the analysis.

b) The results of all checks are recorded on Sample Receipt and, as needed, in the Corrective Action field on the login in LIMS.

c) When there is any doubt as to the item's suitability for testing, when the sample does not conform to the description provided, and when the test required is not fully specified, the laboratory makes every attempt to consult the client for further instruction before proceeding. The laboratory establishes whether the sample has received all necessary preparation, or whether sample preparation has yet to be performed. If the sample does not meet the sample receipt acceptance criteria listed in this standard, the laboratory:

1) Retains correspondence and/or records of conversations concerning the final disposition of rejected samples; or

2) Fully documents any decision to commence with the analysis of samples not meeting acceptance criteria.

i. The condition of these samples is, at a minimum, noted on the chain of custody record or transmittal form, and laboratory receipt documents.

ii. The analysis data is/are appropriately "qualified" on the final report.

d) The laboratory utilizes a permanent chronological electronic database to document receipt of all sample containers.

1) This sample receipt log records the following:

i. Client/Project Name;

ii. Date and time of laboratory receipt;

iii. Unique laboratory ID code (see YORKQSM Section 11.1); and

iv. Signature or initials of the person making the entries.

2) During the login process, the following information is linked to the log record or included as a part of the log. If such information is recorded/documented elsewhere, that document becomes part of the laboratory's permanent records, easily retrievable upon request, and readily available to individuals who will process the sample. Note: The placement of the laboratory ID number on the sample container is not considered a permanent record.

i. The field ID code that identifies each container is linked to the laboratory ID code in the sample receipt log.
ii. The date and time of sample collection is linked to the sample container and to the date and time of receipt in the laboratory.
iii. The requested analyses (including applicable approved test method numbers) are linked to the laboratory ID code.
iv. Any comments resulting from inspection for sample rejection are linked to the laboratory ID code.

e) All documentation (i.e., memos or transmittal forms) that are conveyed to the laboratory by the sample submitter is retained.

f) A complete chain of custody record form is maintained.

11.6 Storage Conditions

The laboratory has documented procedures and appropriate facilities to avoid deterioration, contamination, and damage to the sample during storage, handling, preparation, and testing; any relevant instructions provided with the item are followed. Where items must be stored or conditioned under specific environmental conditions, these conditions are maintained, monitored, and recorded.

a) Samples are stored according to the conditions specified by preservation protocols:

   1) Samples that require thermal preservation are stored under refrigeration at +/-2° of the specified preservation temperature unless method-specific requirement pre-empt this, such as volatile soil samples using Terracore (frozen). For samples with a specified storage temperature of 4°C, storage at a temperature above the freezing point of water to 6°C is acceptable.

   2) Samples are stored away from all standards, reagents, food, and other potentially contaminating sources. Samples are stored in such a manner to prevent cross contamination. Samples for analysis of volatile organics are stored in separate storage refrigerators/freezers to reduce vross contamination potential.

b) Sample fractions, extracts, leachates, and other sample preparation products are stored according to YORKQSM Section 11.4.a above or according to specifications in the test method.

c) When a sample or portion of a sample needs to be held secure (for example, for reasons of record, safety or value, or to enable check calibrations or tests to be performed later), the laboratory has storage and security arrangements that protect the condition and integrity of the secured items or portions concerned.

11.7 Sample Disposal

The laboratory has standard operating procedures for the disposal of samples, digestates, leachates and extracts or other sample preparation products.

12.1 RECORDS

The laboratory maintains a record system to suit its particular circumstances and comply with any applicable regulations. The system produces unequivocal, accurate records that document all laboratory activities. The laboratory retains all original observations, calculations and derived data, calibration records and a copy of the test report for a minimum of five years and for lead and copper in potable water, 12 years.

There are two levels of sample handling: 1) sample tracking and 2) legal chain of custody protocols that are used for evidentiary or legal purposes. All essential requirements for sample tracking (e.g., chain of custody form) are outlined in YORKQSM Sections 12.1, 12.2 and 12.3. YORK details the Legal/Evidentiary and Chain of Custody procedures in the appropriate SOPs.

12.2 Record Keeping System and Design

The YORK record keeping system allows historical reconstruction of all laboratory activities that produced the analytical data. The history of the sample is readily understood through the documentation. This includes inter-laboratory transfers of samples and/or extracts.

a) The records include the identity of personnel involved in sampling, sample receipt, preparation, and calibration or testing.

b) All information relating to the laboratory facilities equipment, analytical test methods, and related laboratory activities, such as sample receipt, sample preparation, or data verification, are documented.

c) The record keeping system facilitates the retrieval of all working files and archived records for inspection and verification purposes, e.g., set format for naming electronic files.

d) All changes to records are signed or initialed by responsible staff. The reason for the signature or initials is clearly indicated in the records such as “sampled by,” “prepared by,” or “reviewed by.”

e) All generated data, except those that are generated by automated data collection systems, are recorded directly, promptly, and legibly in permanent ink.

f) Entries in records are not be obliterated by methods such as erasures, overwritten files or markings. All corrections to record-keeping errors are made by one line marked through the error. The individual making the correction signs (or initials) and dates the correction. These criteria also apply to electronically maintained records.

g) Refer to 10.9 for Computer and Electronic Data.

12.3 Records Management and Storage

a) All records (including those pertaining to calibration and test equipment), certificates and reports are safely stored, and held secure and in confidence to the client. NELAP-related records are available to the accrediting authority.

b) All records, including those specified in YORKQSM Section 12.3, are retained for a minimum of five years from generation of the last entry in the records. The laboratory maintains all information necessary for the historical reconstruction of data. Records stored only on electronic media are supported by the hardware and software necessary for their retrieval. For potable water lead and copper data are retained for 10 years.

c) Records that are stored or generated by computers or personal computers have hard copy or write-protected backup copies.

d) The laboratory has an established record management system for control of laboratory notebooks, instrument logbooks, standards logbooks, and records for data reduction, validation storage and reporting.

e) Access to archived information is documented with an access log. These records are protected against fire, theft, loss, environmental deterioration, vermin, and in the case of electronic records, electronic or magnetic sources.

f) The laboratory has a plan to ensure that the records are maintained or transferred according to the clients’ instructions (see 4.1.8.e of NELAC) in the event of Laboratory Transfer of Ownership, Going out of Business or Bankruptcy. In all cases, appropriate regulatory and state legal requirements concerning laboratory records will be followed.

12.4 Laboratory Sample Tracking

12.4.1 Sample Handling

A record of all procedures to which a sample is subjected while in YORK’s possession is maintained. These include but are not limited to all records pertaining to:

a) Sample preservation, including appropriateness of sample container and compliance with holding time requirement;
b) Sample identification, receipt, acceptance or rejection, and log-in;
c) Sample storage and tracking, including shipping receipts, sample transmittal forms (chain of custody form); and
d) Documentation procedures for the receipt and retention of test items, including all provisions necessary to protect the integrity of samples.

12.4.2 Laboratory Support Activities

In addition to documenting all the above-mentioned activities, the following is retained:

a) All original raw data, whether hard copy or electronic, for calibrations, samples and quality control measures, including analysts work sheets and data output records (chromatograms, strip charts, and other instrument response readout records);

b) A written description or reference to the specific test method used, which includes a description of the specific computational steps used to translate parametric observations into a reportable analytical value;

c) Copies of final reports;

d) Archived standard operating procedures;

e) Correspondence relating to laboratory activities for a specific project;

f) All corrective/preventive action reports, audits and audit responses;

g) Proficiency test results and raw data; and,

h) Results of data review, verification, and cross-checking procedures.

12.4.3 Analytical Records

The essential information associated with analyses, such as strip charts, tabular printouts, computer data files, analytical notebooks, and run logs, include:

a) Laboratory sample ID code;

b) Date of analysis and time of analysis if the method-specified holding time is 72 hours or less, or when time critical steps are included in the analysis, e.g., extractions, and incubations;

c) Instrument identification and instrument operating conditions/parameters (or reference to such data);

d) Analysis type;

e) All manual calculations e.g., manual integrations;

f) Analyst's or operator's initials/signature;

g) Sample preparation including cleanup, separation protocols, incubation periods, ID codes, volumes, weights, instrument printouts, meter readings, calculations, reagents;

h) Sample analysis;

i) Standard and reagent origin, receipt, preparation, and use;

j) Calibration criteria, frequency and acceptance criteria;

k) Data and statistical calculations, review, confirmation, interpretation, assessment and reporting conventions;

l) Quality control protocols and assessment;

m) Electronic data security, software documentation and verification, software and hardware audits, backups, and records of any changes to automated data entries; and,

n) Method performance criteria including expected quality control requirements.

12.4.4 Administrative Records

The following are maintained:

a) Personnel qualifications, experience and training records;

b) Ethics Statements;

c) Records of demonstration of capability for each analyst; and

d) A log of names, initials and signatures for all individuals who are responsible for signing or initialing any laboratory record.

13.0 LABORATORY REPORT FORMAT AND CONTENTS

The results of each test, or series of tests carried out by the laboratory must be reported accurately, clearly, unambiguously and objectively. The results normally reported in a test report and include all the information necessary for the interpretation of the test results and all information required by the method used. Some regulatory reporting requirements or formats, such as monthly operating reports may not require all items listed below, however, YORK will provide all the required information to their client for use in preparing such regulatory reports.

a) Except as discussed in 13.b, each report to an outside client includes at least the following information (those prefaced with “where relevant” are not mandatory):

1) A title, e.g., "Technical Report”;

2) Name and address of laboratory, and location where the test was carried out if different from the address of the laboratory and phone number with name of contact person for questions;

3) Unique identification of the certificate or report (such as Work order no.) and of each page, and the total number of pages;

This requirement may be presented in several ways:

i. The total number of pages may be listed on the first page of the report as long as the subsequent pages are identified by the unique report identification and consecutive numbers, or

ii. Each page is identified with the unique report identification, the pages are identified as a number of the total report pages (example: 3 of 10, or 1 of 20).

Other methods of identifying the pages in the report may be acceptable as long as it is clear to the reader that discrete pages are associated with a specific report, and that the report contains a specified number of pages.

4) Name and address of client, where appropriate and project name if applicable;

5) Description and unambiguous identification of the tested sample including the client identification code;

6) Identification of test results derived from any sample that did not meet NELAC sample acceptance requirements such as improper container, holding time, or temperature;

7) Date of receipt of sample, date and time of sample collection, date(s) of performance test, and time of sample preparation and/or analysis if the required holding time for either activity is less than or equal to 72 hours;

8) Identification of the test method used, or unambiguous description of any nonstandard method used;

9) If the laboratory collected the sample, reference to sampling procedure;

10) Any deviations from (such as failed quality control), additions to or exclusions from the test method (such as environmental conditions), and any nonstandard conditions that may have affected the quality of results, and including the use and definitions of data qualifiers.

11) Measurements, examinations and derived results, supported by tables, graphs, sketches, and photographs as appropriate, and any failures identified; identify whether data are calculated on a dry weight or wet weight basis; identify the reporting units such as µg/l or mg/kg;

12) When required, a statement of the estimated uncertainty of the test results;

13) A signature and title, or an equivalent electronic identification of the person(s) accepting responsibility for the content of the report (however produced), and date of issue;

14) At the YORK's discretion, a statement to the effect that the results relate only to the items tested or to the sample as received by the laboratory;

15) At the YORK's discretion, a statement that the certificate or report shall not be reproduced except in full, without the written approval of the laboratory;

16) Clear identification of all test data provided by outside sources, such as subcontracted laboratories, clients, etc.; and

17) Clear identification of numerical results with values outside of quantitation limits.

b) Where the certificate or report contains results of tests performed by subcontractors, these results are clearly identified by subcontractor name or applicable accreditation number and the entirety of the subcontract report is included with the final YORK report.

c) After issuance of the report, the laboratory report remains unchanged. Material amendments to a calibration certificate, test report or test certificate after issue may be made only in the form of a further document, or data transfer, including the statement "Revision No. . . . [or as otherwise identified]" with explanation, or equivalent form of wording. Such amendments meet all the relevant requirements of the NELAC Standard.

d) YORK notifies clients promptly, in writing, of any event such as the identification of defective measuring or test equipment that casts doubt on the validity of results given in any calibration certificate, test report or test certificate or amendment to a report or certificate.

e) The laboratory will, where clients require transmission of test results by telephone, telex, facsimile or other electronic means, follow documented procedures that ensure that the requirements of this Standard are met and that confidentiality is preserved.

f) YORK will certify that all its NELAC-certified test results reported meet all requirements of NELAC or provide reasons and/or justification if they do not.

14.0 SUBCONTRACTING ANALYTICAL SAMPLES

When YORK subcontracts work whether because of unforeseen circumstances (e.g. workload, need for further expertise or temporary incapacity) or on a continuing basis (e.g. through client direction, contractual arrangement or permanent subcontracting), this work shall be placed with a laboratory accredited under NELAP, or other appropriate certification, for the tests to be performed or with a laboratory that meets applicable statutory and requirements for performing the tests and submitting the results of tests performed. All subcontracted work shall be referenced and so noted in the final YORK analytical report.

Subcontract laboratories will provide or make available, current copies of the following documents prior to YORK submitting samples. This information will be updated annually or on an as needed basis.

a) Laboratory accreditations / certifications

b) Upon request, any Proficiency Testing (PT) or Performance Evaluation (PE) results relevant to the

subcontracted samples.

c) Insurance Certificates

d) Quality Assurance Manual

e) Subcontract laboratories will also submit statements affirming that YORK will be notified if any of the following occur.

- There is a change or loss in accreditation for the applicable analysis.
- Most recent PT or PE study results for the applicable analysis are unacceptable *AND* are not able to be addressed via Corrective Action.
- There is a need to subcontract YORK project samples. Prior YORK approval is required in writing for subcontracting samples.

f) The client project requirements will be used to evaluate the subcontract laboratories and to determine their acceptability. Approval by either: the QA Manager, Laboratory Manager or Client Services Director (or designee) is required.

g) A master list of approved laboratories will be created and distributed to Sample Control and all Project Managers. All subcontracting must utilize a laboratory from this list.

The procedure for subcontracting samples will follow these guidelines:

a) YORK will advise its client via written, facsimile or e-mail notification of its intention to subcontract any portion of the testing to another party in cases when unforeseen circumstances occur. YORK shall gain approval by the client in writing, facsimile or via e-mail response.

b) YORK may subcontract samples on a continuing basis without written, facsimile or e-mail notification under the following (but not limited to) cases:

- Standing Client direction or instruction
- Contractual specification or requirement
- Project historical precedent

c) A separate Chain of Custody will be created specifically for the subcontracted sample(s). This (or a copy) will be included with the full and complete subcontract report in the final YORK analytical report.

d) YORK shall retain records demonstrating that the above requirements have been met.

15.0 OUTSIDE SUPPORT SERVICES AND SUPPLIES

YORK does not procure outside services and supplies, other than those referred to in this Manual.

Service providers and vendors are evaluated in accordance with ISO/IEC 17025:2005 or ISO 9001 guidelines prior to use by YORK with detailed vendors listed in each SOP.

16.0 INQUIRIES AND COMPLAINTS

York's SOP addresses the policies and procedures for the resolution of inquiries and complaints received from clients or other parties about the laboratory's activities. Where an inquiry or complaint, or any other circumstance, raises doubt concerning the laboratory's compliance with the laboratory's policies or procedures, or with the requirements of this manual or otherwise concerning the quality of the laboratory's calibrations or tests, the laboratory shall ensure that those areas of activity and responsibility involved are promptly audited in accordance with NELAC Section 5.3.1. Records of the complaint and subsequent actions are maintained and are available for audits.

17.0 REVIEW OF WORK REQUESTS, CONTRACTS AND TENDERS

YORK has established procedures for the review of work requests contracts and tenders. Projects, proposals and contracts are reviewed for adequately defined requirements and the ability of YORK to meet those requirements. A thorough review of all technical and quality control requirements contained in these requests is performed to ensure a project's success. The appropriateness of requested methods, and the lab's capability to perform them must be established. A review of the laboratory's capability to analyze non-routine analytes is also part of this review process. Additionally, alternate test methods that are capable of meeting the clients' requirements may be proposed by the lab.

All projects, proposals and contracts are reviewed for the client's requirements in terms of compound lists, test methodology requested, detection and reporting levels, and quality control limits. During the review process, the laboratory determines whether it has the necessary physical, personnel and information resources to meet the project requirements, and if the personnel have the expertise needed to perform the required testing. Each proposal is also checked for its impact on the overall capacity of the laboratory. The proposed turnaround time will be checked for feasibility. Electronic or hard copy deliverable requirements are evaluated against the laboratory's ability to produce such documentation.

This review process ensures that the laboratory's test methods are suitable to achieve regulatory and/or client requirements and that the laboratory holds the appropriate certifications to perform the work. In the event that the use of a subcontract laboratory is needed, also confirming that they meet all project requirements and maintain the appropriate certifications for the proposed subcontract analyses. If the laboratory cannot provide all services and therefore intends to use the services of a subcontract laboratory, this will be documented and discussed with the client prior to project or contract approval.

Following the review process, the laboratory (Client Services) informs the client of the results of the review and notes any potential conflict, lack of accreditation, or inability of the lab to complete the work satisfactorily. Any discrepancy between the client's requirements and the capability of the laboratory to meet those requirements is resolved in writing before acceptance of the project or contract. It is necessary that the project requirements or contract be acceptable to both the client and the laboratory prior to the start of the work. The review process is repeated when there are amendments to the original contract by the client.

All contracts, Quality Assurance Project Plans (QAPPs), contract amendments, and documented communications become part of the project record.

Review Personnel

Depending upon the scope of a project or contract, one or more key persons may review and accept work on behalf of the laboratory. For routine projects, a review by the Project Manager (PM) is considered adequate. The PM confirms that the laboratory has the necessary certifications, that it can meet the clients' data quality, reporting and turn-around time requirements.

For new, complex or large projects, the proposed project proposal or contract is given to the Business Development Director and/or Client Services Director for an initial review that encompasses all facets of the operation. The scope of work is then distributed to the following personnel, as needed based on scope of contract, to evaluate all of the project related requirements:

- Chief Technology Officer
- Laboratory Manager
- Technical Director (s)
- Quality Assurance Officer
- Group Leaders
- Project Manager(s)

Appropriate records are maintained for every contract or work request. Copies of the agreed-upon contract will be distributed to key personnel as needed and the signed copies maintained by the Business Development Director and/or Laboratory Manager(s).

Project Kick-off and Status Meetings

For routine project work, project managers ensure that specific technical and QC requirements are effectively evaluated and communicated to laboratory personnel through the use of the LIMS system: special requirements/Comments section in the appropriate work order field. These comments then appear on the lab staff worklists for implementation.

Prior to work on a new or complex project, project managers or key personnel will hold meetings via Zoom with operations personnel to discuss schedules and any unique aspects of the project. Items discussed include the project technical profile, turnaround times, holding times, methods, analyte lists, reporting limits, deliverables, sample hazards, and any other special requirements.

Project requirements are given to the laboratory staff during project kick-off meetings or the daily status meetings. Information disseminated during these meetings provides direction to the laboratory staff in order to maximize production, maintain high quality and ensure client satisfaction.

During the project, changes to the scope of work may occur due to client, sampling or regulatory reasons. If these changes impact the laboratory's role in the project (use of a non-standard method or modification of a method to comply with revised requirements) then the changes need to be discussed with and agreed upon with the client prior to continuing with the work. These changes must be documented prior to implementation and communicated to the laboratory staff via email, zoom meeting or via the Laboratory Manager.

And at all times, records of all pertinent discussions with a client relating to the project or contract are documented and maintained as a part of the project record using the "Other Documents" in the work Order LIMS field.

18.0 MANAGEMENT REVIEW, MANAGEMENT OF CHANGE AND CONTINUOUS IMPROVEMENT

Management Review

A comprehensive Management Review of the entire YORK Quality System will be conducted by the Laboratory Managers on an annual basis, no later than the end of the first quarter for the previous year's review. All major stakeholders will be given an opportunity to provide comment or input for the review. These will include:

- Chief Technology Officer
- Client Services Director
- Lab Managers
- Technical Directors
- Senior Project Managers
- Other Operational / Project Management personnel as appropriate.
- Clients

The purpose and goal of the Management Review will identify areas of improvement, areas requiring more resources or oversight, opportunities for continuous improvement and follow up on previous recommendations.

The final completed review is part of the NELAP laboratory documentation requirements and may be submitted to YORK authorized auditing agencies or clients upon request.

18.1 Management of Change

Whenever a change is made in a controlled environment (not just production) the laboratory is put at risk. However, one needs to constantly make changes to keep pace with business / regulatory requirements. The challenge to the laboratory is to minimize the risk and impact of that change.

An organization must have an operating process in place for which an evaluation has been conducted, and that allows proper lead times and approvals to ensure that the laboratory is unaffected when changes are made. But to successfully implement a change, one also needs to have a comprehensive understanding of the infrastructure that supports the services to determine the overall impact.

The Management of Change process will track and implement the following types of changes:

a) Permanent Change: – A change that is considered long term and durable. Any change which is not categorized as a Temporary Change.
b) Temporary Change: – A change which has a defined lifetime and which will be removed before a defined date (usually no more than six months).
c) Emergency Change: – An emergency change path that allows the change to be implemented and commissioned immediately in order to address an immediate safety, operational, health, environmental, or product quality situations.

The functional categories that will be managed include:

a) Laboratory Facility Acquisition
b) Laboratory Instrument Acquisition
c) Analytical Method Development and Validation
d) Laboratory Operations Process Change
e) Department Relocation
f) Activation of Analytical Method
g) Information Technology (Major Initiatives)
h) New Accreditation or Certification

18.2 Continuous Improvement

In order for YORK to be proactive and a leader in the industry, the entire YORK Quality system is designed to ensure the production of scientifically sound, legally defensible data of known and proven quality. The addition of the Management Review and Management of Change processes enhances YORK's ability to foster continuous improvement.

Continuous improvement is an ongoing effort to improve data integrity, services or processes. These efforts can seek "incremental" improvement over time or "breakthrough" improvement all at once. All staff at YORK participates in continuous improvement, from the Chief Technology Officer down to the beginning technician, as well as external stakeholders when applicable.

The following procedures / inputs have direct involvement in the continuous improvement process:

a) External Audits (Regulatory and Client Based)
b) Internal Audits
c) Corrective / Preventive Actions
d) Statistical Quality Control (SQC) Monitoring
e) Proficiency Testing Performance
f) Client Feedback – Complaints and Commendations
g) Management Review
h) Management of Change

The Management of Change process will guide and document the major improvements. The Corrective / Preventive Action procedure will enable and record the more incremental changes.
The principal elements are commitment to quality, focused effort, involvement of all employees, willingness to change, and communication.

NELAC APPENDICES

APPENDIX A - REFERENCES

NELAC Standards, Chapters 1-6., Effective July 01, 2016

40 CFR Part 136, Appendix A, paragraphs 8.1.1 and 8.2.

American Association for Laboratory Accreditation April 1996. General Requirements for Accreditation.

"American National Standards Speficiationn and Guidelines for Quality Systems for Environmental Data Collection and Environmental Technology Programs (ANSI/ASQC E-4)," 1994.

EPA 2185 - Good Automated Laboratory Practices, 1995 available at www.epa.gov/docs/etsdwe1/irm_galp/

EPA/600/3-89/013 Ecological Assessment of Hazardous Waste Sites, Office of Research and Development, Washington, DC, 1991.

EPA/503/8-91/001 Evaluation of Dredged Material Proposed for Ocean Disposal – Testing Manual. Office of Water, Washington, DC, 1991.

EPA/600/4-90/031 Manual for Evaluation of Laboratories Performing Aquatic Toxicity Tests, Office of Research and Development, Washington, DC, 1991.

EPA/600/3-88/029 Protocol for Short-term Toxicity Screening of Hazardous Wastes, Office of Research and Development, Washington, DC, 1991.

EPA/600/4-90/027F Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms, 4th Ed., Office of Research and Development, Washington, DC, 1993.

EPA/823/B-98/004 Evaluation of Dredged Material Proposed for Discharge in Waters of the U.S. – Inland Testing Manual. Office of Water, Washington, DC, 1994.

"Glossary of Quality Assurance Terms and Acronyms," Quality Assurance Division, Office of Research and Development, USEPA.

"Guidance on the Evaluation of Safe Drinking Water Act Compliance Monitoring Results from Performance Based Methods," September 30, 1994, Second draft.

ISO/IEC 17025: 2005. General requirements for the competence of calibration and testing laboratories. "

Manual for the Certification of Laboratories Analyzing Drinking Water, Revision 4, EPA 815-B-97-001.

Performance Based Measurement System, EPA EMMC Method Panel, PBMS Workgroup, 1996.

APPENDIX B - GLOSSARY

The following definitions are used in the text of Quality Systems. In writing this document, the following hierarchy of definition references was used: ISO 8402, ANSI/ASQC E-4, EPA's Quality Assurance Division Glossary of Terms, and finally definitions developed by NELAC. The source of each definition, unless otherwise identified, is the Quality Systems Committee.

Acceptance Criteria: Specified limits placed on characteristics of an item, process, or service defined in requirement documents. (ASQC)

Accreditation: The process by which an agency or organization evaluates and recognizes a laboratory as meeting certain predetermined qualifications or standards, thereby accrediting the laboratory. In the context of the National Environmental Laboratory Accreditation Program (NELAP), this process is a voluntary one. (NELAC)

Accrediting Authority: The Territorial, State, or Federal agency having responsibility and accountability for environmental laboratory accreditation and which grants accreditation. (NELAC) [1.5.2.3]

Accuracy: The degree of agreement between an observed value and an accepted reference value. Accuracy includes a combination of random error (precision) and systematic error (bias) components which are due to sampling and analytical operations; a data quality indicator. (QAMS)

Analysis Duplicate: The second measurement of the target analyte(s) performed on a single sample or sample preparation.

Analyst: The designated individual who performs the "hands-on" analytical methods and associated techniques and who is the one responsible for applying required laboratory practices and other pertinent quality controls to meet the required level of quality. (NELAC)

Analytical Reagent (AR) Grade: Designation for the high purity of certain chemical reagents and solvents given by the American Chemical Society. (Quality Systems)

Assessment: The evaluation process used to measure or establish the performance, effectiveness, and conformance of an organization and/or its systems to defined criteria (to the standards and requirements of NELAC). (NELAC)

Audit: A systematic evaluation to determine the conformance to quantitative and qualitative spYorkfications of some operational function or activity. (EPA-QAD)

Batch: Environmental samples, which are prepared and/or analyzed together with the same process and personnel using the same lot(s) of reagents. A **preparation batch** is composed of one to 20 environmental samples of the same NELAC-defined matrix, meeting the above-mentioned criteria and with a maximum time between the start of processing of the first and last sample in the batch to be 24 hours. An **analytical batch** is composed of prepared environmental samples (extracts, digestates or concentrates) which are analyzed together as a group. An analytical batch can include prepared samples originating from various environmental matrices and can exceed 20 samples. (NELAC Quality Systems Committee)

Blank: A sample that has not been exposed to the analyzed sample stream in order to monitor contamination during sampling, transport, storage or analysis. The blank is subjected to the usual analytical and measurement process to establish a zero baseline or background value and is sometimes used to adjust or correct routine analytical results. (ASQC)

Blind Sample: A sub-sample for analysis with a composition known to the submitter. The analyst/ laboratory may know the identity of the sample but not its composition. It is used to test the analyst's or laboratory's proficiency in the execution of the measurement process. (NELAC)

Calibration: To determine, by measurement or comparison with a standard, the correct value of each scale reading on a meter or other device. The levels of the applied calibration standard should bracket the range of planned or expected sample measurements. (NELAC)

Calibration Curve: The graphical relationship between the known values, such as concentrations, of a series of calibration standards and their instrument response. (NELAC)

Calibration Method: A defined technical procedure for performing a calibration. (NELAC)

Calibration Standard: A substance or reference material used to calibrate an instrument. (QAMS)

Certified Reference Material (CRM): A reference material one or more of whose property values are certified by a technically valid procedure, accompanied by or traceable to a certificate or other documentation which is issued by a certifying body. (ISO Guide 30 - 2.2)

Chain of Custody Form: A record that documents the possession of the samples from the time of collection to receipt in the laboratory. This record generally includes: the number and types of containers; the mode of collection; collector; time of collection; preservation; and requested analyses. (NELAC)

Compromised Samples: Those samples which are improperly sampled, insufficiently documented (chain of custody and other sample records and/or labels), improperly preserved, collected in improper containers, or exceeding holding times when delivered to a laboratory. Under normal conditions compromised samples are not analyzed. If emergency situations require analysis, the results must be appropriately qualified. (NELAC)

Confirmation: Verification of the identity of a component through the use of an approach with a different scientific principle from the original method. These may include, but are not limited to:

- Second column confirmation;
- Alternate wavelength;
- Derivatization;
- Mass spectral interpretation;
- Alternative detectors; or
- Additional cleanup procedures. (NELAC)

Conformance: An affirmative indication or judgment that a product or service has met the requirements of the relevant specifications, contract, or regulation; also the state of meeting the requirements. (ANSI/ ASQC E4-1994)

Corrective Action: The action taken to eliminate the causes of an existing nonconformity, defect or other undesirable situation in order to prevent recurrence. (ISO 8402)

Data Audit: A qualitative and quantitative evaluation of the documentation and procedures associated with environmental measurements to verify that the resulting data are of acceptable quality (i.e., that they meet spYorkfied acceptance criteria). (NELAC)

Data Reduction: The process of transforming raw data by arithmetic or statistical calculations, standard curves, concentration factors, etc., and collation into a more useable form. (EPA-QAD)

Deficiency: An unauthorized deviation from acceptable procedures or practices, or a defect in an item. (ASQC)

Demonstration of Capability: A procedure to establish the ability of the analyst to generate acceptable accuracy. (NELAC)

Desorption Efficiency: The mass of target analyte recovered from sampling media, usually a sorbent tube, divided by the mass of target analyte spiked on to the sampling media expressed as a percentage. Sample target analyte masses are usually adjusted for the desorption efficiency. (NELAC)

Detection Limit: The lowest concentration or amount of the target analyte that can be identified, measured, and reported with confidence that the analyte concentration is not a false positive value. See Method Detection Limit. (NELAC)

Document Control: The act of ensuring that documents (and revisions thereto) are proposed, reviewed for accuracy, approved for release by authorized personnel, distributed properly and controlled to ensure use of the correct version at the location where the prescribed activity is performed. (ASQC)

Duplicate Analyses: The analyses or measurements of the variable of interest performed identically on two subsamples of the same sample. The results from duplicate analyses are used to evaluate analytical or measurement precision but not the precision of sampling, preservation or storage internal to the laboratory. (EPA- QAD)

Holding Times (Maximum Allowable Holding Times): The maximum times that samples may be held prior to analysis and still be considered valid or not compromised. (40 CFR Part 136)

Inspection: An activity such as measuring, examining, testing, or gauging one or more characteristics of an entity and comparing the results with specified requirements in order to establish whether conformance is achieved for each characteristic. (ANSI/ ASQC E4-1994)

Internal Standard: A known amount of standard added to a test portion of a sample as a reference for evaluating and controlling the precision and bias of the applied analytical method. (NELAC)

Instrument Blank: A clean sample (e.g., distilled water) processed through the instrumental steps of the measurement process; used to determine instrument contamination. (EPA-QAD)

Laboratory: A body that calibrates and/or tests. (ISO 25)

Laboratory Control Sample (however named, such as laboratory fortified blank, spiked blank, or QC check sample): A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes. It is generally used to establish intra-laboratory or analyst-spYorkfic prYorksion and bias or to assess the performance of all or a portion of the measurement system. (NELAC)

Laboratory Duplicate: Aliquots of a sample taken from the same container under laboratory conditions and processed and analyzed independently. (NELAC)

Limit of Detection (LOD): Limit of Detection (LOD): The smallest concentration of a substance that must be present in a sample in order to be detected at the DL with 99% confidence. At the LOD, the false negative rate (Type II error) is 1%. (NELAC)

Limit of Quantitation (LOQ): The smallest concentration that produces a quantitative result with known and recorded precision and bias. (NELAC)

Manager (however named): The individual designated as being responsible for the overall operation, all personnel, and the physical plant of the environmental laboratory. A supervisor may report to the manager. In some cases, the supervisor and the manager may be the same individual. (NELAC)

Matrix: The component or substrate that contains the analyte of interest. For purposes of batch and QC requirement determinations, the following matrix distinctions shall be used:

- Aqueous: Any aqueous sample excluded from the definition of Drinking Water matrix or Saline/Estuarine source. Includes surface water, groundwater, effluents, and TCLP or other extracts.
- Drinking Water: Any aqueous sample that has been designated a potable or potential potable water source.
- Non-aqueous Liquid: Any organic liquid with <15% settleable solids.
- Solids: Includes soils, sediments, sludges and other matrices with >15% settleable solids.
- Chemical Waste: A product or by-product of an industrial process that results in a matrix not previously defined.
- Air: Whole gas or vapor samples including those contained in flexible or rigid wall containers.

Matrix Spike (spiked sample or fortified sample): A sample prepared by adding a known mass of target analyte to a specified amount of matrix sample for which an independent estimate of target analyte concentration is available. Matrix spikes are used, for example, to determine the effect of the matrix on a method's recovery efficiency.

Matrix Spike Duplicate (spiked sample or fortified sample duplicate): A second replicate matrix spike prepared in the laboratory and analyzed to obtain a measure of the precsion of the recovery for each analyte.

May: Denotes permitted action, but not required action. (NELAC)

Method Blank: A sample of a matrix similar to the batch of associated samples (when available) that is free from the analytes of interest and is processed simultaneously with and under the same conditions as samples through all steps of the analytical procedures, and in which no target analytes or interferences are present at concentrations that impact the analytical results for sample analyses. (NELAC)

Method Detection Limit: The minimum concentration of a substance (an analyte) that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte. (40 CFR Part 136 Appendix B)

Must: Denotes a requirement that must be met.

National Accreditation Database: The publicly accessible database listing the accreditation status of all laboratories participating in NELAP. (NELAC)

National Environmental Laboratory Accreditation Conference (NELAC): A voluntary organization of State and Federal environmental officials and interest groups purposed primarily to establish mutually acceptable standards for accrediting environmental laboratories. A subset of NELAP. (NELAC)

National Environmental Laboratory Accreditation Program (NELAP): The overall National Environmental Laboratory Accreditation Program of which NELAC is a part. (NELAC)

Negative Control: Measures taken to ensure that a test, its components, or the environment do not cause undesired effects, or produce incorrect test results. (NELAC)

Objective Evidence: Any documented statement of fact, other information, or record, either quantitative or qualitative, pertaining to the quality of an item or activity, based on observations, measures, or tests that can be verified. (ASQC)

Performance Audit: The routine comparison of independently obtained qualitative and quantitative measurement system data with routinely obtained data in order to evaluate the proficiency of an analyst or laboratory. (NELAC)

Performance Based Measurement System (PBMS): A set of processes wherein the data quality needs, mandates or limitations of a program or project are spYorkfied and serve as criteria for selecting appropriate test methods to meet those needs in a cost-effective manner. (NELAC)

Positive Control: Measures taken to ensure that a test and/or its components are working properly and producing correct or expected results from positive test subjects. (NELAC)

Precision: The degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves; a data quality indicator. Precision is usually expressed as standard deviation, variance or range, in either absolute or relative terms. (NELAC)

Preservation: Refrigeration and/or reagents added at the time of sample collection (or later) to maintain the chemical and/or biological integrity of the sample. (NELAC)

Proficiency Testing: A means of evaluating a laboratory's performance under controlled conditions relative to a given set of criteria through analysis of unknown samples provided by an external source. (NELAC) [2.1]

Proficiency Testing Program: The aggregate of providing rigorously controlled and standardized environmental samples to a laboratory for analysis, reporting of results, statistical evaluation of the results and the collective demographics and results summary of all participating laboratories. (NELAC)

Proficiency Test Sample (PT): A sample, the composition of which is unknown to the analyst and is provided to test whether the analyst/laboratory can produce analytical results within spYorkfied acceptance criteria. (QAMS)

Protocol: A detailed written procedure for field and/or laboratory operation (e.g., sampling, and analysis) which must be strictly followed. (EPA- QAD)

Pure Reagent Water: Shall be water (defined by national or international standard) in which no target analytes or interferences are detected as required by the analytical method. (NELAC)

Quality Assurance: An integrated system of activities involving planning, quality control, quality assessment, reporting and quality improvement to ensure that a product or service meets defined standards of quality with a stated level of confidence. (QAMS)

Quality Assurance (Project) Plan (QAPP): A formal document describing the detailed quality control procedures by which the quality requirements defined for the data and decisions pertaining to a specific project are to be achieved. (EPA-QAD)

Quality Control: The overall system of technical activities whose purpose is to measure and control the quality of a product or service so that it meets the needs of users. (QAMS)

Quality Control Sample: An uncontaminated sample matrix with known amounts of analytes from a source independent from the calibration standards. It is generally used to establish intra-laboratory or analyst specific precision and bias or to assess the performance of all or a portion of the measurement system. (EPA-QAD)

Quality Manual: A document stating the management policies, objectives, principles, organizational structure and authority, responsibilities, accountability, and implementation of an agency, organization, or laboratory, to ensure the quality of its product and the utility of its product to its users. (NELAC)

Quality System: A structured and documented management system describing the policies, objectives, principles, organizational authority, responsibilities, accountability, and implementation plan of an organization for ensuring quality in its work processes, products (items), and services. The quality system provides the framework for planning, implementing, and assessing work performed by the organization and for carrying out required QA and QC. (ANSI/ ASQC E-41994)

Quantitation Limits: Levels, concentrations, or quantities of a target variable (e.g., target analyte) that can be reported at a spYorkfic degree of confidence. (NELAC)

Range: The difference between the minimum and the maximum of a set of values. (EPA-QAD)

Raw Data: Any original factual information from a measurement activity or study recorded in a laboratory notebook, worksheets, records, memoranda, notes, or exact copies thereof that are necessary for the reconstruction and evaluation of the report of the activity or study. Raw data may include computer printouts and recorded data from automated instruments. If exact copies of raw data have been prepared.

Reagent Blank (method reagent blank): A sample consisting of reagent(s), without the target analyte or sample matrix, introduced into the analytical procedure at the appropriate point and carried through all subsequent steps to determine the contribution of the reagents and of the involved analytical steps. (QAMS)

Record Retention: The systematic collection, indexing and storing of documented information under secure conditions. (EPA-QAD)

Reference Material: A material or substance one or more properties of which are sufficiently well established to be used for the calibration of an apparatus, the assessment of a measurement method, or for assigning values to materials. (ISO Guide 30- 2.1)

Reference Method: A method of known and documented accuracy and prYorksion issued by an organization recognized as competent to do so. (NELAC)

Reference Standard: A standard, generally of the highest metrological quality available at a given location, from which measurements made at that location are derived. (VIM-6.08)

Reference Toxicant: The toxicant used in performing toxicity tests to indicate the sensitivity of a test organism and to demonstrate the laboratory's ability to perform the test correctly and obtain consistent results (see Chapter 5, Appendix D, Section 2.1.f). (NELAC)

Replicate Analyses: The measurements of the variable of interest performed identically on two or more sub-samples of the same sample within a short time interval. (NELAC)

Requirement: Denotes a mandatory specification; often designated by the term “shall”. (NELAC)

Sampling Media: Material used to collect and concentrate the target analytes(s) during air sampling such as solid sorbents, filters, or impinger solutions.

Selectivity: (Analytical chemistry) The capability of a test method or instrument to respond to a target substance or constituent in the presence of non-target substances. (EPA-QAD)

Sensitivity: The capability of a method or instrument to discriminate between measurement responses representing different levels (e.g., concentrations) of a variable of interest. (NELAC)

Shall: Denotes a requirement that is mandatory whenever the criterion for conformance with the specification requires that there be no deviation. This does not prohibit the use of alternative approaches or methods for implementing the specification so long as the requirement is fulfilled. (ANSI)

Should: Denotes a guideline or recommendation whenever noncompliance with the specification is permissible. (ANSI)

Spike: A known mass of target analyte added to a blank sample or sub-sample; used to determine recovery efficiency or for other quality control purposes. (NELAC)

Standard: The document describing the elements of laboratory accreditation that has been developed and established within the consensus principles of NELAC and meets the approval requirements of NELAC procedures and policies. (ASQC)

Standard Operating Procedure (SOP): A written document which details the method of an operation, analysis or action whose techniques and procedures are thoroughly prescribed and which is accepted as the method for performing certain routine or repetitive tasks. (QAMS)

Standardized Reference Material (SRM): A certified reference material produced by the U.S. National Institute of Standards and Technology or other equivalent organization and characterized for absolute content, independent of analytical method. (EPA-QAD)

Supervisor (however named): The individual(s) designated as being responsible for a particular area or category of scientific analysis. This responsibility includes direct day-to-day supervision of technical

employees, supply and instrument adequacy and upkeep, quality assurance/quality control duties and ascertaining that technical employees have the required balance of education, training and experience to perform the required analyses. (NELAC)

Surrogate: A substance with properties that mimic the analyte of interest. It is unlikely to be found in environment samples and is added to them for quality control purposes. (QAMS)

Systems Audit (also Technical Systems Audit): A thorough, systematic, qualitative on-site assessment of the facilities, equipment, personnel, training, procedures, record keeping, data validation, data management, and reporting aspects of a total measurement system. (EPA-QAD)

Technical Director: Individual(s) who has overall responsibility for the technical operation of the environmental testing laboratory. (NELAC)

Test: A technical operation that consists of the determination of one or more characteristics or performance of a given product, material, equipment, organism, physical phenomenon, process or service according to a specified procedure. The result of a test is normally recorded in a document sometimes called a test report or a test certificate. (ISO/IEC Guide 2-12.1, amended)

Test Method: An adoption of a scientific technique for a specified measurement problem, as documented in a laboratory SOP. (NELAC)

Testing Laboratory: Laboratory that performs tests. (ISO/ IEC Guide 2 - 12.4)

Test Sensitivity/Power: The minimum significant difference (MSD) between the control and test concentration that is statistically significant. It is dependent on the number of replicates per concentration, the selected significance level, and the type of statistical analysis (see Chapter 5, Appendix D, Section 2.4.a). (NELAC)

Traceability: The property of a result of a measurement whereby it can be related to appropriate standards, generally international or national standards, through an unbroken chain of comparisons. (VIM - 6.12)

Validation: The process of substantiating specified performance criteria. (EPA- QAD)

Verification: Confirmation by examination and provision of evidence that spYorkfied requirements have been met. (NELAC)

NOTE: In connection with the management of measuring equipment, verification provides a means for checking that the deviations between values indicated by a measuring instrument and corresponding known values of a measured quantity are consistently smaller than the maximum allowable error defined in a standard, regulation or specification peculiar to the management of the measuring equipment.

The result of verification leads to a decision either to restore in service, to perform adjustment, to repair, to downgrade, or to declare obsolete. In all cases, it is required that a written trace of the verification performed shall be kept on the measuring instrument's individual record.

Work Cell: A well-defined group of analysts that together perform the method analysis. The members of the group and their specific functions within the work cell must be fully documented. (NELAC)

Sources:

- American Society for Quality Control (ASQC), Definitions of Environmental Quality Assurance Terms, 1996
- American National Standards Institute (ANSI), Style Manual for Preparation of Proposed American National Standards, Eighth Edition, March 1991
- International Standards Organization (ISO) Guides 2, 30, 8402
- International Vocabulary of Basic and General Terms in Metrology (VIM): 1984. Issued by BIPM, IEC, ISO
- National Institute of Standards and Technology (NIST)
- 40 CFR Part 31

APPENDIX C - DEMONSTRATION OF CAPABILITY

C.1 PROCEDURE FOR DEMONSTRATION OF CAPABILITY

A demonstration of capability (DOC) must be made prior to using any test method, and at any time there is a change in instrument type, personnel or test method. (See NELAC 10.2.1.)

Note: Where tests are performed by specialized "work cells" (a well-defined group of analysts that together perform the method analysis), the work cell as a unit meets the above criteria and this demonstration is fully documented.

In general, this demonstration does not test the performance of the method in real world samples, but in the applicable and available clean matrix (a sample of a matrix in which no target analytes or interferences are present at concentrations that impact the results of a specific test method), e.g., water, solids and air. However, before any results are reported using this method, actual sample spike results may be used to meet this standard, i.e., at least four consecutive matrix spikes within the last twelve months. In addition, for analytes that do not lend themselves to spiking, e.g., TSS, the demonstration of capability may be performed using quality control samples.

All demonstrations shall be documented through the use of the form in this appendix.

The following steps, which are adapted from the EPA test methods published in 40 CFR Part 136, Appendix A, are performed if required by mandatory test method or regulation. Note: For analytes for which spiking is not an option and for which quality control samples are not readily available, the 40 CFR approach is one way to perform this demonstration. The laboratory documents that other approaches to DOC are adequate, and this is documented in the laboratory's Quality Manual.

a) A quality control sample is obtained from an outside source. If not available, the QC sample may be prepared by the laboratory using stock standards that are prepared independently from those used in instrument calibration.

b) The analyte(s) is diluted in a volume of clean matrix sufficient to prepare four aliquots at the concentration specified, or if unspecified, to a concentration approximately 10 times the method-stated or laboratory-calculated method detection limit.

c) At least four aliquots are prepared and analyzed according to the test method either concurrently or over a period of days.

d) Using all of the results, the mean recovery ($\overline{X}$) is calculated in the appropriate reporting units (such as µg/L) and the standard deviations of the population sample (n-1) (in the same units) for each parameter of interest. When it is not possible to determine mean and standard deviations, such as for presence/absence and logarithmic values, the laboratory will assess performance against established and documented criteria.

e) Compare the information from (d) above to the corresponding acceptance criteria for precision and accuracy in the test method (if applicable) or in laboratory-generated acceptance criteria (if there are no established mandatory criteria). If all parameters meet the acceptance criteria, the analysis of actual samples may begin. If any one of the parameters do not meet the acceptance criteria, the performance is unacceptable for that parameter.

f) When one or more of the tested parameters fail at least one of the acceptance criteria, the analyst must proceed according to 1) or 2) below.

1) Locate and correct the source of the problem and repeat the test for all parameters of interest beginning with c) above.

2) Beginning with c) above, repeat the test for all parameters that failed to meet criteria. Repeated failure, however, will confirm a general problem with the measurement system. If this occurs, locate and correct the source of the problem and repeat the test for all compounds of interest beginning with c).

C.2 CERTIFICATION STATEMENT

The following certification statement shall be used to document the completion of each demonstration of capability. A copy of the certification statement shall be retained in the personnel records of each affected employee (see YORKQSM Section 6.3 and 12.3.4.b.).

Demonstration of Capability
Certification Statement

Date: Page of ___
Laboratory Name:
Laboratory Address:
Analyst(s) Name(s):

Matrix: _____
Examples: laboratory pure water, soil, air, solid)

Method number, SOP#, Rev #, and Analyte, or Class of Analytes or Measured Parameters:
_____ (examples: barium by 200.7, trace metals by 6010, benzene by 8021, etc.)

We, the undersigned, CERTIFY that:

1. The analysts identified above, using the cited test method(s), which is in use at this facility for the analyses of samples under the National Environmental Laboratory Accreditation Program, have met the Demonstration of Capability.

2. The test method(s) was performed by the analyst(s) identified on this certification.

3. A copy of the test method(s) and the laboratory-specific SOPs are available for all personnel on-site.

4. The data associated with the demonstration capability are true, accurate, complete and self-explanatory (1).

5. All raw data (including a copy of this certification form) necessary to reconstruct and validate these analyses have been retained at the facility, and that the associated information is well organized and available for review by authorized assessors.

Technical Director's Name and Title	Signature	Date
Quality Assurance Officer's Name	Signature	Date

This certification form must be completed each time a demonstration of capability study is completed.

(1) True: Consistent with supporting data.
Accurate: Based on good laboratory practices consistent with sound scientific principles/practices.
Complete: Includes the results of all supporting performance testing.
Self-explanatory: Data properly labeled and stored so that the results are clear and require no additional explanation.

(Note: Form may be modified so long as the essential items are included in the revised form)

APPENDIX D - ESSENTIAL QUALITY CONTROL REQUIREMENTS

The quality control protocols specified by the laboratory's method manual (10.1.2) shall be followed. The laboratory shall ensure that the essential standards outlined in Appendix D are incorporated into their method manuals.

All quality control measures shall be assessed and evaluated on an ongoing basis and quality control acceptance criteria shall be used to determine the validity of the data. The laboratory shall have procedures for the development of acceptance/rejection criteria where no method or regulatory criteria exists.

The requirements from the body of Chapter 5, e.g., Section 5.4, apply to all types of testing. The specific manner in which they are implemented is detailed in each of the sections of this Appendix, i.e., chemical testing.

D.1 CHEMICAL TESTING

D.1.1 Positive and Negative Controls

a) Negative Controls

1) Method Blanks - Shall be performed at a frequency of one per preparation batch of samples per matrix type. The results of this analysis shall be one of the QC measures to be used to assess the batch. The source of contamination must be investigated and measures taken to correct, minimize or eliminate the problem if

i) the blank contamination exceeds a concentration greater than 1/10 of the measured concentration of any sample in the associated sample batch or

ii) the blank contamination exceeds the concentration present in the samples and is greater than 1/10 of the specified regulatory limit.

Any sample associated with the contaminated blank shall be reprocessed for analysis or the results reported with appropriate data qualifying codes.

b) Positive Controls

1) Laboratory Control Sample (LCS) - (QC Check Samples) Shall be analyzed at a minimum of 1 per preparation batch of 20 or less samples per matrix type, except for analytes for which spiking solutions are not available such as total suspended solids, total dissolved solids, total volatile solids, total solids, pH, color, odor, temperature, dissolved oxygen or turbidity. The results of these samples shall be used to assess the batch. NOTE: The matrix spike (see 2 below) may be used in place of this control as long as the acceptance criteria are as stringent as for the LCS.

a. The NELAC requirements (2009 Standard, Section 1.7.4.2 b) allow the usage of LCS Marginal Exceedance control limits for those analyses with multiple reporting analytes.

b. The NELAC standards state that if a large number of analytes are in the LCS, it becomes statistically likely that a few will be outside control limits. This may not indicate that the system is out of control; therefore, corrective action may not be necessary. Upper and lower marginal exceedance (ME) limits can be established to determine when corrective action is necessary. ME is defined as being beyond the LCS control limit but within the ME limits. ME limits are between 3 and 4 standard deviations around the mean.

c. The number of allowable marginal exceedance is based on the number of analytes in the LCS. If there is any analyte that exceed the LCS control limits, it does not necessary mean the LCS fails. The NELAC standard states if the number of analytes fails LCS control limits but is within the ME limits, it is acceptable.

2) Matrix Spikes (MS) - Shall be performed at a frequency of one out of every 20 samples per matrix type prepared over time, except for analytes for which spiking solutions are not available such as, total suspended solids, total dissolved solids, total volatile solids, total solids, pH, color, odor, temperature, dissolved oxygen or turbidity. The selected sample(s) shall be rotated among client samples so that various matrix problems may be noted and/or addressed. Poor performance in a matrix spike may indicate a problem with the sample composition and shall be reported to the client whose sample was used for the spike.

3) Surrogates - Surrogate compounds must be added to all samples, standards, and blanks, for all organic chromatography methods except when the matrix precludes its use or when a surrogate is not available. Poor surrogate recovery may indicate a problem with the sample composition and shall be reported to the client whose sample produced the poor recovery.

4) If the mandated or requested test method does not specify the spiking components, the laboratory shall spike all reportable components to be reported in the Laboratory Control Sample and Matrix Spike. However, in cases where the components interfere with accurate assessment (such as simultaneously spiking chlordane, toxaphene, and PCBs in Method 608), the test method has an extremely long list of components or components that are incompatible, a representative number (minimum of 10%) of the listed components may be used to control the test method. The selected components of each spiking mix shall represent all chemistries, elution patterns and masses, permit-specified analytes, and other client-requested components. However, the laboratory shall ensure that all reported components are used in the spike mixture within a two-year time period.

D.1.2 Analytical Variability/Reproducibility

Matrix Spike Duplicates (MSDs) or Laboratory Duplicates - Shall be analyzed at a minimum of 1 in 20 samples per matrix type per sample extraction or preparation method. The laboratory shall document its procedure to select the use of appropriate type of duplicate. The selected sample(s) shall be rotated among client samples so that various matrix problems may be noted and/or addressed. Poor performance in the duplicates may indicate a problem with the sample composition and shall be reported to the client whose sample was used for the duplicate.

D.1.3 Method Evaluation

In order to ensure the accuracy of the reported result, the following procedures shall be in place:

a) Demonstration of Analytical Capability - (Section 10.5) shall be performed initially (prior to the analysis of any samples) and with a significant change in instrument type, personnel, matrix or test method.

b) Calibration - Calibration protocols specified in Section 9.4 shall be followed.

c) Proficiency Test Samples - The results of such analyses (4.2.j or 5.3.4) shall be used by the laboratory to evaluate the ability of the laboratory to produce accurate data.

D.1.4 Analytical Measurement Uncertainty Estimation

Uncertainty is “a parameter associated with the result of a measurement, that characterizes the dispersion of the values that could reasonably be attributed to the measurand” (as defined by the International Vocabulary of Basic and General Terms in Metrology, ISO Geneva, 1993, ISBN 92-67-10175-1).

Uncertainty is not error. Error is a single value, the difference between the true result and the measured result. For environmental samples, the true result is never known. The measurement is the sum of the unknown true value and the unknown error.

Unknown error is a combination of systematic error, or bias, and random error. Bias varies predictably, constantly, and independently from the number of measurements. Random error is unpredictable, assumed to have a Gaussian distribution, and be reducible by increasing the total number of measurements.

Knowledge of the uncertainty of a measurement provides additional confidence in the validity of a result as its value accounts for all the factors which could possibly affect the result. Certain test methods will specify limits to the values of sources of uncertainty of measurement (EPA 500 series methods, etc.) and will specify the

form of presentation of calculated results.

When the method makes these stipulations, there is no need to provide a mechanism for calculating the uncertainty. Where this information is not provided within a method or other regulatory device, the uncertainty associated with results generated by the laboratory can be determined by using the Laboratory Control Sample (LCS) accuracy range for a given analyte because LCS recoveries incorporate all of the laboratory-related variables associated with a given test over time. It is recognized that other approaches exist; however, YORK's standard for estimating analytical data uncertainty uses this approach.

D.1.4.1 Using the Laboratory Control Sample (LCS) to Estimating Analytical Uncertainty

a) The estimated measurement uncertainty can be expressed as a range (±) around the reported analytical results at a specified confidence level. For methods that use statistically-derived LCS control limits based on historical LCS recovery data to assess the performance of the measurement system, these limits are considered an estimate of the minimum laboratory contribution to measurement uncertainty at a 99% confidence interval, The percent recovery of the LCS is compared either to the method-required LCS accuracy limits or to the statistical, historical, in-house LCS accuracy limits.

- Uncertainty values may be reported for specific projects upon request. In absence of alternate client-specified approaches or confidence levels,

  YORK will use the following procedure:

  To calculate the uncertainty value of a reported analytical result, the lower uncertainty range value is calculated by subtracting the product of the result and the lower LCS percent recovery from the result; and the upper uncertainty value result is calculated by adding the product of the result and the upper LCS percent recovery.

  These calculated values represent approximately a 99% confidence level. In other words, approximated 99% of the measured values for the analyte will fall within this calculated range.

- Example: If the reported result is 1.0 mg/l, and the LCS percent recovery range is 75 to 125%. The uncertainty range would be 0.75 to 1.25 mg/l, which could also be written as 1.0 +/- 0.25 mg/l.

- The Laboratory Quality and Accreditation Office has made available to the public both a spreadsheet that calculates analytical measurement uncertainty and an SOP describing how to use it. This SOP applies to test methods that are within the scope of ISO/IEC 17025-1999 Standard: General Requirements for the Competence of Testing and Calibration Laboratories and it is based on the general rules outlined in Guide to the Expression of Uncertainty in Measurement (GUM).

  The spreadsheet provides a QC-based nested approach for estimating measurement uncertainty using laboratory generated calibration and QC spike results

D.1.4.2 Additional Components to Estimating Analytical Uncertainty

When estimating analytical measurement uncertainty, all significant components of uncertainty must be identified and quantified. Components that affect analytical measurement uncertainty include sampling, handling, transport, storage, preparation and testing. A typical environmental laboratory will have the greatest contribution to uncertainty in the storage, preparation and testing portion of the analytical train, hence the estimation can be limited to those three areas, assuming all other factors are within recommended guidelines for sample size, container type, preservation (chemical, temperature, temporal) and handling/transport. If the latter are *NOT* within guidelines then these additional estimations of variability must be accounted for, and may supersede the laboratory contribution to uncertainty.

Definitive references and procedural manuals for calculating Analytical Measurement Uncertainty are listed below. Note that there are different theories on the "best" way to estimate uncertainty, it is up to the end user to determine that which best meets their project needs.

a) "Environmental Analytical Measurement Uncertainty Estimation – Nested Hierarchical Approach", William Ingersoll, Defense Technical Information Center # ADA396946, 2001

b) "Quantifying Uncertainty in Analytical Measurement", EuraChem / CITAC Guide CG 4, Second Edition, QUAM 2000.1

c) "Quantifying Measurement Uncertainty in Analytical Chemistry – A Simplified Practical Approach", Thomas W. Vetter, National Institute of Standards and Technology

d) ISO Guide to the Expression of Uncertainty in Measurement (GUM), 1993

e) "Estimation of Analytical Measurement Uncertainty - Laboratory Quality and Accreditation Office Uncertainty Calculator Standard Operating Procedure. Downloaded from http://www.denix.osd.mil/edqw/upload/UNCERTAINTY-SOP.PDF , 2013

f) QC-based Nested Approach for Estimating Measurement Uncertainty Spreadsheet, Microsoft Excel Spreadsheet, Ingersoll, William Stephen, 2002

The process in general involves the following steps:

1. Specify the Measurand – Write down a clear statement of what is being measured, including the relationship between the measurand and the input quantities, i.e., measured quantities, constants, calibration standard values, etc.

2. Identify uncertainty sources – This will include sources that contribute to the uncertainty on the parameters in the relationships identified in step 1, but may include other sources and must include sources arising from chemical assumptions.

3. Quantify uncertainty components – Measure or estimate the size of the uncertainty component associated with each potential source of uncertainty identified. It is often possible to estimate or determine a single contribution to uncertainty from the aggregate of multiple sources.

4. Calculate combined uncertainty – The information obtained in step 3 will consist of a number of quantified contributions to overall uncertainty, whether associated with individual sources or with the combined effects of several sources.

The process outlined above relates to the measurement of uncertainty for the preparative / analytical laboratory procedure. However, there are uncertainty contributions from other factors outside the preparative / analytical procedure. These can be controlled to a great extent by specifying uniform and standardized training or conditions.

Examples: Human Factors

a) All personnel at YORK undergo documented training in the method and / or instrument used. Minimum levels of education or experience are required.

b) Initial and continuing Demonstrations of Capability (DOC) must be performed and documented prior to and in continuance of analytical work related to their areas of responsibilities.

c) Blind Proficiency Testing samples are analyzed twice a year to gauge each department, matrix and method.

d) Data Integrity and Ethics Training are provided to new employees and on an annual basis to all employees.

Accommodation and Environmental Conditions

a) YORK has standardized operating procedures for transport, storage and tracking of samples, extracts and digests throughout the laboratory. All incoming orders are logged into a Laboratory Information System that assigns a specific identifier code to each work order, sample container and analytical result.

b) The sample control areas are secured with restricted access using card key portals. Internal chain of custody is available if the project requires.
c) The laboratory has over 13,000 sq ft of laboratory space with temperature controlled and air positive or negative environmental controls.

d) Regular safety inspections are performed to identify potentially hazardous conditions and to ensure general cleanliness.

Environmental Test Methods and Method Validation

a) All methods in use have Standard Operating Procedures (SOPs) based upon published methods from the EPA, ASTM, Standard Methods or other established body. These are controlled documents assigned to each department. An annual review is performed.

b) Each method has internal and external quality control criteria for preparative efficiency, instrument performance, calibration, continuing method performance and possible matrix effects as appropriate.

c) Ongoing Proficiency Testing program.

Equipment and Instrumentation

a) Each instrument in use has performance parameters that must be evaluated to specific standards based on the established method prior to any analytical use.

b) Routine and preventative maintenance is performed to maintain optimum operational performance.

c) Complex instrument systems are covered under manufacturer service contracts as appropriate.
Measurement Traceability

a) Every reagent used must meet the indicated purity and fitness for usage as referenced in the method SOPs.

b) All calibration standards are certified by the manufacturer to meet or exceed purity levels as recorded in the accompanying Certificate of Traceability to NIST or other standards verification.

c) Each reagent, standard or working standard is recorded, assigned a tracking identifier. This is referenced in the analytical log book as needed to assure traceability to the original source.

d) All Balances, Dispensers, Pipettors, Refrigerators, Freezers and Thermometers are checked on a daily or other routine basis to specified tolerances.

D.1.5 Detection Limits

The laboratory shall utilize a test method that provides a detection limit that is appropriate and relevant for the intended use of the data. Detection limits shall be determined by the protocol in the mandated test method or applicable regulation, e.g., Reporting Limit and or Method Detection Limit (MDL). If the protocol for determining detection limits is not specified, the selection of the procedure must reflect instrument limitations and the intended application of the test method.

a) A detection limit study is not required for any component for which spiking solutions or quality control samples are not available such as temperature.

b) The detection limit shall be initially determined for the compounds of interest in each test method in a matrix in which there are not target analytes nor interferences at a concentration that would impact the results or the detection limit must be determined in the matrix of interest (see definition of matrix).

c) Detection limits must be determined each time there is a change in the test method that affects how the test is performed, or when a change in instrumentation occurs that affects the sensitivity of the analysis.

d) All samples processing steps of the analytical method shall be included in the determination of the detection limit.

e) All procedures used must be documented. Documentation must include the matrix type. All supporting data must be retained.

f) The laboratory must have established procedures to relate detection limits with quantitation limits.

g) The test method's quantitation limits must be established and must be above the detection limits.

D.1.6 Data Reduction

The procedures for data reduction, such as use of linear regression or Quadratic regression shall be documented.

D.1.7 Quality of Standards and Reagents

a) The source of standards shall comply with 9.3.

b) Reagent Quality, Water Quality and Checks:

1) Reagents - In methods where the purity of reagents is not specified, analytical reagent grade (ACS) shall be used. Reagents of lesser purity than those specified by the test method shall not be used. The labels on the container should be checked to verify that the purity of the reagents meets the requirements of the particular test method. Such information shall be documented.

2) Water - The quality of water sources shall be monitored and documented and shall meet method specified requirements.

3) The laboratory will verify the concentration of titrants in accordance with written laboratory procedures.

D.1.8 Selectivity

a) Absolute retention time and relative retention time aid in the identification of components in chromatographic analyses and to evaluate the effectiveness of a column to separate constituents. The laboratory shall develop and document acceptance criteria for retention time windows.

b) The laboratory shall document acceptance criteria for mass spectral tuning.

D.1.9 Constant and Consistent Test Conditions

a) The laboratory shall assure that the test instruments consistently operate within the specifications required of the application for which the equipment is used.

b) Glassware Cleaning - Glassware shall be cleaned to meet the sensitivity of the test method.

Any cleaning and storage procedures that are not specified by the test method shall be documented in laboratory records and SOPs.

D.1.10 Method Validation – Modified Procedures, Non-Standard Methods, Additional Analytes

Often times, modifications to published methods are promulgated to allow the laboratory flexibility, increased productivity and, in some cases, it allows for better hazardous waste management, all while maintaining the quality of the data generated. But, this cannot be done without following standard method validation procedures to guarantee that the results achieved from the modified version are equal to or greater than the actual published or routinely accepted method.

Validation procedures are done to make sure that the sensitivity and selectivity of the process is appropriate

for the method or analytes chosen. Interference checks are performed to show that the changes or additions will not contribute interferences to previous analytes or on-going processes. Accuracy and precsion requirements are established, or previously defined, and used to demonstrate the capability of an analyst to perform the method, initially and on-going.

In the event that a non-standard method (significantly modified or newly-developed) is needed to meet client requirements, the method specifications and how they impact the project requirements must be relayed to the client for approval prior to beginning work on project samples. The client must understand the limits of the method, why it was developed and when it will be used on their project samples, and they must agree to its use.

Any significantly modified or newly-developed method (including the addition of analytes to established procedures) must be fully defined in a Standard Operating Procedure. The validation must be performed by qualified personnel, using appropriate reagents, standards and equipment/instrumentation and that process must be documented. The following items must be performed (as applicable to the method) and the completed documentation with all raw data provided to the Laboratory Manager and QA Officer for review prior to granting approval for use. A new method cannot be put into production without Operations and QA approval. For situations where NELAP approval is being sought, the method cannot be used for client samples until the certification has been received from the State, unless approval is given by the client.

D.1.10.1 Significant Modification / New Method / Additional Analyte Documentation:

Prior to the acceptance of client samples for analysis, the following documentation, as applicable to the type of modification or method status, must be provided to both Operations and QA for review and approval.

1. Approved Standard Operating Procedure for Analytical or Preparation Processes. Include all related raw data for the SOP revision with the draft version.

    a) Modification of existing method: - Revised SOP with modifications clearly spelled out:

    b) New Method: - New SOP in NELAC format – QA will assign SOP number

    c) Additional Analytes: - Revised SOP with modifications clearly spelled out:

2. Method Detection Limit (MDL) Study: Compliant with 40CFR, Part 136.

    a) Include summary form and all raw data for the review

3. MDL Verification Standard spiked at 1-4x the MDL, or the level specified by the specific program or contract. Example: 1-2x the MDL, reference specific program requirements.

    b) Recovery within 30 -150%, or a minimum response distinguishable from the established instrument noise level.

4. Reporting Limit Verification (when an MDL verification is not performed)

    a) For analytical methods, reprocess the low calibration standard as percent recovery – recovery between 50% and 150% is acceptable.

    b) For extraction methods, or where required by project or program, spike a blank matrix at the 1 - 2 x t h e reporting limit and process through all steps of the procedure. Note the spike level and percent recoveries. Method defined control limits are used for recovery evaluation, or default recoveries between 40% and 160% if method defined limits are not available.

5. Tuning Check (as applicable to the method)

6. Degradation Check (as applicable to the method)

7. A Valid Initial Calibration and Verification

    a) Minimum of 5 sequential points, unless otherwise stated in the method or in-house SOP.

b) Low calibration standard at or below the Reporting/Quantitation Limit where required.

c) Initial Calibration Verification Standard

8. Retention Time Window Study where required by the method

9. Second Column Confirmation for all analytes (as applicable to the method)

10. Inter-element Correction (as applicable to the method)

11. Linear Range Study (as applicable to the method)

12. GCMS Spectral Profile(s) (as applicable to the method)

13. Interference Check – Method Blank

a) Analysis of a blank matrix that has gone through all related steps, preparation and /or analysis, as applicable.

14. Acceptable PT Sample required for all new analytes where NELAP accreditation is being sought.

a) At least one PT sample (preferably two) required for all new methods

b) Where a PT sample is not available, or accreditation is not needed, accuracy can be measured through the use of a second source standard.

c) Use Tap Water for drinking water only methods, tap or other clean water source for ground, surface, etc. methods

d) Local Soil sample or Ottawa sand for SW-846 methods (if applying for soil or soil/water)

15. Initial Demonstration of Capability (IDOC) per analyst

a) 4 LCS for each matrix, spiked with all associated new analytes – most acceptance criteria are in the methods, if none, use an initial recovery range of 40-160% and an RPD of 30%.

b) Non-Standard methods – Follow the procedure in the 2003 NELAC Standards, Chapter 5 appendix C.3.3 (b).

16. Certification / Approval from Regulatory Agency where available.

APPENDIX E – LIST OF CERTIFICATIONS, ACCREDITED METHODS AND ANALYTE CLASSES

To View all details click on our Dataport link below and log in
To request a user name and password please contact clientservices@yorklab.com

http://24.187.239.122/ElmntCC/DataPORT/LabCertifications

- **New York State Department of Health Lab Cert. No. 10854 (CT Lab)**
  - Volatiles Organics – soil, non-potable water, potable water
  - Semi-Volatiles Organics - soil, non-potable water
  - Pesticides, Herbicides, PCBs - soil, non-potable water
  - TPH-DRO, TPH-GRO - soil, non-potable water
  - Metals, including Mercury- soil, non-potable water, potable water
  - Wet Chemistry parameters - soil, non-potable water, potable water

- **New York State Department of Health Lab Cert. No. 12058 (NYC Lab)**
  - Volatiles Organics – soil, non-potable water
  - Volatile Organics- Air
  - PFAS – potable water

- **New Jersey Dept. of Environmental Protection Lab Cert. No. CT-005 (CT Lab)**
  - Volatiles Organics – soil, non-potable water
  - Semi-Volatiles Organics - soil, non-potable water
  - Pesticides, Herbicides, PCBs - soil, non-potable water
  - EPH, TPH-DRO, TPH-GRO - soil, non-potable water
  - Metals, including Mercury- soil, non-potable water
  - Wet Chemistry parameters - soil, non-potable water

- **New Jersey Dept. of Environmental Protection Lab Cert. No. NY-037 (NYC Lab)**
  - Volatiles Organics – soil, non-potable water
  - Volatile Organics - Air

- **Pennsylvania Environmental Protection Lab Cert. No. 68-04440 (CT Lab)**
  - Volatiles Organics – soil, non-potable water
  - Semi-Volatiles Organics - soil, non-potable water
  - Pesticides, Herbicides, PCBs - soil, non-potable water
  - TPH-DRO, TPH-GRO - soil, non-potable water
  - Metals, including Mercury- soil, non-potable water
  - Wet Chemistry parameters - soil, non-potable water

APPENDIX F – LIST OF PHYSICAL LOCATIONS

F.1 Main Laboratory

- 120 Research Drive Stratford, CT 06615
- 203-325-1371 Fax 203-357-0166
  - clientservices@yorklab.com

F.2 New York City Laboratory

- 132-02 89th Avenue Suite 217 Richmond Hill, NY 11418
- 203-325-1371 Fax 203-357-0166
  - clientservices@yorklab.com

F.3 New Jersey Service Center

- 94 Planten Avenue Prospect Park, NJ 07506
- 203-325-1371 Fax 203-357-0166
  - clientservices@yorklab.com

F.4 New York Executive Offices

- 50 Gedney Street Nyack, NY 10960
- 203-325-1371
  - clientservices@yorklab.com

APPENDIX G – LISTING OF MAJOR ANALYTICAL INSTRUMENTATION

Equipment & Instrumentation	*Year Acquired*	*Quantity*
Accelerated Solvent Extraction System-Buchi-Speed Extractor	2012	1
Automated Concentration Systems – Biotage TurboVap II and LV	2014, 2016, 2021	8
Balances, Analytical Mettler AT 200)	2003	1
Balance, Analytical (Sartorius E24-15)	2016	1
Balance, Analytical (S/P 120, ASP, Inc.)	2019	1
Balances-Scout and Radwag Pro top loaders	2008-2021	7
Balance, Top Loading (EC, Symmetry)	2010	1
Balance, Top Loading (ANDEJ)	2015-2016	3
Barometer (Airguide Model 211B)	1991	1
Centrifuges, low speed	2020,2021	3
Class S Weights, 10 mg to 100 g (Troemner, Inc.)	2008, 2012,2020	3
Clean_up System_Florisil/Alumina_ 12 Position (Supelco, Inc.)	1997	1
Cold Vapor Mercury Analysis System (Buck Scientific, Inc.)	2018	1
Computers –Data Server/LIMS Servers/E-mail server, Terminal Server	2021	6
Computers –Backup servers on site DATTO and off site-Hypervisor/cloud	2013, 2014, 2016,2021	6
Computers/Workstations (Various mfg.)	2008-2021	100
Conductance Meter, Field/Laboratory Model (YSI)	1999, 2021	2
Conductivity Meter (YSI)	2007	1
Dessicator, Stainless Steel, 1 CF (Boekel)	1999	2
Dessicator, Stainless Steel, 3 CF (Boekel)	1997, 2016	3
Diazomethane generator, Wheaton/Aldrich DIAZALD KIT	2002, 2005	2
Dispensing Pipet, 1.0 mL (Eppendorf, Inc.)	2001-2013	10
Dispensing Pipet, 5 mL_100 L (Eppendorf, Inc.)	2005-2013	10
Distillation System, Ammonia (Wheaton)	1997	9
Extraction Apparatus, Liquid_Liquid (Supelco, Inc.)	1995	5
Extractors, Zero Headspace TCLP	2013, 2015, 2018	25
Extraction systems, Automated SPE-Promochrom Technologies	2018, 2020	2
Eye Wash Station, Portable (Bel_Art, Inc.)	2001	1
Eyewash System (Speakman Company)	2004	1
Flash Point Apparatus (Pensky_Martin, Closed Cup)	2012	1
Furnace (Thermolyne Type 1500)	2005	2
Furnace, Muffle Furnace, 1.5 CF , Thermolyne	2010	1
Gas Chromatograph (HP 5890 ECD,FID ALS7673,HP ChemSta.)	1999	1
Gas Chromatograph (HP 5890 dual ECD dual ALS7673,HP ChemSta.)	2004, 2006,2013	7
Gas Chromatograph (HP 5890II,G.S.V.FPD,TCD	1995	1
Gas Chromatographs (HP 6890 dual ECD dual ALS7673,HP ChemSta.)	2015-2020	5
Gas Chromatograph (HP 5890 Dual Inj/Dual FID, HP Chem Sta.)	2011-2014	3

Equipment & Instrumentation	*Year Acquired*	*Quantity*
EST PT2 VOA analysis interface modules	2006	3
Gas Chromatograph/Mass Spectrometer/Data System (HP 6890 II/5973 / HP Chemstation)	2006-2020	12
Gas Chromatograph/Mass Spectrometer/Data System (HP 6890 II/5973/w/ ALS 7673,7683)	2009, 2016, 2020	9
Gas Chromatograph/Mass Spectrometer/Data System (HP 7890/5975 / HP Chemstation) (1 TO15 Air))-Queens Lab	2011, 2016	2
Gas Concentration System/Interface TO-15-ENTECH 7200 with 7016 autosampler and 3100 canister cleaning systems-	2011, 2016	2
Gas Dilution Systems (Environics Model 2000); Entech 3150-	2005, 2016	2
Gas Leak Detector (GM 21_250)-Helium detector; Restek	2001, 2016	2
Gas Regulators, Brass (Airco, Inc.)	Various	45
Gas Regulators, SS (Airco,Inc.)	Various	7
Heater (Lab_Line Multi Boil Heater No. 2090)	1994	1
Hot Plate (Corning PC_100 1 SF)	2001-2012	6
Hot Plate (Thermolyne Type 2200)	2010	1
Hot Plate/Stirrer (Cimarec 3, Thermolyne)	2011	1
Hot Plate/Stirrer (Corning PC_351)	2010	1
Hot Plate/Stirrer (Nuova II, Sybron/Nalge)	2010	1
Hot Plate/Stirrer (Thermolyne Cimarec 2)	2010	1
Hot Plate/Stirrer (Thermolyne Cimarec 3)	2012	1
HPLC/MS-MS- Agilent 1260/6470A triple Quad system w/ autosampler	2018	1
HPLC/MS-MS- Agilent 1290/6460C triple Quad system w/autosampler	2020	1
HPLC –Agilent 1100 with DAD/UV detectors	2014	1
Incubator, 20C, BOD (VWR 2005)	2005	2
Inductively Coupled Plasma/Mass Spectrometer (PE Nexion 350)	2020	1
Inductively Coupled Plasma/Mass Spectrometer (PE Nexion 2000)	2018	1
Inductively Coupled Plasma (PE7300 DV_Axial/Radial)	2016	1
Inductively Coupled Plasma (PE Avio 500_Axial/Radial)	2020	1
Ion Chromatograph Dionex 1100 with AS40 ALS-PeakNet 7 software; Dionex ICS 1500/AS 50ALS system Chromeleon data system	2012, 2016	2
Laboratory Hoods (Labconco, others)	Various	12
LIMS System- Promium Element/instrument interfaces	2010	1
Mercury Analysis Systems-Milestone DMA-80 Tricell Direct systems	2012, 2015	2
Microwave Digestion Systems- Milestone Ethos UP	2016, 2020	2
Microwave Extraction Systems-Milestone Ethos EXII	2020	2
Microwave Extraction system-Milestone Ethos EX	2017	1
Nitrogen/TKN Digestor-Westco Smart Digest system	2015	1
Oven, 5 CF (OF-02 TDS forced air oven)	2016	1
Oven, 3 CF (Baxter S/P Tempcon)	2001	1
Oven, 5 CF (Blue M)-drying oven	2005	1

Equipment & Instrumentation	*Year Acquired*	*Quantity*
Oven, Radiant Heat (Lab_Line Imperial II)	2001	1
Oxygen Meter/BOD Probe (VWR 122372)	2005, 2011	2
pH/ISE Meter, Portable (Orion Serial)	1999	1
pH Meter (Corning Model 10)	2004	1
pH Meter (Orion EA 940)	2006	1
pH Meter/Specific Ion Meter (Orion SA_720)	2004	1
Photocopier/Scanner (Image runner 5055)	2011	1
Printers (HP2055dn)	2005-2012	6
Printer Brother HL diff. models	2006-2012	5
Printer (HP LaserJet 4000N)	2005	4
Printer (Okidata Microline 320)	2004	1
Printer, Xerox Phaser 6300	2006	1
Pump, Liquid, Peristaltic, 4 gpm (Cole Parmer)	1999	1
Pump, Vacuum (GE)	1998	1
Pump, Vacuum (GE)	2004	1
Pumps, Personal Sampling (SKC & Gilian)	2001	6
Purge & Trap (Tekmar LCS 3000)	2001-2012	3
Purge & Trap autosampler systems-Archon 51/81 position samplers	2004-2012	6
Purge & Trap autosamplers-Encon Evolution	2013, 2014, 2016	5
P/T autosamplers-Centurion-EST	2015-2016	3
Reflux/Distillation Systems-cyanide	2004	8
Refrigeration Freezer (Kenmore)	2001,2018	4
Refrigerator (Sanyo)	2002, 2018	4
Refrigerator (Summit)	2002	1
Refrigerator, Walk-in custom design-CCI-350 ft2	2016	1
Refrigerator (Welbilt 1.5 C.F.)	2003, 2010	3
Refrigerator (Westinghouse)	2005	4
Refrigerator, 10 CF (Sears)	2008	1
Refrigerator, 14 CF (Gibson)	2009	5
Refrigerator(Sanyo,1.5 C.F.)	2003	2
Sample Concentrator (Supelco, Inc. Mini_VAP_6) and tubes	2001	1
Sample Concentrator (Zymak Turbo VAP II ZW8001)	2003	2
Sample Concentrator (Zymark Tubro VAP II ZW8001)	2004	1
Sample Concentrators (Zymark Turbo VAP II)	2005, 2016	3
SKALAR Flow injection Analyzer-NO3, NO2, NH3, o-PO4, TN, TOC	2010	1
Sonic Cleaning System (Branson 1200)	2010	1
Sonic Disruptor (Tekmar)	1997	3
Sonic Disruptor & Sound Enclosure (Heat Systems, Inc.)	2004	3
Sonic Disruptor Sound Chambers	1997-2004	3
Soxhlet Extraction Apparati/hot plates	2010	24
Specific Ion Electrode, Chloride (Orion)	2001	1
Specific Ion Electrode, Chlorine (Orion)	2004	1

Equipment & Instrumentation	*Year Acquired*	*Quantity*
Specific Ion Electrode, Flouride (Orion)	2005	1
Spectrophotometer (Bausch & Lomb Spectronic 2D0)	1995	1
Spectrophotometer, Visible (Milton_Roy, SPEC_20D)	2012	1
Stirrer, Gang, 6 Position (Phipps & Bird)	1994	1
Storage Cabinet (ACIDS)	2004	2
Storage Cabinet, Solvent, Safety (Justrite, Inc.)	2004	2
Summa Canisters, Restek, Entech, 6 liter	2000-2021	230
Summa Canister Flow controllers, 1 hr, 4 hr, 8 hr, 24 hr adjustable, Entech	2005-2014	125
TCLP Extraction Pressure Filtration System (Millipore)	2001, 2004	2
TCLP Extraction System (Millipore, Inc.)	2001	4
TCLP Rotator, 12 Position (Assoc. Design & Mfg 12)	2001, 2010, 2013	3
TCLP_ZHE Volatile Extraction System	2001-2012	20
Thermometers, NIST Traceable (ASP, Inc.)	2001, 2012	2
Thermometers, Various Ranges (ASP, Inc.)	1999-2012	10
Total Organic Carbon Analyzer-SKALAR	2010	1
Turbidity Meter (Lamotte)	2012	1
Vortex _ Genie SI)	1995	1
Water Bath (25_100C, ASP, Inc.)	1996	1
Water Purification System (Hydro Inc. RO/DI/Carbon)	2004, 2012	2
Hydrogen Generator, Parker Hannifan H2-500	2013	1
Generator, 200 KVA for full facility, Cummins Diesel	2020	1

APPENDIX D – LISTING OF CONTROLLED DOCUMENTS

SOP#	Description	SOP Name	Effective Date
	PFAS		
1	Preparation of Non-Potable Water and Soils for Target Per- and Polyfluorinated Alkyl Substances (PFAS) for analysis by LC-MS/MS	PFASExtr_AQ_S Rev 1.0	5/10/2019
2	Analysis of Target Per- and Polyfluorinated Alkyl Substances (PFAS) in Non-Potable Water and Soil by EPA Method 537 Modified using LC/MS-MS	PFAS_LCMSMS_MOD Rev. 1.1	2/13/2020
3	Analysis of Target Per- and Polyfluorinated Alkyl Substances (PFAS) in Potable Water by EPA Method 537.1 using HPLC/MS-MS	PFAS_ LCMSMS Rev 1.3	4/22/2021
	GC/MS-TO-15		
1	VOCs in AIR by EPA TO-14A/TO-15	GCMS AIR 111692-Rev 9.7	1/15/2019
2	Cleaning of Summa Canisters	SummaClean111507 Rev 1.4	1/15/2019
3	Calibration of Flow Controllers	FLOWCONT011312 Rev 1.3	1/15/2019
	GC/MS - Volatiles		
1	Volatile Organics using GC/MS	GCMS VOC 011700-Rev 3.6	1/21/2019
2	Volatile Organics in Drinking Water using GC/MS by EPA 524.2	GCMS VOC524.2 011700-Rev 2.0	12/7/2016
3	Soil Sampling Procedure by EPA method 5035A	GCMS VOC5035 060712-Rev 1.0	6/7/2012
4	Screening of Aqueous and Soil Samples for Volatile Compounds by Dynamic Headspace/GC/FID	VOASCREEN121615-Rev.1.1	11/17/2016
5	Determination of Gasoline Range Organics in Aqueous and Solid Samples by method 8015D	GC GROFID 022715-Rev. 1.2	3/27/2017

	GC/MS - Semi-volatiles		
1	Semi-Volatiles using GC/MS by EPA 8270C and 8270D	GCMS SVOC-Rev 3.3	4/20/2017
1	Semi-Volatiles using GC/MS by EPA 8270E	GCMS SVOC-Rev 3.4	8/24/2020
1	Analysis of 1,4-Dioxane by GC/MS/SIM by EPA method 8270E SIM with Isotope Dilution	SVOC-1,4-DIOX_ALL-01 Rev 1.4	8/28/2020
1	Analysis of 1,4-Dioxane by GC/MS/SIM by EPA method 522	SVOC-1,4-DIOXPW-01 Rev 1.1	2/9/2021

	Gas Chromatography		
1	PCBs using GC/ECD by EPA 8082	GC PCB-Rev 1.8	1/20/2021
2	TPH-DRO using GC/FID by EPA 8015D	GC TPHDRO 091009 Rev.1.7	6/28/2019
3	Pesticides (Chlorinated) using GC/ECD by EPA 8081	GC Pest 011799-Rev 1.9	12/11/2019
4	Herbicides using GC/ECD by EPA 8151A	GC Herb-Rev 1.7	1/21/2020
6	CT ETPH	GC ETPH 111704-Rev 1.7	11/9/2228
7	NJ EPH	GC NJEPH 031313-Rev 1.0	3/13/2013
8	EDB, DBCP	GC EDB,DBCP 102413-Rev 1.3	7/13/2019
	Extractions		
1	Herbicide Extraction of Solids	EXT Herb-Rev 1.7	6/17/2019
1a	Extraction of Chlorinated Herbicides from Aqueous Samples and TCLP extracts by EPA SW-846 Method 8151A	EXT AQ TCLP Herb- Rev 1.5	6/17/2019
2	UltraSonic Extraction of Solids [EPA 3550]	EXT SSVOC-Rev 2.8	8/14/2019

3	ASE Extraction of Solids [EPA 3545]	EXT SVOCASE-Rev 2.4	2/10/2017

4	Aqueous Extraction [EPA 3510C]	EXT AqSVOC -Rev 2.9	5/24/2016
5	Extraction Laboratory Glassware Washing Procedure	EXTGP052600Rev1.1	4/3/2012
6	Soxhlet Extraction of Solids for PCBs [3540C]	EXT PCBSox-Rev 1.2	9/6/2020
7	MA EPH Extraction from Waters and Soils	EXTMAEPHAQASE121207Rev2.0	10/22/2009
8	Spike and Surrogate Standard Preparation for Extractable Organics	EXT SVOCStds-Rev 1.3	5/31/2016
9	NJEPH Extraction from Waters and Soils	EXT NJEPH-Rev 1.1	1/15/2014
10	Extraction of Herbicides [SM 6640B]	EXT HerbSM-Rev 1.1	12/3/2014
11	Glycols Extraction with SPE Tubes	EXT GlyLL-Rev 1.1	7/13/2015
12	Extraction of Semi-Volatile Organic Compounds from Solid Samples using Microwave Assisted Extraction by SW-846 3546	EXT SSVOCMAE-Rev1.1	5/24/2016
12	Extraction of 1,4-Dioxane from Aqueous Samples using SPE by EPA Method 3535A	EXT AQ_1,4-DIOXANE	9/9/2020
Metals			
1	ICP/MS Analysis of Sample Digestates by EPA 200.8 and SW-846 6020A and B	ICPMS 080106-Rev1.8	6/16/2018
2	Preparation of Samples for Metals Analysis by ICP and ICP/MS by SW-846 3010A and 3050B	M SPrep 030695-Rev1.8	10/25/2017
3	ICP Analysis of Sample Digestates by EPA 200.7 and SW-846 6010C	M ICP 031195-Rev1.8	11/20/2017

3	ICP Analysis of Sample Digestates by EPA 6010D	M ICP 031195-Rev1.2	7/10/2018
4	Mercury by Cold Vapor Technique EPA SW-846 7470 annd 7471	M Hg 120998-Rev 1.8	3/27/2017
5	Mercury by Direct Technique EPA SW-846 7473	M Hg2-Rev 1.4	3/29/2018
6	Preparation of Samples for Metals Analysis by ICP and ICP/MS by SW-846 3015	M PrepMAD071715-Rev 1.1	11/20/2017
	Wet Chemistry		
1	Chemical Oxygen Demand	WC COD Rev 2.3	4/29/2014
2	TKN, Ammonia and TON	WC TKN-Rev. 1.8	5/4/2018
3	Reactivity-Cyanide	WC CNR-Rev 1.4	4/3/2018
4	Hexavalent Chromium	WC Cr+6-Rev 1.7	4/5/2018
5	Total Cyanide	WC CNT-Rev 1.9	1/10/2018
6	Reactivity-Sulfide	WC ReacSulf-Rev 1.5	4/3/2018
7	Alkalinity	WC T-Alk 022600-Rev 1.5	1/2/2015
8	Hexane Extactable Material (O&G)	WC HemGrav-Rev.1.8	6/8/2015
9	Ion Chromatography	WC IC-Rev2.2	4/4/2018
10	Biochemical Oxygen Demand (BOD)	WC BOD-Rev1.7	3/28/2017

11	TSS / VSS in Aqueous Samples	WC TSS-Rev1.7	5/10/2018
12	pH	WC pH-Rev1.9	4/3/2018
13	Total Phosphorous and Ortho-Phosphate	WC Phos 051000-Rev-1.7	7/3/2017
14	TCLP / SPLP Extraction	WC TCLPEX-Rev1.7	6/4/2018
15	Cyanide Amenable to Chlorination	WC CNA-Rev1.4	10/15/2014
16	Flash Point	WC FP-Rev1.5	1/5/2014
17	Methylene Blue Active Substances (MBAS)	WC MBAS-Rev1.4	7/18/2017
18	TS, VS, TDS in Aqueous Samples	WC TSTDS-Rev1.5	2/15/2016
19	Color	WC COLOR 04262010 Rev1.2	3/27/2017
20	Glassware Washing	WC GlassPrep 090299Rev2.1	12/16/2013
21	Total Phenols (low level)	WC PhenolsLL-Rev1.5	1/5/2014
22	Total Phenols	WC Phenols-Rev 1.6	5/18/2017

23	Conductivity	WCCond-Rev 1.3	1/5/2014
24	Turbidity	WC Turbidity-Rev 1.6	3/27/2017

25	TS, FS, VS and % Moisture in Solid Samples	WC TS%M 022912-Rev 1.2	4/5/2018
26	Extractable Organic Halogens (EOX) in Soil Samples	WC EOX 041112-Rev 1.2	11/9/2012
27	Total Organic Carbon (TOC) in Aqueous Samples	WC TOC Rev 1.3	10/7/2014
28	Oxidation-Reduction Potential (ORP)	WC ORP 031213-Rev 1.0	3/12/2013
29	Settleable Solids	WC SetSol-Rev 1.2	1/5/2014
30	Sulfide	WC Sulfide-Rev 1.1	1/5/2014
31	Chlorine Demand	WC Cl Demand-Rev 1.0	4/9/2014
32	TKN by Skalar	WC TKN SK- Rev 1.5	5/10/2018
33	Free Liquids	WC Free Liquids Rev 1.0	3/7/2016
	General Laboratory		
1	MDL Studies, Organics	GL MDL 113005-Rev.1.4	3/9/2018
2	Chemical Expiration Dates	GL ExpDt 041812 Rev1.0	4/18/2012
3	LOQ/LOD Determination and Verification	GL LODLOQ 122812-Rev 1.4	1/27/2017
4	Balance Calibration Check Procedure	GL Balance 082514-Rev 1.0	8/25/2014
	Sample Control		
1	Sample Control Procedures (Receipt, Log-in, Storage, Archival, Disposal)	SC Proc 011501-Rev 2.5	5/27/2015

2	Sample Handling and Chain-of-Custody for Sample Couriers	Couriers091207Rev1.1	3/25/2015
Administration			
1	Laboratory Safety and Health	ADMINSAFETY011600Rev1.1	11/13/2017
2	Purchasing	ADMIN Purchasing 043010-Rev1.2	4/11/2013
3	QC Review/Evaluation of Data	QC040202Rev1.2	9/28/2016
4	Education and Training in Ethics and Legal Responsibilities	ADMIN Ethics-Rev1.6	11/20/2017
5	Training of Personnel	ADMIN Training-Rev 1.4	9/4/2014
6	Manual Integration of Chromatographic Data	Admin Integration 091107 Rev. 2.3	9/27/2018
7	Laboratory Notebook Control and Use	ADMIN LabNote 091107-Rev 1.1	1/13/2013
8	Control of Records	ADMIN Records 043010-Rev 1.2	11/20/2017
9	Control of Nonconforming Work	QSP 4-9-1 Rev1.0	4/30/2010
10	Management Review	ADMINMGMTREVIEW043010Rev1.1	9/27/2016
11	Internal Quality Audit	ADMIN IntAudit 043010Rev 1.2	2/22/2017
12	Estimation of Uncertainty	ADMINESTUNCERT043010 rev 1.1	10/17/2014
13	Document Control	ADMINDOC043010Rev1.2	6/2/2012

14	Corrective/Preventive Action	ADMIN CorrAction 043010 Rev 1.2	6/15/2016
15	Complaints	COMPLAINTS043010 Rev. 1.1	9/12/2016
16	Review of Chromatographic Data for Detection of Manual Re-Integration Issues	SOP ADMINManINTReview04302010 Rev 1.0	4/30/2010
17	Additional Policies/Procedures	Additional Policies 05/07/10 Rev1.2	10/17/2014

18	EDDs and Reports for Client Connect	ADMIN REPORT100714 Rev1.0	9/16/2010
19	Preparation of CTDEP RCP Deliverables	ADMINRCPDELIVS Rev1.0	8/2/2010
19	Preparation , Documentation and Traceability of Standards within the Element LIMS	ADMIN_STDS031816 Rev 1.0	4/15/2016

END OF DOCUMENT

Nancy Weaver

Education

B.S., Chemistry, University of Colorado, Denver, Colorado

Certifications and Training

State of New York Department of Environmental Conservation certified Asbestos Inspector

40-Hour OSHA Hazardous Waste Training

8-Hour Health and Safety Supervisor Training for Hazardous Waste Operations

Relevant Experience

- More than 20 years combined laboratory, data validation and project management experience
- Experienced in writing Quality Assurance Project Plans (QAPPs), managing subcontracted analytical laboratories, performing laboratory audits, and analyzing samples in a laboratory.

Experience Overview

Ms. Weaver has over twenty years combined laboratory, data validation and project management experience. She is the President and co-founder of EDS and is responsible for the technical data review and validation of laboratory data. Ms. Weaver has performed data validation on thousands of data validation projects. She has extensive knowledge in applying the various regional and project specific data validation guidelines and QAPPs. Her experience also includes writing Quality Assurance Project Plans (QAPPs), managing subcontracted analytical laboratories, performing laboratory audits, participating in field sampling activities and analyzing samples in a laboratory.

Relevant Project Experience

Principal/Senior Chemist, Environmental Data Services, Inc., Williamsburg, Virginia, August 1994 - Present. As the Principal Chemist at Environmental Data Services, Inc., Ms. Weaver has provided Level IV data review on more than 6000 Sample Delivery Groups (SDGs) generated through site investigations and/or remediations. These SDGs have included every analytical fraction possible including VOC, SVOC, pesticides, PCBs, herbicides, DRO, GRO, dioxin/furans, PCB congeners, metals, wet chemistry and radiological parameters. Sample matrices include water, soil, sediment, wipe, concrete and air. The SDGs have included CLP data packages produced under the CLP SOWs and CLP-like data packages with samples analyzed under SW-864 methodologies. Sample quantities validated may reach upwards of 120,000 per fraction over the past 20 years. Ms. Weaver has been using the USEPA National Functional Data Validation Guidelines since 1993 and has provided Level IV (full) and Level III (cursory) validation. Specifically validated PCB congeners by EPA Method 1668 and dioxin/furans by EPA Method 1613 using the USEPA National Functional Guidelines, USEPA Region I and USEPA Region III data validation guidelines. Validated radiological parameters analyzed by alpha and gamma spectrometry using the USACE Kansas City and St. Louis District Radionuclide Data Quality Evaluation Guidance.

Chemist-Analyst Specialist, City & County of Denver, Denver, Colorado, June 1992 - August 1994. As a Chemist-Analyst Specialist for the City and County of Denver, Ms. Weaver supervised performance and compliance sampling for O & M requirements at groundwater treatment facility. She provided assessment of analytical data for quarterly reports to local regulatory agencies. She also acted as liaison between the technical group and laboratory to coordinate sampling events and resolve problems with analyses. While in this capacity, she performed data validation for organic, inorganic and radiological analyses. Ms. Weaver reviewed over 2000 VOC, SVOC, pesticide, PCB, TPH, metals and wet chemistry samples. Ms. Weaver managed the database for groundwater and treatment plant sampling events and performed environmental site assessments for commercial and residential properties. She provided technical review and recommendations of Phase I and Phase II site investigations performed by outside consultants. She also analyzed policy and interpreted city, state and federal environmental regulations.

Data Validation Specialist, C.C. Johnson & Malhotra, Lakewood, Colorado, January 1990 to June 1992. While a Data Validation Specialist at C.C. Johnson & Malhorta, Ms. Weaver performed data validation and interpretation of organic analytical data generated from the EPA Contract Laboratory Program (CLP). Data analysis included VOC,

SVOC, pesticides, PCBs, metals and wet chemistry. Ms. Weaver reviewed more than 600 SDGs and 9000 samples. She interpreted gas chromatograms, gas chromatography/mass spectral data and verified mathematical calculations.

Environmental Chemist, The Anschutz Corporation - SP Environmental Systems, Inc., Denver, Colorado, July 1990 to January 1992. As an Environmental Chemist for The Anschutz Corporation - SP Environmental Systems, Inc., Ms. Weaver assisted in the management of site investigations and remediation for Southern Pacific Transportation Company properties. In this capacity, she performed environmental audits and site assessments and conducted site investigations at potential Superfund sites with state and federal agencies. She researched and prepared responses to regulatory agencies for non-compliant sites and defined the needs for hazardous waste disposal including the analysis required and disposal. Ms. Weaver also supervised the removal of underground storage tanks and remediation. She prepared closure reports for UST removals, as well as annual waste summary forms for TSD facilities throughout the state of Texas. She also constructed, developed, and sampled groundwater monitoring wells.

Environmental Specialist, Martin Marietta Astronautics Group, Denver, Colorado, January 1988 to January 1990. While with Martin Marietta Astronautics Group as an Environmental Specialist, Ms. Weaver performed organic analysis and sampling of wastewater, groundwater, and drinking water in support of NPDES permit. She operated and maintained laboratory instrumentation including GC and GC/MS for volatile, semi-volatile, and pesticide/PCB analysis. Ms. Weaver also coordinated sample collection and preparation activities, developed and authored standard operating procedures for laboratory analysis, and followed EPA protocol for QA/QC requirements for analysis. She calculated and interpreted data and reported results.

Environmental Chemist, Camp, Dresser, & McKee, Boston, Massachusetts, April 1986 to October 1987. As an Environmental Chemist with Camp, Dresser, & McKee, Ms. Weaver analyzed water/wastewater for organic compounds. She operated and maintained laboratory instrumentation including GC and infrared spectrophotometer for volatile, pesticide/PCB, and petroleum hydrocarbon analysis. She also calculated and interpreted data and reported results. Ms. Weaver analyzed more than 2000 samples.

Employment History

Environmental Data Services, Inc.	Principal/Senior Chemist	1994–Present
City & County of Denver	Chemist-Analyst Specialist	1992–1994
C.C. Johnson & Malhorta	Contractor/Data Validation Specialist	1990–1992
The Anschutz Corporation - SP Environmental Systems, Inc.	Environmental Chemist	1990–1992
Martin Marietta Astronautics Group	Environmental Specialist	1988–1990
Camp, Dresser, & McKee	Environmental Chemist	1986–1987

DOUGLAS WEAVER
Contracts Administrator/Database Manager

OVERALL EXPERIENCE

Mr. Weaver has over twenty years combined environmental management experience. He is the Vice-President and co-founder of EDS and is responsible for the administrative and database management. His administrative experience includes business and proposal development, contract administration, financial administration and staff management. His database management includes database development, manipulation, entry and review using Excel and project-specific software.

PROFESSIONAL EXPERIENCE

Environmental Data Services, Inc., Virginia Beach, Virginia
June 1995 - Present
Contracts & Administration Manager

- Responsible for the contracts and administration of an environmental consulting firm specializing in the review and validation of environmental laboratory data. Position involves all contract administration, business development, financial analysis and personnel administration of the business.
- Responsible for database management tasks including updating electronic data deliverables (EDDs) with data validation qualifiers. Highly experienced with Excel and the many EDD formats utilized by many different clients including NYSDEC and Equis database formats.

ERM-Rocky Mountain, Inc., Greenwood Village, Colorado
April 1991 - June 1995
Senior Engineer

- Responsible for negotiating, managing, and reporting on contracts and contract delivery orders at the Department of Energy's Rocky Flats Environmental Technology Site (RFETS). Prepared technical and cost proposals in response to individual delivery order Request for Proposals under three Master Task Subcontracts (MTS) with EG&G Rocky Flats (M&O Prime Contractor). Task orders involved environmental restoration and RCRA permitting and compliance. Interfaced with the EG&G Procurement Managers and technical Project Managers for each contract. Prepared cost and schedule reports required by the MTS and the task orders including monthly accrual reports and Department of Energy Cost and Schedule Control Systems Criteria (C/SCSC) monthly reports.
- Prepared and coordinated federal sector technical proposals in response to Request for Proposals (RFPs). Prepared SF-254 and 255s, SF-1411s, wrote technical sections of proposals, prepared cost estimates and schedules, and organized and prepared proposals in accordance with submittal instructions.
- Prepared RCRA Part A and B Permit Applications for hazardous and mixed waste storage and treatment at RFETS. Responsibilities included the container storage section of the mixed residue Part B permit application which included over 150 container storage areas in all production buildings at the plant.

KMI Energy Services, Boulder, Colorado
August 1990 to April 1991
Project Controls Specialist

- Support services contractor to DOE Program Office for a Major Systems Acquisition (MSA) project. Supported and interfaced with government and contractor personnel with day-to-day program planning and execution. Performed and evaluated project management contractual documents including labor and cost plans, budgets, and cost and schedule reports. Provided support in developing Major System Acquisition (MSA) documents required by DOE Order 4700.1, Project Management Systems, including a Project Plan, Project Management Plan, and Construction Project Data Sheets.

Systematic Management Services, Inc., Golden, Colorado
October 1988 to August 1990
Project Controls Specialist

- Previous support services contractor to the DOE Program Office. Responsible for monitoring and evaluating contractor cost and schedule performance on the PRMP MSA project as well as a $50 million plutonium recovery design project. Analyzed monthly cost performance reports and provided detailed written assessments. Prepared MSA documentation required by DOE Order 4700.1 and supported DOE presentations to headquarters.

EDUCATION

- Bachelor of Science in Industrial Engineering, Northeastern University, Boston, MA, 1991

COMPUTER PROFICIENCIES

- Microsoft (MS) Windows, MS Word/Excel/Access/PowerPoint, Paradox, and Word Perfect
- Project management software including Primavera and MS Project.

CLEARANCES

- Department of Energy, Top Secret "Q" Clearance - Inactive since 1995

REFERENCES

- Furnished upon request.

Victoria Whelan, NYSPG, QEP
Senior Project Manager
Preferred Environmental Services

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PROFESSIONAL EXPERIENCE

Victoria Whelan has more than fifteen (15) years of progressive experience as a Project Manager and Senior NYS Licensed Geologist in the field of environmental assessment. Ms. Whelan has performed and managed field investigations and remedial activities at numerous sites on Long Island, Metro New York and New York State. She is a New York State Licensed Professional Geologist (#000318), a Qualified Environmental Professional (QEP) certified by the Institute of Professional Environmental Practice, a Certified Professional Geologist (CPG) certified by the American Institute of Professional Geologists and is certified for Health and Safety Operations at Hazardous Material Sites.

Ms. Whelan is competent in conducting all aspects of environmental investigations and remediation including Phase I and Phase II Environmental Site Assessments, monitoring well design/installation, comprehensive sampling programs, Underground Injection Control (UIC) Closures under both county and USEPA auspices, UST removals, excavation, and solid and hazardous waste disposal. Ms. Whelan has also assisted with the design; construction, and on-going maintenance of groundwater pump-and-treat systems, air sparge/soil vapor extraction systems, sub-slab depressurization systems, and in-situ chemical oxidation programs.

Her primary focus is to accurately assess, investigate, remediate, and maintain environmental integrity for real estate transactions and the redevelopment of brownfield and other similar environmental impaired properties. Ms. Whelan has managed all aspects of multiple projects with the New York State Department of Environmental Conservation (NYSDEC) Brownfield (BCP) and Voluntary Cleanup Program (VCP), the New York City Office of Environmental Remediation (NYC OER), the New York City Department of Environmental Protection (NYCDEP) and the United States Environmental Protection Agency (USEPA). These projects include NYSDEC Spills Program, NYSDEC Brownfield Cleanups, regulated RCRA Closures, and Voluntary Cleanup Program (VCP) sites. She has worked with numerous prominent developer teams at 'E' hazardous material designated properties to help them comply with CEQR and obtain their "Notice to Proceed" and "Notice of Satisfaction" approvals.

During her work as a Senior Associate at Preferred, Ms. Whelan is responsible for the Technical Management of staff geologists and environmental scientists as well as the Operations Management of highly technical projects for environmental restoration. Her expertise is used to navigate the complex world of regulatory negotiations, effective communication and strategy development with client and clients' attorney and knowledge of state-of-the-art remediation technologies.

This expertise is derived from years of successful experience working on numerous projects under the NYCOER and completion of resolution of hazardous materials in combination with construction. Work flow that Ms. Whelan has successfully performed and managed included Phase I and Phase II Environmental Site Assessments and all other related aspects of due diligence, delineation of the nature and extent of contamination and developing cost to cure and the actual remediation of contamination.

She has specifically has repeatedly coordinated environmental assessment and required remediation at large construction projects for numerous large NYS and NYC General Contractors, NYS & NYC VCPs and

BCPs, Remedial Investigation/Feasibility Study (RI/FS); RCRA Closures, comprehensive site investigations, remedial design and remedial action programs; interim remedial measures; UST/hazardous and non-hazardous waste investigations and regulatory compliance; developing and scoping of field programs including QA/QC protocols, sampling plans and health and safety control plans; as well as regulatory compliance and negotiations. Ms. Whelan has a strong working knowledge of local, state and federal regulations affecting hazardous and non-hazardous waste materials as well as standards and guidance's for soil and groundwater quality.

Ms. Whelan has years of experience as a Project Director for In-Situ and Ex-Situ Soil and Waste Characterization Projects underway for General Contractors performing on various NYCDEP, NYCDDC, NYCEDC, MTA NYCT, MTA LIRR and NYSDOT construction projects. These programs included the preparation of associated environmental submittals, Health and Safety Plans, Stormwater Pollution Prevent and Sediment and Erosion Control Plans, Pollution Prevention, Contingency Plans, Hazardous Materials Plans, Community and Worker Documentation Air Monitoring Plans (CAMPs), as well as the performance of sample collection and analytical testing for full range of contaminated media. Further, Ms. Whelan has successfully prepared numerous Excavation Material Disposal Plans (EMDP) at NYCSCA Sites for Waste Characterization purposes for general contractors building school foundations. Major recent accomplishments of the firm wherein Ms. Whelan has been involved includes the following:

- Environmental Manager for staff providing environmental consulting services for Engineering Prime for NYCEDC Contract Learning Bridges Sites, NYC.

- Environmental Manager for several NYSDEC BCP Sites: (e.g., Loring Avenue, Brooklyn, Green Building project – Atlantic Terrace, Fifth Avenue Committee and Mega Contracting, NYS BCP
- Environmental Manager for Numerous NYC OER Sites: (e.g., Affordable Housing Project – Putnam Court, Dunn Development Corp., and HLS Builders, Supportive Housing Project – Hour Apartment houses for Hour Children, Hour Children and Eldelman Sultan Knox, Affordable Housing Projects - East Burnside and Walton Avenue, Walison Corp. 381 Chester Street, Brooklyn etc.)
- Environmental Manager for a NYSDEC RCRA site: 386 Oakwood Huntington Station.

- Environmental Manager for a large-scale remediation site in Hicksville involving soil vapor extraction and air sparging.

- Environmental Manager for NYS OGS Underground Storage Tank (UST) removal programs for NYSDOT facilities, under engineering prime.

- Worker Health and Safety Assistance/EHASP for MGP-contaminated sites for several General Contractors during implementation of construction activities.

Victoria Whelan, NYSPG, QEP
Senior Project Manager
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- Management of staff conducting ongoing compliance monitoring of commercial, industrial and residential petroleum spill remediations as well as Operations, Maintenance and Monitoring (OM&M) and groundwater monitoring efforts required for Preferred's contracts with major engineering firms for the technical support of the NYS Superfund program. She manages staff providing field support for soil vapor, soil sampling, groundwater sampling and remediation projects involving petroleum hydrocarbons, VOCs and inorganic media within Metro New York, upstate areas and New Jersey. The soil and groundwater remediation projects that include pump and treat, sub slab depressurization system (SSDS) operation, the operations and maintenance of oil-water separators, spill busters, removal of floating product by Vacuum Enhanced Fluid Recovery (VEFR), soil vapor extraction (SVE), air sparging (AS), excavation, closed loop in-well-stripping system, chemical injection/oxidation, sub-slab depressurization systems (SSDS), and natural attenuation.

WORK HISTORY

Senior Project Manager - Preferred Environmental Services, February 2019-present
Operations Manager -AARCO Environmental Services Corp. September 2017- February 2019
Project Manager, CA RICH Consultants, Inc. September 2006 to September 2017
Project Manager, Geologist Walden Associates July 2005-September 2006

EDUCATION

B.S., Geology, State University of New York College at Oswego, 2001-2005
James Cook University 2004-2005

REGISTRATIONS/CERTIFICATIONS
Registered Professional Geologist in New York State #000318
Qualified Environmental Professional - Institute of Professional Environmental Practice
Certified Professional Geologist (CPG) - American Institute of Professional Geologists
OSHA 40-hour Hazwoper Certification and 8-hour refreshers
OSHA 8-hour Hazwoper refresher training
OSHA 10-hour Construction Safety Course
OSHA 30-hr Construction Safety Course
First Aid
CPR Training
LIRR Roadway Worker Training required by 49 CFR Part 214 Subpart C
ARC Flash Training

HONORS & AWARDS
Big Apple Brownfield Award - Hour Apartment House III
Supportive Living Affordable Housing Award - Putnam Court
Who's Who in Green Award - Atlantic Terrace

William J. Schlageter, Vice President, NYSPG

Preferred Environmental Services

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PROFESSIONAL EXPERIENCE

Bill Schlageter is a NYS Licensed Professional Geologist and Vice President of the firm. He is responsible for the overall technical management of environmental projects at Preferred and manages its resources. Mr. Schlageter has managed and negotiated environmental projects for more than 22 years under administrative consent orders, stipulation agreements and other enforcement actions under regulatory agencies such as the New York State Department of Environmental Conservation (NYSDEC), and the New York City Office of Environmental Remediation (NYC OER) and local county authorities as well as the United States Environmental Protection Agency (USEPA). These projects were performed under programs such as NYSDEC VCP, NYSDEC BCP, USEPA CERCLA, NYSDEC RCRA, and as well as remediation programs performed under memorandum of agreements for local and county authorities.

Mr. Schlageter has a long term and strong working relationship with NYS and NYC regulators and has a comprehensive knowledge of current standards and guidance values regulating indoor air, surface water, dredge materials, sediment, soil and groundwater quality. Mr. Schlageter has also served as an expert witness providing testimony and depositions to assist in litigation regarding environmental issues of regulations affecting the use, handling and storage of hazardous and non-hazardous (petroleum) materials

Mr. Schlageter's management of the firm includes technical direction, QA/QC and supervision of the implementation of comprehensive Environmental Site Assessments, Phase I/II due diligence, delineation and abatement of hazardous materials, subsurface vapor intrusion and indoor air quality investigations, environmental compliance and the remediation/abatement of contamination. Mr. Schlageter has designed and executed more than 1,000 Environmental Site Assessments involving complex commercial and industrial properties for a multitude of municipal (NYC) and NYS clients and private clients (schools, state/MTA fueling facilities, healthcare and corrections facilities, recreational, scholastic and industrial facilities, residential, commercially developed land, cellular communications facilities; municipally-owned properties; and vacant land awaiting development, etc.) over the last 22 years.

His years of experience provide the expertise required to navigate the complex world of regulatory negotiations, effective communication and strategy development with client and clients' attorney and knowledge of state-of-the-art remediation technologies. His diversified technical experience includes, but is not limited, to the following: hazardous and regulated material assessment, implementation and management of comprehensive environmental site investigations; construction support, regulatory compliance activities; environmental impact assessment and remediation including supervision and management of staff and subcontractors. As a result of this work flow, Mr. Schlageter is an expert in the development and scoping of field sampling programs including QA/QC protocols, sampling plans and health and safety control plans; as well as regulatory compliance, negotiations and detailed reporting. Mr. Schlageter has served as a liaison between clients and regulatory authorities, from discovery of release, to regulatory closure.

Major recent accomplishments of the firm wherein Mr. Schlageter has been involved includes the following:

- Environmental Manager for 3TC Constructors as part of the Metropolitan Transportation Authority (MTA) Long Island Railroad (LIRR) design-build program for the LIRR Expansion Project from Floral Park to Hicksville, New York. The LIRR expansion project includes the installation of a third track along a 9.8-mile stretch of the LIRR mainline, between Floral Park and Hicksville, NY. Mr. Schlageter has managed the in-situ characterization and re-use of 100,000s of cubic yards of material, due diligence of parcels to be acquired, contamination delineation of construction areas and the development of Site Management Plans.
- Environmental Manager for Numerous NYSDEC BCP Sites: (e.g., Loring Avenue, Brooklyn, Wortman Avenue, Brooklyn, 48 Sewell Avenue, Hempstead, NYSDEC Remediation contract for BB&S Speonk, etc.
- Environmental Manager for Numerous NYSDEC VCP Sites: (e.g., Dry Cleaners Americana, American, Rose, Smucklers, Burton Chemicals, etc.
- Environmental Manager for Numerous NYC OER Sites: (e.g., 1066 Myrtle Avenue, Brooklyn **(BAPA Award**), Whitestone Plaza, 132-01 14th Avenue Whitestone, NY, 39-27 29th Street LIC, 22-10- Jackson Avenue, LIC, 536 W28th Street, 462 Broadway, etc.
- Environmental Manager for two RCRA sites: 386 Oakwood Huntington Station, Konica Minolta.
- MTA Contracts: Implementation of Petroleum and Chemical Bulk Storage Compliance monitoring and testing being conducted year-long at various MTA Bus Yards in the Metro NY Area. Mr. Schlageter interfaces with our client and the MTA to ensure timely information and no capacity issues relative to the ongoing fueling activities at these facilities. Under his scrutiny, Preferred staff provides direct inspection and certification of MTA subcontractors being contracted to maintain, certify and keep USTs and CBS facilities in compliance with ongoing and updated regulations and requirements for continuous monitoring and demonstrations of integrity.
- MTA Contracts: Supervision of field inspection of fuel oil spills, SPDES discharges and other sampling and monitoring. Design, supervision and reporting on the conduct of industrial hygiene and indoor air quality studies at MTA and LIRR facilities that include mold, PCBs, silica, thermite welding, asbestos, noise, general parameters, CO, H2S, etc.
- Management of dozens of In-Situ and Ex-Situ Soil and Waste Characterization Projects underway for General Contractors for various New York City agencies (NYCSCA, NYCDEP, NYC DDC, NYCDOT, MTA NYCT, and MTA LIRR.
- Technical Management for the operation, maintenance and monitoring of a PCE soil vapor extraction system with GAC treatment under a NYSDEC Standby Contract for a multi-acre NYC Inactive Hazardous Waste Site.

- Forensic Evaluations for more than 3,000 fuel oil and other petroleum releases into residential and commercial structures to facilitate insurance coverage determinations. Collection of soil and groundwater samples to document first or third-party impacts. Summary reports for reserve estimation and spill management oversight.

- Operation, Maintenance and Monitoring of varied soil vapor extraction, air-sparge groundwater remediation systems at former Psychiatric Center Power Plants, bus dispatching center, gasoline stations, redeveloped properties, and State Superfund sites;

- Preparation and completion of Underground Storage Tank (UST) removals and/or abandonment activities for over 500 facilities in New York;

- Soils and sediment remediation of over 300 hundred properties in Nassau and Suffolk Counties under the oversight of the USEPA, NCDH and SCDHS in conjunction with the USEPA Underground Injection Control program or NYSDEC spill programs;

- Environmental Site Assessments of the former St. John's Episcopal Hospital in Smithtown, NY, Hempstead General Hospital, South Shore Community Hospital and Peconic Medical Center, Mercy Hospital in the Bronx and other varied services;

- Phase I/Phase II Assessments and remediation management for numerous institutional facilities seeking HUD financing;

- Completion of more than 25 Phase I ESAs for a transportation corridor study for Town of Babylon East Farmingdale New York;

- Environmental Compliance Audits, Determination of Monitoring Requirements, preparation of Spill Prevention and Control plans, Management of facility chemical storage and reporting requirements, Due Diligence, Regulatory Interface, and related compliance activities for petroleum retail distributors; and

- Phase I and II Site Assessment and Remediation Coordination, various financial lenders, Metropolitan New York Area. Project Manager for the completion of over 600 combined Phase I/II and Remediation projects involving commercial-industrial lenders during property transactions, risk mitigation and compliance activities.

WORK HISTORY

Vice President/Operations Manager - Preferred Environmental Services, 2005 to present
Project Manager, Freudenthal & Elkowitz, Environmental Consulting, Commack, New York 1998-2005

William J. Schlageter, Vice President, NYSPG
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EDUCATION

B.S., Geology, State University of New York at Stony Brook, December 1998.
A.A., Liberal Arts, Suffolk County Community College, May 1995.

REGISTRATIONS/CERTIFICATIONS

Registered Professional Geologist in New York State #000222
NYSDOH Licensed Mold Assessor
NJDEP Certified HHO UST Closure Specialist
OSHA 40-hour Hazwoper Certification and 8-hour refreshers
NORA Certificate of Achievement for Storage Tank Installers & Maintenance Training
OSHA 8-hour Hazwoper refresher training
OSHA 10-hour Construction Safety Course
First Aid
CPR Training
LIRR Roadway Worker Training required by 49 CFR Part 214 Subpart C

Christopher Zweier, Environmental Scientist
Preferred Environmental Services

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Mr. Christopher Zweier is an Environmental Scientist working as part of an experienced field support team directed by Senior Staff at Preferred Environmental Services. As a team member, Mr. Zweier participates in wide ranging environmental projects involving biota, flora, hazardous materials (PCBs, lead, mercury, asbestos-containing materials (ACM), mold, etc.), environmental condition assessments and characterization, environmental chemical spills as well as indoor air quality assessments. He also participates in numerous projects involving environmental monitoring, site investigation and environmental assessment, contamination delineation and remediation. Further this work requires Mr. Zweier to be part of teams working on the on-going compliance monitoring of commercial, industrial and residential petroleum spill remediation projects, as well as the monitoring of in-situ remediation systems and associated groundwater monitoring networks.

Circa 2020, Mr. Zweier and other field personnel at Preferred are part of a state-of-the-art sampling team performing NYSDEC Spill compliance monitoring for our Engineering Prime responding to Environmental Services In Support Of Contract CM-1061 NYCT MTA Underground Storage Tank (UST) Remediation Program. This work included groundwater sampling; oversight and documentation of drilling and well decommissioning; groundwater and product level monitoring and product recovery; and oversight, documentation, and endpoint sampling of UST removals.

Mr. Zweier has gained additional experience as part of a support team responsible for the sampling of existing remediation systems that include both active systems (air sparge/soil vapor extraction (AS/SVE), in-situ oxygen (ISCO), chemical injection monitoring) as well as passive (e.g., natural attenuation and baseline sampling). He has provided field support for soil sampling, groundwater sampling and remediation projects involving petroleum hydrocarbons, VOCs and inorganic media within Metro New York, upstate areas and New Jersey, Connecticut, and Pennsylvania. The soil and groundwater remediation projects that Mr. Zweier is currently participating in include but are not limited to the following- removal of floating product by vacuum enhanced fluid recovery, chemical injection at residential properties in New Jersey and New York, soil excavation, end point sampling and all phases of groundwater monitoring for on-site and off-site remediation systems. Under Preferred' s environmental risk mitigation program for insurance carriers, Mr. Zweier provides field support for soil vapor, soil sampling, groundwater sampling and remediation projects involving petroleum hydrocarbons, VOCs and inorganic media within Metro New York, upstate areas, CT, PA and New Jersey. Mr. Zweier' s educational background includes the identification, ecology, management of endangered species (flora and fauna) as well as evaluation of climate change, development and population studies associated with same. Significant projects within which Mr. Zweier has a historical technical field support role include, but are not limited to:

- Conducted community air monitoring, health and safety oversight and sample collection on a daily basis on brownfield projects throughout the five boroughs.

- Field management of contaminated soil excavation on numerous projects within NYC, NYS and NJ. Including waste characterization sampling, inspection of stormwater pollution prevention measures, compliance with SWPPP Plans, endpoint sampling and regulatory agency correspondence.
- Participated in multiple phases of environmental projects including but not limited to Phase I Environmental Site Assessments and Phase II Investigations, underground storage tank removals, and remediations.

- Environmental Monitor for endangered species and flora during a road construction project for the installation of a bike lane under a NYSDOT project within a protected zone, wetlands and migratory/breeding grounds, Long Island, New York.

- Participated in Cause and Origin Evaluations for fuel oil and other petroleum releases into residential and commercial structures to facilitate insurance coverage determinations. Mr. Zweier is part of an experienced team that routinely performs the collection of soil and groundwater samples for laboratory analysis to document first or third-party impacts, relative to insurance claims.

- Major fuel oil remediation projects on commercial/residential properties through New York State including investigation, remedial design, groundwater disposal management, soil disposal management, site safety procedures, etc.

- Completion of sampling activities under the NYCT MTA Bottom Sludge at Oil/Water Separators Various MTA Sampling Locations, 5 Boroughs, NYC for Clean Harbors Facility. Coordination with facilities, laboratories, and site superintendents.

- Management of the oversight of chemical injection at residential properties in New Jersey and New York, soil screening and segregation during excavation, end point soil sampling, monitoring well installation oversight and all aspects of groundwater monitoring for on-site and off-site remediation systems.

- Sampling of soils at NYCSCA Sites for Waste Characterization for general contractors.

- Phase I and II ESAs inclusive of reviewing and evaluating Municipal, NYSDEC, Queens, Bronx and Brooklyn Building Departments, NYSDOH, SCHDS and NCDH for due diligence.

WORK HISTORY

Environmental Scientist - Preferred Environmental Services, September 2019 – present

EDUCATION
Bachelor of Science in Environmental Science**,** SUNY Plattsburgh, New York – May 2019

CERTIFICATIONS/TRAINING

OSHA 40-hour Hazwoper Certification
OSHA 30-hour Construction Safety Course
OSHA 10-hour Construction Safety Course
First Aid
CPR Training
LIRR Roadway Worker Training required by 49 CFR Part 214 Subpart C
ARC Flash Training

Christopher R. Murphy, Environmental Scientist
Preferred Environmental Services

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Mr. Murphy is one of Preferred' s most experienced Environmental Scientists who has been assigned to a wide-ranging series of extremely high scrutinized municipal environmental projects in heavily populated and active community districts in New York City. The majority of Mr. Murphy's responsibilities on these projects include the environmental monitoring of site conditions, emphasis on Community Air Monitoring and work zone monitoring for potentially hazardous fugitive air emissions, the implementation of site investigations and assessments, PBS and CBS Compliance monitoring, in-situ waste characterization testing for material handling projects, site contamination delineation, and oversight of environmental remediation. Mr. Murphy's work has been performed under the technical direction by Preferred' s Senior Level Environmental Scientists, Geologists, Certified Industrial Hygienist (CIH) and Engineers, and his work products have been refined to the highest level due to this mentorship.

In addition to performing Supervisory and actual field investigatory work as described above, Mr. Murphy has more than five (5) years of direct experience participating in in the field collection of all types of environmental media samples (soil, soil vapor, surface water, potable water and groundwater) for representative laboratory analysis and ultimate data interpretation. At Preferred, his responsibilities include both team and independent environmental monitoring of site conditions, the implementation of site investigations, site contamination delineation and oversight of environmental remediation systems. Of specific note, Mr. Murphy has provided years of field support in soil and groundwater Phase II Subsurface Site investigations, ongoing compliance monitoring (groundwater, soil vapor, and soil sampling) at industrial, commercial and residential sites. He has become the field leader in the implementation of Petroleum Bulk Storage Compliance inspections for engineering firms responding to the requirements of the MTA LIRR and Bus Divisions under NYCT Metropolitan Transportation Authority (MTA) Full Environmental Consulting Contract. Mr. Murphy also provides routine efforts in the operation, maintenance, monitoring and sampling of several NYSDEC-operated remediation systems for soil vapor, groundwater and soil compliance.

Further, Mr. Murphy is a very valuable staff member of an experienced field support team performing operations, maintenance and monitoring of remediations systems. This team is responsible for the sampling of existing remediation systems that include both active systems (air sparge/soil vapor extraction (AS/SVE), in-situ oxygen (ISCO), chemical injection monitoring) as well as passive (e.g., natural attenuation and baseline sampling) and groundwater monitoring networks associated with these sites. Mr. Murphy has provided field support for soil vapor, soil sampling, groundwater sampling and remediation projects involving petroleum hydrocarbons, VOCs and inorganic media within Metro New York, upstate areas, CT, PA and New Jersey. The soil and groundwater remediation projects that Mr. Murphy is currently participating in include the removal of floating product by vacuum enhanced fluid recovery, chemical injection at residential properties in New Jersey and New York, soil excavation, end point sampling and all phases of groundwater monitoring for on-site and off-site remediation systems.

Of recent additional note, is Mr. Murphy's participation in a Community Air Monitoring Program for an Engineering Prime for the redevelopment of a large municipal Hospital project in New York City. Mr. Murphy was also fully responsible for implementing a large-scale community and air monitoring project for dredging operations in the Gowanus Bay for a General Contractor; monitoring is performed on a routine basis with reoccurring responsibilities. Last year, Mr. Murphy extensively participated in the City

of Glen Cove and NYSDOT – Garvies Point & Herb Hill Road Construction project in tandem with Senior Staff, during the installation of a Road and associated subgrade utilities within a redevelopment area of Glen Cove, through four (4) State Superfund Sites and One (1) Federal Superfund Site**.** For more than six months, Mr. Murphy assisted Senior Associates at Preferred by providing supplemental inspection and environmental compliance monitoring during the installation of this major roadway in the Glen Cove Area, undergoing extensive redevelopment. Over 140,000 cubic yards of contaminated soil was managed under this program and Preferred's efforts included detailed construction inspection to ensure that all environmental assessments, waste characterization, endpoint sampling, SWPPP, Community Air Monitoring and related environmental controls are implemented.

During 2019, Mr. Murphy has responsibility associated with the implementation of the in-situ characterization associated with MTA Long Island Railroad (LIRR) LIRR Expansion Project from Floral Park to Hicksville, New York. This LIRR expansion project included the installation of a third track along a 9.8-mile stretch of the LIRR mainline, between Floral Park and Hicksville, NY and the elimination of seven (7) existing grade crossings within the proposed project limits. During the tenure of this project, Mr. Murphy has characterized more than 100,000 cubic yards of material for handling.

Circa 2020, Mr. Murphy and other field personnel at Preferred are part of a state-of-the-art sampling team performing NYSDEC Spill compliance monitoring for our Engineering Prime responding to Environmental Services In Support Of Contract CM-1061 NYCT MTA Underground Storage Tank (UST) Remediation Program**.** This work included groundwater sampling; oversight and documentation of drilling and well decommissioning; groundwater and product level monitoring and product recovery; and oversight, documentation, and endpoint sampling of UST removals.

Significant other projects within which Mr. Murphy has a technical field support role include, but are not limited to:

- Community Air Monitoring for large demolition project in New York City for the redevelopment of the property for a municipal hospital
- Community and Worker Air Monitoring for Dredging Contractor in Gowanus Bay for large remediation project.
- Silica monitoring, thermite welding, mold, indoor air quality, and related industrial hygiene investigations for the MTA Long Island Railroad LIRR and related projects
- Sampling of soils at NYCSCA Sites for Waste Characterization for general contractors
- Completion of sampling activities under the NYCT MTA Bottom Sludge at Oil/Water Separators Contract.
- Various MTA Sampling Locations, 5 Boroughs, NYC for Clean Harbors Facility. Coordination with facilities, laboratories, and site superintendents.
- Participation in Cause and Origin Evaluations for fuel oil and other petroleum releases into residential and commercial structures to facilitate insurance coverage determinations. Mr. Murphy is part of an experienced team that routinely performs the collection of soil and groundwater samples for laboratory analysis to document first or third-party impacts, relative to insurance claims.
- Management and oversight of chemical injection at residential properties in New Jersey and New York, soil screening and segregation during excavation, end point soil sampling, monitoring well

installation oversight and all aspects of groundwater monitoring for on-site and off-site remediation systems.

- Phase I and II Environmental Site Assessments (ESAs) inclusive of reviewing and evaluating Municipal, NYSDEC, Bronx, Queens and Brooklyn Building Departments, NYSDOH, SCHDS and NCDH for due diligence studies.

WORK HISTORY

Geologist - Preferred Environmental Services, November 2018 - present
Suffolk County Water Authority, Hauppauge, New York
Laboratory and Potable Water and Groundwater Sampling Technician II, 2015-November 2018

EDUCATION

SUNY Stony Brook, Stony Brook, NY
Bachelor of Science: Geology, 2014
Bachelor of Arts: Earth and Space Sciences, 2014

COMMITTEES/MEMBERSHIP/CERTIFICATIONS

OSHA 40-hour Hazwoper Certification
OSHA 30-hour Construction Safety Course
OSHA 10-hour Construction Safety Course
First Aid
CPR Training
LIRR Roadway Worker Training required by 49 CFR Part 214 Subpart C
ARC Flash Training

Appendix B

Parameters, Methods, and Quantitation Limits

York Analytical Laboratories, Inc.

4/25/2022

Analytical Method Information

Volatile Organic Compounds by GC/MS

Volatile Organics, 8260 - Comprehensive in Water (EPA 8260C)

Units: **ug/L**

Preservation: Add HCl to pH<2; Store cool at 4°C

Hold Time to Analysis days

Container: 00_40mL Clear Vial (pre-pres.) HCl; Cool to 4° C **Amount Required:** 80 mL

Hold Time to Extr. 14 days

Analyte	MDL	Reporting Limit	Surrogate %R	Duplicate RPD	Matrix Spike %R	Matrix Spike RPD	Blank Spike / LCS %R	Blank Spike / LCS RPD
1,1,1,2-Tetrachloroethane	0.20	0.50 ug/L			45 - 161	30	82 - 126	30
1,1,1-Trichloroethane	0.20	0.50 ug/L			70 - 146	30	78 - 136	30
1,1,2,2-Tetrachloroethane	0.20	0.50 ug/L			74 - 121	30	76 - 129	30
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)	0.20	0.50 ug/L			21 - 217	30	54 - 165	30
1,1,2-Trichloroethane	0.20	0.50 ug/L			59 - 146	30	82 - 123	30
1,1-Dichloroethane	0.20	0.50 ug/L			54 - 146	30	82 - 129	30
1,1-Dichloroethylene	0.20	0.50 ug/L			44 - 165	30	68 - 138	30
1,2,3-Trichlorobenzene	0.20	0.50 ug/L			40 - 161	30	40 - 130	30
1,2,3-Trichloropropane	0.20	0.50 ug/L			74 - 127	30	77 - 128	30
1,2,4-Trichlorobenzene	0.20	0.50 ug/L			41 - 161	30	65 - 137	30
1,2,4-Trimethylbenzene	0.20	0.50 ug/L			72 - 129	30	82 - 132	30
1,2-Dibromo-3-chloropropane	0.20	0.50 ug/L			31 - 151	30	45 - 147	30
1,2-Dibromoethane	0.20	0.50 ug/L			75 - 125	30	83 - 124	30
1,2-Dichlorobenzene	0.20	0.50 ug/L			63 - 122	30	79 - 123	30
1,2-Dichloroethane	0.20	0.50 ug/L			68 - 131	30	73 - 132	30
1,2-Dichloropropane	0.20	0.50 ug/L			77 - 121	30	78 - 126	30
1,3,5-Trimethylbenzene	0.20	0.50 ug/L			69 - 126	30	80 - 131	30
1,3-Dichlorobenzene	0.20	0.50 ug/L			74 - 119	30	86 - 130	30
1,4-Dichlorobenzene	0.20	0.50 ug/L			70 - 124	30	85 - 130	30
1,4-Dioxane	40	40 ug/L			10 - 310	30	10 - 349	30
2-Butanone	0.20	0.50 ug/L			10 - 193	30	49 - 152	30
2-Hexanone	0.20	0.50 ug/L			53 - 133	30	51 - 146	30
4-Methyl-2-pentanone	0.20	0.50 ug/L			38 - 150	30	57 - 145	30
Acetone	1.0	2.0 ug/L			13 - 149	30	14 - 150	30
Acrolein	0.20	0.50 ug/L			10 - 195	30	10 - 153	30
Acrylonitrile	0.20	0.50 ug/L			37 - 165	30	51 - 150	30
Benzene	0.20	0.50 ug/L			38 - 155	30	85 - 126	30
Bromochloromethane	0.20	0.50 ug/L			75 - 121	30	77 - 128	30
Bromodichloromethane	0.20	0.50 ug/L			70 - 129	30	79 - 128	30
Bromoform	0.20	0.50 ug/L			66 - 136	30	78 - 133	30
Bromomethane	0.20	0.50 ug/L			30 - 158	30	43 - 168	30
Carbon disulfide	0.20	0.50 ug/L			10 - 138	30	68 - 146	30
Carbon tetrachloride	0.20	0.50 ug/L			71 - 146	30	77 - 141	30
Chlorobenzene	0.20	0.50 ug/L			81 - 117	30	88 - 120	30
Chloroethane	0.20	0.50 ug/L			51 - 145	30	65 - 136	30
Chloroform	0.20	0.50 ug/L			80 - 124	30	82 - 128	30
Chloromethane	0.20	0.50 ug/L			16 - 163	30	43 - 155	30
cis-1,2-Dichloroethylene	0.20	0.50 ug/L			76 - 125	30	83 - 129	30
cis-1,3-Dichloropropylene	0.20	0.50 ug/L			58 - 131	30	80 - 131	30
Cyclohexane	0.20	0.50 ug/L			70 - 130	30	63 - 149	30
Dibromochloromethane	0.20	0.50 ug/L			71 - 129	30	80 - 130	30
Dibromomethane	0.20	0.50 ug/L			76 - 120	30	72 - 134	30
Dichlorodifluoromethane	0.20	0.50 ug/L			30 - 147	30	44 - 144	30
Ethyl Benzene	0.20	0.50 ug/L			72 - 128	30	80 - 131	30
Hexachlorobutadiene	0.20	0.50 ug/L			34 - 166	30	67 - 146	30
Isopropylbenzene	0.20	0.50 ug/L			66 - 139	30	76 - 140	30

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Analytical Method Information

Volatile Organic Compounds by GC/MS

Analyte	MDL	Reporting Limit	Surrogate %R	Duplicate RPD	Matrix Spike %R	Matrix Spike RPD	Blank Spike / LCS %R	Blank Spike / LCS RPD
Methyl acetate	0.20	0.50 ug/L			10 - 200	30	51 - 139	30
Methyl tert-butyl ether (MTBE)	0.20	0.50 ug/L			75 - 128	30	76 - 135	30
Methylcyclohexane	0.20	0.50 ug/L			70 - 130	30	72 - 143	30
Methylene chloride	1.0	2.0 ug/L			57 - 128	30	55 - 137	30
n-Butylbenzene	0.20	0.50 ug/L			61 - 138	30	79 - 132	30
n-Propylbenzene	0.20	0.50 ug/L			66 - 134	30	78 - 133	30
o-Xylene	0.20	0.50 ug/L			69 - 126	30	78 - 130	30
p- & m- Xylenes	0.50	1.0 ug/L			67 - 130	30	77 - 133	30
p-Isopropyltoluene	0.20	0.50 ug/L			64 - 137	30	81 - 136	30
sec-Butylbenzene	0.20	0.50 ug/L			53 - 155	30	79 - 137	30
Styrene	0.20	0.50 ug/L			69 - 125	30	67 - 132	30
tert-Butyl alcohol (TBA)	0.50	1.0 ug/L			10 - 130	30	25 - 162	30
tert-Butylbenzene	0.20	0.50 ug/L			65 - 139	30	77 - 138	30
Tetrachloroethylene	0.20	0.50 ug/L			64 - 139	30	82 - 131	30
Toluene	0.20	0.50 ug/L			76 - 123	30	80 - 127	30
trans-1,2-Dichloroethylene	0.20	0.50 ug/L			79 - 131	30	80 - 132	30
trans-1,3-Dichloropropylene	0.20	0.50 ug/L			55 - 130	30	78 - 131	30
trans-1,4-dichloro-2-butene	0.20	0.50 ug/L			25 - 155	30	63 - 141	30
Trichloroethylene	0.20	0.50 ug/L			53 - 145	30	82 - 128	30
Trichlorofluoromethane	0.20	0.50 ug/L			61 - 142	30	67 - 139	30
Vinyl Chloride	0.20	0.50 ug/L			31 - 165	30	58 - 145	30
Xylenes, Total	0.60	1.5 ug/L						

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Analytical Method Information

Volatile Organic Compounds by GC/MS

Analyte	MDL	Reporting Limit	Surrogate %R	Duplicate RPD	Matrix Spike %R	Matrix Spike RPD	Blank Spike / LCS %R	Blank Spike / LCS RPD
Volatile Organics, 8260 - Comprehensive in Soil (EPA 8260C)					Units: **ug/kg**			
Preservation: Cool 4°C						**Hold Time to Analysis**	days	
Container: 03_5035 Vial Set		**Amount Required:** 20 g.				**Hold Time to Extr.**	14 days	
1,1,1,2-Tetrachloroethane	2.5	5.0 ug/kg			15 - 161	33	75 - 129	30
1,1,1-Trichloroethane	2.5	5.0 ug/kg			42 - 145	30	71 - 137	30
1,1,2,2-Tetrachloroethane	2.5	5.0 ug/kg			16 - 167	56	79 - 129	30
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)	2.5	5.0 ug/kg			11 - 160	31	58 - 146	30
1,1,2-Trichloroethane	2.5	5.0 ug/kg			44 - 145	40	83 - 123	30
1,1-Dichloroethane	2.5	5.0 ug/kg			46 - 142	36	75 - 130	30
1,1-Dichloroethylene	2.5	5.0 ug/kg			30 - 153	31	64 - 137	30
1,2,3-Trichlorobenzene	2.5	5.0 ug/kg			10 - 157	47	81 - 140	30
1,2,3-Trichloropropane	2.5	5.0 ug/kg			38 - 155	48	81 - 126	30
1,2,4-Trichlorobenzene	2.5	5.0 ug/kg			10 - 151	52	80 - 141	30
1,2,4-Trimethylbenzene	2.5	5.0 ug/kg			10 - 170	242	84 - 125	30
1,2-Dibromo-3-chloropropane	2.5	5.0 ug/kg			36 - 138	54	74 - 142	30
1,2-Dibromoethane	2.5	5.0 ug/kg			40 - 142	39	86 - 123	30
1,2-Dichlorobenzene	2.5	5.0 ug/kg			10 - 147	52	85 - 122	30
1,2-Dichloroethane	2.5	5.0 ug/kg			48 - 133	32	71 - 133	30
1,2-Dichloropropane	2.5	5.0 ug/kg			47 - 141	37	81 - 122	30
1,3,5-Trimethylbenzene	2.5	5.0 ug/kg			10 - 150	62	82 - 126	30
1,3-Dichlorobenzene	2.5	5.0 ug/kg			10 - 144	51	84 - 124	30
1,4-Dichlorobenzene	2.5	5.0 ug/kg			10 - 160	52	84 - 124	30
1,4-Dioxane	50	100 ug/kg			10 - 191	196	10 - 228	30
2-Butanone	2.5	5.0 ug/kg			10 - 189	67	58 - 147	30
2-Hexanone	2.5	5.0 ug/kg			10 - 181	60	70 - 139	30
4-Methyl-2-pentanone	2.5	5.0 ug/kg			10 - 166	47	72 - 132	30
Acetone	5.0	10 ug/kg			10 - 196	150	36 - 155	30
Acrolein	5.0	10 ug/kg			10 - 192	128	10 - 238	30
Acrylonitrile	2.5	5.0 ug/kg			13 - 161	48	66 - 141	30
Benzene	2.5	5.0 ug/kg			43 - 139	64	77 - 127	30
Bromochloromethane	2.5	5.0 ug/kg			38 - 145	30	74 - 129	30
Bromodichloromethane	2.5	5.0 ug/kg			38 - 147	37	81 - 124	30
Bromoform	2.5	5.0 ug/kg			29 - 156	51	80 - 136	30
Bromomethane	2.5	5.0 ug/kg			10 - 166	42	32 - 177	30
Carbon disulfide	2.5	5.0 ug/kg			10 - 131	36	10 - 136	30
Carbon tetrachloride	2.5	5.0 ug/kg			35 - 145	31	66 - 143	30
Chlorobenzene	2.5	5.0 ug/kg			21 - 154	32	86 - 120	30
Chloroethane	2.5	5.0 ug/kg			15 - 160	40	51 - 142	30
Chloroform	2.5	5.0 ug/kg			47 - 142	29	76 - 131	30
Chloromethane	2.5	5.0 ug/kg			10 - 159	31	49 - 132	30
cis-1,2-Dichloroethylene	2.5	5.0 ug/kg			42 - 144	30	74 - 132	30
cis-1,3-Dichloropropylene	2.5	5.0 ug/kg			18 - 159	39	81 - 129	30
Cyclohexane	2.5	5.0 ug/kg			70 - 130	30	70 - 130	30
Dibromochloromethane	2.5	5.0 ug/kg			10 - 179	41	10 - 200	30
Dibromomethane	2.5	5.0 ug/kg			47 - 143	41	83 - 124	30
Dichlorodifluoromethane	2.5	5.0 ug/kg			10 - 145	34	28 - 158	30
Ethyl Benzene	2.5	5.0 ug/kg			11 - 158	42	84 - 125	30
Hexachlorobutadiene	2.5	5.0 ug/kg			10 - 158	45	83 - 133	30
Isopropylbenzene	2.5	5.0 ug/kg			10 - 162	57	81 - 127	30

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Analytical Method Information

Volatile Organic Compounds by GC/MS

Analyte	MDL	Reporting Limit	Surrogate %R	Duplicate RPD	Matrix Spike %R	Matrix Spike RPD	Blank Spike / LCS %R	Blank Spike / LCS RPD
Methyl acetate	2.5	5.0 ug/kg			10 - 149	64	41 - 143	30
Methyl tert-butyl ether (MTBE)	2.5	5.0 ug/kg			42 - 152	47	74 - 131	30
Methylcyclohexane	2.5	5.0 ug/kg			70 - 130	30	70 - 130	30
Methylene chloride	5.0	10 ug/kg			28 - 151	49	57 - 141	30
n-Butylbenzene	2.5	5.0 ug/kg			10 - 162	96	80 - 130	30
n-Propylbenzene	2.5	5.0 ug/kg			10 - 155	56	74 - 136	30
o-Xylene	2.5	5.0 ug/kg			10 - 158	51	83 - 123	30
p- & m- Xylenes	5.0	10 ug/kg			10 - 156	47	82 - 128	30
p-Isopropyltoluene	2.5	5.0 ug/kg			10 - 147	60	85 - 125	30
sec-Butylbenzene	2.5	5.0 ug/kg			10 - 157	56	83 - 125	30
Styrene	2.5	5.0 ug/kg			13 - 171	39	86 - 126	30
tert-Butyl alcohol (TBA)	2.5	5.0 ug/kg			34 - 179	35	70 - 130	30
tert-Butylbenzene	2.5	5.0 ug/kg			10 - 160	79	80 - 127	30
Tetrachloroethylene	2.5	5.0 ug/kg			30 - 167	33	80 - 129	30
Toluene	2.5	5.0 ug/kg			21 - 160	50	85 - 121	30
trans-1,2-Dichloroethylene	2.5	5.0 ug/kg			29 - 153	30	72 - 132	30
trans-1,3-Dichloropropylene	2.5	5.0 ug/kg			18 - 155	30	78 - 132	30
trans-1,4-dichloro-2-butene	2.5	5.0 ug/kg			17 - 154	30	75 - 135	30
Trichloroethylene	2.5	5.0 ug/kg			24 - 169	30	84 - 123	30
Trichlorofluoromethane	2.5	5.0 ug/kg			35 - 142	30	62 - 140	30
Vinyl Chloride	2.5	5.0 ug/kg			12 - 160	35	52 - 130	30
Xylenes, Total	7.5	15 ug/kg						

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York Analytical Laboratories, Inc.

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Analytical Method Information

Semivolatile Organic Compounds by GC/MS

Semi-Volatiles, 8270 - Comprehensive in Water (EPA 8270D)

Units: **ug/L**

Preservation: Cool 4°C

Hold Time to Analysis 40 days

Container: 07_1000mL Amber Glass Cool to 4° C

Amount Required: 1000 mL

Hold Time to Extr. 7 days

Analyte	MDL	Reporting Limit	Surrogate %R	Duplicate RPD	Matrix Spike %R	Matrix Spike RPD	Blank Spike / LCS %R	Blank Spike / LCS RPD
1,1-Biphenyl	2.50	5.00 ug/L			40 - 140	20	21 - 102	20
1,2,4,5-Tetrachlorobenzene	2.50	5.00 ug/L			40 - 140	20	28 - 105	20
1,2,4-Trichlorobenzene	2.50	5.00 ug/L			31 - 92	20	35 - 91	20
1,2-Dichlorobenzene	2.50	5.00 ug/L			31 - 91	20	42 - 85	20
1,2-Diphenylhydrazine (as Azobenzene)	2.50	5.00 ug/L			40 - 140	20	16 - 137	20
1,3-Dichlorobenzene	2.50	5.00 ug/L			24 - 93	20	45 - 80	20
1,4-Dichlorobenzene	2.50	5.00 ug/L			26 - 95	20	42 - 82	20
2,3,4,6-Tetrachlorophenol	2.50	5.00 ug/L			30 - 130	20	30 - 130	20
2,4,5-Trichlorophenol	2.50	5.00 ug/L			44 - 96	20	36 - 112	20
2,4,6-Trichlorophenol	2.50	5.00 ug/L			39 - 107	20	41 - 107	20
2,4-Dichlorophenol	2.50	5.00 ug/L			38 - 99	20	43 - 92	20
2,4-Dimethylphenol	2.50	5.00 ug/L			10 - 116	20	25 - 92	20
2,4-Dinitrophenol	2.50	5.00 ug/L			10 - 168	20	10 - 149	20
2,4-Dinitrotoluene	2.50	5.00 ug/L			26 - 120	20	41 - 114	20
2,6-Dinitrotoluene	2.50	5.00 ug/L			28 - 118	20	49 - 106	20
2-Chloronaphthalene	2.50	5.00 ug/L			33 - 99	20	40 - 96	20
2-Chlorophenol	2.50	5.00 ug/L			25 - 106	20	35 - 84	20
2-Methylnaphthalene	2.50	5.00 ug/L			29 - 102	20	33 - 101	20
2-Methylphenol	2.50	5.00 ug/L			10 - 118	20	10 - 90	20
2-Nitroaniline	2.50	5.00 ug/L			48 - 99	20	31 - 122	20
2-Nitrophenol	2.50	5.00 ug/L			36 - 103	20	37 - 97	20
3- & 4-Methylphenols	2.50	5.00 ug/L			10 - 102	20	10 - 101	20
3,3-Dichlorobenzidine	2.50	5.00 ug/L			10 - 140	20	25 - 155	20
3-Nitroaniline	2.50	5.00 ug/L			10 - 169	20	29 - 128	20
4,6-Dinitro-2-methylphenol	2.50	5.00 ug/L			10 - 142	20	10 - 135	20
4-Bromophenyl phenyl ether	2.50	5.00 ug/L			35 - 109	20	38 - 116	20
4-Chloro-3-methylphenol	2.50	5.00 ug/L			20 - 117	20	28 - 101	20
4-Chloroaniline	2.50	5.00 ug/L			24 - 116	20	10 - 154	20
4-Chlorophenyl phenyl ether	2.50	5.00 ug/L			31 - 112	20	34 - 112	20
4-Nitroaniline	2.50	5.00 ug/L			24 - 143	20	15 - 143	20
4-Nitrophenol	2.50	5.00 ug/L			10 - 119	20	10 - 112	20
Acenaphthene	0.0500	0.0500 ug/L			17 - 132	20	24 - 114	20
Acenaphthylene	0.0500	0.0500 ug/L			13 - 124	20	26 - 112	20
Acetophenone	2.50	5.00 ug/L			40 - 140	20	47 - 92	20
Aniline	2.50	5.00 ug/L			10 - 133	20	10 - 107	20
Anthracene	0.0500	0.0500 ug/L			40 - 105	20	35 - 114	20
Atrazine	0.500	0.500 ug/L			40 - 140	20	43 - 101	20
Benzaldehyde	2.50	5.00 ug/L			40 - 140	20	17 - 117	20
Benzidine	10.0	20.0 ug/L				20		20
Benzo(a)anthracene	0.0500	0.0500 ug/L			23 - 141	20	38 - 127	20
Benzo(a)pyrene	0.0500	0.0500 ug/L			46 - 118	20	30 - 146	20
Benzo(b)fluoranthene	0.0500	0.0500 ug/L			22 - 133	20	36 - 145	20
Benzo(g,h,i)perylene	0.0500	0.0500 ug/L			10 - 126	20	10 - 163	20
Benzo(k)fluoranthene	0.0500	0.0500 ug/L			18 - 152	20	16 - 149	20
Benzoic acid	25.0	50.0 ug/L			10 - 162	20	30 - 130	20
Benzyl alcohol	2.50	5.00 ug/L			10 - 114	20	18 - 75	20

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Analytical Method Information

Semivolatile Organic Compounds by GC/MS

Analyte	MDL	Reporting Limit	Surrogate %R	Duplicate RPD	Matrix Spike %R	Matrix Spike RPD	Blank Spike / LCS %R	Blank Spike / LCS RPD
Benzyl butyl phthalate	2.50	5.00 ug/L			31 - 121	20	28 - 129	20
Bis(2-chloroethoxy)methane	2.50	5.00 ug/L			23 - 110	20	27 - 112	20
Bis(2-chloroethyl)ether	2.50	5.00 ug/L			10 - 132	20	24 - 114	20
Bis(2-chloroisopropyl)ether	2.50	5.00 ug/L			12 - 132	20	21 - 124	20
Bis(2-ethylhexyl)phthalate	0.500	0.500 ug/L			14 - 131	20	10 - 171	20
Caprolactam	2.50	5.00 ug/L			40 - 140	20	10 - 29	20
Carbazole	2.50	5.00 ug/L			10 - 169	20	49 - 116	20
Chrysene	0.0500	0.0500 ug/L			30 - 127	20	33 - 120	20
Dibenzo(a,h)anthracene	0.0500	0.0500 ug/L			10 - 131	20	10 - 149	20
Dibenzofuran	2.50	5.00 ug/L			37 - 103	20	42 - 105	20
Diethyl phthalate	2.50	5.00 ug/L			41 - 106	20	38 - 112	20
Dimethyl phthalate	2.50	5.00 ug/L			38 - 105	20	49 - 106	20
Di-n-butyl phthalate	2.50	5.00 ug/L			24 - 121	20	36 - 110	20
Di-n-octyl phthalate	2.50	5.00 ug/L			25 - 141	20	12 - 149	20
Diphenylamine	2.50	5.00 ug/L			40 - 140	25	40 - 140	20
Fluoranthene	0.0500	0.0500 ug/L			29 - 123	20	33 - 126	20
Fluorene	0.0500	0.0500 ug/L			20 - 133	20	28 - 117	20
Hexachlorobenzene	0.0200	0.0200 ug/L			24 - 120	20	27 - 120	20
Hexachlorobutadiene	0.500	0.500 ug/L			26 - 98	20	25 - 106	20
Hexachlorocyclopentadiene	2.50	5.00 ug/L			10 - 103	20	10 - 99	20
Hexachloroethane	0.500	0.500 ug/L			11 - 102	20	33 - 84	20
Indeno(1,2,3-cd)pyrene	0.0500	0.0500 ug/L			10 - 130	20	10 - 150	20
Isophorone	2.50	5.00 ug/L			19 - 113	20	29 - 115	20
Naphthalene	0.0500	0.0500 ug/L			26 - 104	20	30 - 99	20
Nitrobenzene	0.250	0.250 ug/L			25 - 107	20	32 - 113	20
N-Nitrosodimethylamine	0.500	0.500 ug/L			10 - 110	20	10 - 63	20
N-nitroso-di-n-propylamine	2.50	5.00 ug/L			16 - 127	20	36 - 118	20
N-Nitrosodiphenylamine	2.50	5.00 ug/L			46 - 116	20	27 - 145	20
Pentachlorophenol	0.250	0.250 ug/L			10 - 181	20	19 - 127	20
Phenanthrene	0.0500	0.0500 ug/L			29 - 121	20	31 - 112	20
Phenol	2.50	5.00 ug/L			10 - 107	20	10 - 37	20
Pyrene	0.0500	0.0500 ug/L			34 - 129	20	42 - 125	20

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Analytical Method Information

Semivolatile Organic Compounds by GC/MS

Semi-Volatiles, 8270 - Comprehensive in Soil (EPA 8270D) Units: **ug/kg**

Preservation: Cool 4°C **Hold Time to Analysis** 40 days

Container: 06_4 oz. WM Clear Glass Cool to 4° C **Amount Required:** 100 g **Hold Time to Extr.** 14 days

Analyte	MDL	Reporting Limit	Surrogate %R	Duplicate RPD	Matrix Spike %R	Matrix Spike RPD	Blank Spike / LCS %R	Blank Spike / LCS RPD
1,1-Biphenyl	20.9	41.7 ug/kg			10 - 130	30	18 - 111	30
1,2,4,5-Tetrachlorobenzene	41.7	83.3 ug/kg			10 - 133	30	21 - 131	30
1,2,4-Trichlorobenzene	20.9	41.7 ug/kg			10 - 127	30	10 - 140	30
1,2-Dichlorobenzene	20.9	41.7 ug/kg			14 - 111	30	34 - 108	30
1,2-Diphenylhydrazine (as Azobenzene)	20.9	41.7 ug/kg			10 - 144	30	17 - 137	30
1,3-Dichlorobenzene	20.9	41.7 ug/kg			11 - 111	30	33 - 110	30
1,4-Dichlorobenzene	20.9	41.7 ug/kg			10 - 106	30	32 - 104	30
2,3,4,6-Tetrachlorophenol	41.7	83.3 ug/kg			30 - 130	30	30 - 130	30
2,4,5-Trichlorophenol	20.9	41.7 ug/kg			10 - 127	30	27 - 118	30
2,4,6-Trichlorophenol	20.9	41.7 ug/kg			10 - 132	30	31 - 120	30
2,4-Dichlorophenol	20.9	41.7 ug/kg			10 - 128	30	20 - 127	30
2,4-Dimethylphenol	20.9	41.7 ug/kg			10 - 137	30	14 - 132	30
2,4-Dinitrophenol	41.7	83.3 ug/kg			10 - 171	30	10 - 171	30
2,4-Dinitrotoluene	20.9	41.7 ug/kg			16 - 135	30	34 - 131	30
2,6-Dinitrotoluene	20.9	41.7 ug/kg			18 - 131	30	31 - 128	30
2-Chloronaphthalene	20.9	41.7 ug/kg			10 - 129	30	31 - 117	30
2-Chlorophenol	20.9	41.7 ug/kg			15 - 116	30	33 - 113	30
2-Methylnaphthalene	20.9	41.7 ug/kg			10 - 147	30	12 - 138	30
2-Methylphenol	20.9	41.7 ug/kg			10 - 136	30	10 - 136	30
2-Nitroaniline	41.7	83.3 ug/kg			10 - 137	30	27 - 132	30
2-Nitrophenol	20.9	41.7 ug/kg			10 - 129	30	17 - 129	30
3- & 4-Methylphenols	20.9	41.7 ug/kg			10 - 123	30	29 - 103	30
3,3-Dichlorobenzidine	20.9	41.7 ug/kg			10 - 155	30	22 - 149	30
3-Nitroaniline	41.7	83.3 ug/kg			12 - 133	30	20 - 133	30
4,6-Dinitro-2-methylphenol	41.7	83.3 ug/kg			10 - 155	30	10 - 143	30
4-Bromophenyl phenyl ether	20.9	41.7 ug/kg			14 - 128	30	29 - 120	30
4-Chloro-3-methylphenol	20.9	41.7 ug/kg			10 - 134	30	24 - 129	30
4-Chloroaniline	20.9	41.7 ug/kg			10 - 145	30	10 - 132	30
4-Chlorophenyl phenyl ether	20.9	41.7 ug/kg			14 - 130	30	27 - 124	30
4-Nitroaniline	41.7	83.3 ug/kg			10 - 147	30	16 - 128	30
4-Nitrophenol	41.7	83.3 ug/kg			10 - 137	30	10 - 141	30
Acenaphthene	20.9	41.7 ug/kg			10 - 146	30	30 - 121	30
Acenaphthylene	20.9	41.7 ug/kg			10 - 134	30	30 - 115	30
Acetophenone	20.9	41.7 ug/kg			10 - 116	30	20 - 112	30
Aniline	83.5	167 ug/kg			10 - 123	30	10 - 119	30
Anthracene	20.9	41.7 ug/kg			10 - 142	30	34 - 118	30
Atrazine	20.9	41.7 ug/kg			19 - 115	30	26 - 112	30
Benzaldehyde	20.9	41.7 ug/kg			10 - 125	30	21 - 100	30
Benzidine	83.5	167 ug/kg				30		30
Benzo(a)anthracene	20.9	41.7 ug/kg			10 - 158	30	32 - 122	30
Benzo(a)pyrene	20.9	41.7 ug/kg			10 - 180	30	29 - 133	30
Benzo(b)fluoranthene	20.9	41.7 ug/kg			10 - 200	30	25 - 133	30
Benzo(g,h,i)perylene	20.9	41.7 ug/kg			10 - 138	30	10 - 143	30
Benzo(k)fluoranthene	20.9	41.7 ug/kg			10 - 197	30	25 - 128	30
Benzoic acid	20.9	41.7 ug/kg			10 - 166	30	10 - 140	30
Benzyl alcohol	20.9	41.7 ug/kg			12 - 124	30	30 - 115	30

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Analytical Method Information

Semivolatile Organic Compounds by GC/MS

Analyte	MDL	Reporting Limit	Surrogate %R	Duplicate RPD	Matrix Spike %R	Matrix Spike RPD	Blank Spike / LCS %R	Blank Spike / LCS RPD
Benzyl butyl phthalate	20.9	41.7 ug/kg			10 - 154	30	26 - 126	30
Bis(2-chloroethoxy)methane	20.9	41.7 ug/kg			10 - 132	30	19 - 132	30
Bis(2-chloroethyl)ether	20.9	41.7 ug/kg			10 - 119	30	19 - 125	30
Bis(2-chloroisopropyl)ether	20.9	41.7 ug/kg			10 - 139	30	20 - 135	30
Bis(2-ethylhexyl)phthalate	20.9	41.7 ug/kg			10 - 167	30	10 - 155	30
Caprolactam	41.7	83.3 ug/kg			10 - 132	30	10 - 127	30
Carbazole	20.9	41.7 ug/kg			10 - 167	30	35 - 123	30
Chrysene	20.9	41.7 ug/kg			10 - 156	30	32 - 123	30
Dibenzo(a,h)anthracene	20.9	41.7 ug/kg			10 - 137	30	10 - 136	30
Dibenzofuran	20.9	41.7 ug/kg			10 - 147	30	29 - 121	30
Diethyl phthalate	20.9	41.7 ug/kg			20 - 120	30	34 - 116	30
Dimethyl phthalate	20.9	41.7 ug/kg			18 - 131	30	35 - 124	30
Di-n-butyl phthalate	20.9	41.7 ug/kg			10 - 137	30	31 - 116	30
Di-n-octyl phthalate	20.9	41.7 ug/kg			10 - 180	30	26 - 136	30
Diphenylamine	41.7	83.3 ug/kg			40 - 140	30	40 - 140	30
Fluoranthene	20.9	41.7 ug/kg			10 - 160	30	33 - 122	30
Fluorene	20.9	41.7 ug/kg			10 - 157	30	29 - 123	30
Hexachlorobenzene	20.9	41.7 ug/kg			10 - 137	30	21 - 124	30
Hexachlorobutadiene	20.9	41.7 ug/kg			10 - 132	30	10 - 149	30
Hexachlorocyclopentadiene	20.9	41.7 ug/kg			10 - 106	30	10 - 129	30
Hexachloroethane	20.9	41.7 ug/kg			10 - 110	30	28 - 108	30
Indeno(1,2,3-cd)pyrene	20.9	41.7 ug/kg			10 - 144	30	10 - 135	30
Isophorone	20.9	41.7 ug/kg			10 - 132	30	20 - 132	30
Naphthalene	20.9	41.7 ug/kg			10 - 141	30	23 - 124	30
Nitrobenzene	20.9	41.7 ug/kg			10 - 131	30	13 - 132	30
N-Nitrosodimethylamine	20.9	41.7 ug/kg			10 - 126	30	11 - 129	30
N-nitroso-di-n-propylamine	20.9	41.7 ug/kg			10 - 125	30	24 - 119	30
N-Nitrosodiphenylamine	20.9	41.7 ug/kg			10 - 177	30	22 - 152	30
Pentachlorophenol	20.9	41.7 ug/kg			10 - 153	30	10 - 139	30
Phenanthrene	20.9	41.7 ug/kg			10 - 148	30	33 - 123	30
Phenol	20.9	41.7 ug/kg			10 - 126	30	23 - 115	30
Pyrene	20.9	41.7 ug/kg			10 - 165	30	32 - 130	30

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Analytical Method Information

Semivolatile Organic Compounds by GC/MS/SIM

Analyte	MDL	Reporting Limit	Surrogate %R	Duplicate RPD	Matrix Spike %R	Matrix Spike RPD	Blank Spike / LCS %R	Blank Spike / LCS RPD
Semi-Volatiles, 1,4-Dioxane 8270 SIM-Soil in Soil (EPA 8270D SIM)					Units: **ug/kg**			
Preservation: Cool 4°C						**Hold Time to Analysis**	28 days	
Container: 06_4 oz. WM Clear Glass Cool to 4° C		**Amount Required:**	250 mL			**Hold Time to Extr.**	14 days	
1,4-Dioxane	3.70	20.0 ug/kg		30	40 - 130	30	40 - 130	30

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Analytical Method Information

Semivolatile Organic Compounds by GC/MS/SIM

Analyte	MDL	Reporting Limit	Surrogate %R	Duplicate RPD	Matrix Spike %R	Matrix Spike RPD	Blank Spike / LCS %R	Blank Spike / LCS RPD
Semi-Volatiles, 1,4-Dioxane 8270 SIM-Aqueous in Water (EPA 8270D SIM)					Units: **ug/L**			
Preservation: Cool 4°C						**Hold Time to Analysis** 28 days		
Container: 09_500 mL Glass Amber		**Amount Required:** 500 mL				**Hold Time to Extr.** 7 days		
1,4-Dioxane	0.200	0.300 ug/L		30	50 - 130	30	50 - 130	30

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Analytical Method Information

PFAS Target compounds by LC/MS-MS

Analyte	MDL	Reporting Limit	Surrogate %R	Duplicate RPD	Matrix Spike %R	Matrix Spike RPD	Blank Spike / LCS %R	Blank Spike / LCS RPD
PFAS, NYSDEC Target List in Water (EPA 537m)					Units: **ng/L**			
Preservation: Cool 4°C						**Hold Time to Analysis**	40 days	
Container: 10_250mL Plastic Cool to 4° C		**Amount Required:**	250 mL			**Hold Time to Extr.**	14 days	
1H,1H,2H,2H-Perfluorodecanesulfonic acid (8:2 FTS)	2.00	2.00 ng/L		30	25 - 200	35	50 - 175	30
1H,1H,2H,2H-Perfluorooctanesulfonic acid (6:2 FTS)	5.00	5.00 ng/L		30	25 - 200	35	50 - 175	30
N-EtFOSAA	2.00	2.00 ng/L		30	25 - 150	35	50 - 130	30
N-MeFOSAA	2.00	2.00 ng/L		30	25 - 150	35	50 - 130	30
Perfluoro-1-decanesulfonic acid (PFDS)	2.00	2.00 ng/L		30	25 - 150	35	50 - 130	30
Perfluoro-1-heptanesulfonic acid (PFHpS)	2.00	2.00 ng/L		30	25 - 150	35	50 - 130	30
Perfluoro-1-octanesulfonamide (FOSA)	2.00	2.00 ng/L		30	25 - 150	35	50 - 130	30
Perfluorobutanesulfonic acid (PFBS)	2.00	2.00 ng/L		30	25 - 150	35	50 - 130	30
Perfluorodecanoic acid (PFDA)	2.00	2.00 ng/L		30	25 - 150	35	50 - 130	30
Perfluorododecanoic acid (PFDoA)	2.00	2.00 ng/L		30	25 - 150	35	50 - 130	30
Perfluoroheptanoic acid (PFHpA)	2.00	2.00 ng/L		30	25 - 150	35	50 - 130	30
Perfluorohexanesulfonic acid (PFHxS)	2.00	2.00 ng/L		30	25 - 150	35	50 - 130	30
Perfluorohexanoic acid (PFHxA)	2.00	2.00 ng/L		30	25 - 150	35	50 - 130	30
Perfluoro-n-butanoic acid (PFBA)	2.00	2.00 ng/L		30	25 - 150	35	50 - 130	30
Perfluorononanoic acid (PFNA)	2.00	2.00 ng/L		30	25 - 150	35	50 - 130	30
Perfluorooctanesulfonic acid (PFOS)	2.00	2.00 ng/L		30	25 - 150	35	50 - 130	30
Perfluorooctanoic acid (PFOA)	2.00	2.00 ng/L		30	25 - 150	35	50 - 130	30
Perfluoropentanoic acid (PFPeA)	2.00	2.00 ng/L		30	25 - 150	35	50 - 130	30
Perfluorotetradecanoic acid (PFTA)	2.00	2.00 ng/L		30	25 - 150	35	50 - 130	30
Perfluorotridecanoic acid (PFTrDA)	2.00	2.00 ng/L		30	25 - 150	35	50 - 130	30
Perfluoroundecanoic acid (PFUnA)	2.00	2.00 ng/L		30	25 - 150	35	50 - 130	30
PFAS, NYSDEC Target List in Soil (EPA 537m)					Units: **ug/kg**			
Preservation: Cool 4°C						**Hold Time to Analysis**	28 days	
Container: 10_250mL Plastic Cool to 4° C		**Amount Required:**	250 mL			**Hold Time to Extr.**	14 days	
1H,1H,2H,2H-Perfluorodecanesulfonic acid (8:2 FTS)	0.250	0.250 ug/kg		30	25 - 200	35	50 - 200	30
1H,1H,2H,2H-Perfluorooctanesulfonic acid (6:2 FTS)	0.250	0.250 ug/kg		30	25 - 200	35	50 - 200	30
N-EtFOSAA	0.250	0.250 ug/kg		30	25 - 150	35	50 - 130	30
N-MeFOSAA	0.250	0.250 ug/kg		30	25 - 150	35	50 - 130	30
Perfluoro-1-decanesulfonic acid (PFDS)	0.250	0.250 ug/kg		30	25 - 150	35	50 - 130	30
Perfluoro-1-heptanesulfonic acid (PFHpS)	0.250	0.250 ug/kg		30	25 - 150	35	50 - 130	30
Perfluoro-1-octanesulfonamide (FOSA)	0.250	0.250 ug/kg		30	25 - 150	35	50 - 130	30
Perfluorobutanesulfonic acid (PFBS)	0.250	0.250 ug/kg		30	25 - 150	35	50 - 130	30
Perfluorodecanoic acid (PFDA)	0.250	0.250 ug/kg		30	25 - 150	35	50 - 130	30
Perfluorododecanoic acid (PFDoA)	0.250	0.250 ug/kg		30	25 - 150	35	50 - 130	30
Perfluoroheptanoic acid (PFHpA)	0.250	0.250 ug/kg		30	25 - 150	35	50 - 130	30
Perfluorohexanesulfonic acid (PFHxS)	0.250	0.250 ug/kg		30	25 - 150	35	50 - 130	30
Perfluorohexanoic acid (PFHxA)	0.250	0.250 ug/kg		30	25 - 150	35	50 - 130	30
Perfluoro-n-butanoic acid (PFBA)	0.250	0.250 ug/kg		30	25 - 150	35	50 - 130	30
Perfluorononanoic acid (PFNA)	0.250	0.250 ug/kg		30	25 - 150	35	50 - 130	30
Perfluorooctanesulfonic acid (PFOS)	0.250	0.250 ug/kg		30	25 - 150	35	50 - 130	30
Perfluorooctanoic acid (PFOA)	0.250	0.250 ug/kg		30	25 - 150	35	50 - 130	30
Perfluoropentanoic acid (PFPeA)	0.250	0.250 ug/kg		30	25 - 150	35	50 - 130	30
Perfluorotetradecanoic acid (PFTA)	0.250	0.250 ug/kg		30	25 - 150	35	50 - 130	30
Perfluorotridecanoic acid (PFTrDA)	0.250	0.250 ug/kg		30	25 - 150	35	50 - 130	30
Perfluoroundecanoic acid (PFUnA)	0.250	0.250 ug/kg		30	25 - 150	35	50 - 130	30

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Analytical Method Information

PFAS Target compounds by LC/MS-MS

Analyte	MDL	Reporting Limit	Surrogate %R	Duplicate RPD	Matrix Spike %R	Matrix Spike RPD	Blank Spike / LCS %R	Blank Spike / LCS RPD

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Analytical Method Information

Organochlorine Pesticides by GC/ECD

Analyte	MDL	Reporting Limit	Surrogate %R	Duplicate RPD	Matrix Spike %R	Matrix Spike RPD	Blank Spike / LCS %R	Blank Spike / LCS RPD
Pesticides, 8081 target list in Water (EPA 8081B)					Units: **ug/L**			
Preservation: Cool 4°C						**Hold Time to Analysis** 40 days		
Container: 07_1000mL Amber Glass Cool to 4° C		**Amount Required:** 1000 mL				**Hold Time to Extr.** 7 days		
4,4'-DDD	0.00400	0.00400 ug/L			30 - 150	20	40 - 140	20
4,4'-DDE	0.00400	0.00400 ug/L			30 - 150	20	40 - 140	20
4,4'-DDT	0.00400	0.00400 ug/L			30 - 150	20	40 - 140	20
Aldrin	0.00400	0.00400 ug/L			30 - 150	20	40 - 140	20
alpha-BHC	0.00400	0.00400 ug/L			30 - 150	20	40 - 140	20
alpha-Chlordane	0.00400	0.00400 ug/L			30 - 150	20	40 - 140	20
beta-BHC	0.00400	0.00400 ug/L			30 - 150	20	40 - 140	20
Chlordane, total	0.0200	0.0200 ug/L				20		20
delta-BHC	0.00400	0.00400 ug/L			30 - 150	20	40 - 140	20
Dieldrin	0.00200	0.00200 ug/L			30 - 150	20	40 - 140	20
Endosulfan I	0.00400	0.00400 ug/L			30 - 150	20	40 - 140	20
Endosulfan II	0.00400	0.00400 ug/L			30 - 150	20	40 - 140	20
Endosulfan sulfate	0.00400	0.00400 ug/L			30 - 150	20	40 - 140	20
Endrin	0.00400	0.00400 ug/L			30 - 150	20	40 - 140	20
Endrin aldehyde	0.0100	0.0100 ug/L			30 - 150	20	40 - 140	20
Endrin ketone	0.0100	0.0100 ug/L			30 - 150	20	40 - 140	20
gamma-BHC (Lindane)	0.00400	0.00400 ug/L			30 - 150	20	40 - 140	20
gamma-Chlordane	0.0100	0.0100 ug/L			30 - 150	20	40 - 140	20
Heptachlor	0.00400	0.00400 ug/L			30 - 150	20	40 - 140	20
Heptachlor epoxide	0.00400	0.00400 ug/L			30 - 150	20	40 - 140	20
Methoxychlor	0.00400	0.00400 ug/L			30 - 150	20	40 - 140	20
Toxaphene	0.100	0.100 ug/L				20		20
Pesticides/PCBs, EPA 8081/8082 Group in Water (varies)					Units: **N/A**			
Preservation: [Group Analysis]						**Hold Time to Analysis** 0 days		
Container: NA		**Amount Required:** NA				**Hold Time to Extr.** 5 days		
Polychlorinated Biphenyls (PCB) in Water (EPA 8082A)					Units: **ug/L**			
Preservation: Cool 4°C						**Hold Time to Analysis** 40 days		
Container: 07_1000mL Amber Glass Cool to 4° C		**Amount Required:** 1000 mL				**Hold Time to Extr.** 7 days		
Aroclor 1016	0.0500	0.0500 ug/L		50	40 - 140	50	40 - 120	30
Aroclor 1221	0.0500	0.0500 ug/L						
Aroclor 1232	0.0500	0.0500 ug/L						
Aroclor 1242	0.0500	0.0500 ug/L						
Aroclor 1248	0.0500	0.0500 ug/L						
Aroclor 1254	0.0500	0.0500 ug/L		50		50		30
Aroclor 1260	0.0500	0.0500 ug/L		50	40 - 140	50	40 - 120	30
Total PCBs	0.0500	0.0500 ug/L						

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York Analytical Laboratories, Inc.

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Analytical Method Information

Organochlorine Pesticides by GC/ECD

Analyte	MDL	Reporting Limit	Surrogate %R	Duplicate RPD	Matrix Spike %R	Matrix Spike RPD	Blank Spike / LCS %R	Blank Spike / LCS RPD
Pesticides, 8081 target list in Soil (EPA 8081B)					Units: **ug/kg**			
Preservation: Cool 4°C						**Hold Time to Analysis** 40 days		
Container: 06_4 oz. WM Clear Glass Cool to 4° C		**Amount Required:** 100 g				**Hold Time to Extr.** 14 days		
4,4'-DDD	0.330	0.330 ug/kg			30 - 150	30	40 - 140	30
4,4'-DDE	0.330	0.330 ug/kg			30 - 150	30	40 - 140	30
4,4'-DDT	0.330	0.330 ug/kg			30 - 150	30	40 - 140	30
Aldrin	0.330	0.330 ug/kg			30 - 150	30	40 - 140	30
alpha-BHC	0.330	0.330 ug/kg			30 - 150	30	40 - 140	30
alpha-Chlordane	0.330	0.330 ug/kg			30 - 150	30	40 - 140	30
beta-BHC	0.330	0.330 ug/kg			30 - 150	30	40 - 140	30
Chlordane, total	6.60	6.60 ug/kg						30
delta-BHC	0.330	0.330 ug/kg			30 - 150	30	40 - 140	30
Dieldrin	0.330	0.330 ug/kg			30 - 150	30	40 - 140	30
Endosulfan I	0.330	0.330 ug/kg			30 - 150	30	40 - 140	30
Endosulfan II	0.330	0.330 ug/kg			30 - 150	30	40 - 140	30
Endosulfan sulfate	0.330	0.330 ug/kg			30 - 150	30	40 - 140	30
Endrin	0.330	0.330 ug/kg			30 - 150	30	40 - 140	30
Endrin aldehyde	0.330	0.330 ug/kg			30 - 150	30	40 - 140	30
Endrin ketone	0.330	0.330 ug/kg			30 - 150	30	40 - 140	30
gamma-BHC (Lindane)	0.330	0.330 ug/kg			30 - 150	30	40 - 140	30
gamma-Chlordane	0.330	0.330 ug/kg			30 - 150	30	40 - 140	30
Heptachlor	0.330	0.330 ug/kg			30 - 150	30	40 - 140	30
Heptachlor epoxide	0.330	0.330 ug/kg			30 - 150	30	40 - 140	30
Methoxychlor	1.65	1.65 ug/kg			30 - 150	30	40 - 140	30
Toxaphene	16.7	16.7 ug/kg				30		30
Pesticides/PCBs, EPA 8081/8082 Group in Soil (varies)					Units: **N/A**			
Preservation: [Group Analysis]						**Hold Time to Analysis** 0 days		
Container:		**Amount Required:**				**Hold Time to Extr.** 5 days		
Polychlorinated Biphenyls (PCB) in Soil (EPA 8082A)					Units: **mg/kg**			
Preservation: Cool 4°C						**Hold Time to Analysis** 40 days		
Container: 06_8 oz. WM Clear Glass Cool to 4° C		**Amount Required:** 100g				**Hold Time to Extr.** 14 days		
Aroclor 1016	0.0167	0.0167 mg/kg			40 - 140	50	40 - 130	25
Aroclor 1221	0.0167	0.0167 mg/kg						
Aroclor 1232	0.0167	0.0167 mg/kg						
Aroclor 1242	0.0167	0.0167 mg/kg						
Aroclor 1248	0.0167	0.0167 mg/kg						
Aroclor 1254	0.0167	0.0167 mg/kg				50		25
Aroclor 1260	0.0167	0.0167 mg/kg			40 - 140	50	40 - 130	25
Total PCBs	0.0167	0.0167 mg/kg						

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Analytical Method Information

Mercury by EPA 7000/200 Series Methods

Analyte	MDL	Reporting Limit	Surrogate %R	Duplicate RPD	Matrix Spike %R	Matrix Spike RPD	Blank Spike / LCS %R	Blank Spike / LCS RPD
Mercury by 7473 in Water (EPA 7473)					Units: **mg/L**			
Preservation: Add HNO3 to pH<2, Cool 4°C						**Hold Time to Analysis**	days	
Container: 10_250mL Plastic pH <2 w/ HNO3		**Amount Required:**	100 mL			**Hold Time to Extr.**	28 days	
Mercury	0.000200	0.000200 mg/L		20	75 - 125		80 - 120	
Metals, Target Analyte, ICP in Water (EPA 6010D)					Units: **mg/L**			
Preservation: Add HNO3 to pH<2, Cool 4°C						**Hold Time to Analysis**	days	
Container: 10_250mL Plastic pH <2 w/ HNO3		**Amount Required:**	250			**Hold Time to Extr.**	180 days	
Aluminum	0.0500	0.0500 mg/L		20	75 - 125	20	80 - 120	
Barium	0.0250	0.0250 mg/L		20	75 - 125	20	80 - 120	
Calcium	0.0500	0.0500 mg/L		20	75 - 125	20	80 - 120	
Chromium	0.00500	0.00500 mg/L		20	75 - 125	20	80 - 120	
Cobalt	0.00400	0.00400 mg/L		20	75 - 125	25	80 - 120	
Copper	0.0200	0.0200 mg/L		20	75 - 125	20	80 - 120	
Iron	0.250	0.250 mg/L		20	75 - 125	20	80 - 120	
Lead	0.00500	0.00500 mg/L		20	75 - 125	20	80 - 120	
Magnesium	0.0500	0.0500 mg/L		20	75 - 125	20	80 - 120	
Manganese	0.00500	0.00500 mg/L		20	75 - 125	20	80 - 120	
Nickel	0.0100	0.0100 mg/L		20	75 - 125	20	80 - 120	
Potassium	0.0500	0.0500 mg/L		20	75 - 125	20	80 - 120	
Silver	0.00500	0.00500 mg/L		20	75 - 125	20	80 - 120	
Sodium	0.500	0.500 mg/L		20	75 - 125	20	80 - 120	
Vanadium	0.0100	0.0100 mg/L		20	75 - 125	20	80 - 120	
Zinc	0.0250	0.0250 mg/L		20	75 - 125	20	80 - 120	
Metals, Target Analyte, ICPMS in Water (EPA 6020B)					Units: **ug/L**			
Preservation: Add HNO3 to pH<2, Cool 4°C						**Hold Time to Analysis**	days	
Container: 10_250mL Plastic pH <2 w/ HNO3		**Amount Required:**	200			**Hold Time to Extr.**	180 days	
Antimony	1.00	1.00 ug/L		20	75 - 125	20	80 - 120	
Arsenic	1.00	1.00 ug/L		20	75 - 125	20	80 - 120	
Beryllium	0.300	0.300 ug/L		20	75 - 125	20	80 - 120	
Cadmium	0.500	0.500 ug/L		20	75 - 125	20	80 - 120	
Selenium	1.00	1.00 ug/L		20	75 - 125	20	80 - 120	
Thallium	1.00	1.00 ug/L		20	75 - 125	20	80 - 120	
Metals, Target Analyte, ICPMS List in Water (varies)					Units: **N/A**			
Preservation: [Group Analysis]						**Hold Time to Analysis**	0 days	
Container:		**Amount Required:**				**Hold Time to Extr.**	5 days	

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Analytical Method Information

Mercury by EPA 7000/200 Series Methods

Analyte	MDL	Reporting Limit	Surrogate %R	Duplicate RPD	Matrix Spike %R	Matrix Spike RPD	Blank Spike / LCS %R	Blank Spike / LCS RPD
Mercury by 7473 in Soil (EPA 7473)					Units: **mg/kg**			
Preservation: Cool 4°C						**Hold Time to Analysis**	days	
Container: 06_8 oz. WM Clear Glass Cool to 4° C		**Amount Required:**	10 g.			**Hold Time to Extr.**	28 days	
Mercury	0.0300	0.0300 mg/kg		35	75 - 125		67.6 - 131	
Metals, Target Analyte in Soil (EPA 6010D)					Units: **mg/kg**			
Preservation: Cool 4°C						**Hold Time to Analysis**	days	
Container: 06_4 oz. WM Clear Glass Cool to 4° C		**Amount Required:**	50			**Hold Time to Extr.**	180 days	
Aluminum	5.00	5.00 mg/kg		35	75 - 125	35	80 - 120	
Antimony	2.50	2.50 mg/kg		35	75 - 125	35	80 - 120	
Arsenic	1.50	1.50 mg/kg		35	75 - 125	35	80 - 120	
Barium	2.50	2.50 mg/kg		35	75 - 125	35	80 - 120	
Beryllium	0.0500	0.0500 mg/kg		35	75 - 125	35	80 - 120	
Cadmium	0.300	0.300 mg/kg		35	75 - 125	35	80 - 120	
Calcium	0.500	5.00 mg/kg		35	75 - 125	35	80 - 120	
Chromium	0.500	0.500 mg/kg		35	75 - 125	35	80 - 120	
Cobalt	0.400	0.400 mg/kg		35	75 - 125	35	80 - 120	
Copper	2.00	2.00 mg/kg		35	75 - 125	35	80 - 120	
Iron	25.0	25.0 mg/kg		35	75 - 125	35	80 - 120	
Lead	0.500	0.500 mg/kg		35	75 - 125	35	80 - 120	
Magnesium	5.00	5.00 mg/kg		35	75 - 125	35	80 - 120	
Manganese	0.500	0.500 mg/kg		35	75 - 125	35	80 - 120	
Nickel	1.00	1.00 mg/kg		35	75 - 125	35	80 - 120	
Potassium	5.00	5.00 mg/kg		35	75 - 125	35	80 - 120	
Selenium	2.50	2.50 mg/kg		35	75 - 125	35	80 - 120	
Silver	0.500	0.500 mg/kg		35	75 - 125	35	80 - 120	
Sodium	50.0	50.0 mg/kg		35	75 - 125	35	80 - 120	
Thallium	2.50	2.50 mg/kg		35	75 - 125	35	80 - 120	
Vanadium	1.00	1.00 mg/kg		35	75 - 125	35	80 - 120	
Zinc	2.50	2.50 mg/kg		35	75 - 125	35	80 - 120	
Metals, Target Analyte List in Soil (varies)					Units: **N/A**			
Preservation: [Group Analysis]						**Hold Time to Analysis**	0 days	
Container:		**Amount Required:**				**Hold Time to Extr.**	5 days	

Appendix C

Low-Flow PFAS Sampling Procedures

United States Environmental Protection Agency | Office of Research and Development | Office of Solid Waste and Emergency Response | EPA/540/S-95/504 April 1996

Ground Water Issue

LOW-FLOW (MINIMAL DRAWDOWN) GROUND-WATER SAMPLING PROCEDURES

by Robert W. Puls[1] and Michael J. Barcelona[2]

Background

The Regional Superfund Ground Water Forum is a group of ground-water scientists, representing EPA's Regional Superfund Offices, organized to exchange information related to ground-water remediation at Superfund sites. One of the major concerns of the Forum is the sampling of ground water to support site assessment and remedial performance monitoring objectives. This paper is intended to provide background information on the development of low-flow sampling procedures and its application under a variety of hydrogeologic settings. It is hoped that the paper will support the production of standard operating procedures for use by EPA Regional personnel and other environmental professionals engaged in ground-water sampling.

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I. Introduction

The methods and objectives of ground-water sampling to assess water quality have evolved over time. Initially the emphasis was on the assessment of water quality of aquifers as sources of drinking water. Large water-bearing units were identified and sampled in keeping with that objective. These were highly productive aquifers that supplied drinking water via private wells or through public water supply systems. Gradually, with the increasing awareness of subsurface pollution of these water resources, the understanding of complex hydrogeochemical processes which govern the fate and transport of contaminants in the subsurface increased. This increase in understanding was also due to advances in a number of scientific disciplines and improvements in tools used for site characterization and ground-water sampling. Ground-water quality investigations where pollution was detected initially borrowed ideas, methods, and materials for site characterization from the water supply field and water analysis from public health practices. This included the materials and manner in which monitoring wells were installed and the way in which water was brought to the surface, treated, preserved and analyzed. The prevailing conceptual ideas included convenient generalizations of ground-water resources in terms of large and relatively homogeneous hydrologic *units*. With time it became apparent that conventional water supply generalizations of *homogeneity* did not adequately represent field data regarding pollution of these subsurface resources. The important role of *heterogeneity* became increasingly clear not only in geologic terms, but also in terms of complex physical,

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chemical and biological subsurface processes. With greater appreciation of the role of heterogeneity, it became evident that subsurface pollution was ubiquitous and encompassed the unsaturated zone to the deep subsurface and included unconsolidated sediments, fractured rock, and *aquitards* or low-yielding or impermeable formations. Small-scale processes and heterogeneities were shown to be important in identifying contaminant distributions and in controlling water and contaminant flow paths.

It is beyond the scope of this paper to summarize all the advances in the field of ground-water quality investigations and remediation, but two particular issues have bearing on ground-water sampling today: aquifer heterogeneity and colloidal transport. Aquifer heterogeneities affect contaminant flow paths and include variations in geology, geochemistry, hydrology and microbiology. As methods and the tools available for subsurface investigations have become increasingly sophisticated and understanding of the subsurface environment has advanced, there is an awareness that in most cases a primary concern for site investigations is characterization of contaminant flow paths rather than entire aquifers. In fact, in many cases, plume thickness can be less than well screen lengths (e.g., 3-6 m) typically installed at hazardous waste sites to detect and monitor plume movement over time. Small-scale differences have increasingly been shown to be important and there is a general trend toward smaller diameter wells and shorter screens.

The hydrogeochemical significance of colloidal-size particles in subsurface systems has been realized during the past several years (Gschwend and Reynolds, 1987; McCarthy and Zachara, 1989; Puls, 1990; Ryan and Gschwend, 1990). This realization resulted from both field and laboratory studies that showed faster contaminant migration over greater distances and at higher concentrations than flow and transport model predictions would suggest (Buddemeier and Hunt, 1988; Enfield and Bengtsson, 1988; Penrose et al., 1990). Such models typically account for interaction between the mobile aqueous and immobile solid phases, but do not allow for a mobile, reactive solid phase. It is recognition of this third *phase* as a possible means of contaminant transport that has brought increasing attention to the manner in which samples are collected and processed for analysis (Puls et al., 1990; McCarthy and Degueldre, 1993; Backhus et al., 1993; U. S. EPA, 1995). If such a phase is present in sufficient mass, possesses high sorption reactivity, large surface area, and remains stable in suspension, it can serve as an important mechanism to facilitate contaminant transport in many types of subsurface systems.

Colloids are particles that are sufficiently small so that the surface free energy of the particle dominates the bulk free energy. Typically, in ground water, this includes particles with diameters between 1 and 1000 nm. The most commonly observed mobile particles include: secondary clay minerals; hydrous iron, aluminum, and manganese oxides; dissolved and particulate organic materials, and viruses and bacteria. These reactive particles have been shown to be mobile under a variety of conditions in both field studies and laboratory column experiments, and as such need to be included in monitoring programs where identification of the *total* mobile contaminant loading (dissolved + naturally suspended particles) at a site is an objective. To that end, sampling methodologies must be used which do not artificially bias *naturally* suspended particle concentrations.

Currently the most common ground-water purging and sampling methodology is to purge a well using bailers or high speed pumps to remove 3 to 5 casing volumes followed by sample collection. This method can cause adverse impacts on sample quality through collection of samples with high levels of turbidity. This results in the inclusion of otherwise immobile artifactual particles which produce an overestimation of certain analytes of interest (e.g., metals or hydrophobic organic compounds). Numerous documented problems associated with filtration (Danielsson, 1982; Laxen and Chandler, 1982; Horowitz et al., 1992) make this an undesirable method of rectifying the turbidity problem, and include the removal of potentially mobile (contaminant-associated) particles during filtration, thus artificially biasing contaminant concentrations low. Sampling-induced turbidity problems can often be mitigated by using low-flow purging and sampling techniques.

Current subsurface conceptual models have undergone considerable refinement due to the recent development and increased use of field screening tools. So-called hydraulic *push* technologies (e.g., cone penetrometer, Geoprobe®, QED HydroPunch®) enable relatively fast screening site characterization which can then be used to design and install a monitoring well network. Indeed, alternatives to conventional monitoring wells are now being considered for some hydrogeologic settings. The ultimate design of any monitoring system should however be based upon adequate site characterization and be consistent with established monitoring objectives.

If the sampling program objectives include accurate assessment of the magnitude and extent of subsurface contamination over time and/or accurate assessment of subsequent remedial performance, then some information regarding plume delineation in three-dimensional space is necessary prior to monitoring well network design and installation. This can be accomplished with a variety of different tools and equipment ranging from hand-operated augers to screening tools mentioned above and large drilling rigs. Detailed information on ground-water flow velocity, direction, and horizontal and vertical variability are essential baseline data requirements. Detailed soil and geologic data are required prior to and during the installation of sampling points. This includes historical as well as detailed soil and geologic logs which accumulate during the site investigation. The use of borehole geophysical techniques is also recommended. With this information (together with other site characterization data) and a clear understanding of sampling

objectives, then appropriate location, screen length, well diameter, slot size, etc. for the monitoring well network can be decided. This is especially critical for new in situ remedial approaches or natural attenuation assessments at hazardous waste sites.

In general, the overall goal of any ground-water sampling program is to collect water samples with no alteration in water chemistry; analytical data thus obtained may be used for a variety of specific monitoring programs depending on the regulatory requirements. The sampling methodology described in this paper assumes that the monitoring goal is to sample monitoring wells for the presence of contaminants and it is applicable whether mobile colloids are a concern or not and whether the analytes of concern are metals (and metalloids) or organic compounds.

II. Monitoring Objectives and Design Considerations

The following issues are important to consider prior to the design and implementation of any ground-water monitoring program, including those which anticipate using low-flow purging and sampling procedures.

A. Data Quality Objectives (DQOs)

Monitoring objectives include four main types: detection, assessment, corrective-action evaluation and resource evaluation, along with *hybrid* variations such as site-assessments for property transfers and water availability investigations. Monitoring objectives may change as contamination or water quality problems are discovered. However, there are a number of common components of monitoring programs which should be recognized as important regardless of initial objectives. These components include:

1) Development of a conceptual model that incorporates elements of the regional geology to the local geologic framework. The conceptual model development also includes initial site characterization efforts to identify hydrostratigraphic units and likely flow-paths using a minimum number of borings and well completions;

2) Cost-effective and well documented collection of high quality data utilizing simple, accurate, and reproducible techniques; and

3) Refinement of the conceptual model based on supplementary data collection and analysis.

These fundamental components serve many types of monitoring programs and provide a basis for future efforts that evolve in complexity and level of spatial detail as purposes and objectives expand. High quality, reproducible data collection is a common goal regardless of program objectives.

High quality data collection implies data of sufficient accuracy, precision, and completeness (i.e., ratio of valid analytical results to the minimum sample number called for by the program design) to meet the program objectives. Accuracy depends on the correct choice of monitoring tools and procedures to minimize sample and subsurface disturbance from collection to analysis. Precision depends on the repeatability of sampling and analytical protocols. It can be assured or improved by replication of sample analyses including blanks, field/lab standards and reference standards.

B. Sample Representativeness

An important goal of any monitoring program is collection of data that is truly representative of conditions at the site. The term *representativeness* applies to chemical and hydrogeologic data collected via wells, borings, piezometers, geophysical and soil gas measurements, lysimeters, and temporary sampling points. It involves a recognition of the statistical variability of individual subsurface physical properties, and contaminant or major ion concentration levels, while explaining extreme values. Subsurface temporal and spatial variability are facts. Good professional practice seeks to maximize representativeness by using proven accurate and reproducible techniques to define limits on the distribution of measurements collected at a site. However, measures of representativeness are dynamic and are controlled by evolving site characterization and monitoring objectives. An evolutionary site characterization model, as shown in Figure 1, provides a systematic approach to the goal of consistent data collection.

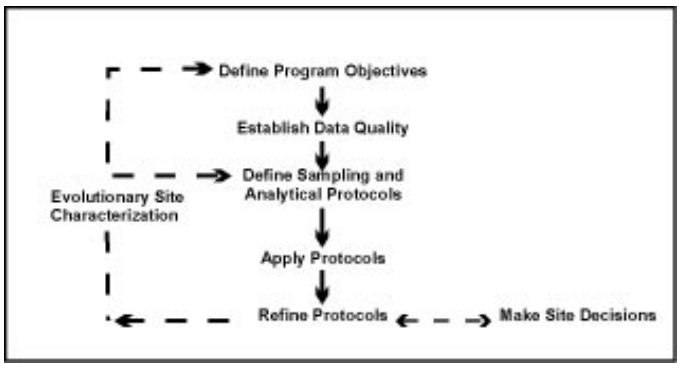

Figure 1. Evolutionary Site Characterization Model

The model emphasizes a recognition of the causes of the variability (e.g., use of inappropriate technology such as using bailers to purge wells; imprecise or operator-dependent methods) and the need to control avoidable errors.

1) Questions of Scale

A sampling plan designed to collect representative samples must take into account the potential scale of changes in site conditions through space and time as well as the chemical associations and behavior of the parameters that are targeted for investigation. In subsurface systems, physical (i.e., aquifer) and chemical properties over time or space are not statistically independent. In fact, samples taken in close proximity (i.e., within distances of a few meters) or within short time periods (i.e., more frequently than monthly) are highly auto-correlated. This means that designs employing high-sampling frequency (e.g., monthly) or dense spatial monitoring designs run the risk of redundant data collection and misleading inferences regarding trends in values that aren't statistically valid. In practice, contaminant detection and assessment monitoring programs rarely suffer these *over-sampling* concerns. In corrective-action evaluation programs, it is also possible that too little data may be collected over space or time. In these cases, false interpretation of the spatial extent of contamination or underestimation of temporal concentration variability may result.

2) Target Parameters

Parameter selection in monitoring program design is most often dictated by the regulatory status of the site. However, background water quality constituents, purging indicator parameters, and contaminants, all represent targets for data collection programs. The tools and procedures used in these programs should be equally rigorous and applicable to all categories of data, since all may be needed to determine or support regulatory action.

C. Sampling Point Design and Construction

Detailed site characterization is central to all decision-making purposes and the basis for this characterization resides in identification of the geologic framework and major hydro-stratigraphic units. Fundamental data for sample point location include: subsurface lithology, head-differences and background geochemical conditions. Each sampling point has a proper use or uses which should be documented at a level which is appropriate for the program's data quality objectives. Individual sampling points may not always be able to fulfill multiple monitoring objectives (e.g., detection, assessment, corrective action).

1) Compatibility with Monitoring Program and Data Quality Objectives

Specifics of sampling point location and design will be dictated by the complexity of subsurface lithology and variability in contaminant and/or geochemical conditions. It should be noted that, regardless of the ground-water sampling approach, few sampling points (e.g., wells, drive-points, screened augers) have zones of influence in excess of a few feet. Therefore, the spatial frequency of sampling points should be carefully selected and designed.

2) Flexibility of Sampling Point Design

In most cases *well-point* diameters in excess of 1 7/8 inches will permit the use of most types of submersible pumping devices for low-flow (minimal drawdown) sampling. It is suggested that *short* (e.g., less than 1.6 m) screens be incorporated into the monitoring design where possible so that comparable results from one device to another might be expected. *Short*, of course, is relative to the degree of vertical water quality variability expected at a site.

3) Equilibration of Sampling Point

Time should be allowed for equilibration of the well or sampling point with the formation after installation. Placement of well or sampling points in the subsurface produces some disturbance of ambient conditions. Drilling techniques (e.g., auger, rotary, etc.) are generally considered to cause more disturbance than *direct-push* technologies. In either case, there may be a period (i.e., days to months) during which water quality near the point may be distinctly different from that in the formation. Proper development of the sampling point and adjacent formation to remove fines created during emplacement will shorten this water quality *recovery* period.

III. Definition of Low-Flow Purging and Sampling

It is generally accepted that water in the well casing is non-representative of the formation water and needs to be purged prior to collection of ground-water samples. However, the water in the screened interval may indeed be representative of the formation, depending upon well construction and site hydrogeology. Wells are purged to some extent for the following reasons: the presence of the air interface at the top of the water column resulting in an oxygen concentration gradient with depth, loss of volatiles up the water column, leaching from or sorption to the casing or filter pack, chemical changes due to clay seals or backfill, and surface infiltration.

Low-flow purging, whether using portable or dedicated systems, should be done using pump-intake located in the middle or slightly above the middle of the screened interval. Placement of the pump too close to the bottom of the well will cause increased entrainment of solids which have collected in the well over time. These particles are present as a result of well development, prior purging and sampling events, and natural colloidal transport and deposition. Therefore, placement of the pump in the middle or toward the top of the screened interval is suggested. Placement of the pump at the top of the water column for sampling is only recommended in unconfined aquifers, screened across the water table, where this is the desired sampling point. Low-

flow purging has the advantage of minimizing mixing between the overlying stagnant casing water and water within the screened interval.

A. Low-Flow Purging and Sampling

Low-flow refers to the velocity with which water enters the pump intake and that is imparted to the formation pore water in the immediate vicinity of the well screen. It does not necessarily refer to the flow rate of water discharged at the surface which can be affected by flow regulators or restrictions. Water level drawdown provides the best indication of the stress imparted by a given flow-rate for a given hydrological situation. The objective is to pump in a manner that minimizes stress (drawdown) to the system to the extent practical taking into account established site sampling objectives. Typically, flow rates on the order of 0.1 - 0.5 L/min are used, however this is dependent on site-specific hydrogeology. Some extremely coarse-textured formations have been successfully sampled in this manner at flow rates to 1 L/min. The effectiveness of using low-flow purging is intimately linked with proper screen location, screen length, and well construction and development techniques. The reestablishment of natural flow paths in both the vertical and horizontal directions is important for correct interpretation of the data. For high resolution sampling needs, screens less than 1 m should be used. Most of the need for purging has been found to be due to passing the sampling device through the overlying casing water which causes mixing of these stagnant waters and the dynamic waters within the screened interval. Additionally, there is disturbance to suspended sediment collected in the bottom of the casing and the displacement of water out into the formation immediately adjacent to the well screen. These disturbances and impacts can be avoided using dedicated sampling equipment, which precludes the need to insert the sampling device prior to purging and sampling.

Isolation of the screened interval water from the overlying stagnant casing water may be accomplished using low-flow minimal drawdown techniques. If the pump intake is located within the screened interval, most of the water pumped will be drawn in directly from the formation with little mixing of casing water or disturbance to the sampling zone. However, if the wells are not constructed and developed properly, zones other than those intended may be sampled. At some sites where geologic heterogeneities are sufficiently different within the screened interval, higher conductivity zones may be preferentially sampled. This is another reason to use shorter screened intervals, especially where high spatial resolution is a sampling objective.

B. Water Quality Indicator Parameters

It is recommended that water quality indicator parameters be used to determine purging needs prior to sample collection in each well. Stabilization of parameters such as pH, specific conductance, dissolved oxygen, oxidation-reduction potential, temperature and turbidity should be used to determine when formation water is accessed during purging. In general, the order of stabilization is pH, temperature, and specific conductance, followed by oxidation-reduction potential, dissolved oxygen and turbidity. Temperature and pH, while commonly used as purging indicators, are actually quite insensitive in distinguishing between formation water and stagnant casing water; nevertheless, these are important parameters for data interpretation purposes and should also be measured. Performance criteria for determination of stabilization should be based on water-level drawdown, pumping rate and equipment specifications for measuring indicator parameters. Instruments are available which utilize in-line flow cells to continuously measure the above parameters.

It is important to establish specific well stabilization criteria and then consistently follow the same methods thereafter, particularly with respect to drawdown, flow rate and sampling device. Generally, the time or purge volume required for parameter stabilization is independent of well depth or well volumes. Dependent variables are well diameter, sampling device, hydrogeochemistry, pump flow rate, and whether the devices are used in a portable or dedicated manner. If the sampling device is already in place (i.e., dedicated sampling systems), then the time and purge volume needed for stabilization is much shorter. Other advantages of dedicated equipment include less purge water for waste disposal, much less decontamination of equipment, less time spent in preparation of sampling as well as time in the field, and more consistency in the sampling approach which probably will translate into less variability in sampling results. The use of dedicated equipment is strongly recommended at wells which will undergo routine sampling over time.

If parameter stabilization criteria are too stringent, then minor oscillations in indicator parameters may cause purging operations to become unnecessarily protracted. It should also be noted that turbidity is a very conservative parameter in terms of stabilization. Turbidity is always the last parameter to stabilize. Excessive purge times are invariably related to the establishment of too stringent turbidity stabilization criteria. It should be noted that natural turbidity levels in ground water may exceed 10 nephelometric turbidity units (NTU).

C. Advantages and Disadvantages of Low-Flow (Minimum Drawdown) Purging

In general, the advantages of low-flow purging include:

- samples which are representative of the *mobile* load of contaminants present (dissolved and colloid-associated);
- minimal disturbance of the sampling point thereby minimizing sampling artifacts;
- less operator variability, greater operator control;

- reduced stress on the formation (minimal drawdown);
- less mixing of stagnant casing water with formation water;
- reduced need for filtration and, therefore, less time required for sampling;
- smaller purging volume which decreases waste disposal costs and sampling time;
- better sample consistency; reduced artificial sample variability.

Some disadvantages of low-flow purging are:

- higher initial capital costs,
- greater set-up time in the field,
- need to transport additional equipment to and from the site,
- increased training needs,
- resistance to change on the part of sampling practitioners,
- concern that new data will indicate a *change in conditions* and trigger an *action*.

IV. Low-Flow (Minimal Drawdown) Sampling Protocols

The following ground-water sampling procedure has evolved over many years of experience in ground-water sampling for organic and inorganic compound determinations and as such summarizes the authors' (and others) experiences to date (Barcelona et al., 1984, 1994; Barcelona and Helfrich, 1986; Puls and Barcelona, 1989; Puls et. al. 1990, 1992; Puls and Powell, 1992; Puls and Paul, 1995). High-quality chemical data collection is essential in ground-water monitoring and site characterization. The primary limitations to the collection of *representative* ground-water samples include: mixing of the stagnant casing and *fresh* screen waters during insertion of the sampling device or ground-water level measurement device; disturbance and resuspension of settled solids at the bottom of the well when using high pumping rates or raising and lowering a pump or bailer; introduction of atmospheric gases or degassing from the water during sample handling and transfer, or inappropriate use of vacuum sampling device, etc.

A. Sampling Recommendations

Water samples should not be taken immediately following well development. Sufficient time should be allowed for the ground-water flow regime in the vicinity of the monitoring well to stabilize and to approach chemical equilibrium with the well construction materials. This lag time will depend on site conditions and methods of installation but often exceeds one week.

Well purging is nearly always necessary to obtain samples of water flowing through the geologic formations in the screened interval. Rather than using a general but arbitrary guideline of purging three casing volumes prior to sampling, it is recommended that an in-line water quality measurement device (e.g., flow-through cell) be used to establish the stabilization time for several parameters (e.g. , pH, specific conductance, redox, dissolved oxygen, turbidity) on a well-specific basis. Data on pumping rate, drawdown, and volume required for parameter stabilization can be used as a guide for conducting subsequent sampling activities.

The following are recommendations to be considered before, during and after sampling:

- use low-flow rates (<0.5 L/min), during both purging and sampling to maintain minimal drawdown in the well;
- maximize tubing wall thickness, minimize tubing length;
- place the sampling device intake at the desired sampling point;
- minimize disturbances of the stagnant water column above the screened interval during water level measurement and sampling device insertion;
- make proper adjustments to stabilize the flow rate as soon as possible;
- monitor water quality indicators during purging;
- collect unfiltered samples to estimate contaminant loading and transport potential in the subsurface system.

B. Equipment Calibration

Prior to sampling, all sampling device and monitoring equipment should be calibrated according to manufacturer's recommendations and the site Quality Assurance Project Plan (QAPP) and Field Sampling Plan (FSP). Calibration of pH should be performed with at least two buffers which bracket the expected range. Dissolved oxygen calibration must be corrected for local barometric pressure readings and elevation.

C. Water Level Measurement and Monitoring

It is recommended that a device be used which will least disturb the water surface in the casing. Well depth should be obtained from the well logs. Measuring to the bottom of the well casing will only cause resuspension of settled solids from the formation and require longer purging times for turbidity equilibration. Measure well depth after sampling is completed. The water level measurement should be taken from a permanent reference point which is surveyed relative to ground elevation.

D. Pump Type

The use of low-flow (e.g., 0.1-0.5 L/min) pumps is suggested for purging and sampling all types of analytes. All pumps have some limitation and these should be investigated with respect to application at a particular site. Bailers are inappropriate devices for low-flow sampling.

1) General Considerations

There are no unusual requirements for ground-water sampling devices when using low-flow, minimal drawdown techniques. The major concern is that the device give consistent results and minimal disturbance of the sample across a range of *low* flow rates (i.e., < 0.5 L/min). Clearly, pumping rates that cause minimal to no drawdown in one well could easily cause *significant* drawdown in another well finished in a less transmissive formation. In this sense, the pump should not cause undue pressure or temperature changes or physical disturbance on the water sample over a reasonable sampling range. Consistency in operation is critical to meet accuracy and precision goals.

2) Advantages and Disadvantages of Sampling Devices

A variety of sampling devices are available for low-flow (minimal drawdown) purging and sampling and include peristaltic pumps, bladder pumps, electrical submersible pumps, and gas-driven pumps. Devices which lend themselves to both dedication and consistent operation at definable low-flow rates are preferred. It is desirable that the pump be easily adjustable and operate reliably at these lower flow rates. The peristaltic pump is limited to shallow applications and can cause degassing resulting in alteration of pH, alkalinity, and some volatiles loss. Gas-driven pumps should be of a type that does not allow the gas to be in direct contact with the sampled fluid.

Clearly, bailers and other *grab* type samplers are ill-suited for low-flow sampling since they will cause repeated disturbance and mixing of *stagnant* water in the casing and the *dynamic* water in the screened interval. Similarly, the use of inertial lift foot-valve type samplers may cause too much disturbance at the point of sampling. Use of these devices also tends to introduce uncontrolled and unacceptable operator variability.

Summaries of advantages and disadvantages of various sampling devices are listed in Herzog et al. (1991), U. S. EPA (1992), Parker (1994) and Thurnblad (1994).

E. Pump Installation

Dedicated sampling devices (left in the well) capable of pumping and sampling are preferred over <u>any</u> other type of device. Any portable sampling device should be slowly and carefully lowered to the middle of the screened interval or slightly above the middle (e.g., 1-1.5 m below the top of a 3 m screen). This is to minimize excessive mixing of the stagnant water in the casing above the screen with the screened interval zone water, and to minimize resuspension of solids which will have collected at the bottom of the well. These two disturbance effects have been shown to directly affect the time required for purging. There also appears to be a direct correlation between size of portable sampling devices relative to the well bore and resulting purge volumes and times. The key is to minimize disturbance of water and solids in the well casing.

F. Filtration

Decisions to filter samples should be dictated by sampling objectives rather than as a *fix* for poor sampling practices, and field-filtering of certain constituents should not be the default. Consideration should be given as to what the application of field-filtration is trying to accomplish. For assessment of truly dissolved (as opposed to operationally *dissolved* [i.e., samples filtered with 0.45 µm filters]) concentrations of major ions and trace metals, 0.1 µm filters are recommended although 0.45 µm filters are normally used for most regulatory programs. Alkalinity samples must also be filtered if significant particulate calcium carbonate is suspected, since this material is likely to impact alkalinity titration results (although filtration itself may alter the CO_2 composition of the sample and, therefore, affect the results).

Although filtration may be appropriate, filtration of a sample may cause a number of unintended changes to occur (e.g. oxidation, aeration) possibly leading to filtration-induced artifacts during sample analysis and uncertainty in the results. Some of these unintended changes may be unavoidable but the factors leading to them must be recognized. Deleterious effects can be minimized by consistent application of certain filtration guidelines. Guidelines should address selection of filter type, media, pore size, etc. in order to identify and minimize potential sources of uncertainty when filtering samples.

In-line filtration is recommended because it provides better consistency through less sample handling, and minimizes sample exposure to the atmosphere. In-line filters are available in both disposable (barrel filters) and non-disposable (in-line filter holder, flat membrane filters) formats and various filter pore sizes (0.1-5.0 µm). Disposable filter cartridges have the advantage of greater sediment handling capacity when compared to traditional membrane filters. Filters must be pre-rinsed following manufacturer's recommendations. If there are no recommendations for rinsing, pass through a minimum of 1 L of ground water following purging and prior to sampling. Once filtration has begun, a filter cake may develop as particles larger than the pore size accumulate on the filter membrane. The result is that the effective pore diameter of the membrane is reduced and particles smaller than the stated pore size are excluded from the filtrate. Possible corrective measures include prefiltering (with larger pore size filters), minimizing particle loads to begin with, and reducing sample volume.

G. Monitoring of Water Level and Water Quality Indicator Parameters

Check water level periodically to monitor drawdown in the well as a guide to flow rate adjustment. The goal is minimal drawdown (<0.1 m) during purging. This goal may be difficult to achieve under some circumstances due to geologic heterogeneities within the screened interval, and may require adjustment based on site-specific conditions and personal experience. In-line water quality indicator parameters should be continuously monitored during purging. The water quality

indicator parameters monitored can include pH, redox potential, conductivity, dissolved oxygen (DO) and turbidity. The last three parameters are often most sensitive. Pumping rate, drawdown, and the time or volume required to obtain stabilization of parameter readings can be used as a future guide to purge the well. Measurements should be taken every three to five minutes if the above suggested rates are used. Stabilization is achieved after all parameters have stabilized for three successive readings. In lieu of measuring all five parameters, a minimum subset would include pH, conductivity, and turbidity or DO. Three successive readings should be within ± 0.1 for pH, ± 3% for conductivity, ± 10 mv for redox potential, and ± 10% for turbidity and DO. Stabilized purge indicator parameter trends are generally obvious and follow either an exponential or asymptotic change to stable values during purging. Dissolved oxygen and turbidity usually require the longest time for stabilization. The above stabilization guidelines are provided for rough estimates based on experience.

H. Sampling, Sample Containers, Preservation and Decontamination

Upon parameter stabilization, sampling can be initiated. If an in-line device is used to monitor water quality parameters, it should be disconnected or bypassed during sample collection. Sampling flow rate may remain at established purge rate or may be adjusted slightly to minimize aeration, bubble formation, turbulent filling of sample bottles, or loss of volatiles due to extended residence time in tubing. Typically, flow rates less than 0.5 L/min are appropriate. The same device should be used for sampling as was used for purging. Sampling should occur in a progression from least to most contaminated well, if this is known. Generally, volatile (e.g., solvents and fuel constituents) and gas sensitive (e.g., Fe^{2+}, CH_4, H_2S/HS^-, alkalinity) parameters should be sampled first. The sequence in which samples for most inorganic parameters are collected is immaterial unless filtered (dissolved) samples are desired. Filtering should be done last and in-line filters should be used as discussed above. During both well purging and sampling, proper protective clothing and equipment must be used based upon the type and level of contaminants present.

The appropriate sample container will be prepared in advance of actual sample collection for the analytes of interest and include sample preservative where necessary. Water samples should be collected directly into this container from the pump tubing.

Immediately after a sample bottle has been filled, it must be preserved as specified in the site (QAPP). Sample preservation requirements are based on the analyses being performed (use site QAPP, FSP, RCRA guidance document [U. S. EPA, 1992] or EPA SW-846 [U. S. EPA, 1982]). It may be advisable to add preservatives to sample bottles in a controlled setting prior to entering the field in order to reduce the chances of improperly preserving sample bottles or introducing field contaminants into a sample bottle while adding the preservatives.

The preservatives should be transferred from the chemical bottle to the sample container using a disposable polyethylene pipet and the disposable pipet should be used only once and then discarded.

After a sample container has been filled with ground water, a Teflon™ (or tin)-lined cap is screwed on tightly to prevent the container from leaking. A sample label is filled out as specified in the FSP. The samples should be stored inverted at 4°C.

Specific decontamination protocols for sampling devices are dependent to some extent on the type of device used and the type of contaminants encountered. Refer to the site QAPP and FSP for specific requirements.

I. Blanks

The following blanks should be collected:

(1) field blank: one field blank should be collected from each source water (distilled/deionized water) used for sampling equipment decontamination or for assisting well development procedures.

(2) equipment blank: one equipment blank should be taken prior to the commencement of field work, from each set of sampling equipment to be used for that day. Refer to site QAPP or FSP for specific requirements.

(3) trip blank: a trip blank is required to accompany each volatile sample shipment. These blanks are prepared in the laboratory by filling a 40-mL volatile organic analysis (VOA) bottle with distilled/deionized water.

V. Low-Permeability Formations and Fractured Rock

The overall sampling program goals or sampling objectives will drive how the sampling points are located, installed, and choice of sampling device. Likewise, site-specific hydrogeologic factors will affect these decisions. Sites with very low permeability formations or fractures causing discrete flow channels may require a unique monitoring approach. Unlike water supply wells, wells installed for ground-water quality assessment and restoration programs are often installed in low water-yielding settings (e.g., clays, silts). Alternative types of sampling points and sampling methods are often needed in these types of environments, because low-permeability settings may require extremely low-flow purging (<0.1 L/min) and may be technology-limited. Where devices are not readily available to pump at such low flow rates, the primary consideration is to avoid dewatering of

the well screen. This may require repeated recovery of the water during purging while leaving the pump in place within the well screen.

Use of low-flow techniques may be impractical in these settings, depending upon the water recharge rates. The sampler and the end-user of data collected from such wells need to understand the limitations of the data collected; i.e., a strong potential for underestimation of actual contaminant concentrations for volatile organics, potential false negatives for filtered metals and potential false positives for unfiltered metals. It is suggested that comparisons be made between samples recovered using low-flow purging techniques and samples recovered using passive sampling techniques (i.e., two sets of samples). Passive sample collection would essentially entail acquisition of the sample with no or very little purging using a dedicated sampling system installed within the screened interval or a passive sample collection device.

A. Low-Permeability Formations (<0.1 L/min recharge)

1. Low-Flow Purging and Sampling with Pumps

a. "portable or non-dedicated mode" - Lower the pump (one capable of pumping at <0.1 L/min) to mid-screen or slightly above and set in place for minimum of 48 hours (to lessen purge volume requirements). After 48 hours, use procedures listed in Part IV above regarding monitoring water quality parameters for stabilization, etc., but do not dewater the screen. If excessive drawdown and slow recovery is a problem, then alternate approaches such as those listed below may be better.

b. "dedicated mode" - Set the pump as above at least a week prior to sampling; that is, operate in a dedicated pump mode. With this approach significant reductions in purge volume should be realized. Water quality parameters should stabilize quite rapidly due to less disturbance of the sampling zone.

2. Passive Sample Collection

Passive sampling collection requires insertion of the device into the screened interval for a sufficient time period to allow flow and sample equilibration before extraction for analysis. Conceptually, the extraction of water from low yielding formations seems more akin to the collection of water from the unsaturated zone and passive sampling techniques may be more appropriate in terms of obtaining "representative" samples. Satisfying usual sample volume requirements is typically a problem with this approach and some latitude will be needed on the part of regulatory entities to achieve sampling objectives.

B. Fractured Rock

In fractured rock formations, a low-flow to zero purging approach using pumps in conjunction with packers to isolate the sampling zone in the borehole is suggested. Passive multi-layer sampling devices may also provide the most "representative" samples. It is imperative in these settings to identify flow paths or water-producing fractures prior to sampling using tools such as borehole flowmeters and/or other geophysical tools.

After identification of water-bearing fractures, install packer(s) and pump assembly for sample collection using low-flow sampling in "dedicated mode" or use a passive sampling device which can isolate the identified water-bearing fractures.

VI. Documentation

The usual practices for documenting the sampling event should be used for low-flow purging and sampling techniques. This should include, at a minimum: information on the conduct of purging operations (flow-rate, drawdown, water-quality parameter values, volumes extracted and times for measurements), field instrument calibration data, water sampling forms and chain of custody forms. See Figures 2 and 3 and "Ground Water Sampling Workshop -- A Workshop Summary" (U. S. EPA, 1995) for example forms and other documentation suggestions and information. This information coupled with laboratory analytical data and validation data are needed to judge the "useability" of the sampling data.

VII. Notice

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Figure 2. **Ground Water Sampling Log**

Project _____ **Site** _____ **Well No.** _____ **Date** _____
Well Depth _____ **Screen Length** _____ **Well Diameter** _____ **Casing Type** _____
Sampling Device _____ **Tubing type** _____ **Water Level** _____
Measuring Point _____ **Other Infor** _____

_____

Sampling Personnel _____

Time	pH	Temp	Cond.	Dis.O_2	Turb.	[ ]Conc			Notes

Type of Samples Collected

_____

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft: $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Figure 3. **Ground Water Sampling Log** (with automatic data logging for most water quality parameters)

Project _____ **Site** _____ **Well No.** _____ **Date** _____

Well Depth _____ **Screen Length** _____ **Well Diameter** _____ **Casing Type** _____

Sampling Device _____ **Tubing type** _____ **Water Level** _____

Measuring Point _____ **Other Infor** _____

_____

Sampling Personnel _____

Time	Pump Rate	Turbidity	Alkalinity	[ ] Conc	Notes

Type of Samples Collected

_____

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft: $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

PFCs Sampling Checklist

Date: _____

Weather (*temp./precipitation*): _____ Site Name: _____

Field Clothing and PPE:

- ☐ No clothing or boots containing Gore-Tex™
- ☐ All safety boots made from polyurethane and PVC
- ☐ No materials containing Tyvek®
- ☐ Field crew has not used fabric softener on clothing
- ☐ Field crew has not used cosmetics, moisturizers, hand cream, or other related products this morning
- ☐ Field crew has not applied unauthorized sunscreen or insect repellant

Field Equipment:

- ☐ No Teflon® or LDPE containing materials on-site
- ☐ All sample materials made from stainless steel, HDPE, acetate, silicon, or polypropylene
- ☐ No waterproof field books on-site
- ☐ No plastic clipboards, binders, or spiral hard cover notebooks on-site
- ☐ No adhesives (Post-It Notes) on-site
- ☐ Coolers filled with regular ice only. No chemical (blue) ice packs in possession

Sample Containers:

- ☐ All sample containers made of HDPE or polypropylene
- ☐ Caps are unlined and made of HDPE or polypropylene

Wet Weather (as applicable):

- ☐ Wet weather gear made of polyurethane and PVC only

Equipment Decontamination:

- ☐ "PFC-free" water on-site for decontamination of sample equipment. No other water sources to be used.
- ☐ Alconox and Liquinox to be used as decontamination materials

Food Considerations:

- ☐ No food or drink on-site with exception of bottled water and/or hydration drinks (i.e., Gatorade and Powerade) that is available for consumption only in the staging area

If any applicable boxes cannot be checked, the Field Lead shall describe the noncompliance issues below and work with field personnel to address noncompliance issues prior to commencement of that day's work. Corrective action shall include removal of noncompliance items from the site or removal of worker offsite until in compliance.

Describe the noncompliance issues (include personnel not in compliance) and action/outcome of noncompliance:

_____

_____

_____

Field Lead Name: _____

Field Lead Signature: _____ Time: _____

PFC Sampling – Prohibited and Acceptable Items

Prohibited	Acceptable
Field Equipment	
Teflon® containing materials	High-density polyethylene (HDPE) materials
Low density polyethylene (LDPE) materials	Acetate Liners
	Silicon Tubing
Waterproof field books	Loose paper (non-waterproof)
Plastic clipboards, binders, or spiral hard cover notebooks	Aluminum field clipboards or with Masonite
	Sharpies®, pens
Post-It Notes®	
Chemical (blue) ice packs	Regular ice
Field Clothing and PPE	
New cotton clothing or synthetic water resistant, waterproof, or stain-treated clothing, clothing containing Gore-Tex™	Well-laundered clothing made of natural fibers (preferable cotton)
Clothing laundered using fabric softener	No fabric softener
Boots containing Gore-Tex™	Boots made with polyurethane and PVC
Tyvek®	Cotton clothing
No cosmetics, moisturizers, hand cream, or other related products as part of personal cleaning/showering routine on the morning of sampling	**Sunscreens** - Alba Organics Natural Sunscreen, Yes To Cucumbers, Aubrey Organics, Jason Natural Sun Block, Kiss my face, Baby sunscreens that are "free" or "natural" **Insect Repellents** - Jason Natural Quit Bugging Me, Repel Lemon Eucalyptus Insect repellant, Herbal Armor, California Baby Natural Bug Spray, BabyGanics **Sunscreen and insect repellant -** Avon Skin So Soft Bug Guard Plus – SPF 30 Lotion
Sample Containers	
LDPE or glass containers	HDPE or polypropylene
Teflon-lined caps	Unlined polypropylene caps
Rain Events	
Waterproof or resistant rain gear	Gazebo tent that is only touched or moved prior to and following sampling activities
Equipment Decontamination	
Decon 90®	Alconox® and/or Liquinox®
Water from an on-site well	Potable water from municipal drinking water supply
Food Considerations	
All food and drink, with exceptions noted on right	Bottled water and hydration fluids (i.e, Gatorade® and Powerade®) to be brought and consumed only in the staging areas

Appendix D

Laboratory PFAS Procedures

YORK ANALYTICAL LABORATORIES, Inc.
Title: PFAS_LCMSMS_MOD
Revision 1.1
Effective Date 02/13/2020

Standard Operating Procedure

Analysis of Target Per- and Polyfluorinated Alkyl Substances (PFAS) in Non-Potable Water and Soil by EPA Method 537 Modified using LC/MS-MS

Approvals

Laboratory Director — Ben Gulizia

Corporate Technical Director — Robert Bradley

Corporate QA/QC Officer — Sarah Widomski

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Controlled Copy No. PFAS_LCMSMS_MOD, Rev 1.1-____

Issued to: _____

Target PFAS in Non-Potable Water and Soil Matrices

1. SCOPE AND APPLICATION

This method is used to identify and quantitate specific PFAS compounds in extracts of non-potable water and soil samples using HPLC/MS-MS (high pressure liquid chromatography/ tandem mass spectrometry. Currently the compounds (26) that can be measured by this methodology at the date/revision of this SOP are listed in the table below.

1H,1H,2H,2H-perfluoro-1-decanesulfonate (8:2 FTS)
1H,1H,2H,2H-perfluoro-1-hexanesulfonate (4:2 FTS)
1H,1H,2H,2H-perfluoro-1-octanesulfonate (6:2 FTS)
N-EtFOSAA
N-MeFOSAA
Perfluoro-1-decanesulfonate (L-PFDS)
Perfluoro-1-heptanesulfonate (L-PFHpS)
Perfluoro-1-octanesulfonamide (FOSA)
Perfluoro-1-pentanesulfonate (L-PFPeS)
Perfluorobutanesulfonic acid (PFBS)
Perfluorodecanoic acid (PFDA)
Perfluorododecanoic acid (PFDoA)
Perfluoroheptanoic acid (PFHpA)
Perfluorohexanesulfonic acid (PFHxS)
Perfluorohexanoic acid (PFHxA)
Perfluoro-n-butanoic acid (PFBA)
Perfluorononanesulfonate (L-PFNS)
Perfluorononanoic acid (PFNA)
Perfluoro-n-pentanoic acid (PFPeA)
Perfluorooctanesulfonic acid (PFOS)
Perfluorooctanoic acid (PFOA)
Perfluorotetradecanoic acid (PFTA)
Perfluorotridecanoic acid (PFTrDA)
Perfluoroundecanoic acid (PFUnA) 2,3,3,3-tetrafluoro-2-(heptafluoropropoxy) propanoic acid (GenX) 4,8-dioxa-3H-perfluorononanoic acid (ADONA)

The estimated reporting limit based upon the preparation/analysis parameters herein at the time of this revision are 2.0 ng/L (ppt) for aqueous samples 0.5-2 ug/kG for soil samples (as-received basis). The linear range for these PFAS can be extended by dilution. The MDLs are conducted according to US EPA MDL Determination Rev. 2.0 Dec. 2016. Current MDLs for both aqueous and soil matrices are attached as Attachment 4 to this SOP.

2. SUMMARY

2.1 This procedure involves fortifying samples and related QC with specific isotopes of target PFAS followed by extraction, concentration and analysis by LC/MS-MS. The preparation of non-potable water and soils is detailed in a separate SOP-PFASExtr_AQ_S_051019, Rev. 1.0 and updates.

2.2 For non-potable waters, a known volume of aqueous sample extracted using automated or manual Solid Phase Extraction (SPE). The compounds are eluted from the solid phase using ammoniated methanol. The extract is then slowly evaporated to a small volume using a nitrogen evaporation system. The resulting extract residue is reconstituted in 96%/4% Methanol/water to a final volume of 1.0 mL.

2.3 For soils, a known weight of sample (as received) is extracted with methanolic potassium hydroxide followed by vigourous vortex mixing, orbital agitation and ultrasonic extraction techniques. Prior to SPE cleanup/extraction the extract is fortified with PFAS free water and the methanol is removed by evaporation. The resulting aqueous extract brought to a 20 mL volume and is pH adjusted to pH 6-8. The aqueous extract is then extracted using automated or manual SPE extraction techniques followed by concentration of the SPE extract to a known final volume.

2.3 A portion of the extract is then fortified with internal standard and the PFAS LC separation is accomplished using a C18 LC column using a gradient program with 5mM ammonium acetate/water and methanol to effect separation followed by analysis using AJI-ESI (Electrospray) injection into a triple Quadrupole MS operated in negative ion mode.

2.4 Quantitation is done by internal standard technique and peak response is measured as the area of the peaks from the dynamic MRM (Multiple Reaction Monitoring) run.

2.5 Concentrations determined by LC/MS-MS are adjusted for isotope recoveries for final reporting into the Element LIMS.

3. DEFINITIONS

3.1 ANALYSIS BATCH – A set of samples that is analyzed on the same instrument during a 24-hour period, including no more than 20 Field Samples, that begins and ends with the analysis of the appropriate Continuing Calibration Check (CCC) standards. Additional CCCs may be required depending on the length of the analysis batch and/or the number of Field Samples.

3.2 CALIBRATION STANDARD (CAL) – A solution prepared from the primary dilution standard solution and/or stock standard solution, internal standard(s), and the surrogate(s). The CAL solutions are used to calibrate the instrument response with

respect to analyte concentration.

3.3 COLLISIONALLY ACTIVATED DISSOCIATION (CAD) – The process of converting the precursor ion's translational energy into internal energy by collisions with neutral gas molecules to bring about dissociation into product ions.

3.4 CONTINUING CALIBRATION VERIFICATION (CCV) – A calibration standard containing the method analytes, internal standard(s) and surrogate(s). The CCv is analyzed periodically to verify the accuracy of the existing calibration for those analytes. The CCV is run after every ten runs and at the end of a run This also refers to a low level CCV which is at the lowest point of the calibration curve (LCV)

3.5 DETECTION LIMIT (DL) – The minimum concentration of an analyte that can be identified, measured, and reported with 99% confidence that the analyte concentration is greater than zero. This is a statistical determination of precision (Sect. 9.2.7), and accurate quantitation is not expected at this level.

3.6 EXTRACTION BATCH – A set of up to 20 Field Samples (not including QC samples) extracted together by the same person(s) during a work day using the same lot of SPE devices, solvents, surrogate, internal standard and fortifying solutions. Required QC samples include Method Blank, Blank Spike, Matrix Spike/Matrix Spike Duplicate.

3.7 FIELD DUPLICATES (FD1 and FD2) – Two separate samples collected at the same time and place under identical circumstances, and treated exactly the same throughout field and laboratory procedures. Analyses of FD1 and FD2 give a measure of the precision associated with sample collection, preservation, and storage, as well as lab procedures.

3.8 FIELD BLANK – An aliquot of reagent water that is placed in a sample container in the laboratory and treated as a sample in all respects, including shipment to the sampling site, exposure to sampling site conditions, storage, preservation, and all analytical procedures. The purpose of the Field Blank is to determine if method analytes or other interferences are present in the field environment.

3.9 INTERNAL STANDARD (IS) – A compound added to an extract or standard solution in a known amount(s) and used to measure the relative response of other method analytes and surrogates that are components of the same solution. The internal standard must be a chemical that is structurally similar to the method analytes, has no potential to be present in samples, and is not a method target analyte.

3.10 BLANK SPIKE (BS) – A volume of reagent water or other blank matrix to which known quantities of the method analytes and any preservation compounds are added in the laboratory. The Blank Spike is prepared and analyzed exactly like a sample, and its purpose is to determine whether the methodology is in control, and whether the laboratory is capable of making accurate measurements.

3.11 MATRIX SPIKE (MS) – A preserved field sample to which known quantities of the method analytes are added in the laboratory.
The MS is processed and analyzed exactly like a sample, and its purpose is to determine whether the sample matrix contributes bias to the analytical results. The background concentrations of the analytes in the sample matrix must be determined in a separate sample extraction and the measured values in the MS corrected for background concentrations.

3.12 MATRIX SPIKE DUPLICATE (MSD) – A duplicate of the Field Sample used to prepare the MSD. The MSD is fortified, extracted, and analyzed identically to the MS. The MSD is used instead of the Field Duplicate to assess method precision when the occurrence of method analytes is low.

3.13 METHOD BLANK – An aliquot of reagent water or other blank matrix that is treated exactly as a sample including exposure to all glassware, equipment, solvents and reagents, sample preservatives, internal standard, and surrogates that are used in the analysis batch. The method blank is used to determine if method analytes or other interferences are present in the laboratory environment, the reagents, or the apparati.

3.14 REPORTING LIMIT – the level at which accuracy of 50-150% is achieved and is based upon the lowest calibration standard. This level is prepared through all steps of the processing/analysis and is verified quarterly.

3.15 PRECURSOR ION – For the purpose of this method, the precursor ion is the deprotonated molecule ($[M-H]^-$) of the method analyte. In MS/MS, the precursor ion is mass selected and fragmented by collisionally activated dissociation to produce distinctive product ions of smaller *m/z*. For certain species that are labile in nature (GenX) under the conditions of analysis the [M-CO2]- is used.

3.16 PRODUCT ION – For the purpose of this method, a product ion is one of the fragment ions produced in MS/MS by collisionally activated dissociation of the precursor ion.

3.17 SURROGATE (isotopic) ANALYTE (SUR) – A compound which is structurally identical to the target analyte or an analog of the target analyte which is isotopically labeled (deuterium, oxygen 18, or carbon13) and chemically resembles method analytes and is unlikely to be found in any environmental sample. This compound(s) is added to a sample aliquot in known amounts before processing and is measured with the same procedures used to measure other method analytes. The purpose of the isotopic surrogate is to monitor method performance with each sample, and to adjust concentration for recovery of the isotopic analog.

4. INTERFERENCES

LC/MS-MS data from blanks, samples, and spikes must be evaluated for interferences. If any interferences are present, take corrective action if necessary. Do not use aluminum foil because PFAS can be potentially transferred from the aluminum foil to the glassware. Only aluminum foil rinsed with HPLC plus grade or LC/MS grade methanol can be used where necessary.

4.1 PFAS have been used in a wide variety of manufacturing processes, and laboratory supplies should be considered potentially contaminated until they have been tested and shown to be otherwise. The materials and supplies used during the method validation process have been tested and shown to be clean. These items are listed in the Reagents section.

4.2 Method interferences may be caused by contaminants in solvents, reagents (including DI water), sample bottles and caps, and other sample processing hardware that lead to discrete artifacts and/or elevated baselines in the chromatograms. All items such as these must be routinely demonstrated to be free from interferences (less than 1/2 the Reporting Limit), under the conditions of the analysis by analyzing Method Blanks. Subtracting blank values from sample results is not permitted.

4.3 PTFE products can be a source of PFAS (PFOA) contamination. The use of PTFE in the procedure should be avoided. Polypropylene (PP) or polyethylene (PE, HDPE) products must be used in place of PTFE products to minimize PFOA contamination.

4.3.1 Standards and samples are injected from polypropylene autosampler vials with polypropylene snap caps, once. Multiple injections may be performed on Primers when conditioning the instrument for analysis.

4.3.2 Random evaporative losses have been observed with the polypropylene caps causing high Internal Std. recovery after the vial was punctured and sample re-injected. For this reason, it is best to inject standards and samples once in the analytical sequence, or recrimp after injection. The auto sampler system employs a refrigerated (4^{o}C) sample compartment which minimizes losses.

4.3.2 Teflon-lined screw caps have detected PFAS at low concentrations. Repeated injection from the same teflon-lined screw cap have detected PFNA at increasing concentration as each repeated injection was performed, therefore, it is required to use only polypropylene snap caps as specified in this SOP.

4.4 HPLC Plus grade or LC/MS grade methanol and water must be used for all steps where methanol or water are used in this method.

4.5 Matrix interferences may be caused by contaminants that are co-extracted from the sample. The extent of matrix interferences will vary considerably from source to source, depending upon the nature of the water or soil. SPE provides the necessary clean-up to reduce the occurrence of matrix effects.

4.6 Solid phase extraction cartridges may be a source of interferences. The analysis of laboratory method blanks can provide important information regarding the presence or absence of such interferences. The Phenomenex Strata-XL-AW or the Oasis WAX SPE tubes have shown no interfering peaks/ions at the retention times of interest. Each new lot of SPE cartridge sorbent must be tested to ensure that contamination does not preclude analyte identification and quantitation.

4.7 Contamination by carryover can occur whenever a high-concentration and low concentration samples are sequentially analyzed. To reduce carryover, the sample syringe in automatically rinsed with solvent between injections. These operations are programmed into the LC multi-sampler system.

4.8 Volumetric glassware and syringes are difficult to clean after being used for solutions containing high levels of PFAS. These items should be labeled for use only with similarly concentrated solutions or verified clean prior to re-use. To the extent possible, disposable labware (mechanical pipetors) are used.

4.9 Both branched and linear PFAS isomers can potentially be found in the environment. Linear and branched isomers are known to exist for PFOS, PFOA, PFHxS, PFBS, EtFOSAA, and MeFOSAA based upon the scientific literature. If multiple isomers are present for one of these PFAS they will be peaks adjacent to the linear isomer (to the left under our operating conditions). The later of these peaks matches the retention time of its labeled linear analog. In general, earlier peaks are the branched isomers and are not the result of peak splitting. In the analysis of real world samples, the most often encountered branched isomers are seen for PFOS and PFHxS.

Currently, all these species are available as linear isomers. Reference standards of the technical mixtures for these specific PFAS are used to ensure that all appropriate peaks are included during peak integration. <u>These branched isomers elute before the linear isomer and are integrated and reported as total for those species.</u>

4.10 In order to reduce bias, it is required that the following ion transitions be used as the quantitation transitions:

Required Quantitation Transitions for PFAS

PFOA	413	>	369
PFOS	499	>	80
PFHxS	399	>	80
PFBS	299	>	80
6:2 FTS	427	>	407
8:2 FTS	527	>	507
N-EtFOSAA	584	>	419
N-MeFOSAA	570	>	419

5. SAMPLE HANDLING

5.1 Aqueous and soil samples are collected by our clients in 250 mL HDPE bottles with HDPE caps.

5.2 FIELD BLANKS (FBLK)- A FBLK must be handled along with each sample set. The sample set is composed of samples collected from the same sample site and at the same time. At the laboratory, fill the field blank sample bottle with reagent water, seal, and ship to the sampling site along with the sample bottles. For each FBLK shipped, an empty sample bottle must also be shipped. At the sampling site, the sampler must open the shipped FBLK and pour the reagent water into the empty shipped sample bottle, seal and label this bottle as the FBLK. The FBLK is shipped back to the laboratory along with the samples and analyzed to ensure that PFAS were not introduced into the samples during sample collection/handling.

5.3 SAMPLE SHIPMENT AND STORAGE – Samples must be chilled during shipment and must not exceed 10 °C during the first 48 hours after collection. Sample temperature must be confirmed to be at or below 10 °C when the samples are received at the laboratory. Samples stored in the lab must be held at or below 6 °C until extraction, but should not be frozen.

NOTE: Samples that are significantly above 10° C, at the time of collection, may need to be iced or refrigerated for a period of time, in order to chill them prior to shipping. This will allow them to be shipped with sufficient ice to meet the above requirements.

5.4 SAMPLE AND EXTRACT HOLDING TIMES –PFAS have adequate stability for 14 days when collected, preserved, shipped and stored as described. Therefore, water and soil samples should be extracted within 14 days of collection. Extracts must be stored at <10^{o}C or room temperature and analyzed within 28 days after extraction.

6. APPARATUS AND MATERIALS

6.1 250 mL High Density Polyethylene (HDPE) bottles with HDPE linerless caps-Greenwood Env. Part no. 07-GW2501: 250ml SMART Natural HDPE Leakproof Wide Mouth Bottle w/43-415 Linerless Cap, Assembled Only (250/cs) or 07-GW2503: 250ml HDPE Leakproof Wide Mouth Bottle w/43-415 Linerless Cap , Certified (250/cs), or equivalent-alternate source: VWR Scientific: Part no. 414004-113 HDPE wide moutgh bottle with HDPE liner less cap. These have been tested and demonstrated to be PFAS-free in initial studies.

6.2 Transport Tube: Virgin Polypropylene, White, Plastic, 10 mL Capacity, 16 mm OD, 93 mm Overall Lg, Self-Standing, 250 PK， Item 710Z420, Gamut.com (Grainger), with PP cap

6.3 Graduated cylinders, 50, 100, 250, 500 and 1000mL, Polypropylene, VWR Scientific or equivalent

6.4 Analytical Balance, 0.0001g., checked for accuracy each day of use with Class S weights.

6.5 Extract concentrator: Organomation Model N-EVAP 112, 24 position concentrator with water batch control and nitrogen supply controls.

6.6 Syringes, polypropylene, luer lock, 50-100 mL for filtration of turbid groundwater samples. Merck XX110500 Fisher Scientific or equivalent

6.6 3.1 Micron in-line filters, Biotage part no. 49-2814-01

6.7 1.0 mL polypropylene snap cap vials, Agilent part no. 5182-0567

6.8 Snap caps, polypropylene, 11 mm, 11/9k, Agilent Part no. 5182-0542

6.9 2mL self standing PP microcentrifuge snap cap tubes, SKS Scientific part no. 0747-17

6.10 15 mL PP or HDPE Centrifuge tubes, Corning Part no. 430791

6.11 3 mL Disposable Transfer pipets, PE, VWR part no. 16001-176

6.12 Solid Phase Extraction Tubes:

For aqueous samples the following have been proven to meet SOP requirements: Phenomenex Strata XL-AW 100 um 200 mg 6mL tubes, part no. 8B-S051-FCH or Phenomenex Strata XL-AW 100 um 500 mg 6 mL tubes, part no.

8BS0510HCH, or Waters OASIS WAX 6cc/500 mg 60um tubes, part no. 186004647

For soils the following tubes can be used: Phenomenex Strata XL-AW 100 um 500 mg 6 mL tubes, part no. 8BS0510HCH; Biotage Evolute 500 mg/6mL 30 um tubes part no. 614-0050-CXG or Waters OASIS WAX 6cc/500 mg 60um tubes, part no. 186004647

6.13 Syringes, Hamilton or equivalent 5.0 uL, 10 uL 25 uL, 100 uL, 250 uL, 500 uL, *teflon free.*

6.14 Solid Phase Extraction System-automated-Horizon/Biotage SmartPrep II system, 12 position autosampler system for 6 mL capacity tubes. System retrofit to remove all PTFE components and replaced with PEEK tubing. Automated bottle rinsing feature required.

6.15 SPE Automated Extraction System, Promochrom Technologies, Inc. 8 position simultaneous processing, PTFE free system.

6.16 Nitrogen Evaporation System- Organomation Model N-EVAP 112-24 position evaporator with water bath and individual nitrogen delivery control. Water bath capable of ambient temperature to 85 C, operated at 60 C.

6.17 LC/MS-MS system- Agilent 1260 HPLC system interfaced to an Agilent 6470A Triple Quadrupole system. The instrument control and qualitative/quantitative analysis software using Mass Hunter versions B.8.0 and B.9.0.

6.17.1 HPLC System-Agilent 1260 Infinity II

6.17.1.1 The Agilent 1660 Infinity II HPLC system is configured with temperature controlled column oven compartment. 4 column configuration, temperature controlled (refrigerated) autosampler compartments, injection valve, proportioning valves, variable flow controls and variable injection capabilities.

6.17.1.2 The delay column (PFAS and other interference removal) is an Agilent Eclipse Plus C18, 4.6mm x 50 mm, 3.5 um-Part no. 959943-902

6.17.1.3 The analytical column is an Agilent ZORBAX Eclipse Plus C18, 3.0 x 50 mm, 1.8 um- part no. 959757-302

6.17.2 Agilent LC/MS-MS- Agilent 6470AAR

6.14.2.1 Agilent model 6470AAR triple Quadrupole system with Agilent Jet Stream ESI source. UHP nitrogen is used as cell gas and High purity

nitrogen is delivered for the sheath gas from a Peak Scientific nitrogen generator system.

6.18 Vortex Mixer- Benchmark Industries or equivalent

6.19 pH paper, short range 6-8- VWR Scientific or equivalent

6.20 Ultrasonic Baths- GT Sonic LS-10D, 240 w and Limplus VGT-1990QT, 240 w

6.21 Orbital Shaker- Jiangau Tenlin Instr. Co., Ltd., Model no. TLSK-III 20-230 RPM, 0-999 min.

6.22 Centrifuge, 50 mL, Premiere Model XC-2450 Series Centrifuge 6 x 50 mL, 3500 RPM max.

6.23 Mini Centrifuge, 2 mL Four E's Scientific, 5400 RPM

6.24 Mechanical Pipettors- 10-100 uL; 100-1000 uL; 1000-5000 uL-4 E'S Scinetific or equivalent, calibrated quarterly.

7. REAGENTS AND STANDARDS

ALL REAGENTS and STANDARDS MUST BE LOGGED INTO THE ELEMENT LIMS SYSTEM. This includes lot numbers, expiration, open and prepared dates, recipe, Certification/traceability documents from supplier(s) if provided and preparer.

7.1 Methanol, hypergrade for LC/MS. (Merck) from Sigma Aldrich Part no. 1060354000. Alternatively Methanol, HPLC plus grade, Sigma Aldrich Part. No. 646377-4L

7.2 Water, hypergrade for LC/MS. (Merck) from Sigma Aldrich Part no. 1153334000; alternatively Water, HPLC Plus grade, Sigma Aldrich part no. 34877-4L.

7.3 Isopropanol-for rinsing valve seats, etc.- Sigma Aldrich Part no. 650447-1L

7.4 Ammonium Acetate, LC-MSMS grade. Sigma Aldrich Part no. 73594-100-G-F

7.4.1 HPLC gradient A- 5 mM Ammonium Acetate/ Water
Weigh 0.3854 g ($\pm$ 0.0005) Ammonium Acetate and add to 1 liter hypergrade Water. Sonicate for 5 mins. To remove air bubbles. Stability- 2 weeks.

7.4.2 HPLC gradient B – 5 mM Ammonium Acetate/95/5 MeOH/H_2O

Weigh 0.3854 g (± 0.0005) Ammonium Acetate and add to 1 liter of 95/5 hypergrade methanol/water (950 mL MeOH/50 mL Water). Sonicate for 5 mins. To remove air bubbles. Stability – 2 weeks

7.5 Ammonium Hydroxide- 28-30%- ACS grade Sigma Aldrich Part no. 221228-500ML-A

7.6 Potassium Hydroxide-BioXtra grade, Sigma Aldrich part no. P5958-250G

7.7 Acetic Acid, Glacial, >99.7%- ACS grade-Sigma Aldrich part no. 695092-500ML

7.8 Agilent Tuning Solution-ESI-L-Agilent Part no. G1969-85000

7.9 **Stock Standards**

Stock Standards are purchased in mid to high concentration form from Wellington Laboratories, Inc. Guelph, ONT, CA. Currently, Wellington is the only supplier of these materials. Second source standards to serve as an initial calibration verification are not available for all compounds. Some of the target compounds from Absolute Standards, Hamden, CT in a 2000 ng/mL mix of linear and branched isomer isomers which limit their use for quantitative analysis due to the uncertainty in the amount of branched species. Until a viable second source is identified, the 5.0 ng/mL level material used for calibration will serve as the ICV for Element purposes.

7.9.1 Internal Standard used for the method described is MPFOA (Perfluoro-[1,2,3,4-$^{13}C_4$]octanoic acid). This is purchased at 50,000 ng/mL and mixed for use. This is purchased from Wellington Labs in 1.2 mL volumes with the following part nos.: MPFOA.

7.9.2 Surrogate (ISOTOPIC) Materials are purchased for this method from Wellington Labs at 50,000 ng/mL levels on an individual basis. The part nos. for 18 isotopes are listed as follows: MPFBA, M5PFPeA, M3PFBS, M5PFHxA, M4PFHpA, M3PFHxS, M2-6:2 FTS, M8PFOA, M8PFOS, M9PFNA, M2-8:2 FTS, M6PFDA, d3-N-MeFOSAA, M8FOSA, M7PFUnDA, d5-N-EtFOSAA, MPFDoA, M2PFTeDA.When GenX is a target- M3HFPO-DA.

7.9.2.1 Alternatively, a mixture of all the above isotopes is available from Wellington Laboratories as part no. MPFAC-24PAR at 1000 ng/mL in Methanol. NOTE: This mixture does not contain GenX or ADONA.

7.9.3 Stock Standard mixture of linear isomers of the target analytes are purchased from Wellington Labs at 2000 ng/mL concentrations under part no. PFAC-24PAR. This is used for native analyte calibration and for the BS/MS/MSDs.

7.10 **Intermediate/Working Standards Preparation**

7.10.1 **Internal Standards -** Preparation at 1000 ng/mL

Internal Standards mixture is prepared into a 10 mL polypropylene transfer tube for use. 10.0 mL final volume is prepared. Before use the mixture is mixed well using a vortex mixer. This approach yields 10 ng/mL of ISTD final concentration in each extract/QC/Cal std.when 3 uL of ISTD mix at 1000 ng/mL is added to 300 uL extract or 5 uL is added to 500 uL.

Preparation of Internal Standard Working Solution-
10.0 mL final volume

For all Calibrations, QC and Samples add 3 uL to 300 uL samples and 5 uL to 500 uL CALSTDS

ISTD Stock	Stock, ng/mL	Vol. to add (uL)	To this vol. MeOH, uL	**Conc. ,ng/mL**
MPFOA	50000	200	9800	1000

7.10.2 **Isotopic Surrogate** Solution Intermediate Preparation-1000 ng/mL

5.0 mL of the 18 Isotope Surrogate mixture is prepared into a 10 mL polypropylene transfer tube for use at a 1000 ng/mL concentration. The GenX isotope M3HFPO-DA is not included. The intermediate is prepared by adding 100uL of each of the 18 isotopes (at 50,000 ng/mL, nominally as the anion) into 3200 uL of MeOH for a final concentration of 1000 ng/mL. Mix using the vortex mixer and carefully transfer to 3 separate labeled self standing 2 mL snap cap vials. Some isotopes are present as salts so the amount of indiv. Added may be more than 100 uL to adjust for salt vs. anion. The amount of MeOH will be reduced proportionately.

7.10.3 –Isotopic Surrogate Preparation for addition to samples/QC

Preparation of Working Surrogate Mixture- 10.0 mL final volume
From 1,000 ng/mL intermediate from 7.10.2 add 1000uL of the intermediate at 1000 ng./mL to 9000 uL methanol to give a final concentration of working isotopic surrogate mix at 100 ng/mL. This mixture is used for addition to all samples/QC that are to be extracted.

7.10.4 **Target Analyte Intermediate/Working Mixture**

From the 2000 ng/mL stock solution (7.9.3), prepare a 100 ng/mL solution by adding 500 uL of the stock to 9500 uL Methanol. This results in a 100 ng/mL working standard. This 10 mL volume is then used for BS/MS/MSD solution (100 uL added for BS/MS/MSD).

7.10.5 **CALIBATION CURVE Preparation**

Using the 1000 ng/mL Isotopic Surrogate intermediate (7.10.2) and the 2000 ng/mL Stock native analytes (7.9.3) make 1.0 mL of an intermediate 100 ng/mL solution of isotopes and native analytes by taking 50uL of the 2000 ng/mL natives and 100 uL of the 1000 ng/mL Isotopic intermediate adding both to 850 uL methanol. This is the 100 ng/mL Calibration intermediate. Follow the preparation in the table as shown.

Initial Calibration Preparation

Initial Calibration-
use solution form 7.10.5
@ 100 ng/mL
Standards Source-Wellington Labs
500 uL Final Volumes prepared into PP vials

Cal Level ID	Std. Conc., ng/mL	Isotopes+Natives Mix @ 100 ng/mL, uL	96/4 MeOH/H2O, uL	ISTD Working MIX, uL
1	0.25	1.25	498.8	5.0
2	0.5	2.5	497.5	5.0
3	1.0	5.0	495	5.0
4	2.5	12.5	487.5	5.0
5	5.0	25.0	475	5.0
6	10.0	50.0	450	5.0
7	20.0	100.0	400	5.0

7.10.6 Second Source - Initial Calibration Verification

Use 5.0 ng/mL cal level until verification of a second source is done. Currently only the 24 compound DOD mix at 2000 ng/mL is available from Absolute Standards, Hamden, CT , part no. 99206. This contains some branched isomers therefore it may not serve its intended purpose. This is optional at this time. This is prepared as an ICV as follows:

Initial Calibration Verification Preparation

Source-Absolute Standards EPA 537 Mix @ 2000 ng/mL

Preparation of Intermediate 100 ng/mL
Take 50 uL of Stock up to 1000 uL in MeOH = 100 ng/mL Intermediate

ICV Level @ 5.0 ng/mL
Take 25 uL of 100 ng/mL ICV ng/mL plus 475 uL 96/4 MeOH/H2O + 5uL ISTDs-no Surrogates

8. PROCEDURE

8.1 Preventative and Routine Maintenance

HPLC/MS/MS Preventative Maintenance	
As Needed:	**Daily (When in use)**
Change pump seals. Change in-line filters in autosampler (HPLC). Check/replace in-line frit if excessive pressure or poor performance. Replace column if no change following in-line frit change. Clean needle. Replace or clean Capillary Replace fused silica tube in ESI interface. Clean lenses. Clean skimmer. Ballast rough pump 30 minutes. Check Nozzle flow pattern	Check solvent reservoirs for sufficient level of solvent. Verify that pump is primed, operating pulse free. (ripple < 1%) Check needle wash reservoir for sufficient solvent. Verify capillary heater temperature functioning. Verify vaporizer heater temperature. Verify rough pump oil levels. Verify turbo-pump functioning. Verify nitrogen pressure for auxiliary and sheath gasses. Replace HPLC Gradient solutions-2 weeks Perform Checktune once per week.
Semi-Annually	**Annually**
Replace oil mist and odor elements. Replace activated alumina filter if applicable	Vacuum system components including fans and fan covers. Clean/replace fan filters, if applicable.

8.2 Running Samples/QC - Acquisition Method

The acquisition methods are detailed in Attachments 1 (HPLC) and Attachments 2 and 3 (MS/MS) of this SOP. The method is a HPLC with dynamic MRM method with precursor and product ions with specific acquisition parameters to maximize sensitivity and specificity. This list may be modified to add other PFAS target analytes as

necessary. It is noted that under the conditions used for analysis, GenX (attachment 3), due to its fragile nature is analyzed separately monitoring the [MCOO]- precursor and related product ion.

8.3.1 The triple Quadrupole (QQQ) system must be optimized for each target analyte (including surrogates and internal standards) using the Mass Hunter Optimizer program. This program determines the most abundant precursor and product ions for each compound and their abundances. These data are then used to build an MRM (multiple reaction monitor) method for acquisition. This is done initially or after any major maintenance procedures are performed to the triple quadrupole system. A high level standard is used for this in the $[M-H]^-$ mode.

8.3.2 The QQQ is checked for tuning on a weekly basis before analysis using the Tune context by selecting the CHECKTUNE radio button. This is done only in negative ion mode since that what we are operating under. If the Checktune fails, or significant change (50%) in the abundances compared to the most recent checktune data, run the Autotune program-note: this takes approx. 45 mins. in negative mode. NOTE: This will require a re-calibration of the instrument.

8.3.3 Before any QC or samples can be run, the HPLC must be allowed to purge/condition for at least thirty minutes. This purge must be done using the initial mobile phase conditions used in the method must be allowed to run for 30 minutes to allow the binary pump pressure to stabilize (ripple must be < 1%) and pressure should be 135-160 barr with a 90/10 gradient (initial HPLC conditions).

8.3.4 An instrument sequence (Worklist) is then made. It should begin with two double blanks if the system has been sitting more that 48 hours, or at a minimum 1 double blank and a conditioner (5 ng/mL).

8.3.5 Those will be followed by the opening low level CCV at 0.25 ng/mL followed by a CCV at 5 ng/mL. If these pass criteria (50-150% R for the LLCCV, 70-130% R for the CCV, then, the worklist can start running. After every 10 injections and at the end of the sequence a CCV at 5.0 ng/mL is run.

8.3.6 The run can end with a script to put the instrument into standby mode.

8.4 Daily Sample Preparation/Analysis Sequence

- Prepare extracts for analysis by placing a 300 ul aliquot of sample extract into a labeled PP auto-sampler vial. Add internal standard (3 uL). Apply snap cap. Vortex to mix.
- Run instrument CCV checks at the start and every ten injections (5 ng/mL) and at the end as described in 8.3.5 above.
- Enter the Worklist (injection sequence) using the naming convention mm-dd-yyyy into the instrument software and load samples onto the auto-sampler in the following order,

- 2 Double Blanks (If system idle > 48 hrs. (1 if not)
- Conditioner @ 5 ng/mL
- Low Level CCV (LLCV@ 0.25 ng/mL) (SEQ-LCV)
- CCV (5.0 ng/mL) (SEQ-CCV1)
- Method Blank
- BS
- Samples /MS/MSDs; CCV every 10 injections
- CCV (ending or continuing) at 5.0 ng/mL
- 10 injections
- Ending CCV -5.0 ng/mL

8.5 Data Review

The Agilent Mass Hunter Quantitation program is used to review all data. All identifications are based upon acceptable ion ratios for the abundance of both precursor and product ions along with retention time information. It is noted that for PFOS specifically the ratios may not always be ideal due to the branched isomer contribution. If native PFOS is found and branched are also found under the conditions of MRM acquisition identity is confirmed.

8.5.1 Since certain PFAS species are manufactured by different processes the presence of branched as well as linear isomers may be found. In order to properly quantitate these species, the analyst must manually integrate the following species to report totals for: PFOS and PFHxS., These should be annotated as total in the element report verbiage or using a qualifier PFAS-T

8.5.2 Any detection greater than the upper limit of the calibration curve requires dilution into the upper half of the curve, where possible.

9. CALIBRATION

9.1 Initial Calibration

The initial calibration covers the range 0.25 ng/mL to 20 ng/mL depending upon the linearity of the PFAS species. After acquisition, the data are quantitated in Mass Hunter and the default calibration model is generated using Average response factor. For average response factor RSDs greater than 20% an alternate model such as Quadratic regression should be used. Depending upon the response and accuracy at each level as shown in the Mass Hunter program, use Quadratic regression not forced through the origin with or without weighting to achieve the best fit which is based upon the best accuracy on a compound by compound basis. In any case, the correlation coefficient R^2) must be greater than 0.990.

9.1.1 The calibration levels as shown in Section 7.6.3 use 7 levels. All points are included in the calibration for all PFAS targets and isotopes.

9.1.2 Certain species in the calibration mixture are present as salts (as opposed to anions). This concentration must be used in the Mass Hunter software to reflect the actual anion concentration present. Also, all responses for the calibration curve are based solely upon the known concentration of the linear isomers where applicable. Refer to the Wellington Labs standard information sheets for each lot of material.

9.1.3 In order to reduce bias, it is required that the following ion transitions be used as the quantitation transitions:

Required Quantitation Transitions for PFAS

PFOA	413	>	369
PFOS	499	>	80
PFHxS	399	>	80
PFBS	299	>	80
6:2 FTS	427	>	407
8:2 FTS	527	>	507
N-EtFOSAA	584	>	419
N-MeFOSAA	570	>	419

9.2 ICV/QCS

A second-source Initial Calibration Verification, if available should be run immediately following initial calibration. The concentration of this standard should be in the middle of the calibration range (e.g. 5.0 ng/mL). Unless project-specific data quality objectives are required, the values from the second-source check should be within 30% of the expected concentration.

Corrective Action: Quantitative sample analyses should not proceed for a failing ICV. Recalibrate and re-run the ICV if necessary. When using the same source for the "ICV" then ± 20% limits apply.

9.3 Continuing Calibration Verification

The CCV must be ± 30% of the true value. The LLCCV must recover 50-150%.

Corrective Action: If any of the required calibration check criteria fail, the system must be evaluated and any appropriate instrument repair or maintenance must be performed. Sample data are unacceptable and must

be rerun. Reinjection the standard may be done. If the calibration check standard still fails, the system must be recalibrated.

10. Quality Control

10.1 Initial Demonstration of Capability (IDOC)

The initial demonstration requirement herein must be acceptable before analysis of samples may begin.

10.2 Batches are defined at the sample preparation step. Batches should be kept together through the whole analytical process as far as possible, but it is not mandatory to analyze prepared extracts on the same instrument or in the same sequence.

10.2.1 The quality control batch is a set of up to 20 samples of the same matrix processed using the same procedure and reagents within the same time period. The quality control batch must contain a matrix spike/matrix spike duplicate (MS/MSD), a laboratory control sample (LCS) and a method blank. Laboratory generated QC samples (Blank, LCS, MS/MSD) do not count toward the maximum 20 samples in a batch. Field QC samples are included in the batch count. In some cases, at client request, the MS/MSD may be replaced with a matrix spike and sample duplicate. If insufficient sample is available for an MS/MSD, an LCSD may be substituted if batch precision is required by the program or client. In the event that multiple MS/MSDs are run with a batch due to client requirements, the additional MS/MSDs do not count toward the maximum 20 samples in a batch.

10.3 METHOD BLANK- One method blank (MB, laboratory reagent blank) must be extracted with every process batch of similar matrix, not to exceed twenty (20) samples. For aqueous samples, the method blank is an aliquot of laboratory reagent water. For solid samples, the method blank is a portion of Ottawa sand. The method blank is processed in the same manner and at the same time as the associated samples. Corrective actions must be documented on a Non-Conformance memo, and then implemented when target analytes are detected in the method blank above the reporting limit or when IDA recoveries are outside of the control limits. Re-extraction of the blank, other batch QC, and the affected samples are required when the method blank is deemed unacceptable.

10.3.1 If the MB produces a peak within the retention time window of any of the analytes, determine the source of the contamination and eliminate the interference before processing samples.

10.3.2 The method blank must not contain any analyte at or above 1/2 the reporting limit.

10.3.3 If there is no target analyte greater than the RL in the samples associated with an unacceptable method blank, the data may be reported with qualifiers. Such action should be taken in consultation with the client.

10.3.4 Re-extraction and reanalysis of samples associated with an unacceptable method blank is required when reportable concentrations are determined in the samples.

10.3.5 Results are acceptable if the blank contamination is less than ½ of the reporting limit/LOQ for each analyte, or less than 1/10 of the regulatory limit, or less than 1/10 of the sample result for the same analyte, whichever is greater. If the method blank does not meet the acceptance criteria, the source of contamination must be investigated and measures taken to correct, minimize or eliminate the problem. Reprepare and reanalyze all field and QC samples associated with the contaminated method blank.

10.4 LABORATORY CONTROL SAMPLE (BLANK SPIKE) must be extracted with every process batch of similar matrix, not to exceed twenty (20) samples. The LCS is an aliquot of laboratory matrix (e.g. water for aqueous samples and Ottawa sand for solids) spiked with analytes of known identity and concentration. The LCS must be processed in the same manner and at the same time as the associated samples. Corrective actions must be documented on a Non-Conformance memo, then implemented when recoveries of any spiked analyte is outside of the control limits. Re-extraction of the blank, other batch QC, and all associated samples are required if the LCS is deemed unacceptable. The control limits for the LCS are stored in Element.

10.5 A matrix spike/matrix spike duplicate (MS/MSD or MS/SD) pair must be

extracted with every process batch of similar matrix, not to exceed twenty (20) samples. An MS/MSD pair is aliquots of a selected field sample spiked with analytes of known identity and concentration. The MS/MSD pair must be processed in the same manner and at the same time as the associated samples. Spiked analytes with recoveries or precision outside of the control limits must be within the control limits in the LCS. Corrective actions must be documented on a nonconformance memo, then implemented when recoveries of any spiked analyte are outside of the control limits provided by ELEMENT or by the client. Again if a specific method or work plan has required limits, this is preempted. Any outliers must be qualified accordingly.

10.6 A LCSD or BSD may be added when insufficient sample volume is provided to process an MS/MSD pair, or is requested by the client. The BSD is evaluated in the same manner as the BS/LCS.

10.7 Initial calibration verification (ICV) –A second source standard, if available, is analyzed with the initial calibration curve. The concentration should be at the mid range of the curve and must recover within 70-130 % of expected value.

Corrective actions for the ICV, if true second source, include:

- Rerun the ICV.
- Remake or acquire a new ICV.
- Evaluate the instrument conditions.
- Evaluate the initial calibration standards.
- Rerun the initial calibration.

10.8 Internal Standard- The Internal Standard (IS) is added to each field and QC sample prior to analysis. The IS response (peak area) must not deviate by more than ½ to 2x the average response (peak area) of the initial calibration.

10.8.1 Sample IS response (peak area) must be within 50-150% of the response (peak area) in the most recent CCV.

10.9 Specific other QC requirements for this method are detailed in Table 1.0 as follows.

Table 1.0 QC Criteria-York PFAS Method

Requirement	**Specification and Frequency**	**Acceptance Criteria**
Sample Holding Time	14 days with appropriate preservation and storage as described in Sections 8.1-8.5.	Sample results are valid only if samples are extracted within sample hold time.
Extract Holding Time	28 days when stored room temp. in polypropylene snap cap vials	Sample results are valid only if extracts are analyzed within extract hold time.
Method Blank (MBLK)	One MBLK with each extraction batch of up to 20 Field Samples.	Demonstrate that the method analyte concentration < 1/2 the RL, and confirm that possible interferences do not prevent quantification. If the background concentration exceeds 1/2 the RL, results for the extraction batch are invalid.
Blank Spike (BS)	One BS is required for each extraction batch of up to 20 Field Samples.	Results of BS analyses must be 50-150% of the true value, after isotopic correction.

Internal Standard (IS)	Compare IS area to the average IS area in the initial calibration and the most recent CCC.	Peak area counts for all injections must be within −50%-200% of the average peak area calculated during the initial cal. and 50−150% from the most recent CCC. If the IS does not meet this criterion, rerun ot dilute
Surrogate(SUR) Standard (isotopes)	The SUR standard added to all calibration standards and samples, including QC samples. Calculate SUR recoveries.	Isotope SURR recovery should be within lab control limits be 25-150% of the true value. If a SUR fails this criterion, report all results for sample as suspect/SUR recovery with appropriate qualifier. Up to a 10x dilution is allowed to apply isotopic dilutions.If more dilution is necessary due to levels or matrix, a smaller volume sub-sample may be reextracted, if necessary.
Sample Matrix Spike	Analyze one MS per extraction batch (of up to 20 Field Samples) fortified target analytes. Calculate MS recoveries (Element)	Recoveries at should be within Lab control Limits. Qualify any outliers using appropriate flags.
MSD	Extract at least one MSD with each extraction batch of 20 field samples or less. Calculate RPD.	RPD should be ≤30%. If not met, qualify data accordingly.
Initial Calibration	Use ISTD technique Use minimum of 7 points at all times	When each standard is calculated against the curve, the accuracy should be 70-130%, except for the lowest standard which should be 50-150% of the true value.
Lower Level CCV (LLCCV)	Run initially with each sequence at the low level cal std. @ 0.25 ng/mL	Recovery between 50-150%
Continuing Calibration Verification(CCV)	Initially, after LLCCV and after every 10 runs and at the end of the run	Surrogates and analyte recovery 70-130% of expected value

10.10 Initial Demonstration of Capability (IDC)

Initial Demonstration of Capability involves the following processes listed in Table 2.0 as follows.

Table 2.0 - Initial Demonstration of Capability (IDC)

Requirement	**Specification**	**Acceptance Criteria**
Initial Demonstration of Low System Background	Analyze MBLK prior to any Other IDC steps	Demonstrate that all method analytes are < 1/2 MRL and possible interferences form extraction media do not prevent identification and quantification of method analytes.
Initial Demonstration of Precision (IDP) *-537.1*	Analyze 4-7 replicate LFBs at mid-cal level	%RSD must be < 20%

Initial Demonstration of Accuracy (IDA)	Using the IDP runs above, Calc. average % Recovery	Mean Recovery ± 30% of true value
Method Detection Limit (MDL Confirmation *EPA Dec. 2016 Rev.2*	Fortify, extract and analyze seven replicates and seven method blanks, extracted over 3 days and analyzed on three separate days per protocol Calculate recovery and precision for these data for MDL.	MDLs are reported with data. Element will automatically "J" flag any detections > MDL and < RL.

11.0 DATA REVIEW, CALCULATIONS AND REPORTING

Samples concentrations are determined using either Average response factor (RRF) or or quadratic regression unforced through the origin. Weighted ($1/x$ or $1/x^2$) may assist with low level accuracy and is recommended where necessary. All calibration curves have 7 points and no points can be removed. Any target analyte exceeding the calibration range will require dilution.

11.1 Data interpretation

All sample data calculations are performed by the Agilent Mass Hunter software in ng/mL and then final data are calculated taking into account final extract volumes and the initial sample volumes extracted which are entered into the Element bench sheet.

11.2 Linear and Branched Isomers are addressed in Section 8.5 and are reported for the noted species as Total which is a sum of the linear and branched isomers for affected species.

11.2.1 After MDL determination, data are reported to the RL with any target PFAS detected > MDL but <RL assigned a "J" flag by the Element LIMS system.

11.3 **Data Handling Procedures**

In order to process data from Mass Hunter, perform isotope dilution corrections and upload to Element, the following steps are followed:

11.3.1 Produce reports for LIMS (.xlsx and pdf) for all samples/QC of interest in Mass Hunter

11.3.2 Move these files to the PFAS Data for Element folder on the Backup(G) network drive in a folder reflecting the work orders in the files (i.e 19D0005_19D0111 Data)

11.3.3 Using the Content Splitter program open the program and navigate to the pdf report of interest and split the pdfs. This sends them named with the file name (e.g. QQQ0453.d.pdf) to the y:\raw_data drive automatically.

11.3.4 Open the PFAS.mdb convertor program with Access 2010 runtime. Open the Admin tab and be sure the analyst is chosen.

11.3.5 Click on the Select Excel file for import (note must be .xlsx). Navigate to the file and enter it. Examine to be sure it is the correct information then click RUN REPORTS and the reports will be sent to the directory the data came from. The files will be named QBPFASxxxxxxxx_T.pdf for the target isotope report and the isotope corrected data for Element will be in a file named QBPFASxxxxxxxx.xlsx

11.3.6 In order for the Isotope Calc report to be part of the Data pkg., it must be posted to the related Bench sheet in Element. Also, be sure the bench sheet is posted using the proper format in Element.

12. HEALTH AND SAFETY

12.1 General safety considerations and requirements are detailed in the York Laboratory Safety and Health Standard Operating Procedure No. Safety011600.

Specific safety rules applying to the conduct of this analysis requiring the following:

- When handling standards and samples, latex gloves are required.
- Also, when handling neat materials, a fume hood and safety glasses are required.
- When handling samples, gloves and glasses are required.
- Highly odorous samples must be handled in a fume hood.
- Refer to SDSs for specific safety/health information.

12.2 The analysts must exercise normal care and be supervised and trained to work in an analytical chemistry laboratory. The analysts will be handling fragile glassware, needles, syringes, volatile and flammable chemicals, toxic chemicals and corrosive chemicals.

- No smoking or open flames are allowed.
- No food or food products may be brought into the laboratory.

Solvents should not be left uncovered on the laboratory benches.
All solvent transfers should be done in the hoods.

Hood doors must be kept in the position which yields approx. 100 fpm face velocity.
Solvent evaporation must be done in the hood with exhaust elevated and in the rear.

Waste containers that had solvents must be vented to a hood until all solvents have evaporated. Safety glasses are provided and must be worn at all times in the laboratory.
Gloves are provided and must be worn when working with chemicals.

Laboratory coats are provided and should be worn to protect the analysts' clothes.
Syringes and needles must be kept in their original cases when not in use.
Care must be exercised in using and handling syringes to avoid injury.
Report any sticking with a needle immediately to your supervisor.

12.3 Specific Safety Concerns

12.3.1 Preliminary toxicity studies indicate that PFAS could have significant toxic effects. In the interest of keeping exposure levels as low as reasonably achievable, PFAS must be handled in the laboratory as hazardous and toxic chemicals.

12.3.2 Exercise caution when using syringes with attached filter disc assemblies. Application of excessive force has, upon occasion, caused a filter disc to burst during the process.

12.3.3 Laboratory procedures such as repetitive use of pipets, repetitive transferring of extracts and manipulation of filled separatory funnels and other glassware represent a significant potential for repetitive motion or other ergonomic injuries. Laboratory associates performing these procedures are in the best position to realize when they are at risk for these types of injuries.

12.3.4 Eye protection, laboratory coat, and nitrile gloves must be worn while handling samples, standards, solvents, and reagents. Disposable gloves that have been contaminated will be removed and discarded; other gloves will be cleaned immediately.

12.3.5 Perfluorocarboxylic acids are acids and are not compatible with strong bases.

12.3.6 Primary Materials Used- The following is a list of the materials used in this method, which have a serious or significant hazard rating. NOTE: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the SDS for each of the materials listed in the table. A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the SDS for each material before using it for the first time or when there are major changes to the SDS.

Methanol (2-3-0)	Flammable Poison Irritant	200 ppm (TWA)	A slight irritant to the mucous membranes. Toxic effects exerted upon nervous system, particularly the optic nerve. Symptoms of overexposure may include headache, drowsiness and dizziness. Methyl alcohol is a defatting agent and may cause skin to become dry and cracked. Skin absorption can occur; symptoms may parallel inhalation exposure. Irritant to the eyes.

13. WASTE MANAGEMENT/POLLUTION PREVENTION

Neat Materials

Waste management procedures require the prudent use of neat materials. The ordering of neat standards and materials must be done to minimize unused material which would result in storage or handling of excess material. Quantities ordered should be sufficient to provide for necessary standards with consideration to shelf life. When ordering a unique material for a standard, be sure to order the smallest practical quantity.

Solvents

The solvents used at York for this procedure include isopropanol and Methanol. These solvents are used for sample extraction or LC cleanup, All amounts are either consumed during concentration or placed in one liter amber jars in the hood areas for evaporation. Any remaining solvent/water is transferred to a drum designated for solvent waste.

Samples

Unused or remaining soil and water samples are returned to the sample control room (CT) for continued storage for proper disposal by the sample control group.

14. REFERENCES

1. US EPA, “Method 537 - Determination of Selected Perfluorinated alkyl acids in Drinking Water by Solid Phase Extraction and Liquid Chromatography/Tandem Mass Spectrometery (LC/MS/MS)”, Version 1.1, September 2009, J.A. Shoemaker, P.E. Grimmett, B.K. Boutin, EPA Document #: EPA/600/R-08/092 and Rev. 1.1 updates, Nov. 2018

2. Method ISO 25101:2009, “Determination of perfluorooctanesulfonate (PFOS) and perfluorooctanoate (PFOA) – Method for unfiltered samples using solid phase extraction and liquid chromatography/mass spectrometry”, April 30, 2009.

3. EPA Technical Advisory-Laboratory Analysis of Drinking Water Samples for Perfluorooctanoic Acid (PFOA) using EPA Method 537 Rev. 1.1 EPA 815-B-16-021 September 2016 and Nov. 2018 update.

15. REVISION HISTORY

Rev. 1.0	05/10/2019	First issue.
Rev. 1.1	02/13/2020	Modified Sections 9.1.3-Ion Transitions required; 9.3 CCV-added Low level CCV; 11.2 Reporting requirement down to MDL with values <RL and >MDL reported as "J" Added Attachment 4-Current MDLs.

Attachment 1 -HPLC Method Parameters

Acquisition Method Report

	Channel	Name 1	Name 2	Selected	Used	Percent
1	A	Water 5mM ammonium acetate		Ch. 1	Yes	10.0 %
2	B	95% MeOH 5mM ammonium acetate		Ch. 1	Yes	90.0 %

Timetable

	Time	A	B	Flow
1	0.50 min	90.0 %	10.0 %	--- mL/min
2	2.00 min	70.0 %	30.0 %	--- mL/min
3	14.00 min	5.0 %	95.0 %	--- mL/min
4	14.50 min	0.0 %	100.0 %	--- mL/min

Name: Column Comp. **Module:** G7116A

Left Temperature Control	
Temperature Control Mode	Temperature Set
Temperature	50.0 °C
Enable Analysis Left Temperature	
Enable Analysis Left Temperature On	Yes
Enable Analysis Left Temperature Value	0.8 °C
Left Temp. Equilibration Time	1.0 min
Right Temperature Control	
Right temperature Control Mode	Temperature Set
Right temperature	50.0 °C
Enable Analysis Right Temperature	
Enable Analysis Right Temperature On	Yes
Enable Analysis Right Temperature Value	0.8 °C
Right Temp. Equilibration Time	1.0 min
Enforce column for run	
Enforce column for run enabled	No
Stop Time	
Stoptime Mode	As pump/injector
Post Time	
Posttime Mode	Off
Timetable	
Valve Position	Position 1 (Port 1 -> 1')
Position Switch After Run	Do not switch

Attachment 2 - Triple Quadrupole Acquisition Method-24 Target PFAS

Method Name PFAS 24_IDA ACQ.m

MS QQQ Mass Spectrometer
Ion Source-AJS-ESI

Compound	Prec Ion	Pr	Frag (V)	CE (V)	Cell	Ret Time	Polarity
1H,1H,2H,2H-perfluoro-1-decanesulfonate (8 2FTS)	527	50	170	28	4	14.58	Negative
1H,1H,2H,2H-perfluoro-1-decanesulfonate (8 2FTS)	527	80	170	40	4	14.58	Negative
1H,1H,2H,2H-perfluoro-1-hexanesulfonate (4 2FTS)	327	30	162	20	4	10.23	Negative
1H,1H,2H,2H-perfluoro-1-hexanesulfonate (4 2FTS)	327	80	162	36	4	10.23	Negative
1H,1H,2H,2H-perfluoro-1-octanesulfonate (6 2FTS)	427	40	162	24	4	12.92	Negative
1H,1H,2H,2H-perfluoro-1-octanesulfonate (6 2FTS)	427	79	162	48	4	12.92	Negative
d3-N-MeFOSAA	572.99	41	130	20	4	14.94	Negative
d5-N-EtFOSAA	589.02	53	130	20	4	15.27	Negative
d5-N-EtFOSAA	589.02	41	130	20	4	15.27	Negative
M2-4-2FTS	329	30	156	20	4	10.1	Negative
M2-4-2FTS	329	81	156	28	4	10.1	Negative
M2-6-2FTS	429	40	162	24	4	12.9	Negative
M2-6-2FTS	429	81	162	40	4	12.9	Negative
M2-8-2FTS	529	50	165	28	4	14.6	Negative
M2-8-2FTS	529	81	165	40	4	14.6	Negative
M2PFTeDA	715	67	62	12	4	16.7	Negative
M3PFBS	302	98	114	32	4	8.7	Negative
M3PFBS	302	79	114	40	4	8.7	Negative
M3PFHxS	402	98	165	40	4	11.9	Negative
M3PFHxS	402	80	165	48	4	11.9	Negative
M4PFHpA	367	32	124	8	4	11.8	Negative
M5PFHxA	318	27	70	4	4	10.3	Negative
M6PFDA	519	47	59	8	4	14.6	Negative
M7PFUdA	570	52	64	8	4	15.3	Negative
MPFDA	514.98	46	90	8	4	14.62	Negative
MPFDA	514.98	21	90	16	4	14.62	Negative
MPFHxA	314.99	26	70	4	4	10.3	Negative
MPFHxA	314.99	12	70	20	4	10.3	Negative
MPFOA - ISTD	417	37	70	6	4	12.9	Negative
MPFOS	502.96	80	150	96	4	13.89	Negative
N-EtFOSAA	584	52	130	20	4	15.28	Negative
N-EtFOSAA	584	41	130	20	4	15.28	Negative
N-MeFOSAA	570	51	150	20	4	14.95	Negative
N-MeFOSAA	570	41	150	20	4	14.95	Negative
Perfluoro-1-[13C8]octanesulfonamide (M8FOSA)	507	80	162	52	4	15.2	Negative
Perfluoro-1-[13C8]octanesulfonamide (M8FOSA)	506	78	162	48	4	15.2	Negative
Perfluoro-1-[13C8]octanesulfonic acid (M8PFOS)	507	98	174	48	4	13.9	Negative
Perfluoro-1-[13C8]octanesulfonic acid (M8PFOS)	507	80	174	54	4	13.9	Negative
Perfluoro-1-decanesulfonate (L-PFDS)	598.9	98	156	50	4	15.181	Negative
Perfluoro-1-decanesulfonate (L-PFDS)	598.9	98	100	60	4	15.181	Negative
Perfluoro-1-decanesulfonate (L-PFDS)	598.9	79	156	50	4	15.181	Negative
Perfluoro-1-decanesulfonate (L-PFDS)	598.9	79	100	80	4	15.181	Negative
Perfluoro-1-heptanesulfonate (L-PFHpS)	448.9	98	162	48	4	13.027	Negative
Perfluoro-1-heptanesulfonate (L-PFHpS)	448.9	80	162	48	4	13.027	Negative
Perfluoro-1-octanesulfonamide (FOSA)	497.9	78	156	40	4	15.2	Negative
Perfluoro-1-octanesulfonamide (FOSA)	497.9	47	156	100	4	15.2	Negative
Perfluoro-1-pentanesulfonate (L-PFPeS)	348.9	98	150	36	4	10.6	Negative
Perfluoro-1-pentanesulfonate (L-PFPeS)	348.9	79	150	40	4	10.6	Negative
Perfluorobutanesulfonic acid (PFBS)	298.9	98	150	32	4	8.7	Negative
Perfluorobutanesulfonic acid (PFBS)	298.9	79	150	36	4	8.7	Negative
Perfluorodecanoic acid (PFDA)	513	46	90	8	4	14.63	Negative
Perfluorodecanoic acid (PFDA)	513	26	90	16	4	14.63	Negative
Perfluorododecanoic acid (PFDoA)	613	56	90	12	4	15.79	Negative
Perfluorododecanoic acid (PFDoA)	613	16	90	28	4	15.79	Negative
Perfluoroheptanoic acid (PFHpA)	363	31	90	8	4	11.8	Negative
Perfluoroheptanoic acid (PFHpA)	363	16	90	16	4	11.8	Negative
Perfluorohexanesulfonic acid (PFHxS)	398.9	98	150	40	4	11.9	Negative
Perfluorohexanesulfonic acid (PFHxS)	398.9	79	150	44	4	11.9	Negative
Perfluorohexanoic acid (PFHxA)	313	26	70	4	4	10.3	Negative
Perfluorohexanoic acid (PFHxA)	313	11	70	20	4	10.3	Negative
Perfluoro-n-[1,2-13C2]dodecanoic acid (MPFDoA)	615	57	53	8	4	15.9	Negative
Perfluoro-n-[13C4]butanoic acid (MPFBA)	217	17	59	4	4	3.9	Negative
Perfluoro-n-[13C54]pentanoic acid (M5PFPeA)	268	22	62	4	4	8	Negative
Perfluoro-n-[13C8]octanoic acid (M8PFOA)	421	37	59	4	4	12.9	Negative
Perfluoro-n-[13C8]octanoic acid (M8PFOA)	421	17	59	16	4	12.9	Negative
Perfluoro-n-[13C9]nonanoic acid (M9PFNA)	472	42	59	8	4	13.9	Negative
Perfluoro-n-[13C9]nonanoic acid (M9PFNA)	472	22	59	16	4	13.9	Negative
Perfluoro-n-butanoic acid (PFBA)	213	16	70	4	4	3.9	Negative
Perfluorononanesulfonate (L-PFNS)	548.9	98	159	48	4	14.6	Negative
Perfluorononanesulfonate (L-PFNS)	548.9	79	159	48	4	14.6	Negative
Perfluorononanoic acid (PFNA)	463	41	90	8	4	13.89	Negative
Perfluorononanoic acid (PFNA)	463	21	90	16	4	13.89	Negative
Perfluoro-n-pentanoic acid (PFPeA)	263	21	62	4	4	8	Negative
Perfluorooctanesulfonic acid (PFOS)	498.9	98	150	44	4	13.9	Negative
Perfluorooctanesulfonic acid (PFOS)	498.9	79	150	84	4	13.9	Negative
Perfluorooctanoic acid (PFOA)	413	36	90	8	4	12.9	Negative
Perfluorooctanoic acid (PFOA)	413	16	90	16	4	12.9	Negative
Perfluorotetradecanoic acid (PFTA)	713	66	110	12	4	16.71	Negative
Perfluorotetradecanoic acid (PFTA)	713	16	110	28	4	16.71	Negative
Perfluorotridecanoic acid (PFTrDA)	663	61	90	12	4	16.25	Negative
Perfluoroundecanoic acid (PFUnA)	563	51	90	8	4	15.25	Negative
Perfluoroundecanoic acid (PFUnA)	563	16	90	24	4	15.25	Negative

Attachment 3 - Triple Quadrupole Acquisition Method for GenX

Acquisition Method Info-GenX

Method Name	PFAS_GenX_IDA_ACQ.m
Method Path	D:\MassHunter\methods\PFAS_GenX_IDA_ACQ.m
Method Description	Target PFAS Isotope Dilution_Acquisition for GenX

Device List

Multisampler
Binary Pump
Column Comp.
QQQ

MS QQQ Mass Spectrometer

Ion Source	AJS ESI	**Tune File**	D:\MassHunter\Tune\QQQ\G6470A \atunes.TUNE.XML
Stop Mode	No Limit/As Pump	**Stop Time (min)**	1
Time Filter	On	**Time Filter Width (min)**	0.07
LC->Waste Pre Row	N/A	**LC->Waste Post Row**	N/A

Time Segments

Index	Start Time (min)	Scan Type	Ion Mode	Div Valve	Delta EMV	Store	Cycle Time (ms)	Triggered?	MRM Repeats
1	0	DynamicMRM	ESI+Agilent Jet Stream	To MS	200	Yes	500	No	3

Time Segment 1

Scan Segments

Cpd Name	ISTD?	Prec Ion	MS1 Res	Prod Ion	MS2 Res	Frag (V)	CE (V)	Cell Acc (V)	Ret Time (min)	Ret Window	Polarity
HPDO-DA (GenX)	No	285	Unit/Enh (6490)	169	Unit/Enh (6490)	162	1	1	10.5	2	Negative
M3HPDO-DA	No	287	Unit/Enh (6490)	169	Unit/Enh (6490)	159	1	1	10.5	2	Negative
MPFOA	Yes	417	Unit/Enh (6490)	372	Unit/Enh (6490)	70	6	4	12.9	1	Negative

Scan Parameters

Data Stg	Threshold
Centroid	0

Source Parameters

Parameter	Value (+)	Value (-)
Gas Temp (°C)	150	150
Gas Flow (l/min)	5	5
Nebulizer (psi)	15	15
SheathGasHeater	200	200
SheathGasFlow	12	12
Capillary (V)	3500	2500
VCharging	500	0

Chromatograms

Chrom Type	Label	Offset	Y-Range
TIC	TIC	0	10000000

Instrument Curves

Actual

Name: Multisampler — Module: G7167A

Sampling Speed

Draw Speed	100.0 µL/min
Eject Speed	400.0 µL/min
Wait Time After Drawing	1.2 s

Injection

Needle Wash Mode	Multi-wash
Injection Volume	5.00 µL

Multi-wash

Report generation date: 03-May-2019 08:38:58 AM

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Attachment 4 - MDLs/RLs, Aqueous and Soil CY 2020

PFAS (24) MDLs/RLs- Summary Aqueous/Soil, Feb. 2020

PFAS Compound	AQUEOUS		SOIL	
	MDL (ng/L)	RL (ng/L)	MDL (ug/kG)	RL (ug/kG)
1H,1H,2H,2H-perfluoro-1-decanesulfonate (8 2FTS)	0.40	2.00	0.03	0.50
1H,1H,2H,2H-perfluoro-1-hexanesulfonate (4 2FTS)	0.33	2.00	0.05	0.50
1H,1H,2H,2H-perfluoro-1-octanesulfonate (6 2FTS)	0.49	2.00	0.07	0.50
N-EtFOSAA	0.56	2.00	0.10	0.50
N-MeFOSAA	0.53	2.00	0.10	0.50
Perfluoro-1-decanesulfonate (L-PFDS)	0.57	2.00	0.04	0.50
Perfluoro-1-heptanesulfonate (L-PFHpS)	0.41	2.00	0.05	0.50
Perfluoro-1-octanesulfonamide (FOSA)	0.30	2.00	0.05	0.50
Perfluoro-1-pentanesulfonate (L-PFPeS)	0.34	2.00	0.03	0.50
Perfluorobutanesulfonic acid (PFBS)	0.29	2.00	1.65	2.00
Perfluorodecanoic acid (PFDA)	0.52	2.00	0.05	0.50
Perfluorododecanoic acid (PFDoA)	0.78	2.00	0.08	0.50
Perfluoroheptanoic acid (PFHpA)	0.64	2.00	0.05	0.50
Perfluorohexanesulfonic acid (PFHxS)	0.28	2.00	0.03	0.50
Perfluorohexanoic acid (PFHxA)	0.47	2.00	0.07	0.50
Perfluoro-n-butanoic acid (PFBA)	1.63	2.00	0.18	0.50
Perfluorononanesulfonate (L-PFNS)	0.50	2.00	0.04	0.50
Perfluorononanoic acid (PFNA)	0.57	2.00	0.06	0.50
Perfluoro-n-pentanoic acid (PFPeA)	0.45	2.00	0.09	0.50
Perfluorooctanesulfonic acid (PFOS)	0.29	2.00	0.04	0.50
Perfluorooctanoic acid (PFOA)	0.53	2.00	0.08	0.50
Perfluorotetradecanoic acid (PFTA)	0.49	2.00	0.07	0.50
Perfluorotridecanoic acid (PFTrDA)	1.37	2.00	0.04	0.50
Perfluoroundecanoic acid (PFUnA)	0.66	2.00	0.12	0.50

Appendix B

Health and Safety Plan

Health and Safety Plan

for

29 Clay Street

Brooklyn, New York 11222

BCP Site No. Not Assigned

Prepared for

Clay Properties, LLC
134 North 4th Street
Brooklyn, NY 11249

Submitted to:

New York State Department of Environmental Conservation

Prepared by

Preferred Environmental Services

323 Merrick Avenue, North Merrick, New York 11566

February 2024

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LIST OF APPENDIXES

1.0 Introduction and Project Description

This Health and Safety Plan (HASP) has been prepared for use during the implementation of the work associated with the Remedial Investigation Work Plan (RIWP) at the 29 Clay Street, Brooklyn, New York site. The HASP is intended to be utilized in conjunction with the RIWP and Quality Assurance Project Plan (QAPP). The RIWP presents the site background and defines the field sampling program. This HASP provides a mechanism for establishing safe working conditions at the site.

The RIWP describes investigatory activities to be implemented in coordination with the NYSDEC to further evaluated the contamination at the Subject Property. The Subject Property is currently in the NYSDEC Brownfield Cleanup Program. Environmental sampling activities will be performed by Preferred, as per the RIWP, prepared for this project. Preferred field personnel will work under the direction of the Preferred Project Directors.

This Health and Safety Plan (HASP) addresses the safety aspects of the spectrum of environmental work activities to be conducted at the Subject Property as per the RIWP. Activities potentially fall under the scope of Code of Federal Regulations, 29 CFR 1910.120, Hazardous Waste Operations and Emergency Response (HAZWOPER). The purpose of this document is to establish overall site-specific health and safety guidelines to be followed by all personnel conducting work at this site regardless of organizational or regulatory affiliation. The levels of protection and procedures specified in this HASP are based on the best information available from historical data and recent evaluations of the Subject Property. Therefore, these recommendations represent the minimum health and safety requirements to be observed by all personnel engaged in work at the Subject Property. Unforeseeable Subject Property conditions, changes in scope of work, or hazardous conditions not previously considered will warrant a reassessment of the protection levels and controls stated.

Project Description

The RIWP prepared by Preferred, summarizes the potential contamination at the Subject Property, as determined from data gathered during previous investigations. In addition, the RIWP describes Investigatory activities to be implemented in coordination with the NYSDEC at the Subject Property. Preferred field personnel will work under the direction of the Preferred Project Directors

Investigatory activities will include:

- Installation and sampling of groundwater monitoring wells, soil borings, soil vapor points and
- the collection of soil, groundwater and air samples

FOREWORD

The Occupational Safety and Health Act (OSHA) implementing regulations of 29 CFR 1910.120 govern hazardous waste operations and emergency response. These regulations require that employers of employees involved in certain specific hazardous waste operations 1) develop and implement a written health and safety PROGRAM for employees involved in hazardous waste operations, and 2) that the program incorporate a site-specific HASP.

Preferred Environmental Services (Preferred) has employees conducting activities which fall within the scope of these regulations, and thus, has in place a written health and safety PROGRAM as required. Its contents are contained in the Preferred HAZWOPER Program Manual. Some activities conducted at the Subject Property may potentially within the scope of these OSHA regulations. Thus, to assure regulatory compliance, this site-specific HASP covering activities to be conducted at portions of the Subject Property have been prepared. The Integrated Safety Management System (ISMS) and Environmental Safety, Health, and Quality check lists will be used to define safe work procedures for work conducted.

1.0 INTRODUCTION

The regulatory requirements for HASPs are found at 29 CFR 1910.120 (b)(4) and include ten specific elements which are outlined in this HASP:

A) Safety and health risk hazard analysis

B) Frequency and types of monitoring required

C) Personal protective equipment requirements

D) Decontamination procedures

E) Site control measures

F) Spill containment program

G) Emergency response plan

H) Employee training assignments and requirements

I) Medical surveillance requirements

J) Confined space entry procedures - (No confined space entry to be performed).

2.0 SITE ORGANIZATION AND COORDINATION

The following section describes the organizational structure for the environmental sampling. Key personnel and their responsibilities are listed below:

Name	Title	Company/Organization	Phone #	Responsibility/Role
Victoria Whelan, NYS P.G.	Senior Associate/Geologist	Preferred Environmental Services	516 546 1100	Project Manager/Director
William Schlageter, NYS P.G.	Vice President	Preferred Environmental Services	516 546 1100	Quality Assurance Manager
Donald Tesoriero	Project manager	Preferred Environmental Services	516 546 1100	Field Task Manager
Chris Zweier	Project Manager	Preferred Environmental Services	516 546 1100	Site Safety Officer

*Any of the above individuals listed can serve as the Site Supervisor (SS) or Site Safety and Health Officer (SSHO) and will act as the Emergency Response Coordinator (ERC).

2.1 SITE SAFETY AND HEALTH OFFICER

The SSHO advises the Site Supervisor on safety and health issues and conducts briefings prior to initiation of remedial action activities. The SSHO assesses the potential for worker exposures to hazardous agents, recommends appropriate hazard controls for protection of task site personnel, and will require personnel to obtain immediate medical attention in the event of a work-related injury or illness. The SSHO ensures any necessary monitoring of potential chemical hazards is performed, reviews the effectiveness of monitoring and personal protective equipment, and recommends upgrades or downgrades in protective safety and health measures. The SSHO ensures that appropriate fall protection measures are available and that needed work permits are obtained. The SSHO notifies the Office of Radiation Protection when radiological support is required. The SSHO has stop work authority and advises emergency response personnel of an emergency. The SSHO authorizes the return to work following resolution of any safety and health hazards or other stop work issues. The SSHO ensures that this HASP is revised and approved if there are changes in site conditions or tasks. The SSHO will be available for consultation when required and will be aware of project-related work occurring on-site.

2.2 SITE SUPERVISOR

The Site Supervisor has primary responsibility for directing and managing all site investigation field activities, including coordination with any support organizations. The Site Supervisor ensures that all on-site project personnel meet the required level of training, have reviewed the HASP, and are instructed in safe work practices. The Site Supervisor also ensures that a qualified SSHO is designated, maintains a current copy of the HASP, and documents field changes to the HASP in the project logbook. In addition, the Site Supervisor and staff perform oversight of field activities, maintain awareness of site operations, and ensure that all project personnel adhere to ES&H requirements in order to prevent potential accidents from occurring.

The Site Supervisor is responsible for ensuring that the following five core functions of the Integrated Safety Management System (ISMS) are fulfilled appropriately:

- Define the work, roles and responsibilities. Allocate resources to ensure that research goals are balanced with safe work practices.
- Identify and analyze the hazards using the ESH&Q evaluation, consultation with subject matter experts, material safety data sheet information, Work Smart Standards (WSS), lessons learned by other Principal Investigators (PIs) and staff, and other resources.
- Develop and implement hazard controls tailored to the work being performed.
- Resources include Preferred staff, subject matter experts, the Hazardous Materials Inventory System, project procedures, Training Needs Assessment process, Laboratory Operating Manuals, Laboratory Stewards, and Lessons Learned and Alerts. Examples of actions and tools include optimization of engineering controls and procedural approaches with training, HAZCOM job-specific training, job pre-briefings, compliance-based and project-specific training, ES&H permits (e.g., RWPs, Lockout/Tagout process), and protective equipment.

  Perform work within controls to ensure the work is done safely:

- Communicate expectations to project staff.
- Ensure that the controls identified in the ESH&Q evaluation and this HASP are carried out.
- Ensure opportunity for procedure modification to respond to unanticipated situations.
- Stop work if imminent danger exists.

Provide feedback and continuous improvement:

- Solicit feedback from project staff regarding ESH&Q issues and act on that input.
- Communicate concerns to and seek help from supervisors and the ESH&Q group.
- Reallocate resources to address issues that arise.
- Ensure safety meetings and site briefings are performed.

2.3 PRINCIPAL INVESTIGATORS AND FIELD PROJECT PERSONNEL

Principal Investigators (PI) and field project personnel involved in on-site operations are responsible for understanding the intent of the principles of Integrated Safety Management and are to be knowledgeable of the processes in place to satisfy the intent of Integrated Safety Management Plan.

Define the Scope of Work

- Understand the expectations they are to meet in their particular work assignment.
- Understand the responsibilities of the Site Supervisor and SSHO.
- Provide documentation of training to the Site Supervisor.
- Identify and Analyze the Hazard.
- Notify the SSHO of any special medical conditions (i.e., allergies, diabetes, etc.).
- Actively participate in identification of hazards prior to beginning work.
- Ensure that potential work hazards have been evaluated by subject matter experts and are accounted for in all work practices.
- Develop and Implement Hazard Controls.
- Seek the help of the SSHO and other subject matter experts, as appropriate, to analyze the hazards.
- Ensure that control strategies are developed and implemented, as appropriate, before work begins.
- Ensure safety measures are incorporated into activities (i.e., through HASP addendums or amendments, work aides, or standard operating procedures).
- Perform Work Within Controls.
- Perform only those tasks that they believe they can do safely.
- Meet the responsibilities and safely perform the tasks that are delegated to them.
- Take all reasonable precautions to prevent injury to themselves and to their fellow employees; be alert to potentially harmful situations.
- Suspend work if unexpected concerns arise and modify plans to address concerns before resuming work.
- Comply with the work plan and HASP as well as postings and rules at the Subject Property.
- Provide Feedback and Continuous Improvement.
- Keep the SSHO and Site Supervisor informed of any issues, problems, or concerns regarding all aspects of their work.

- Notify appropriate management personnel or the facility point of contact of any unsafe condition, violation, noncompliance, or an environmental threat discovered in a facility.
- Report to the SSHO any changes in site conditions that may affect safety and health.
- Immediately notify the SSHO of symptoms or signs of exposure potentially related to any chemical, physical, or biological hazards present at the Subject Property and immediately report any accidents, injuries, and/or unsafe conditions to the SSHO.
- If unsafe conditions develop, task site personnel are authorized and expected to stop work and notify the SSHO and Site Supervisor of the unsafe condition.

3.0 INTEGRATED SAFETY MANAGEMENT SYSTEM

The Integrated Safety Management System (ISMS) process systematically integrates safety into management and work practices at all levels so work objectives are accomplished while protecting the public, the worker, and the environment. Direct involvement of workers during the development and implementation of safety management systems is essential for success. Therefore, all personnel are expected to incorporate the following basic ISMS core functions during all work activities:

- Defining the scope of work;
- Identifying and analyzing hazards associated with the work;
- Developing and implementing hazard controls;
- Performing work activities within these controls; and
- Providing feedback on the adequacy of the controls to continue improving safety management.

4.0 TASK SPECIFIC HAZARD EVALUATION AND CONTROLS

The purpose of this section is to provide task hazard evaluation to identify and assess potential hazards that personnel might encounter and to prescribe methods of hazard control. This includes information on Personal Protection Equipment (PPE), physical hazards, and other requirements for the implementation of environmental sampling.

As per requirements of Hazard Corrective Actions (OSHA 29 CFR 1926.32 (f)), a tool box safety meeting form (Appendix A) will be used for this project.

Material Safety Data Sheets (MSDS) for of chemicals to be potentially brought to the Subject Property the environmental sampling are included also in Appendix B. A description of sampling procedures and the activities to be conducted at the Subject Property during the required environmental sampling work is described below.

4.1 INSTALLATION OF SOIL BORINGS AND FIELD SAMPLING

Task Description: Procedures for the installation of soil borings and field sampling are described in the RIWP. Soil samples will be retrieved by a Geoprobe during installation of soil borings. The air monitoring action levels using Photo-Ionization Detector (PID) cited in this section will be used to safeguard workers and observers during the implementation of the field investigation program.

Samples will be handled and transported according to regulatory requirements and procedures outlined in the RIWP. Samples will be preserved and stored as required by the analytical protocols (e.g., cooled, preservative added). Storage on-site may occur for short periods of time, packed on-ice but will be quickly transferred to refrigerator storage in the fixed base laboratory at the appropriate temperatures. All storage of contaminated samples will follow procedures and relevant regulations.

Equipment Utilized: Equipment utilized during remediation/investigation activities may include, an excavation, Geoprobe drill rig, hand augers, shovels, etc.

Task Hazards and Controls:

- *Chemical and Radiological Hazards*

  Soil Contact: As soil samples will be handled briefly by workers in appropriate PPE, the risk of chemical exposure from short-term exposure to soil or other environmental media samples is minimal. However, direct contact with contaminated materials will be avoided, therefore, disposable latex or nitrile gloves and safety glasses will be worn when conducting soil and sediment sampling to prevent eye and skin contact.

- *Physical Hazards*

Direct contact with equipment: Precautions will be made to keep a minimum of ten (10) feet from the maximum reach of the excavator and/or drill rig during operation. Furthermore, all on-ground personnel will wear hard hats, work gloves, construction boots and safety glasses as necessary.

Tripping/Falling: Precautions should be taken to avoid trip, slip, and fall accidents when climbing irregular or slippery surfaces. Before changing location visually survey the area for slippery surfaces and tripping hazards.

Heat/Cold Stress: Wear clothing appropriate for environmental and weather conditions. Temperature extremes may be a hazard for consideration depending on the timing of the activity. Refer to Section 5.5 for discussion of recognition of symptoms and controls.

- *Biological/Vector Hazards:*

  Ticks/Snakes/Rodent/Pathogens: Be cautious of snakes, and vector carriers such as ticks. Check clothing and skin for ticks after walking in brush. Wash hands before eating and drinking.

- **Personal Protective Equipment Required to Address General Site Hazards** (OSHA 29 CFR 1926.26)

  Level of Protection: D - Minimum PPE required to be worn by all staff on this project, with proper clothing requirements (no sorts, proper shoes, shirt) will be enforced, especially during summer:

  - Protective Clothing: Preferred-issued work clothes or disposable tyvek
  - Hard Hat that meet ANSI Standard Z89.1;
  - Safety Vest - Class II
  - Safety glasses meeting ANSI Standard Z87 will be worn.
  - Gloves: Latex or nitrile (when conducting groundwater sampling or handling corrosive or oxidizing reagents)
  - Footwear: Steel toe or comparable work boots meeting ANSI Standard Z41 will be worn.

Potable water will be provided, and consumption encouraged via toolbox talk about heat stroke exposures.

Level C protection may consist of the following:

- Work clothes
- Steel toe or comparable work boots meeting ANSI Standard Z41 will be worn.
- Work Gloves
- Hard hat that meet ANSI Standard Z89.1;
- Safety Vest

- Safety glasses meeting ANSI Standard Z87 will be worn
- Chemical Resistant Outer Gloves
- Chemical Resistant Inner Surgical Gloves
- Hearing protection
- Chemical Resistant Coveralls
- Full-Face or Half-Face Piece APR (NIOSH) with combination cartridges

Air Monitoring Requirements

Air Quality: Air monitoring with an organic vapor analyzer or other suitable instrument will be performed during all soil sampling activities. A volatile organic compound (VOC) ambient air monitoring result of 3.0 parts per million (ppm) will trigger a warning response. If a detection of 5.0 ppm VOC in ambient air is detected, the SSHO will suspend work and instruct the workers to move to a safe zone until such time the work zone is tested safe.

No additional monitoring is proposed at this time.

- **Noise (OSHA 29 CFR 1926.52)**

Noise is a potential hazard associated with the operation of heavy equipment, power tools, pumps and generators. Workers who will perform or be proximate to high noise tasks (such as drilling) and operations for short durations (less than 1-hour) would be provided with hearing protection devices. If deemed necessary, the SSO will be consulted on the need for additional hearing protection and the need to monitor sound levels for site activities.

- **Hand and Power Tools**

In order to complete the various tasks for the project, personnel will utilize hand and power tools. The use of hand and power tools can present a variety of hazards, including physical harm from being struck by flying objects, being cut or struck by the tool, fire, and electrocution. Work gloves, safety glasses, and hard hats will be worn by the operating personnel at all times when utilizing hand and power tools and GFI-equipped circuits will be used for all power tools. Tool inspections will be conducted prior to each work shift by labor force that will use the tool. Damaged tools will be tagged out of service and repaired. In order to protect against electrocution:

- Equipment will be equipped with GFCI;
- All electrical work will be conducted by a licensed electrician;
- All equipment will stay a minimum of ten (10) feet from overhead energized electrical lines. This distance will increase 0.4 inches for each 1 kV above 50 kV.

- **Slips, Trips, and Falls, and Fall Protection**

Working in and around the Subject Property will pose slip, trip and fall hazards due to slippery surfaces that may be wet from rain or ice. Soil boring and groundwater monitoring well installation may cause uneven footing in the trenches and around the spoil piles. Daily housekeeping inspections of the work areas will be conducted to identify, eliminate, and control slip trip and fall hazards. Preferred requires 100 percent tie-off for working heights in excess of above six (6) feet of a working surface; however, no such elevated work is anticipated. Preferred will take precautions to comply with fall protection in accordance with OSHA 29 CFR 1926.

- **Manual Lifting**

Manual lifting of heavy objects may be required. Failure to follow proper lifting technique can result in back injuries and strains. Site workers will be instructed to use power equipment to lift heavy loads whenever possible and to evaluate loads before trying to lift them (i.e. they should be able to easily tip the load and then return it to its original position). Carrying heavy loads with a buddy and proper lifting techniques:

1) Make sure footing is solid.
2) Make back straight with no curving or slouching.
3) Center body over feet.
4) Grasp the object firmly and as close to your body as possible.
5) Lift with legs.
6) Turn with your feet, to avoid stress in the lower back. Back injuries are a serious concern as they are the most common workplace injury, often resulting in lost or restricted work time, and long treatment and recovery periods. In addition, hand digging for pipes may present lifting/ergonomic hazards.

- **Confined Space Entry (29 CFR 1926 Subpart AA)**

No Confined Space Entry concerns were identified for the RIWP activities.

- **Severe Weather**

Outdoor operations will cease in the event of severe weather conditions as decided by the SSO. Severe weather may include but not limited to heavy rains, high winds, snow and ice. All heavy equipment use will cease prior to the onset of a thunderstorm regardless of the stage of activity. Work continuation after other severe weather will be determined by SSO and/or competent person overseeing operation.

- **Maintenance and Protection of Traffic Plan**
  - Spotters will be used when backing up trucks and heavy equipment and when moving equipment.

- **Overhead Hazards:**
  - Personnel will be required to wear hard hats that meet ANSI Standard Z89.1;
  - All ground personnel will stay clear of suspended loads;

- All equipment will be provided with guards, canopies or grills to protect the operator from falling or flying objects; and
- All overhead hazards will be identified prior to commencing work operations.

- **Fire/Explosion:**
  - ABC type fire extinguishers will be readily available; and
  - No smoking in work area.

- **Pinch/Cut/Smash:**
  - Cut resistant Kevlar work gloves will be worn when dealing with sharp objects;
  - All hand and power tools will be maintained in safe condition; and
  - Guards will be kept in place while using hand and power tools.

4.2 AIR MONITORING

Therefore, Preferred will implement a air monitoring plan during the conduct of the soil sampling activities. The air monitoring will be implemented during the installation of soil borings and during soil sampling activities to be completed as part of the SC activities. The purpose of the air monitoring is to provide a measure of protection for the area immediately adjacent to the work zone, from potential airborne contaminant releases as a result of SC activities performed at the Site.

Particulate monitoring will be conducted during ground intrusive activities at the Site. Dust and particulate monitoring will be conducted near the approximate downwind perimeter of the work/exclusion zone, when possible, or where dust generating operations are apparent.

Particulate air monitoring will be conducted with a DustTrak (or a similar device). This instrument is equipped with an audible alarm (indication of exceedance) and is capable of measuring particulate matter less than 10 micrometers in size (PM-10). It will continually record emissions (calculating 15-minute running average concentrations) generated during field activities. The dust monitoring devices will be checked and recorded periodically throughout the day of intrusive activities to assess emissions and the need for corrective action.

Particulate monitoring response and action levels include:

- If the downwind PM-10 particulate level is 100 micrograms per cubic meter (ug/m3) greater than background (upwind perimeter - established earlier in the day) for the 15-minute period or if airborne dust is observed leaving the work area, then dust suppression techniques must be employed. Work may continue with dust suppression techniques provided that downwind PM-10 particulate levels do not exceed 150 ug/m3 above 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 ug/m3 above the upwind level, work must be stopped and a re-evaluation of activities initiated. Work can resume provided that dust suppression measures

and other controls are successful in reducing the downwind PM-10 particulate concentration to within 150 ug/m3 of the upwind level and in preventing visible dust migration.

Volatile Organic Compound Air Monitoring. Volatile organic compound (VOC) air monitoring will be conducted in conjunction with the dust monitoring program. VOC air monitoring will be conducted using a RAE Systems MiniRAE 3000 VOC instrument (or a similar photoionization detector device) to provide real-time recordable air monitoring data. VOC monitoring will be conducted for ground intrusive (continuous monitoring). VOCs will be monitored and recorded at the downwind perimeter of the immediate work area. Upwind concentrations will be measured before field activities commence and periodically throughout the day to establish background conditions. The downwind VOC monitoring device will also be checked periodically throughout the day to assess emissions and the need for corrective action.

VOC monitoring response and action levels include:

- 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 must be temporarily halted and monitoring continued. If the total organic vapor level readily decreases (per instantaneous readings) below 5 ppm over background, work activities can resume with continued monitoring.

- If the organic vapor level remains sustained above 5 ppm at the perimeter of the work area, activities must be shutdown and work will be re-evaluated.

Documentation and Calibration

The volatile organic compound air monitoring device shall be calibrated prior to daily field activities according to manufacturer's instructions and standard industrial hygiene practices. In addition, monitoring instruments will be checked for “drift” upon completion of daily field activities. Calibration measurements will be recorded on a field data record. Field measurements will be recorded and available for State (NYSDEC and NYSDOH) personnel to review. The particulate monitoring device is factory calibrated on an annual basis.

5.0 OTHER HEALTH AND SAFETY PLAN ELEMENTS

5.1 Revisions / Modifications to the HASP

The following actions will warrant revision and approval of this plan by the appropriate health and safety disciplines:

- Change in tasks (or previously unidentified tasks) that could impact employee health and safety.
- Changes in hazards (unknown or not previously addressed) which require a significant change in, or addition to, respiratory protection (as defined in exemptions to the plan modifications), physical/barrier protection features, or other engineering controls.

5.1.1 Modifications allowed

The SSHO may upgrade PPE as necessary. These changes must be documented in the field logbook. The change and reason or evidence for the change must also be documented in the field logbook. For upgrades to include respiratory protection (including air-purifying and supplied air) for previously unidentified non-radiological issues or contaminants such as VOCs, the appropriate health and safety disciplines must be contacted. The SSHO will approve and document changes in PPE in the field logbook. Upgrades to include respiratory protection will require the SSHO to ensure workers have 40-Hour HAZWOPER Training and to assess any additional medical surveillance requirements.

5.2 MONITORING

Historical site data indicate that chemical exposure of site personnel will not be a significant concern within the scope of this project, as direct exposure will be limited. Due to the documented findings of the historical site data, exposure to contaminates is possible; therefore, monitoring will be required for all field activities. Site monitoring requirements may change based on site conditions. All changes must be documented in the site logbook.

5.3 SITE AND SPILL CONTROL

Subject Property access is available from public roads and therefore will not be controlled to the general Subject Property. Based on the anticipated levels and for site security reasons, construction fence will be established around the perimeter for the Subject Property. Exclusion zones may be required for drilling operations and other field activities if required to reduce the accidental spread of hazardous substances from contaminated areas to clean areas; and to secure the work zone. The SSHO will determine, as needed, the locations of the support zone, contamination reduction zone, and the exclusion zone. Personnel accessing the zones must meet access requirements as stated in this HASP.

5.4 PERSONAL PROTECTIVE EQUIPMENT

Level D protection is normally used when the potential for personnel contamination is low, due to mitigation direct exposure during sampling. Level D protection has been specified and special requirements have been covered in the hazard control sections of the specific tasks in Section 4.0, above.

Unexpected new hazards will require a reassessment of the specified PPE. Minimum PPE required to be worn by all staff on this project, includes the following:

- Protective Clothing: Preferred-issued work clothes or disposable tyvek
- Hard Hat
- Safety Vest - Class II
- Safety glasses
- Gloves: Latex or nitrile (when conducting groundwater sampling or handling corrosive or oxidizing reagents)
- Footwear: Steel toe or comparable work boots

5.5 TEMPERATURE EXTREMES AND SITE CHARACTERISTICS

The effect of temperature extremes on personnel is a primary hazard associated with the activities conducted at the site. Symptoms and controls related to temperature extremes are considered in detail in this section.

Field activities conducted during the summer or winter pose a hazard because of temperature extremes. Since the project site is located in a relatively open area, workers will dress appropriately for environmental conditions, wearing clothing that provides reasonable protection against winter cold and summer sun. Although extreme physical exertion will not be likely within the scope of this project, during hot weather workers are encouraged to be aware of their own symptoms of heat stress (headaches, dizziness, increased heart rate), to drink plenty of water, and to take breaks as needed. Heat stress symptoms, remedies, and monitoring are discussed in Section 5.5.1. Cold exposure effects are discussed in Section 5.5.2.

Workers are also encouraged to apply insect repellant and/or sunscreen as needed prior to field activities. Workers should exercise caution by visually inspecting their immediate area of activity for presence of poisonous/harmful plant, insect, and animal species as well as any hazard resulting from previous human activity.

5.5.1 Effects and Prevention of Heat Stress

If the body's physiological processes fail to maintain a normal body temperature because of excessive heat, a number of physical reactions can occur. They can range from mild symptoms such as fatigue, irritability, anxiety, and decreased concentration, dexterity, or movement, to death.

Heat-related health concerns can include the following:

- **Heat rash**: Caused by continuous exposure to heat and humid air and aggravated by chafing clothes. Decreases ability to tolerate heat and is a nuisance.
- **Heat cramps**: Caused by profuse perspiration combined with inadequate fluid intake and chemical replacement, particularly salts. Signs include muscle spasm and pain in the extremities and abdomen.

- **Heat exhaustion**: Caused by increased stress on various organs to meet increased demands to cool the body. Signs include shortness of breath; increased pulse rate (120-200 beats per minute); pale, cool, moist skin; profuse sweating; dizziness; and lassitude.
- **Heat stroke**: Is the most severe form of heat stress. Body must be cooled immediately to prevent severe injury and/or death. Signs include red, hot, dry skin; no perspiration; nausea; dizziness and confusion; strong, rapid pulse; and possibly coma. Medical help must be obtained immediately.

Medical attention must be obtained for the more serious symptoms of heat stress. One or more of the following methods are recommended to help reduce the potential for heat stress:

1. Provide plenty of liquids. To replace body fluids (water and electrolytes) lost due to sweating, use a 0.1 percent saltwater solution, more heavily salted foods, or commercial mixes. The commercial mixes may be preferable for those employees on a low-sodium diet.
2. Provide cooling devices to aid natural body ventilation. These devices, however, add weight, and their use should be balanced against worker efficiency.
3. Wear long cotton underwear, which acts as a wick to help absorb moisture and protect the skin from direct contact with heat-absorbing protective clothing.
4. Install mobile showers and/or hose-down facilities to reduce body temperature and cool protective clothing.
5. In extremely hot weather, conduct non-emergency response operations in the early morning or evening.
6. Ensure that adequate shelter is available to protect personnel against sun, heat, or other adverse weather conditions that decrease physical efficiency and increase the probability of accidents.
7. In hot weather, rotate workers wearing protective clothing.
8. Maintain good hygiene frequently changing clothing and showering daily. Clothing should be permitted to dry during rest periods. Workers who notice skin problems should immediately consult medical personnel.

5.5.2 Cold Exposure

Persons working outdoors in temperatures at or below freezing may suffer from cold exposure. During prolonged outdoor periods with inadequate clothing for protection, the effects of cold exposure may occur even at temperatures well above freezing. Cold exposure may cause severe injury due to freezing of exposed body surfaces (frostbite), or profound generalized cooling (hypothermia), possibly resulting in death. Areas of the body which have high surface area-to-volume ratios such as fingers, toes, and ears are the most susceptible to frostbite.

Local injury resulting from cold is included in the generic term frostbite. There are several degrees of damage. Frostbite of the extremities can be categorized into:

- **Frost nip or incident frostbite:** characterized by sudden blanching or whitening of skin.
- **Superficial frostbite:** skin has a waxy or white appearance and is firm to the touch, but tissue beneath is resilient.

- **Deep frostbite:** tissues are cold, pale, and solid; extremely serious injury.

Systemic hypothermia, or lowering of the core body temperature, is caused by exposure to freezing or rapidly dropping temperatures. Symptoms are usually exhibited in five stages: 1) shivering and loss of coordination; 2) apathy, listlessness, sleepiness, and (sometimes) rapid cooling of the body to less than 95ºF (35ºC); 3) unconsciousness, glassy stare, slow pulse, and slow respiratory rate; 4) freezing the extremities; and 5) death.

5.6 DECONTAMINATION

Preferred and its subcontractors will maintain on-site decontamination equipment such as potable water, alconox, isopropyl alcohol, and water reservoir tank. Groundwater, soil and soil vapor sampling, and drilling equipment will be decontaminated between each boring, well installation, sampling event, and prior to mobilization on- or off-site.

Decontamination of personnel will be conducted only in the unexpected event that contamination is detected. At a minimum, personnel who have conducted work at the Subject Property will wash their hands prior to eating or drinking. Preferred personnel will supervise, assist, and document incidents involving personnel contamination.

5.7 EMERGENCY PREPAREDNESS/RESPONSE

The first worker who notices that a medical emergency or personal injury has occurred will immediately make a subjective decision as to whether the emergency is life threatening and/or otherwise serious.

Life-Threatening and/or Otherwise Serious Incident

If a life-threatening incident occurs, those persons recognizing the situation should do whatever actions in their capabilities to reduce the threat and then the SSHO will be contacted. The SSHO will immediately notify the local emergency agencies and implement emergency action procedures to have someone meet and guide EMS to the incident location.

The SSHO will be kept apprised of the situation and the location of the victim(s). As the SSHO proceeds to the accident scene, communications channels will be opened and kept on standby until the SSHO has surveyed the scene and performed a primary survey of the victim. The SSHO will provide emergency action guidance consistent with the injury and will relay the appropriate information to the site person meeting the emergency response team.

Depending on the nature of the injury and the location at which the injury occurred, the SSHO will determine whether the person can be moved or whether the EMS team will need to come into the work area to assist the victim. Should the victim be injured in the work zone, all appropriate life-saving methods will be exercised in that area before attempting decontamination (if required) of the victim. The extent of emergency decontamination performed will depend on the severity of the injury or illness and the nature of the contamination. If the emergency is such that emergency decontamination cannot be performed

safely, the victim will be given necessary first-aid treatment and wrapped in a blanket prior to transportation by the emergency response team..

If heat stress is a factor in a victim's injury/illness, all protective clothing will be removed from the victim immediately.

Non-Life-Threatening Incident

Should it be determined that no threat to life is present, a co-worker will assist the injured person and contact the SSHO as soon as reasonably possible. The SSHO will notify the Contractor of the incident. For all non-life threatening injuries, all medical assistance will be provided outside the work zone to reduce the spread of contamination to medical personnel or equipment.

All emergency services can be reached by dialing 911 from any facility or mobile telephone. Access to phones and/or radios will be provided to onsite personnel. The Emergency Response Coordinator (ERC) will coordinate all emergency response operations. Should evacuation from the site become necessary, the evacuation route to the hospital is shown in Figure 1. Emergency telephone numbers are given below.

Emergency Response Coordinator

Preferred Environmental Services - Key Personnel & In-Office Project Directors

Mr. William Schlageter 516-546-1100, cell 917-715-0752 - bschlageter@preferredenv.com

Ms. Victoria Whelan 516-546-1100, cell 631-793-8821 – vwhelan@preferrredenv.com

Field Staff and SSHO

Marcello Iaboni cell: 631-835-1188

Chris Zweier cell: 516 729-3293

EMERGENCY TELEPHONE NUMBERS

Police - 911

Fire Dept:

New York City Fire Department, Engine Company 319
78-11 67th Rd., Queens, NY

Other Emergency Contact information:

Consolidated Edison: Gas/Electric Emergency 1-800-752-6633
Water/Sewer: NYCDEP- 311
NY Poison Control: 800-222-1222

5.8 ACCESS AND EGRESS

All entrances and exits at this project site will be kept free of ice and snow to prevent worker injuries from slips, trips and falls or vehicle accidents. Aisles, stairways and walkways, and access to safety, firefighting equipment and first aid equipment will be kept clear of obstructions (e.g., equipment deliveries, office supplies) and/or tripping hazards. All fire lanes, access roads and evacuation routes will be kept clear of equipment, materials and parked vehicles at all times.

A list of potential unsafe situations will also be avoided to make any on-site workplace safer:

– Blocked or cluttered exit passageways (e.g., halls, stairwells);

– Extra or unnecessary boxes, paper or other flammable/combustible products;

– Improper storage of office equipment and supplies;

– Overloaded outlets;

– File and desk drawers in poor condition and left opened; and

– Sharp/bladed equipment (e.g., scissors, cutting knives) improperly stored and poorly maintained.

5.9 MATERIAL HANDLING, STORAGE, USE AND DISPOSAL

Use of Drums and Containers - OSHA defines "anything that holds hazardous chemicals except pipes and piping systems" as a container. Although OSHA does not concern itself with nonhazardous materials; this does not mean that drums or containers containing nonhazardous materials cannot cause injury to workers. Prior to moving drums or containers storing hazardous materials or that otherwise pose a threat to the safety of employees, all employees must be informed of the potential hazards associated with the contents of the drums or containers.

Additional activities requiring appropriate training of employees may include:

- Sampling procedures
- Communication methods
- Methods for relieving pressure from drums and containers or for shielding when pressure cannot be relieved from a remote location
- Emergency response to accidents onsite
- Characterization of wastes to be bulked
- Use of monitoring equipment

Labeling Drums and Containers - Drums and containers will be identified and classified prior to packaging for shipment.

Procedures for Handling Drums and Containers - Where containers with capacities greater than 5 gallons are used for chemical products or waste materials, the containers are to be handled according to the following procedures:

- When not in use, cover drums/containers with tightfitting lids or bung caps.
- At the conclusion of each work shift, place all drums/ containers in a designated storage area. This area will not properly marked and secured.
- Use mechanical or powered drum handling equipment to move "filled" drums/ containers.
- Manual handling of the drums leads to muscular skeletal injuries and will be avoided to the maximum extent possible.

Drum Staging - The following practices should be followed when staging drums to eliminate or reduce unnecessary drum movement:

- Stage drums in rows, two drums wide, with adequate walking space between rows.
- Face drum labels out, toward the aisle so they can be easily read without moving a drum.
- Face the bolt on drums with lid rings out, toward the aisle.
- Do not stack drums on top of one another.
- Stage drums on pallets prior to filling, if possible.

Opening Drums and Containers - Only a couple of pounds of built-up pressure can cause a loosened fitting to fly into the air. This can cause injury to site workers and can puncture adjacent containers or drums, causing rupture and leakage. If the drum or container is filled to or near the level of the opening, material can fly from the opening causing injury to site personnel, formation of hazardous/flammable

atmospheres at the project site and/or environmental damage. The procedure for opening drums and containers must incorporate the minimum safeguards listed below:

- Employees not directly involved in opening the drum or container must stay a safe distance from the drum or container during the process.
- If the potential for a flammable atmosphere exists or may develop onsite, all equipment and tools must be of a type to prevent sources of ignition (non-sparking, explosion proof, intrinsically safe) and grounding/ bonding of containers must be considered.
- If the pressure within a drum or container cannot be relieved from a remote location, the employee opening the drum or container must be protected by an appropriate shield to reduce the risk of injury.
- Drums and containers are not stepladders. Employees are not allowed to stand on or work off of drums or containers.
- Material handling equipment used to move drums and containers must be selected, positioned and operated in a manner that minimizes the potential for the equipment to act as a source of ignition if a drum or container should rupture.
- When a drum or container exhibits signs of over-pressurization such as swelling or bulging, the drum or container will not be moved until the cause of the over-pressurization has been determined and proper containment procedures have been implemented.
- The number of areas where drums and containers are staged should be limited in order to identify and classify them.
- Areas where drums and containers are staged must be provided with adequate routes for access and egress from the staging area.

Use of Approved Drums or Containers - Drums and containers are required to meet the appropriate DOT, OSHA and USEPA regulations and/or Canadian requirements for the materials they contain. Large containers or drums will carry either a DOT approval, or a nationally recognized testing laboratory approval or both. The use of approved drums and containers provides some assurance that the drum or container will not fail due to incompatibility with the stored material and that the drum or container is structurally suitable for designated duty.

Drum Condition - The following requirements apply to assessment of the drum condition:

When practical, inspect drums and containers and verify their integrity prior to being moved. Drums and containers that cannot be inspected prior to being moved due to storage conditions (e.g., buried, in a pile, stacked several tiers high) must be moved to an accessible location and inspected prior to further handling.

- Empty drums and containers that cannot be moved without risk of rupture, leakage or spillage into a sound container using a device classified (i.e., intrinsically safe or explosion proof for the class of flammable material) for use around the material being transferred.
- Open drums and containers in a manner that safely relieves excess internal pressure.
- If crystalline material is noted on any container, handle the contents of the container as a shock sensitive waste until positive identification of the contents is determined.

Other Considerations - Unlabeled drums and containers must be considered to contain hazardous substances and will be handled accordingly until positive content identification has been made. Polyethylene drums and containers are not equipped with a means for electrical grounding. When transferring flammable materials, the polyethylene container (or any other container for that matter) must be equipped with a mechanism that allows for grounding. A grounded suction pump (approved only) or a grounded metallic self-closing faucet can be used to accomplish safe transfer of flammable materials from these containers.

If leaking drums or containers may be present, or ruptures or spills may occur, DOT-specified salvage drums or containers must be available onsite along with suitable quantities of an appropriate absorbent material. Move drums and barrels with a barrel truck or forklift whenever possible. However, if they must be moved manually, follow these safety precautions:

- Before attempting to move a drum or barrel, identify the load or its contents. Read the label on the drum and look for symbols, words or other marks that indicate if contents are hazardous, corrosive, toxic or flammable.
- Check for leaks in the drum or barrel. If leaks are detected, ensure that you have the correct materials to clean up the chemical. Make sure you have been trained in the hazards of the chemical and review the appropriate MSDS if required.
- Roll the drums or barrels by pushing on the center rolling rings. Do not grasp the ends because this places your hands in a position to be pinched between the barrel and another object. Never kick barrels with your feet.

5.10 SIGNS, SIGNALS AND BARRICADES

Properly located and clearly understood safety signs provide a reminder to facility/location personnel to take proper action or precautions. The placement of such signs is dependent upon the following:

- Required by law governing the work at the property, resulting in mandatory posting
- Where facility/location personnel believe that the posting of such signs may assist in the prevention of accidents and injuries.

Sign Selection - In addition to specifically worded signs to serve a particular purpose, there are generally four types of signs:

- Danger Sign/Tags—to be used only where an immediate hazard exists or to tag out defective equipment or equipment in need of repair. Signs and tags should have white background and the word “Danger’’ will appear in white letters on a red oval inside a black rectangular panel.
- Caution Sign/Tags—warn against potential hazards or to caution against unsafe practices. Sign and tag wording will be in black letters on a yellow background. The word “Caution” will appear in yellow letters on a black rectangular panel.
- Warning Sign/Tags—indicate a potentially hazardous situation, capable of resulting in severe, but not irreversible injury.

- Notice or Instructional Signs/Tags—convey information not necessarily of a safety nature, but often aimed at avoiding confusion and misunderstanding. Signs and tags can be of various colors, but not red or yellow.

Sign Wording - General requirements for sign wording are summarized below:

- Concise and easy to read
- Contain sufficient information to be easily understood
- Make a positive, rather than negative message and be accurate in fact
- Be presented in English, unless facility/location personnel determine that an additional language is necessary

Sign Placement - requirements for sign placement are presented below:

- Place signs properly so that the intended message is received by facility/location personnel and visitors.
- Securely affix signs to prevent accidental displacement by weather and normal wear and tear.
- Promptly replace illegible or damaged signs.

Training - Training will be provided to aid personnel in understanding signs posted at project sites, as summarized below:

- Personnel will be trained to understand signs posted in their workplace.
- Such training is not difficult or time consuming and will be documented. Often such training is accomplished via a safety meeting or as a part of new employee orientation.

Temporary Signage and Barricades - Warning signs and barricades will be used at all project sites to clearly identify hazards. Use signage to identify hazards (e.g., open holes trenches).

5.11 EXCAVATION

No excavation is proposed as part of the RIWP activities.

6.0 TRAINING/MEDICAL REQUIREMENTS

6.1 SITE-SPECIFIC HAZARD COMMUNICATION AND ACCESS BRIEFING

Since different training requirements may be needed based on the nature of different tasks to be performed, specific training requirements may be identified. However, generally applicable training requirements are presented here. Visitors not entering any exclusion zone or contamination reduction zone who have very limited potential for exposure to contaminants require:

1. Site-specific hazard communication and access briefing.

All project personnel performing hands-on work that could potentially expose them to hazardous substances, safety, or health hazards will meet the following training requirements:

2. General Employee Training (GET)
   - 40 hour HAZWOPER (SARA/OSHA) training, or equivalent (Note: for certain types of low risk work, 8 or 24 hour training is acceptable)
   - Current HAZWOPER 8-hour Annual Refresher (as applicable)
   - Site-specific hazard communication and access briefing

In addition, the Site Safety and Health Officer requires:

- 8-hour HAZWOPER Supervisor training

Personnel involved in service or maintenance work on energized equipment require:

- Lockout/Tagout training

Prior to beginning work at the project site, all personnel will review this Health and Safety Plan and sign the training acknowledgment form (Appendix C). The site-specific hazard communication and access briefing is documented in the project logbook. If site conditions change, or other hazards are detected, the training and access requirements will be revised accordingly. In the event of a medical emergency, an Accident/Injury Report (Appendix D) is to be completed.

6.2 MEDICAL SURVEILLANCE

A medical surveillance program will be conducted in accordance with the requirements of 29 CFR 1910.120 for:

- All employees who are or may be exposed to hazardous substances or health hazards at or above the established permissible exposure limits or, if there is no permissible exposure limit, above the published exposure levels for these substances, without regard to the use of respirators, for 30 days or more a year.
- All employees who wear a respirator for 30 days or more a year or as required by 29 CFR 1910.134.
- All employees who are injured, become ill or develop signs or symptoms due to possible overexposure involving hazardous substances or health hazards from an emergency response or hazardous waste operation.
- Members of HAZMAT teams.

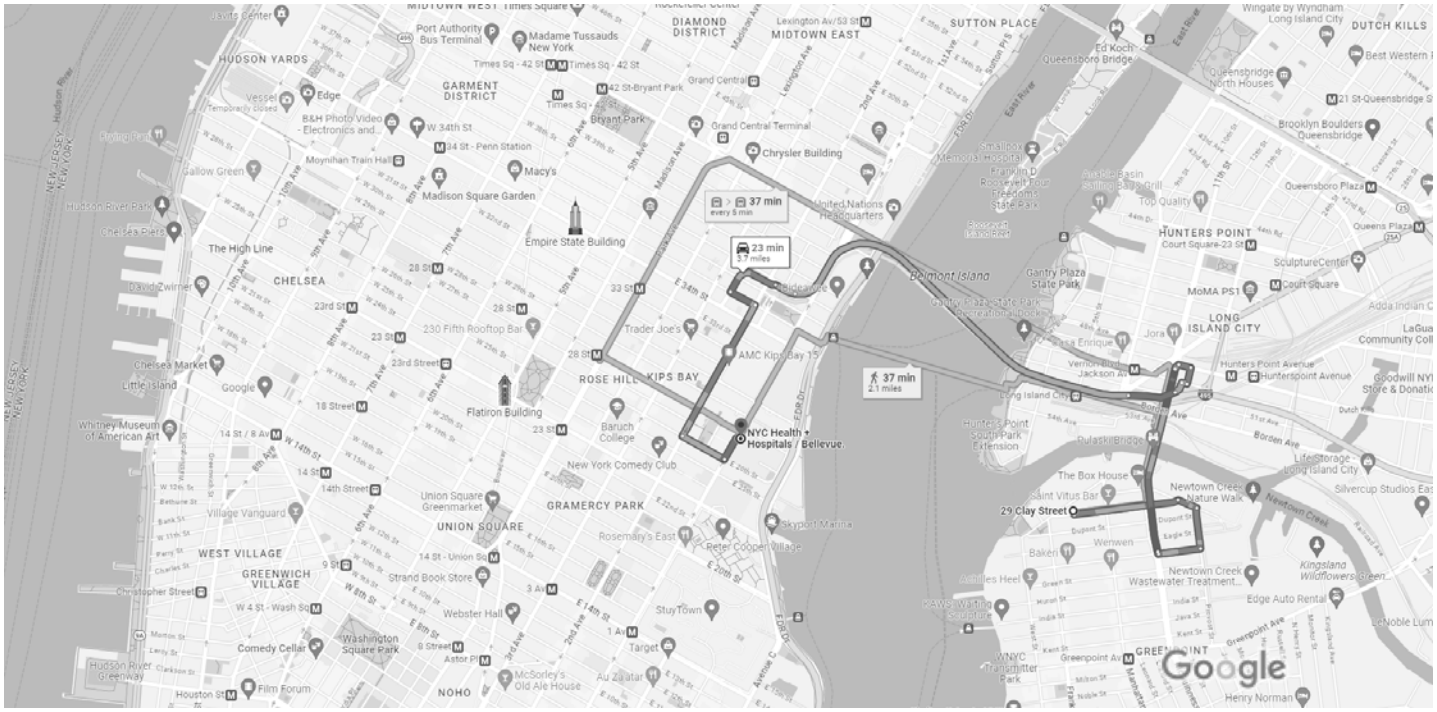
All Preferred employees receive periodic medical examinations. Because of the low potential for exposure to hazardous agents, it is not expected that additional medical surveillance will be required for any personnel undertaking this project. If necessary, non-Preferred personnel will be required to acknowledge coverage by a medical surveillance program sufficient to satisfy the requirements of 29 CFR 1910.120.

FIGURES

Google Maps

29 Clay St, Brooklyn, NY 11222 to NYC Health + Hospitals / Bellevue., 462 1st Ave., New York, NY 10016

Drive 3.7 miles, 23 min



Map data ©2023 Google 1000 ft

29 Clay St
Brooklyn, NY 11222

⚠ This route has tolls.

Take Clay St to McGuinness Blvd

3 min (0.6 mi)

1. Head east on Clay St toward Manhattan Ave

0.3 mi

2. Turn right onto Paidge Ave

312 ft

3. Turn right onto Provost St

0.1 mi

4. Turn right onto Freeman St

0.1 mi

Take Pulaski Bridge, Queens Midtown Tunnel and 2nd Ave to 1st Ave. in Manhattan

10 min (3.1 mi)

5. Turn right onto McGuinness Blvd

43 ft

6. Keep left to continue on Pulaski Bridge

0.6 mi

7. Slight right toward 49th Ave

95 ft

8. Turn right onto 49th Ave

203 ft

9. Turn right onto 11th Pl

259 ft

10. Turn right onto 50th Ave

85 ft

11. Turn left onto the I-495 W ramp

⚠ Toll road

194 ft

12. Keep left, follow signs for Interstate 495 W and merge onto I-495 W

⚠ Toll road

0.1 mi

13. Continue onto Queens Midtown Tunnel

⚠ Toll road

1.2 mi

14. Continue onto I-495 W/Queens Midtown Tunnel

⚠ Toll road

338 ft

15. Use the left lane to take the 35 St exit toward Downtown/34 St/2 Ave

⚠ Toll road

0.2 mi

16. Use the left 2 lanes to turn left onto E 35th St

440 ft

17. Turn right at the 1st cross street onto 2nd Ave

0.4 mi

18. Turn left onto E 26th St

0.1 mi

19. Turn left onto 1st Ave.

384 ft

NYC Health + Hospitals / Bellevue.
462 1st Ave., New York, NY 10016

Appendix A

Tool Box Form

TAILGATE HEALTH & SAFETY MEETING FORM

This form documents the tailgate meeting conducted in accordance with the Project HASP. Personnel who perform work operations on-site during the day are required to attend this meeting and to acknowledge their attendance, at least daily.

Project Name:			**Project Location:**
Date:	**Time:**	**Conducted by:**	**Signature/Title:**
Client:		**Client Contact:**	**Subcontractor companies:**

TRACKing the Tailgate Meeting

Think through the Tasks (list the tasks for the day):

1 _____ 3 _____ 5 _____

2 _____ 4 _____ 6 _____

Other Hazardous Activities - Check the box if there are any other ARCADIS, Client or other party activities that may pose hazards to ARCADIS operations ☐ If there are none, write "None" here: _____

If yes, describe them here: _____

How will they be controlled? _____

Prework Authorization - check activities to be conducted that require permit issuance or completion of a checklist or similar before work begins:

	Doc #		Doc #		Doc #
☐ Not applicable		☐ Working at Height		☐ Confined Space	
☐ Energy Isolation (LOTO)		☐ Excavation/Trenching		☐ Hot Work	
☐ Mechanical Lifting Ops		☐ Overhead & Buried Utilities		☐ Other permit	

Discuss following questions (for some review previous day's post activities). **Check if yes :**

☐ Topics from Corp H&S to cover?		
☐ Incidents from day before to review?	☐ Lessons learned from the day before?	☐ Any Stop Work Interventions yesterday?
☐ Any corrective actions from yesterday?	☐ Will any work deviate from plan?	☐ If deviations, notify PM & client
☐ JLAs or procedures are available?	☐ Field teams to "dirty" JLAs, as needed?	☐ All equipment checked & OK?
☐ Staff has appropriate PPE?	☐ Staff knows Emergency Plan (EAP)?	☐ Staff knows gathering points?

Comments: _____

Recognize the hazards (check all those that are discussed) (Examples are provided) and **Assess** the Risks (Low, Medium, High - circle risk level) - Provide an overall assessment of hazards to be encountered today and briefly list them under the hazard category.

☐ Gravity (i.e., ladder, scaffold, trips) (L M H)	☐ Motion (i.e., traffic, moving water) (L M H)	☐ Mechanical (i.e., augers, motors) (L M H)
☐ Electrical (i.e., utilities, lightning) (L M H)	☐ Pressure (i.e., gas cylinders, wells) (L M H)	☐ Environment (i.e., heat, cold, ice) (L M H)
☐ Chemical (i.e., fuel, acid, paint) (L M H)	☐ Biological (i.e., ticks, poison ivy) (L M H)	☐ Radiation (i.e., alpha, sun, laser) (L M H)
☐ Sound (i.e., machinery, generators) (L M H)	☐ Personal (i.e. alone, night, not fit) (L M H)	☐ Driving (i.e. car, ATV, boat, dozer) (L M H)

Continue TRACK Process on Page 2

TAILGATE HEALTH & SAFETY MEETING FORM - Pg. 2

Control the hazards (Check all and discuss those methods to control the hazards that will be implemented for the day): Review the HASP, applicable JLAs, and other control processes. Discuss and document any additional control processes.

☒	**STOP WORK AUTHORITY** (Must be addressed in every Tailgate meeting - (*See statements below*)		
☐	Elimination	☐ Substitution	☐ Isolation
☐	Engineering controls	☐ Administrative controls	☐ Monitoring
☐	General PPE Usage	☐ Hearing Conservation	☐ Respiratory Protection
☐	Personal Hygiene	☐ Exposure Guidelines	☐ Decon Procedures
☐	Emergency Action Plan (EAP)	☐ Fall Protection	☐ Work Zones/Site Control
☐	JLA to be developed/used ***(specify)***	☐ LPO conducted ***(specify job/JLA)***	☐ Traffic Control
☐		☐	☐ Other ***(specify)***
☐		☐	☐

Signature and Certification Section - Site Staff and Visitors

Name/Company/Signature	Initial & Sign in Time	Initial & Sign out Time	I have read and understand the

Important Information and Numbers

All site staff should arrive fit for work. If not, they should report to the supervisor any restrictions or concerns.

In the event of an injury, employees will call WorkCare at 1.800.455.6155 and then notify the field supervisor who will, in turn, notify Corp H&S at 1.720.344.3844.

In the event of a motor vehicle accident, employees will notify the field supervisor who will then notify Corp H&S at 1.720.344.3844 and then Corp Legal at 1.720.344.3756.

In the event of a utility strike or other damage to property of a client or 3rd party, employees will immediately notify the field supervisor, who will then immediately notify Corp Legal at 1.678.373.9556 and Corp H&S at

Visitor Name/Co - not involved in work

In	Out
In	Out
In	Out
In	Out

I will STOP the job any time anyone is concerned or uncertain about health & safety or if anyone identifies a hazard or additional mitigation not recorded in the site, project, job or task hazard assessment.

I will be alert to any changes in personnel, conditions at the work site or hazards not covered by the original hazard assessments.

If it is necessary to **STOP THE JOB,** I will perform **TRACK**; and then amend the hazard assessments or the HASP as needed.

I will not assist a subcontractor or other party with their work unless it is absolutely necessary and then only after I have done TRACK and I have thoroughly controlled the hazard.

Post Daily Activities Review - Review at end of day or before next day's work (Check those applicable and explain:)

- ☐ Lessons learned and best practices learned today: _____
- ☐ Incidents that occurred today: _____
- ☐ Any Stop Work interventions today? _____
- ☐ Corrective/Preventive Actions needed for future work: _____
- ☐ Any other H&S issues: _____

Keep H&S 1st in all things

WorkCare - 1.800.455.6155

Appendix B

Material Safety Data Sheets

MATERIAL SAFETY DATA SHEET

THE BIOSOLVE® COMPANY
329 Massachusetts Avenue
Lexington, Massachusetts 02420 USA

Phone: +1 (781) 482-7900 Fax: +1 (781) 482-7909
Emergency Phone-24 Hours: +1 (800) 225-3909

E-Mail: info@biosolve.com
Web Site: www.biosolve.com

Ref. No.: 2001
Date: 7/26/2010

SECTION I - IDENTITY

Name:	**BioSolve®**
CAS #:	138757-63-8
Formula:	Proprietary
Chemical Family:	Water Based, Biodegradable, Wetting Agents & Surfactants
HMIS Code:	Health 1, Fire 0, Reactivity 0
HMIS Key:	4 = Extreme, 3 = High, 2 = Moderate, 1 = Slight, 0 = Insignificant

SECTION II - HAZARDOUS INGREDIENTS

Massachusetts Right to Know Law or 29 C.F.R. (Code of Federal Regulations) 1910.1000 require listing of hazardous ingredients.

This product does not contain any hazardous ingredients as defined by CERCLA, Massachusetts Right to Know Law and California's Prop. 65.

DOT Class: Not Regulated/Non Hazardous

SECTION III - PHYSICAL - CHEMICAL CHARACTERISTICS

Boiling Point	: 265°F	Specific Gravity	: 1.00 +/-.01
Melting Point	: 32°F	Vapor Pressure mm/Hg	: Not Applicable
Surface Tension- 6% Solution	: 29.1 Dyne/cm at 25°C	Vapor Density Air = 1	: Not Applicable
Reactivity with Water	: No	Viscosity - Concentrate	: 490 Centipoise
Evaporation Rate	: >1 as compared to Water	Viscosity - 6% Solution	: 15 Centipoise
Appearance	: Clear Liquid unless Dyed	Solubility in Water	: Complete
Odor	: Pleasant Fragrance	pH	: 9.1+/-.3
Pounds per Gallon	: 8.38		

SECTION IV - FIRE AND EXPLOSION DATA

Special Fire Fighting Procedures	: None	Flammable Limit	: None
Unusual Fire and Explosion Hazards	: None	Auto Ignite Temperature	: None
Solvent for Clean-Up	: Water	Fire Extinguisher Media	: Not Applicable
Flash Point	: None		

SECTION V - SPECIAL PRECAUTIONS AND SPILL/LEAK PROCEDURES

Precautions to be taken in Handling and Storage: Use good normal hygiene.
Precautions to be taken in case of Spill or Leak -

Small spills, in an undiluted form, contain. Soak up with absorbent materials.
Large spills, in an undiluted form, dike and contain. Remove with vacuum truck or pump to storage/salvage vessel. Soak up residue with absorbent materials.

Waste Disposal Procedures -

Dispose in an approved disposal area or in a manner which complies with all local, provincial, and federal regulations.

SECTION VI - HEALTH HAZARDS

Threshold Limit Values: Not applicable
Signs and Symptoms of Over Exposure-

Acute : Moderate eye irritation. Skin: Causes redness, edema, drying of skin.
Chronic: Pre-existing skin and eye disorders may be aggravated by contact with this product.

Medical Conditions Generally Aggravated by Exposure: Unknown
Carcinogen: No

Emergency First Aid Procedures -

Eyes: Flush thoroughly with water for 15 minutes. Get medical attention.
Skin: Remove contaminated clothing. Wash exposed areas with soap and water. Wash clothing before reuse. Get medical attention if irritation develops.
Ingestion: Get medical attention.
Inhalation: None considered necessary.

SECTION VII - SPECIAL PROTECTION INFORMATION

Respiratory Protection	: Not necessary	Local Exhaust Required	: No, except in confined space as required.
Ventilation Required	: Normal	Protective Clothing	: Neoprene or other chemical resistant gloves, safety goggles or chemical face shield. Wash clothing before reuse.

WHEN UTILIZED IN CONFINED SPACE OPERATIONS, ADDITIONAL PPE MAY BE REQUIRED AS PER OSHA GUIDELINES.

SECTION VIII - PHYSICAL HAZARDS

Stability	: Stable	Incompatible Substances	: None Known
Polymerization	: No	Hazardous Decomposition Products	: None Known

SECTION IX - TRANSPORT & STORAGE

DOT Class	: Not Regulated/Non Hazardous		
Freeze Temperature	: 28°F	Storage	: 35°F-120°F
Freeze Harm	: None (thaw & stir)	Shelf Life	: Unlimited Unopened

SECTION X - REGULATORY INFORMATION

The Information on this Material Safety Data Sheet reflects the latest information and data that we have on hazards, properties, and handling of this product under the recommended conditions of use. Any use of this product or method of application, which is not described on the Product label or in this Material Safety Data Sheet, is the sole responsibility of the user. This Material Safety Data Sheet was prepared to comply with the OSHA Hazardous Communication Regulation and Massachusetts Right to Know Law.

REGENESIS

Technology-Based Solutions for the Environment

SAFETY DATA SHEET

1. Identification

Product identifier **Hydrogen Release Compound (HRC®)**

Other means of identification None.

Recommended use Remediation of soils and groundwater.

Recommended restrictions None known.

Manufacturer/Importer/Supplier/Distributor information

Company Name Regenesis

Address 1011 Calle Sombra
San Clemente, CA 92673

Telephone 949-366-8000

E-mail CustomerService@regenesis.com

Emergency phone number CHEMTREC® at 1-800-424-9300 (International)

2. Hazard(s) identification

Physical hazards Not classified.

Health hazards

Skin corrosion/irritation	Category 2
Serious eye damage/eye irritation	Category 1

OSHA defined hazards Not classified.

Label elements

Signal word Danger

Hazard statement Causes skin irritation. Causes serious eye damage.

Precautionary statement

Prevention Wash thoroughly after handling. Wear protective gloves. Wear eye/face protection.

Response If on skin: Wash with plenty of water. If in eyes: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Immediately call a poison center/doctor. If skin irritation occurs: Get medical advice/attention. Take off contaminated clothing and wash before reuse.

Storage Store away from incompatible materials.

Disposal Dispose of waste and residues in accordance with local authority requirements.

Hazard(s) not otherwise classified (HNOC) None known.

3. Composition/information on ingredients

Mixtures

Chemical name	CAS number	%
Glycerol Tripolylactate	201167-72-8	62-67
Glycerin	56-81-5	33-38
Lactic acid	50-21-5	<10

Composition comments All concentrations are in percent by weight unless otherwise indicated.

4. First-aid measures

Inhalation Move to fresh air. Call a physician if symptoms develop or persist.

Skin contact	Remove contaminated clothing. Wash with plenty of soap and water. If skin irritation occurs: Get medical advice/attention. Wash contaminated clothing before reuse.
Eye contact	Immediately flush eyes with plenty of water for at least 15 minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Get medical attention immediately.
Ingestion	Rinse mouth. Never give anything by mouth to a victim who is unconscious or is having convulsions. Do not induce vomiting without advice from poison control center. Get medical attention if symptoms occur.
Most important symptoms/effects, acute and delayed	Severe eye irritation. Symptoms may include stinging, tearing, redness, swelling, and blurred vision. Permanent eye damage including blindness could result. Skin irritation. May cause redness and pain.
Indication of immediate medical attention and special treatment needed	Provide general supportive measures and treat symptomatically. Keep victim under observation. Symptoms may be delayed.
General information	Ensure that medical personnel are aware of the material(s) involved, and take precautions to protect themselves.

5. Fire-fighting measures

Suitable extinguishing media	Water spray. Carbon dioxide (CO2). Dry chemical powder. Foam.
Unsuitable extinguishing media	Do not use water jet as an extinguisher, as this will spread the fire.
Specific hazards arising from the chemical	During fire, gases hazardous to health may be formed. Combustion products may include: carbon oxides, phosphorus compounds and metal oxides.
Special protective equipment and precautions for firefighters	Self-contained breathing apparatus and full protective clothing must be worn in case of fire.
Fire fighting equipment/instructions	Move containers from fire area if you can do so without risk. Water spray should be used to cool containers.
Specific methods	Use standard firefighting procedures and consider the hazards of other involved materials.
General fire hazards	No unusual fire or explosion hazards noted.

6. Accidental release measures

Personal precautions, protective equipment and emergency procedures	Keep unnecessary personnel away. Keep people away from and upwind of spill/leak. Wear appropriate protective equipment and clothing during clean-up. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Ensure adequate ventilation. Local authorities should be advised if significant spillages cannot be contained. For personal protection, see section 8 of the SDS.
Methods and materials for containment and cleaning up	Large Spills: Stop the flow of material, if this is without risk. Use water spray to reduce vapors or divert vapor cloud drift. Dike the spilled material, where this is possible. Cover with plastic sheet to prevent spreading. Absorb in vermiculite, dry sand or earth and place into containers. Following product recovery, flush area with water. Small Spills: Wipe up with absorbent material (e.g. cloth, fleece). Clean surface thoroughly to remove residual contamination. Never return spills to original containers for re-use. For waste disposal, see section 13 of the SDS.
Environmental precautions	Avoid discharge into drains, water courses or onto the ground.

7. Handling and storage

Precautions for safe handling	Do not get this material in contact with eyes. Avoid contact with eyes, skin, and clothing. Provide adequate ventilation. Wear appropriate personal protective equipment. Observe good industrial hygiene practices.
Conditions for safe storage, including any incompatibilities	Store in original tightly closed container. Store in a cool, dry, well-ventilated place. Store away from incompatible materials (see Section 10 of the SDS). Recommended storage containers: plastic lined steel, plastic, glass, aluminum, stainless steel, or reinforced fiberglass.

8. Exposure controls/personal protection

Occupational exposure limits

US. OSHA Table Z-1 Limits for Air Contaminants (29 CFR 1910.1000)

Components	Type	Value	Form
Glycerin (CAS 56-81-5)	PEL	5 mg/m3	Respirable fraction.
		15 mg/m3	Total dust.

Biological limit values	No biological exposure limits noted for the ingredient(s).
Appropriate engineering controls	Good general ventilation (typically 10 air changes per hour) should be used. Ventilation rates should be matched to conditions. If applicable, use process enclosures, local exhaust ventilation, or other engineering controls to maintain airborne levels below recommended exposure limits. If exposure limits have not been established, maintain airborne levels to an acceptable level. Eye wash facilities and emergency shower must be available when handling this product.

Individual protection measures, such as personal protective equipment

Eye/face protection	Wear approved, tight fitting indirect vented or non-vented safety goggles where splashing is probable. Face shield is recommended.
Skin protection	
Hand protection	Wear appropriate chemical resistant gloves. Rubber or vinyl-coated gloves are recommended.
Other	Wear appropriate chemical resistant clothing.
Respiratory protection	If engineering controls do not maintain airborne concentrations below recommended exposure limits (where applicable) or to an acceptable level (in countries where exposure limits have not been established), an approved respirator must be worn.
Thermal hazards	Wear appropriate thermal protective clothing, when necessary.
General hygiene considerations	Always observe good personal hygiene measures, such as washing after handling the material and before eating, drinking, and/or smoking. Routinely wash work clothing and protective equipment to remove contaminants.

9. Physical and chemical properties

Appearance	
Physical state	Liquid.
Form	Viscous gel/liquid.
Color	Amber.
Odor	Odorless.
Odor threshold	Not available.
pH	3 (3% solution/water)
Melting point/freezing point	Not available.
Initial boiling point and boiling range	Not available.
Flash point	Not available.
Evaporation rate	Not available.
Flammability (solid, gas)	Not applicable.
Upper/lower flammability or explosive limits	
Flammability limit - lower (%)	Not available.
Flammability limit - upper (%)	Not available.
Explosive limit - lower (%)	Not available.
Explosive limit - upper (%)	Not available.
Vapor pressure	Not available.
Vapor density	Not available.
Relative density	1.1 - 1.3
Solubility(ies)	
Solubility (water)	Not available.
Solubility (other)	Acetone and DMSO.
Partition coefficient (n-octanol/water)	Not available.
Auto-ignition temperature	Not available.
Decomposition temperature	Not available.
Viscosity	20,000 - 40,000 cP

10. Stability and reactivity

Reactivity	The product is stable and non-reactive under normal conditions of use, storage and transport.

Chemical stability	Undergoes hydrolysis in water to form lactic acid and glycerol.
Possibility of hazardous reactions	No dangerous reaction known under conditions of normal use.
Conditions to avoid	Avoid temperatures exceeding the flash point. Contact with incompatible materials.
Incompatible materials	Strong oxidizing agents. Bases. Acids.
Hazardous decomposition products	Thermal decomposition or combustion may produce: carbon oxides, phosphorus compounds, metal oxides.

11. Toxicological information

Information on likely routes of exposure

Inhalation	May cause irritation to the respiratory system.
Skin contact	Causes skin irritation.
Eye contact	Causes serious eye damage.
Ingestion	Ingestion may cause irritation and malaise.
Symptoms related to the physical, chemical and toxicological characteristics	Severe eye irritation. Symptoms may include stinging, tearing, redness, swelling, and blurred vision. Permanent eye damage including blindness could result. Skin irritation. May cause redness and pain.

Information on toxicological effects

Acute toxicity

Components	Species	Test Results
Glycerin (CAS 56-81-5)		
Acute		
Oral		
LD50	Rat	12600 mg/kg

Skin corrosion/irritation	Causes skin irritation.
Serious eye damage/eye irritation	Causes serious eye damage.
Respiratory or skin sensitization	
Respiratory sensitization	Not a respiratory sensitizer.
Skin sensitization	This product is not expected to cause skin sensitization.
Germ cell mutagenicity	No data available to indicate product or any components present at greater than 0.1% are mutagenic or genotoxic.
Carcinogenicity	This product is not considered to be a carcinogen by IARC, ACGIH, NTP, or OSHA.

OSHA Specifically Regulated Substances (29 CFR 1910.1001-1050)

Not listed.

Reproductive toxicity	This product is not expected to cause reproductive or developmental effects.
Specific target organ toxicity - single exposure	Not classified.
Specific target organ toxicity - repeated exposure	Not classified.
Aspiration hazard	Not an aspiration hazard.

12. Ecological information

Ecotoxicity	The product is not classified as environmentally hazardous. However, this does not exclude the possibility that large or frequent spills can have a harmful or damaging effect on the environment.
Persistence and degradability	Material is readily degradable and undergoes hydrolysis in several hours.
Bioaccumulative potential	No data available.

Partition coefficient n-octanol / water (log Kow)

Glycerin (CAS 56-81-5)	-1.76
Lactic acid (CAS 50-21-5)	-0.72

Mobility in soil	No data available.
Other adverse effects	None known.

13. Disposal considerations

Disposal instructions	Collect and reclaim or dispose in sealed containers at licensed waste disposal site. Dispose of contents/container in accordance with local/regional/national/international regulations.
Local disposal regulations	Dispose in accordance with all applicable regulations.
Hazardous waste code	The waste code should be assigned in discussion between the user, the producer and the waste disposal company.
Waste from residues / unused products	Dispose of in accordance with local regulations. Empty containers or liners may retain some product residues. This material and its container must be disposed of in a safe manner (see: Disposal instructions).
Contaminated packaging	Empty containers should be taken to an approved waste handling site for recycling or disposal. Since emptied containers may retain product residue, follow label warnings even after container is emptied.

14. Transport information

DOT

Not regulated as dangerous goods.

IATA

Not regulated as dangerous goods.

IMDG

Not regulated as dangerous goods.

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code	Not established.

15. Regulatory information

US federal regulations

This product is a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200.
One or more components are not listed on TSCA.

TSCA Section 12(b) Export Notification (40 CFR 707, Subpt. D)

Not regulated.

OSHA Specifically Regulated Substances (29 CFR 1910.1001-1050)

Not listed.

CERCLA Hazardous Substance List (40 CFR 302.4)

Not listed.

Superfund Amendments and Reauthorization Act of 1986 (SARA)

Hazard categories	Immediate Hazard - Yes Delayed Hazard - No Fire Hazard - No Pressure Hazard - No Reactivity Hazard - No

SARA 302 Extremely hazardous substance

Not listed.

SARA 311/312 Hazardous chemical	Yes

SARA 313 (TRI reporting)

Not regulated.

Other federal regulations

Clean Air Act (CAA) Section 112 Hazardous Air Pollutants (HAPs) List

Not regulated.

Clean Air Act (CAA) Section 112(r) Accidental Release Prevention (40 CFR 68.130)

Not regulated.

Safe Drinking Water Act (SDWA)	Not regulated.

US state regulations

US. Massachusetts RTK - Substance List

Glycerin (CAS 56-81-5)

US. New Jersey Worker and Community Right-to-Know Act

Glycerin (CAS 56-81-5)

US. Pennsylvania Worker and Community Right-to-Know Law

Glycerin (CAS 56-81-5)

US. Rhode Island RTK

Not regulated.

US. California Proposition 65

California Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65): This material is not known to contain any chemicals currently listed as carcinogens or reproductive toxins.

International Inventories

Country(s) or region	Inventory name	On inventory (yes/no)*
Australia	Australian Inventory of Chemical Substances (AICS)	Yes
Canada	Domestic Substances List (DSL)	Yes
Canada	Non-Domestic Substances List (NDSL)	Yes
China	Inventory of Existing Chemical Substances in China (IECSC)	Yes
Europe	European Inventory of Existing Commercial Chemical Substances (EINECS)	Yes
Europe	European List of Notified Chemical Substances (ELINCS)	No
Japan	Inventory of Existing and New Chemical Substances (ENCS)	Yes
Korea	Existing Chemicals List (ECL)	Yes
New Zealand	New Zealand Inventory	Yes
Philippines	Philippine Inventory of Chemicals and Chemical Substances (PICCS)	Yes
United States & Puerto Rico	Toxic Substances Control Act (TSCA) Inventory	Yes

*A "Yes" indicates this product complies with the inventory requirements administered by the governing country(s).
A "No" indicates that one or more components of the product are not listed or exempt from listing on the inventory administered by the governing country(s).

16. Other information, including date of preparation or last revision

Issue date 10-April-2015

Revision date -

Version # 01

Further information HMIS® is a registered trade and service mark of the American Coatings Association (ACA).

HMIS® ratings Health: 3
Flammability: 1
Physical hazard: 0

NFPA ratings

Disclaimer Regenesis cannot anticipate all conditions under which this information and its product, or the products of other manufacturers in combination with its product, may be used. It is the user's responsibility to ensure safe conditions for handling, storage and disposal of the product, and to assume liability for loss, injury, damage or expense due to improper use. The information in the sheet was written based on the best knowledge and experience currently available.

SAFETY DATA SHEET

Acetone

Section 1. Identification

GHS product identifier : Acetone

Chemical name : acetone

Other means of identification : propan-2-one; propanone; 2-Propanone; dimethyl ketone

Product use : Synthetic/Analytical chemistry.

Synonym : propan-2-one; propanone; 2-Propanone; dimethyl ketone

SDS # : 001088

Supplier's details : Airgas USA, LLC and its affiliates
259 North Radnor-Chester Road
Suite 100
Radnor, PA 19087-5283
1-610-687-5253

Emergency telephone number (with hours of operation) : 1-866-734-3438

Section 2. Hazards identification

OSHA/HCS status : This material is considered hazardous by the OSHA Hazard Communication Standard (29 CFR 1910.1200).

Classification of the substance or mixture : FLAMMABLE LIQUIDS - Category 2
SERIOUS EYE DAMAGE/ EYE IRRITATION - Category 2
SPECIFIC TARGET ORGAN TOXICITY (SINGLE EXPOSURE) (Narcotic effects) - Category 3

GHS label elements

Hazard pictograms :

Signal word : Danger

Hazard statements : Highly flammable liquid and vapor.
May form explosive mixtures with air.
Causes serious eye irritation.
May cause drowsiness and dizziness.

Precautionary statements

General : Read label before use. Keep out of reach of children. If medical advice is needed, have product container or label at hand.

Prevention : Wear protective gloves. Wear eye or face protection. Keep away from heat, sparks, open flames and hot surfaces. - No smoking. Use explosion-proof electrical, ventilating, lighting and all material-handling equipment. Use only non-sparking tools. Take precautionary measures against static discharge. Keep container tightly closed. Use only outdoors or in a well-ventilated area. Avoid release to the environment. Avoid breathing vapor. Wash hands thoroughly after handling.

Section 2. Hazards identification

Response : IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing. Call a POISON CENTER or physician if you feel unwell. IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water or shower. IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. If eye irritation persists: Get medical attention.

Storage : Store locked up. Store in a well-ventilated place. Keep cool.

Disposal : Dispose of contents and container in accordance with all local, regional, national and international regulations.

Hazards not otherwise classified : None known.

Section 3. Composition/information on ingredients

Substance/mixture : Substance

Chemical name : acetone

Other means of identification : propan-2-one; propanone; 2-Propanone; dimethyl ketone

CAS number/other identifiers

CAS number : 67-64-1

Product code : 001088

Ingredient name	%	CAS number
acetone	100	67-64-1

There are no additional ingredients present which, within the current knowledge of the supplier and in the concentrations applicable, are classified as hazardous to health or the environment and hence require reporting in this section.

Occupational exposure limits, if available, are listed in Section 8.

Section 4. First aid measures

Description of necessary first aid measures

Eye contact : Immediately flush eyes with plenty of water, occasionally lifting the upper and lower eyelids. Check for and remove any contact lenses. Continue to rinse for at least 10 minutes. Get medical attention.

Inhalation : Remove victim to fresh air and keep at rest in a position comfortable for breathing. If it is suspected that fumes are still present, the rescuer should wear an appropriate mask or self-contained breathing apparatus. If not breathing, if breathing is irregular or if respiratory arrest occurs, provide artificial respiration or oxygen by trained personnel. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation. Get medical attention. If necessary, call a poison center or physician. If unconscious, place in recovery position and get medical attention immediately. Maintain an open airway. Loosen tight clothing such as a collar, tie, belt or waistband.

Skin contact : Flush contaminated skin with plenty of water. Remove contaminated clothing and shoes. Get medical attention if symptoms occur. Wash clothing before reuse. Clean shoes thoroughly before reuse.

Ingestion : Wash out mouth with water. Remove dentures if any. Remove victim to fresh air and keep at rest in a position comfortable for breathing. If material has been swallowed and the exposed person is conscious, give small quantities of water to drink. Stop if the exposed person feels sick as vomiting may be dangerous. Do not induce vomiting unless directed to do so by medical personnel. If vomiting occurs, the head should be kept low so that vomit does not enter the lungs. Get medical attention. If necessary, call a poison center or physician. Never give anything by mouth to an unconscious person. If unconscious, place in recovery position and get medical attention

Section 4. First aid measures

immediately. Maintain an open airway. Loosen tight clothing such as a collar, tie, belt or waistband.

Most important symptoms/effects, acute and delayed

Potential acute health effects

Eye contact : Causes serious eye irritation.

Inhalation : Can cause central nervous system (CNS) depression. May cause drowsiness and dizziness.

Skin contact : No known significant effects or critical hazards.

Frostbite : Try to warm up the frozen tissues and seek medical attention.

Ingestion : Can cause central nervous system (CNS) depression. Irritating to mouth, throat and stomach.

Over-exposure signs/symptoms

Eye contact : Adverse symptoms may include the following:
pain or irritation
watering
redness

Inhalation : Adverse symptoms may include the following:
nausea or vomiting
headache
drowsiness/fatigue
dizziness/vertigo
unconsciousness

Skin contact : No specific data.

Ingestion : No specific data.

Indication of immediate medical attention and special treatment needed, if necessary

Notes to physician : Treat symptomatically. Contact poison treatment specialist immediately if large quantities have been ingested or inhaled.

Specific treatments : No specific treatment.

Protection of first-aiders : No action shall be taken involving any personal risk or without suitable training. If it is suspected that fumes are still present, the rescuer should wear an appropriate mask or self-contained breathing apparatus. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation.

See toxicological information (Section 11)

Section 5. Fire-fighting measures

Extinguishing media

Suitable extinguishing media : Use dry chemical, CO_2, water spray (fog) or foam.

Unsuitable extinguishing media : Do not use water jet.

Specific hazards arising from the chemical : Highly flammable liquid and vapor. In a fire or if heated, a pressure increase will occur and the container may burst, with the risk of a subsequent explosion. The vapor/gas is heavier than air and will spread along the ground. Vapors may accumulate in low or confined areas or travel a considerable distance to a source of ignition and flash back. Runoff to sewer may create fire or explosion hazard. This material is toxic to aquatic life. This material is harmful to aquatic life with long lasting effects. Fire water contaminated with this material must be contained and prevented from being discharged to any

Section 5. Fire-fighting measures

waterway, sewer or drain.

Hazardous thermal decomposition products : Decomposition products may include the following materials:
carbon dioxide
carbon monoxide

Special protective actions for fire-fighters : Promptly isolate the scene by removing all persons from the vicinity of the incident if there is a fire. No action shall be taken involving any personal risk or without suitable training. Move containers from fire area if this can be done without risk. Use water spray to keep fire-exposed containers cool.

Special protective equipment for fire-fighters : Fire-fighters should wear appropriate protective equipment and self-contained breathing apparatus (SCBA) with a full face-piece operated in positive pressure mode.

Section 6. Accidental release measures

Personal precautions, protective equipment and emergency procedures

For non-emergency personnel : No action shall be taken involving any personal risk or without suitable training. Evacuate surrounding areas. Keep unnecessary and unprotected personnel from entering. Do not touch or walk through spilled material. Shut off all ignition sources. No flares, smoking or flames in hazard area. Avoid breathing vapor or mist. Provide adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Put on appropriate personal protective equipment.

For emergency responders : If specialised clothing is required to deal with the spillage, take note of any information in Section 8 on suitable and unsuitable materials. See also the information in "For non-emergency personnel".

Environmental precautions : Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers. Inform the relevant authorities if the product has caused environmental pollution (sewers, waterways, soil or air). Water polluting material. May be harmful to the environment if released in large quantities.

Methods and materials for containment and cleaning up

Small spill : Stop leak if without risk. Move containers from spill area. Use spark-proof tools and explosion-proof equipment. Dilute with water and mop up if water-soluble. Alternatively, or if water-insoluble, absorb with an inert dry material and place in an appropriate waste disposal container. Dispose of via a licensed waste disposal contractor.

Large spill : Stop leak if without risk. Move containers from spill area. Use spark-proof tools and explosion-proof equipment. Approach release from upwind. Prevent entry into sewers, water courses, basements or confined areas. Wash spillages into an effluent treatment plant or proceed as follows. Contain and collect spillage with non-combustible, absorbent material e.g. sand, earth, vermiculite or diatomaceous earth and place in container for disposal according to local regulations (see Section 13). Dispose of via a licensed waste disposal contractor. Contaminated absorbent material may pose the same hazard as the spilled product. Note: see Section 1 for emergency contact information and Section 13 for waste disposal.

Section 7. Handling and storage

Precautions for safe handling

Protective measures : Put on appropriate personal protective equipment (see Section 8). Do not ingest. Avoid contact with eyes, skin and clothing. Avoid breathing vapor or mist. Avoid release to the environment. Use only with adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Do not enter storage areas and confined spaces unless adequately ventilated. Keep in the original container or an approved alternative made from a compatible material, kept tightly closed when not in use. Store and use away from heat, sparks, open flame or any other ignition source. Use explosion-proof electrical (ventilating, lighting and material handling) equipment. Use only non-sparking

Section 7. Handling and storage

tools. Take precautionary measures against electrostatic discharges. Empty containers retain product residue and can be hazardous. Do not reuse container.

Advice on general occupational hygiene : Eating, drinking and smoking should be prohibited in areas where this material is handled, stored and processed. Workers should wash hands and face before eating, drinking and smoking. Remove contaminated clothing and protective equipment before entering eating areas. See also Section 8 for additional information on hygiene measures.

Conditions for safe storage, including any incompatibilities : Store in accordance with local regulations. Store in a segregated and approved area. Store in original container protected from direct sunlight in a dry, cool and well-ventilated area, away from incompatible materials (see Section 10) and food and drink. Store locked up. Eliminate all ignition sources. Separate from oxidizing materials. Keep container tightly closed and sealed until ready for use. Containers that have been opened must be carefully resealed and kept upright to prevent leakage. Do not store in unlabeled containers. Use appropriate containment to avoid environmental contamination.

Section 8. Exposure controls/personal protection

Control parameters

Occupational exposure limits

Ingredient name	Exposure limits
acetone	**ACGIH TLV (United States, 3/2012).** STEL: 1782 mg/m³ 15 minutes. STEL: 750 ppm 15 minutes. TWA: 1188 mg/m³ 8 hours. TWA: 500 ppm 8 hours. **NIOSH REL (United States, 1/2013).** TWA: 590 mg/m³ 10 hours. TWA: 250 ppm 10 hours. **OSHA PEL (United States, 6/2010).** TWA: 2400 mg/m³ 8 hours. TWA: 1000 ppm 8 hours. **OSHA PEL 1989 (United States, 3/1989).** STEL: 2400 mg/m³ 15 minutes. STEL: 1000 ppm 15 minutes. TWA: 1800 mg/m³ 8 hours. TWA: 750 ppm 8 hours.

Appropriate engineering controls : Use only with adequate ventilation. Use process enclosures, local exhaust ventilation or other engineering controls to keep worker exposure to airborne contaminants below any recommended or statutory limits. The engineering controls also need to keep gas, vapor or dust concentrations below any lower explosive limits. Use explosion-proof ventilation equipment.

Environmental exposure controls : Emissions from ventilation or work process equipment should be checked to ensure they comply with the requirements of environmental protection legislation. In some cases, fume scrubbers, filters or engineering modifications to the process equipment will be necessary to reduce emissions to acceptable levels.

Individual protection measures

Section 8. Exposure controls/personal protection

Hygiene measures : Wash hands, forearms and face thoroughly after handling chemical products, before eating, smoking and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.

Eye/face protection : Safety eyewear complying with an approved standard should be used when a risk assessment indicates this is necessary to avoid exposure to liquid splashes, mists, gases or dusts. If contact is possible, the following protection should be worn, unless the assessment indicates a higher degree of protection: chemical splash goggles.

Skin protection

Hand protection : Chemical-resistant, impervious gloves complying with an approved standard should be worn at all times when handling chemical products if a risk assessment indicates this is necessary. Considering the parameters specified by the glove manufacturer, check during use that the gloves are still retaining their protective properties. It should be noted that the time to breakthrough for any glove material may be different for different glove manufacturers. In the case of mixtures, consisting of several substances, the protection time of the gloves cannot be accurately estimated.

Body protection : Personal protective equipment for the body should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product. When there is a risk of ignition from static electricity, wear anti-static protective clothing. For the greatest protection from static discharges, clothing should include anti-static overalls, boots and gloves.

Other skin protection : Appropriate footwear and any additional skin protection measures should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product.

Respiratory protection : Use a properly fitted, air-purifying or air-fed respirator complying with an approved standard if a risk assessment indicates this is necessary. Respirator selection must be based on known or anticipated exposure levels, the hazards of the product and the safe working limits of the selected respirator.

Section 9. Physical and chemical properties

Appearance

Physical state : Liquid. [COLORLESS LIQUID WITH A FRAGRANT, MINT-LIKE ODOR]

Color : Colorless.

Molecular weight : 58.09 g/mole

Molecular formula : C3-H6-O

Boiling/condensation point : 56.05°C (132.9°F)

Melting/freezing point : -94.7°C (-138.5°F)

Critical temperature : 234.85°C (454.7°F)

Odor : Characteristic.

Odor threshold : Not available.

pH : Not available.

Flash point : Closed cup: -20°C (-4°F)

Burning time : Not applicable.

Burning rate : Not applicable.

Evaporation rate : 6.06 (butyl acetate = 1)

Flammability (solid, gas) : Not available.

Lower and upper explosive (flammable) limits : Lower: 2.5%
Upper: 13%

Vapor pressure : 24 kPa (180.014626188 mm Hg) [room temperature]

Section 9. Physical and chemical properties

Vapor density : 2 (Air = 1)

Specific Volume (ft ^{3}/lb) : 1.2642

Gas Density (lb/ft ^{3}) : 0.791

Relative density : 0.8

Solubility : Not available.

Solubility in water : Not available.

Partition coefficient: n-octanol/water : -0.23

Auto-ignition temperature : 465°C (869°F)

Decomposition temperature : Not available.

SADT : Not available.

Viscosity : Not available.

Section 10. Stability and reactivity

Reactivity : No specific test data related to reactivity available for this product or its ingredients.

Chemical stability : The product is stable.

Possibility of hazardous reactions : Under normal conditions of storage and use, hazardous reactions will not occur.

Conditions to avoid : Avoid all possible sources of ignition (spark or flame). Do not pressurize, cut, weld, braze, solder, drill, grind or expose containers to heat or sources of ignition. Do not allow vapor to accumulate in low or confined areas.

Incompatibility with various substances : Extremely reactive or incompatible with the following materials: oxidizing materials.

Hazardous decomposition products : Under normal conditions of storage and use, hazardous decomposition products should not be produced.

Hazardous polymerization : Under normal conditions of storage and use, hazardous polymerization will not occur.

Section 11. Toxicological information

Information on toxicological effects

Acute toxicity

Product/ingredient name	Result	Species	Dose	Exposure
acetone	LC50 Inhalation Vapor LD50 Oral	Rat Rat	59528 ppm 5800 mg/kg	1 hours -

Irritation/Corrosion

Section 11. Toxicological information

Product/ingredient name	Result	Species	Score	Exposure	Observation
acetone	Eyes - Mild irritant	Human	-	186300 parts per million	-
	Eyes - Mild irritant	Rabbit	-	10 microliters	-
	Eyes - Moderate irritant	Rabbit	-	24 hours 20 milligrams	-
	Eyes - Severe irritant	Rabbit	-	20 milligrams	-
	Skin - Mild irritant	Rabbit	-	24 hours 500 milligrams	-
	Skin - Mild irritant	Rabbit	-	395 milligrams	-

Sensitization

Not available.

Mutagenicity

Not available.

Carcinogenicity

Not available.

Reproductive toxicity

Not available.

Teratogenicity

Not available.

Specific target organ toxicity (single exposure)

Name	Category	Route of exposure	Target organs
acetone	Category 3	Not applicable.	Narcotic effects

Specific target organ toxicity (repeated exposure)

Not available.

Aspiration hazard

Not available.

Information on the likely routes of exposure : Not available.

Potential acute health effects

Eye contact : Causes serious eye irritation.

Inhalation : Can cause central nervous system (CNS) depression. May cause drowsiness and dizziness.

Skin contact : No known significant effects or critical hazards.

Ingestion : Can cause central nervous system (CNS) depression. Irritating to mouth, throat and stomach.

Symptoms related to the physical, chemical and toxicological characteristics

Eye contact : Adverse symptoms may include the following:
pain or irritation
watering
redness

Section 11. Toxicological information

Inhalation : Adverse symptoms may include the following:
nausea or vomiting
headache
drowsiness/fatigue
dizziness/vertigo
unconsciousness

Skin contact : No specific data.

Ingestion : No specific data.

Delayed and immediate effects and also chronic effects from short and long term exposure

Short term exposure

Potential immediate effects : Not available.

Potential delayed effects : Not available.

Long term exposure

Potential immediate effects : Not available.

Potential delayed effects : Not available.

Potential chronic health effects

Not available.

General : No known significant effects or critical hazards.

Carcinogenicity : No known significant effects or critical hazards.

Mutagenicity : No known significant effects or critical hazards.

Teratogenicity : No known significant effects or critical hazards.

Developmental effects : No known significant effects or critical hazards.

Fertility effects : No known significant effects or critical hazards.

Numerical measures of toxicity

Acute toxicity estimates

Not available.

Section 12. Ecological information

Toxicity

Product/ingredient name	Result	Species	Exposure
acetone	Acute EC50 20.565 mg/l Marine water	Algae - Ulva pertusa	96 hours
	Acute LC50 6000000 µg/l Fresh water	Crustaceans - Gammarus pulex	48 hours
	Acute LC50 10000 µg/l Fresh water	Daphnia - Daphnia magna	48 hours
	Acute LC50 100 mg/l Fresh water	Fish - Pimephales promelas - Juvenile (Fledgling, Hatchling, Weanling)	96 hours
	Chronic NOEC 4.95 mg/l Marine water	Algae - Ulva pertusa	96 hours
	Chronic NOEC 0.1 ml/L Fresh water	Daphnia - Daphnia magna - Neonate	21 days

Persistence and degradability

Not available.

Section 12. Ecological information

Bioaccumulative potential

Product/ingredient name	$LogP_{ow}$	BCF	Potential
acetone	-0.23	-	low

Mobility in soil

Soil/water partition coefficient (K_{OC}) : Not available.

Other adverse effects : No known significant effects or critical hazards.

Section 13. Disposal considerations

Disposal methods : The generation of waste should be avoided or minimized wherever possible. Disposal of this product, solutions and any by-products should at all times comply with the requirements of environmental protection and waste disposal legislation and any regional local authority requirements. Dispose of surplus and non-recyclable products via a licensed waste disposal contractor. Waste should not be disposed of untreated to the sewer unless fully compliant with the requirements of all authorities with jurisdiction. Waste packaging should be recycled. Incineration or landfill should only be considered when recycling is not feasible. This material and its container must be disposed of in a safe way. Care should be taken when handling emptied containers that have not been cleaned or rinsed out. Empty containers or liners may retain some product residues. Vapor from product residues may create a highly flammable or explosive atmosphere inside the container. Do not cut, weld or grind used containers unless they have been cleaned thoroughly internally. Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers.

United States - RCRA Toxic hazardous waste "U" List

Ingredient	CAS #	Status	Reference number
Acetone (I); 2-Propanone (I)	67-64-1	Listed	U002

Section 14. Transport information

	DOT	TDG	Mexico	IMDG	IATA
UN number	UN1090	UN1090	UN1090	UN1090	UN1090
UN proper shipping name	ACETONE	ACETONE	ACETONE	ACETONE (ACETONE SOLUTIONS)	ACETONE
Transport hazard class(es)	3 	3 	3 	3 	3 
Packing group	II	II	-	II	II
Environment	No.	No.	No.	No.	No.

Section 14. Transport information

Additional information	**Reportable quantity** 5000 lbs / 2270 kg [758.12 gal / 2869.8 L] Package sizes shipped in quantities less than the product reportable quantity are not subject to the RQ (reportable quantity) transportation requirements. **Limited quantity** Yes. **Packaging instruction** **Passenger aircraft** Quantity limitation: 5 L **Cargo aircraft** Quantity limitation: 60 L **Special provisions** IB2, T4, TP1	**Explosive Limit and Limited Quantity Index** 1 **Passenger Carrying Ship Index** Forbidden **Passenger Carrying Road or Rail Index** 5	-	-	**Passenger and Cargo Aircraft**Quantity limitation: 5 L **Cargo Aircraft Only** Quantity limitation: 60 L **Limited Quantities - Passenger Aircraft** Quantity limitation: 1 L

"Refer to CFR 49 (or authority having jurisdiction) to determine the information required for shipment of the product."

Special precautions for user : **Transport within user's premises:** always transport in closed containers that are upright and secure. Ensure that persons transporting the product know what to do in the event of an accident or spillage.

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code : Not available.

Section 15. Regulatory information

U.S. Federal regulations : **TSCA 8(a) CDR Exempt/Partial exemption**: Not determined

United States inventory (TSCA 8b): This material is listed or exempted.

Clean Air Act Section 112 (b) Hazardous Air Pollutants (HAPs) : Not listed

Clean Air Act Section 602 Class I Substances : Not listed

Clean Air Act Section 602 Class II Substances : Not listed

DEA List I Chemicals (Precursor Chemicals) : Not listed

DEA List II Chemicals (Essential Chemicals) : Listed

SARA 302/304

Composition/information on ingredients

No products were found.

SARA 304 RQ : Not applicable.

SARA 311/312

Section 15. Regulatory information

Classification : Fire hazard
Immediate (acute) health hazard

Composition/information on ingredients

Name	%	Fire hazard	Sudden release of pressure	Reactive	Immediate (acute) health hazard	Delayed (chronic) health hazard
acetone	100	Yes.	No.	No.	Yes.	No.

State regulations

Massachusetts : This material is listed.

New York : This material is listed.

New Jersey : This material is listed.

Pennsylvania : This material is listed.

Canada inventory : This material is listed or exempted.

International regulations

International lists : **Australia inventory (AICS)**: This material is listed or exempted.
China inventory (IECSC): This material is listed or exempted.
Japan inventory: This material is listed or exempted.
Korea inventory: This material is listed or exempted.
Malaysia Inventory (EHS Register): Not determined.
New Zealand Inventory of Chemicals (NZIoC): This material is listed or exempted.
Philippines inventory (PICCS): This material is listed or exempted.
Taiwan inventory (CSNN): Not determined.

Chemical Weapons Convention List Schedule I Chemicals : Not listed

Chemical Weapons Convention List Schedule II Chemicals : Not listed

Chemical Weapons Convention List Schedule III Chemicals : Not listed

Canada

WHMIS (Canada) : Class B-2: Flammable liquid
Class D-2B: Material causing other toxic effects (Toxic).

CEPA Toxic substances: This material is listed.
Canadian ARET: This material is not listed.
Canadian NPRI: This material is listed.
Alberta Designated Substances: This material is not listed.
Ontario Designated Substances: This material is not listed.
Quebec Designated Substances: This material is not listed.

Section 16. Other information

Canada Label requirements : Class B-2: Flammable liquid
Class D-2B: Material causing other toxic effects (Toxic).

Hazardous Material Information System (U.S.A.)

Section 16. Other information

Physical hazards	0

Caution: HMIS® ratings are based on a 0-4 rating scale, with 0 representing minimal hazards or risks, and 4 representing significant hazards or risks Although HMIS® ratings are not required on SDSs under 29 CFR 1910. 1200, the preparer may choose to provide them. HMIS® ratings are to be used with a fully implemented HMIS® program. HMIS® is a registered mark of the National Paint & Coatings Association (NPCA). HMIS® materials may be purchased exclusively from J. J. Keller (800) 327-6868.

The customer is responsible for determining the PPE code for this material.

National Fire Protection Association (U.S.A.)

Reprinted with permission from NFPA 704-2001, Identification of the Hazards of Materials for Emergency Response Copyright ©1997, National Fire Protection Association, Quincy, MA 02269. This reprinted material is not the complete and official position of the National Fire Protection Association, on the referenced subject which is represented only by the standard in its entirety.

Copyright ©2001, National Fire Protection Association, Quincy, MA 02269. This warning system is intended to be interpreted and applied only by properly trained individuals to identify fire, health and reactivity hazards of chemicals. The user is referred to certain limited number of chemicals with recommended classifications in NFPA 49 and NFPA 325, which would be used as a guideline only. Whether the chemicals are classified by NFPA or not, anyone using the 704 systems to classify chemicals does so at their own risk.

History

Date of printing	:	4/26/2015.
Date of issue/Date of revision	:	4/26/2015.
Date of previous issue	:	10/21/2014.
Version	:	0.02
Key to abbreviations	:	ATE = Acute Toxicity Estimate BCF = Bioconcentration Factor GHS = Globally Harmonized System of Classification and Labelling of Chemicals IATA = International Air Transport Association IBC = Intermediate Bulk Container IMDG = International Maritime Dangerous Goods LogPow = logarithm of the octanol/water partition coefficient MARPOL 73/78 = International Convention for the Prevention of Pollution From Ships, 1973 as modified by the Protocol of 1978. ("Marpol" = marine pollution) UN = United NationsACGIH – American Conference of Governmental Industrial Hygienists AIHA – American Industrial Hygiene Association CAS – Chemical Abstract Services CEPA – Canadian Environmental Protection Act CERCLA – Comprehensive Environmental Response, Compensation, and Liability Act (EPA) CFR – United States Code of Federal Regulations CPR – Controlled Products Regulations DSL – Domestic Substances List GWP – Global Warming Potential IARC – International Agency for Research on Cancer ICAO – International Civil Aviation Organisation Inh – Inhalation LC – Lethal concentration

Section 16. Other information

LD – Lethal dosage
NDSL – Non-Domestic Substances List
NIOSH – National Institute for Occupational Safety and Health
TDG – Canadian Transportation of Dangerous Goods Act and Regulations
TLV – Threshold Limit Value
TSCA – Toxic Substances Control Act
WEEL – Workplace Environmental Exposure Level
WHMIS – Canadian Workplace Hazardous Material Information System

References : Not available.

Indicates information that has changed from previously issued version.

Notice to reader

To the best of our knowledge, the information contained herein is accurate. However, neither the above-named supplier, nor any of its subsidiaries, assumes any liability whatsoever for the accuracy or completeness of the information contained herein.
Final determination of suitability of any material is the sole responsibility of the user. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that exist.

SAFETY DATA SHEET

Ethanol

Section 1. Identification

GHS product identifier : Ethanol

Chemical name : ethanol

Other means of identification : ethyl alcohol; Denatured Alcohol; ALCOHOL; Ethyl alcohol (Ethanol)

Product use : Synthetic/Analytical chemistry.

Synonym : ethyl alcohol; Denatured Alcohol; ALCOHOL; Ethyl alcohol (Ethanol)

SDS # : 001114

Supplier's details : Airgas USA, LLC and its affiliates
259 North Radnor-Chester Road
Suite 100
Radnor, PA 19087-5283
1-610-687-5253

Emergency telephone number (with hours of operation) : 1-866-734-3438

Section 2. Hazards identification

OSHA/HCS status : This material is considered hazardous by the OSHA Hazard Communication Standard (29 CFR 1910.1200).

Classification of the substance or mixture : FLAMMABLE LIQUIDS - Category 2

GHS label elements

Hazard pictograms :

Signal word : Danger

Hazard statements : Highly flammable liquid and vapor.
May form explosive mixtures with air.

Precautionary statements

General : Read label before use. Keep out of reach of children. If medical advice is needed, have product container or label at hand.

Prevention : Wear protective gloves. Wear eye or face protection. Keep away from heat, sparks, open flames and hot surfaces. - No smoking. Use explosion-proof electrical, ventilating, lighting and all material-handling equipment. Use only non-sparking tools. Take precautionary measures against static discharge. Keep container tightly closed. Use and store only outdoors or in a well ventilated place.

Response : IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water or shower.

Storage : Store in a well-ventilated place. Keep cool.

Disposal : Dispose of contents and container in accordance with all local, regional, national and international regulations.

Hazards not otherwise classified : None known.

Section 3. Composition/information on ingredients

Substance/mixture : Substance

Chemical name : ethanol

Other means of identification : ethyl alcohol; Denatured Alcohol; ALCOHOL; Ethyl alcohol (Ethanol)

CAS number/other identifiers

CAS number : 64-17-5

Product code : 001114

Ingredient name	%	CAS number
ethanol	100	64-17-5

There are no additional ingredients present which, within the current knowledge of the supplier and in the concentrations applicable, are classified as hazardous to health or the environment and hence require reporting in this section.

Occupational exposure limits, if available, are listed in Section 8.

Section 4. First aid measures

Description of necessary first aid measures

Eye contact : Immediately flush eyes with plenty of water, occasionally lifting the upper and lower eyelids. Check for and remove any contact lenses. Continue to rinse for at least 10 minutes. Get medical attention if irritation occurs.

Inhalation : Remove victim to fresh air and keep at rest in a position comfortable for breathing. If not breathing, if breathing is irregular or if respiratory arrest occurs, provide artificial respiration or oxygen by trained personnel. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation. Get medical attention if adverse health effects persist or are severe. If unconscious, place in recovery position and get medical attention immediately. Maintain an open airway. Loosen tight clothing such as a collar, tie, belt or waistband.

Skin contact : Flush contaminated skin with plenty of water. Remove contaminated clothing and shoes. Get medical attention if symptoms occur. Wash clothing before reuse. Clean shoes thoroughly before reuse.

Ingestion : Wash out mouth with water. Remove dentures if any. Remove victim to fresh air and keep at rest in a position comfortable for breathing. If material has been swallowed and the exposed person is conscious, give small quantities of water to drink. Stop if the exposed person feels sick as vomiting may be dangerous. Do not induce vomiting unless directed to do so by medical personnel. If vomiting occurs, the head should be kept low so that vomit does not enter the lungs. Get medical attention if adverse health effects persist or are severe. Never give anything by mouth to an unconscious person. If unconscious, place in recovery position and get medical attention immediately. Maintain an open airway. Loosen tight clothing such as a collar, tie, belt or waistband.

Most important symptoms/effects, acute and delayed

Potential acute health effects

Eye contact : No known significant effects or critical hazards.

Inhalation : No known significant effects or critical hazards.

Skin contact : No known significant effects or critical hazards.

Frostbite : Try to warm up the frozen tissues and seek medical attention.

Ingestion : No known significant effects or critical hazards.

Over-exposure signs/symptoms

Eye contact : No specific data.

Section 4. First aid measures

Inhalation : No specific data.

Skin contact : No specific data.

Ingestion : No specific data.

Indication of immediate medical attention and special treatment needed, if necessary

Notes to physician : Treat symptomatically. Contact poison treatment specialist immediately if large quantities have been ingested or inhaled.

Specific treatments : No specific treatment.

Protection of first-aiders : No action shall be taken involving any personal risk or without suitable training. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation.

See toxicological information (Section 11)

Section 5. Fire-fighting measures

Extinguishing media

Suitable extinguishing media : Use dry chemical, CO_2, water spray (fog) or foam.

Unsuitable extinguishing media : Do not use water jet.

Specific hazards arising from the chemical : Highly flammable liquid and vapor. In a fire or if heated, a pressure increase will occur and the container may burst, with the risk of a subsequent explosion. The vapor/gas is heavier than air and will spread along the ground. Vapors may accumulate in low or confined areas or travel a considerable distance to a source of ignition and flash back. Runoff to sewer may create fire or explosion hazard.

Hazardous thermal decomposition products : Decomposition products may include the following materials:
carbon dioxide
carbon monoxide

Special protective actions for fire-fighters : Promptly isolate the scene by removing all persons from the vicinity of the incident if there is a fire. No action shall be taken involving any personal risk or without suitable training. Move containers from fire area if this can be done without risk. Use water spray to keep fire-exposed containers cool.

Special protective equipment for fire-fighters : Fire-fighters should wear appropriate protective equipment and self-contained breathing apparatus (SCBA) with a full face-piece operated in positive pressure mode.

Section 6. Accidental release measures

Personal precautions, protective equipment and emergency procedures

For non-emergency personnel : No action shall be taken involving any personal risk or without suitable training. Evacuate surrounding areas. Keep unnecessary and unprotected personnel from entering. Do not touch or walk through spilled material. Shut off all ignition sources. No flares, smoking or flames in hazard area. Avoid breathing vapor or mist. Provide adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Put on appropriate personal protective equipment.

For emergency responders : If specialised clothing is required to deal with the spillage, take note of any information in Section 8 on suitable and unsuitable materials. See also the information in "For non-emergency personnel".

Environmental precautions : Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers. Inform the relevant authorities if the product has caused environmental pollution (sewers, waterways, soil or air).

Section 6. Accidental release measures

Methods and materials for containment and cleaning up

Small spill : Stop leak if without risk. Move containers from spill area. Use spark-proof tools and explosion-proof equipment. Dilute with water and mop up if water-soluble. Alternatively, or if water-insoluble, absorb with an inert dry material and place in an appropriate waste disposal container. Dispose of via a licensed waste disposal contractor.

Large spill : Stop leak if without risk. Move containers from spill area. Use spark-proof tools and explosion-proof equipment. Approach release from upwind. Prevent entry into sewers, water courses, basements or confined areas. Wash spillages into an effluent treatment plant or proceed as follows. Contain and collect spillage with non-combustible, absorbent material e.g. sand, earth, vermiculite or diatomaceous earth and place in container for disposal according to local regulations (see Section 13). Dispose of via a licensed waste disposal contractor. Contaminated absorbent material may pose the same hazard as the spilled product. Note: see Section 1 for emergency contact information and Section 13 for waste disposal.

Section 7. Handling and storage

Precautions for safe handling

Protective measures : Put on appropriate personal protective equipment (see Section 8). Do not ingest. Avoid contact with eyes, skin and clothing. Avoid breathing vapor or mist. Use only with adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Do not enter storage areas and confined spaces unless adequately ventilated. Keep in the original container or an approved alternative made from a compatible material, kept tightly closed when not in use. Store and use away from heat, sparks, open flame or any other ignition source. Use explosion-proof electrical (ventilating, lighting and material handling) equipment. Use only non-sparking tools. Take precautionary measures against electrostatic discharges. Empty containers retain product residue and can be hazardous. Do not reuse container.

Advice on general occupational hygiene : Eating, drinking and smoking should be prohibited in areas where this material is handled, stored and processed. Workers should wash hands and face before eating, drinking and smoking. Remove contaminated clothing and protective equipment before entering eating areas. See also Section 8 for additional information on hygiene measures.

Conditions for safe storage, including any incompatibilities : Store in accordance with local regulations. Store in a segregated and approved area. Store in original container protected from direct sunlight in a dry, cool and well-ventilated area, away from incompatible materials (see Section 10) and food and drink. Eliminate all ignition sources. Separate from oxidizing materials. Keep container tightly closed and sealed until ready for use. Containers that have been opened must be carefully resealed and kept upright to prevent leakage. Do not store in unlabeled containers. Use appropriate containment to avoid environmental contamination.

Section 8. Exposure controls/personal protection

Control parameters

Occupational exposure limits

Ingredient name	Exposure limits
ethanol	**ACGIH TLV (United States, 3/2012).** STEL: 1000 ppm 15 minutes. **OSHA PEL 1989 (United States, 3/1989).** TWA: 1000 ppm 8 hours. TWA: 1900 mg/m³ 8 hours. **NIOSH REL (United States, 1/2013).** TWA: 1000 ppm 10 hours. TWA: 1900 mg/m³ 10 hours.

Section 8. Exposure controls/personal protection

	OSHA PEL (United States, 6/2010). TWA: 1000 ppm 8 hours. TWA: 1900 mg/m³ 8 hours.

Appropriate engineering controls : Use only with adequate ventilation. Use process enclosures, local exhaust ventilation or other engineering controls to keep worker exposure to airborne contaminants below any recommended or statutory limits. The engineering controls also need to keep gas, vapor or dust concentrations below any lower explosive limits. Use explosion-proof ventilation equipment.

Environmental exposure controls : Emissions from ventilation or work process equipment should be checked to ensure they comply with the requirements of environmental protection legislation. In some cases, fume scrubbers, filters or engineering modifications to the process equipment will be necessary to reduce emissions to acceptable levels.

Individual protection measures

Hygiene measures : Wash hands, forearms and face thoroughly after handling chemical products, before eating, smoking and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.

Eye/face protection : Safety eyewear complying with an approved standard should be used when a risk assessment indicates this is necessary to avoid exposure to liquid splashes, mists, gases or dusts. If contact is possible, the following protection should be worn, unless the assessment indicates a higher degree of protection: safety glasses with side-shields.

Skin protection

Hand protection : Chemical-resistant, impervious gloves complying with an approved standard should be worn at all times when handling chemical products if a risk assessment indicates this is necessary. Considering the parameters specified by the glove manufacturer, check during use that the gloves are still retaining their protective properties. It should be noted that the time to breakthrough for any glove material may be different for different glove manufacturers. In the case of mixtures, consisting of several substances, the protection time of the gloves cannot be accurately estimated.

Body protection : Personal protective equipment for the body should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product. When there is a risk of ignition from static electricity, wear anti-static protective clothing. For the greatest protection from static discharges, clothing should include anti-static overalls, boots and gloves.

Other skin protection : Appropriate footwear and any additional skin protection measures should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product.

Respiratory protection : Use a properly fitted, air-purifying or air-fed respirator complying with an approved standard if a risk assessment indicates this is necessary. Respirator selection must be based on known or anticipated exposure levels, the hazards of the product and the safe working limits of the selected respirator.

Section 9. Physical and chemical properties

Appearance

Physical state : Liquid. [CLEAR, COLORLESS LIQUID WITH A WEAK, ETHEREAL, VINOUS ODOR]

Color : Colorless. Clear.

Molecular weight : 46.08 g/mole

Molecular formula : C2-H6-O

Boiling/condensation point : 78.29°C (172.9°F)

Section 9. Physical and chemical properties

Melting/freezing point	:	-114°C (-173.2°F)
Critical temperature	:	Not available.
Odor	:	Characteristic.
Odor threshold	:	Not available.
pH	:	Not available.
Flash point	:	Closed cup: 9.7°C (49.5°F)
Burning time	:	Not applicable.
Burning rate	:	Not applicable.
Evaporation rate	:	1.7 (butyl acetate = 1)
Flammability (solid, gas)	:	Not available.
Lower and upper explosive (flammable) limits	:	Lower: 3.3% Upper: 19%
Vapor pressure	:	5.7 kPa (42.948650611 mm Hg) [room temperature]
Vapor density	:	1.6 (Air = 1)
Specific Volume (ft^3/lb)	:	1.2716
Gas Density (lb/ft^3)	:	0.7864 (25°C / 77 to °F)
Relative density	:	0.8
Solubility	:	Not available.
Solubility in water	:	1000 g/l
Partition coefficient: n-octanol/water	:	-0.35
Auto-ignition temperature	:	455°C (851°F)
Decomposition temperature	:	Not available.
SADT	:	Not available.
Viscosity	:	Dynamic (room temperature): 0.544 to 0.59 mPa·s (0.544 to 0.59 cP)

Section 10. Stability and reactivity

Reactivity	:	No specific test data related to reactivity available for this product or its ingredients.
Chemical stability	:	The product is stable.
Possibility of hazardous reactions	:	Under normal conditions of storage and use, hazardous reactions will not occur.
Conditions to avoid	:	Avoid all possible sources of ignition (spark or flame). Do not pressurize, cut, weld, braze, solder, drill, grind or expose containers to heat or sources of ignition. Do not allow vapor to accumulate in low or confined areas.
Incompatibility with various substances	:	Highly reactive or incompatible with the following materials: oxidizing materials and alkalis.
Hazardous decomposition products	:	Under normal conditions of storage and use, hazardous decomposition products should not be produced.
Hazardous polymerization	:	Under normal conditions of storage and use, hazardous polymerization will not occur.

Section 11. Toxicological information

Information on toxicological effects

Acute toxicity

Not available.

Irritation/Corrosion

Not available.

Sensitization

Not available.

Mutagenicity

Not available.

Carcinogenicity

Not available.

Reproductive toxicity

Not available.

Teratogenicity

Not available.

Specific target organ toxicity (single exposure)

Not available.

Specific target organ toxicity (repeated exposure)

Not available.

Aspiration hazard

Not available.

Information on the likely routes of exposure : Not available.

Potential acute health effects

Eye contact : No known significant effects or critical hazards.

Inhalation : No known significant effects or critical hazards.

Skin contact : No known significant effects or critical hazards.

Ingestion : No known significant effects or critical hazards.

Symptoms related to the physical, chemical and toxicological characteristics

Eye contact : No specific data.

Inhalation : No specific data.

Skin contact : No specific data.

Ingestion : No specific data.

Delayed and immediate effects and also chronic effects from short and long term exposure

Short term exposure

Potential immediate effects : Not available.

Potential delayed effects : Not available.

Long term exposure

Section 11. Toxicological information

Potential immediate effects : Not available.

Potential delayed effects : Not available.

Potential chronic health effects

Not available.

General : No known significant effects or critical hazards.

Carcinogenicity : No known significant effects or critical hazards.

Mutagenicity : No known significant effects or critical hazards.

Teratogenicity : No known significant effects or critical hazards.

Developmental effects : No known significant effects or critical hazards.

Fertility effects : No known significant effects or critical hazards.

Numerical measures of toxicity

Acute toxicity estimates

Not available.

Section 12. Ecological information

Toxicity

Not available.

Persistence and degradability

Not available.

Bioaccumulative potential

Product/ingredient name	$LogP_{ow}$	BCF	Potential
ethanol	-0.35	-	low

Mobility in soil

Soil/water partition coefficient (K_{OC}) : Not available.

Other adverse effects : No known significant effects or critical hazards.

Section 13. Disposal considerations

Disposal methods : The generation of waste should be avoided or minimized wherever possible. Disposal of this product, solutions and any by-products should at all times comply with the requirements of environmental protection and waste disposal legislation and any regional local authority requirements. Dispose of surplus and non-recyclable products via a licensed waste disposal contractor. Waste should not be disposed of untreated to the sewer unless fully compliant with the requirements of all authorities with jurisdiction. Waste packaging should be recycled. Incineration or landfill should only be considered when recycling is not feasible. This material and its container must be disposed of in a safe way. Care should be taken when handling emptied containers that have not been cleaned or rinsed out. Empty containers or liners may retain some product residues. Vapor from product residues may create a highly flammable or explosive atmosphere

Section 13. Disposal considerations

inside the container. Do not cut, weld or grind used containers unless they have been cleaned thoroughly internally. Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers.

Section 14. Transport information

	DOT	TDG	Mexico	IMDG	IATA
UN number	UN1170	UN1170	UN1170	UN1170	UN1170
UN proper shipping name	ETHANOL OR ETHYL ALCOHOL OR ETHANOL SOLUTIONS OR ETHYL ALCOHOL SOLUTIONS	ETHANOL MORE THAN 24 PER CENT ETHANOL, BY VOLUME; ETHANOL SOLUTION MORE THAN 24 PER CENT ETHANOL, BY VOLUME; ETHYL ALCOHOL MORE THAN 24 PER CENT ETHANOL, BY VOLUME; OR ETHYL ALCOHOL SOLUTION MORE THAN 24 PER CENT ETHANOL, BY VOLUME	ETHANOL OR ETHYL ALCOHOL OR ETHANOL SOLUTIONS OR ETHYL ALCOHOL SOLUTIONS	ETHANOL (ETHYL ALCOHOL) OR ETHANOL SOLUTION (ETHYL ALCOHOL SOLUTION)	ETHANOL
Transport hazard class(es)	3 	3 	3 	3 	3 
Packing group	II	II	II	II	II
Environment	No.	No.	No.	No.	No.
Additional information	**Limited quantity** Yes. **Packaging instruction** **Passenger aircraft** Quantity limitation: 5 L **Cargo aircraft** Quantity limitation: 60 L **Special provisions** 24, IB2, T4, TP1	**Explosive Limit and Limited Quantity Index** 5 **Passenger Carrying Road or Rail Index** 60	-	-	**Passenger and Cargo Aircraft**Quantity limitation: 5 L **Cargo Aircraft Only** Quantity limitation: 60 L **Limited Quantities - Passenger Aircraft** Quantity limitation: 1 L

"Refer to CFR 49 (or authority having jurisdiction) to determine the information required for shipment of the product."

Special precautions for user : **Transport within user's premises:** always transport in closed containers that are upright and secure. Ensure that persons transporting the product know what to do in the event of an accident or spillage.

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code : Not available.

Section 15. Regulatory information

U.S. Federal regulations : **TSCA 8(a) CDR Exempt/Partial exemption**: Not determined

United States inventory (TSCA 8b): This material is listed or exempted.

Clean Air Act Section 112 (b) Hazardous Air Pollutants (HAPs) : Not listed

Clean Air Act Section 602 Class I Substances : Not listed

Clean Air Act Section 602 Class II Substances : Not listed

DEA List I Chemicals (Precursor Chemicals) : Not listed

DEA List II Chemicals (Essential Chemicals) : Not listed

SARA 302/304

Composition/information on ingredients

No products were found.

SARA 304 RQ : Not applicable.

SARA 311/312

Classification : Fire hazard

Composition/information on ingredients

Name	%	Fire hazard	Sudden release of pressure	Reactive	Immediate (acute) health hazard	Delayed (chronic) health hazard
ethanol	100	Yes.	No.	No.	No.	No.

State regulations

Massachusetts : This material is listed.

New York : This material is not listed.

New Jersey : This material is listed.

Pennsylvania : This material is listed.

Canada inventory : This material is listed or exempted.

International regulations

International lists : **Australia inventory (AICS)**: This material is listed or exempted.
China inventory (IECSC): This material is listed or exempted.
Japan inventory: This material is listed or exempted.
Korea inventory: This material is listed or exempted.
Malaysia Inventory (EHS Register): Not determined.
New Zealand Inventory of Chemicals (NZIoC): This material is listed or exempted.
Philippines inventory (PICCS): This material is listed or exempted.
Taiwan inventory (CSNN): Not determined.

Chemical Weapons Convention List Schedule I Chemicals : Not listed

Chemical Weapons Convention List Schedule II Chemicals : Not listed

Section 15. Regulatory information

Chemical Weapons Convention List Schedule III Chemicals : Not listed

Canada

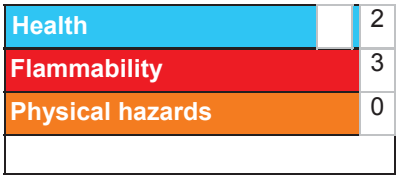
WHMIS (Canada) : Class B-2: Flammable liquid
Class D-2B: Material causing other toxic effects (Toxic).

CEPA Toxic substances: This material is not listed.
Canadian ARET: This material is not listed.
Canadian NPRI: This material is listed.
Alberta Designated Substances: This material is not listed.
Ontario Designated Substances: This material is not listed.
Quebec Designated Substances: This material is not listed.

Section 16. Other information

Canada Label requirements : Class B-2: Flammable liquid
Class D-2B: Material causing other toxic effects (Toxic).

Hazardous Material Information System (U.S.A.)



Caution: HMIS® ratings are based on a 0-4 rating scale, with 0 representing minimal hazards or risks, and 4 representing significant hazards or risks Although HMIS® ratings are not required on SDSs under 29 CFR 1910. 1200, the preparer may choose to provide them. HMIS® ratings are to be used with a fully implemented HMIS® program. HMIS® is a registered mark of the National Paint & Coatings Association (NPCA). HMIS® materials may be purchased exclusively from J. J. Keller (800) 327-6868.

The customer is responsible for determining the PPE code for this material.

National Fire Protection Association (U.S.A.)

Reprinted with permission from NFPA 704-2001, Identification of the Hazards of Materials for Emergency Response Copyright ©1997, National Fire Protection Association, Quincy, MA 02269. This reprinted material is not the complete and official position of the National Fire Protection Association, on the referenced subject which is represented only by the standard in its entirety.

Copyright ©2001, National Fire Protection Association, Quincy, MA 02269. This warning system is intended to be interpreted and applied only by properly trained individuals to identify fire, health and reactivity hazards of chemicals. The user is referred to certain limited number of chemicals with recommended classifications in NFPA 49 and NFPA 325, which would be used as a guideline only. Whether the chemicals are classified by NFPA or not, anyone using the 704 systems to classify chemicals does so at their own risk.

History

Date of printing : 5/18/2015.

Date of issue/Date of revision : 5/18/2015.

Date of previous issue : 10/28/2014.

Version : 0.02

Section 16. Other information

Key to abbreviations : ATE = Acute Toxicity Estimate
BCF = Bioconcentration Factor
GHS = Globally Harmonized System of Classification and Labelling of Chemicals
IATA = International Air Transport Association
IBC = Intermediate Bulk Container
IMDG = International Maritime Dangerous Goods
LogPow = logarithm of the octanol/water partition coefficient
MARPOL 73/78 = International Convention for the Prevention of Pollution From Ships, 1973 as modified by the Protocol of 1978. ("Marpol" = marine pollution)
UN = United NationsACGIH – American Conference of Governmental Industrial Hygienists
AIHA – American Industrial Hygiene Association
CAS – Chemical Abstract Services
CEPA – Canadian Environmental Protection Act
CERCLA – Comprehensive Environmental Response, Compensation, and Liability Act (EPA)
CFR – United States Code of Federal Regulations
CPR – Controlled Products Regulations
DSL – Domestic Substances List
GWP – Global Warming Potential
IARC – International Agency for Research on Cancer
ICAO – International Civil Aviation Organisation
Inh – Inhalation
LC – Lethal concentration
LD – Lethal dosage
NDSL – Non-Domestic Substances List
NIOSH – National Institute for Occupational Safety and Health
TDG – Canadian Transportation of Dangerous Goods Act and Regulations
TLV – Threshold Limit Value
TSCA – Toxic Substances Control Act
WEEL – Workplace Environmental Exposure Level
WHMIS – Canadian Workplace Hazardous Material Information System

References : Not available.

Indicates information that has changed from previously issued version.

Notice to reader

To the best of our knowledge, the information contained herein is accurate. However, neither the above-named supplier, nor any of its subsidiaries, assumes any liability whatsoever for the accuracy or completeness of the information contained herein.
Final determination of suitability of any material is the sole responsibility of the user. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that exist.

SAFETY DATA SHEET

N-Hexane

Section 1. Identification

GHS product identifier : N-Hexane

Chemical name : n-hexane

Other means of identification : Hexane; Hexane (n-Hexane)

Product use : Synthetic/Analytical chemistry.

Synonym : Hexane; Hexane (n-Hexane)

SDS # : 001060

Supplier's details : Airgas USA, LLC and its affiliates
259 North Radnor-Chester Road
Suite 100
Radnor, PA 19087-5283
1-610-687-5253

Emergency telephone number (with hours of operation) : 1-866-734-3438

Section 2. Hazards identification

OSHA/HCS status : This material is considered hazardous by the OSHA Hazard Communication Standard (29 CFR 1910.1200).

Classification of the substance or mixture : FLAMMABLE LIQUIDS - Category 2
TOXIC TO REPRODUCTION (Fertility) - Category 2
TOXIC TO REPRODUCTION (Unborn child) - Category 2
SPECIFIC TARGET ORGAN TOXICITY (SINGLE EXPOSURE) (Narcotic effects) - Category 3
SPECIFIC TARGET ORGAN TOXICITY (REPEATED EXPOSURE) - Category 2
AQUATIC HAZARD (LONG-TERM) - Category 2

GHS label elements

Hazard pictograms :

Signal word : Danger

Hazard statements : Highly flammable liquid and vapor.
May form explosive mixtures with air.
Suspected of damaging fertility or the unborn child.
May cause drowsiness and dizziness.
May cause damage to organs through prolonged or repeated exposure.
Toxic to aquatic life with long lasting effects.

Precautionary statements

General : Read label before use. Keep out of reach of children. If medical advice is needed, have product container or label at hand.

Section 2. Hazards identification

Prevention : Obtain special instructions before use. Do not handle until all safety precautions have been read and understood. Use personal protective equipment as required. Wear protective gloves. Wear eye or face protection. Keep away from heat, sparks, open flames and hot surfaces. - No smoking. Use explosion-proof electrical, ventilating, lighting and all material-handling equipment. Use only non-sparking tools. Take precautionary measures against static discharge. Keep container tightly closed. Use only outdoors or in a well-ventilated area. Avoid release to the environment. Do not breathe vapor. Wash hands thoroughly after handling.

Response : Collect spillage. Get medical attention if you feel unwell. IF exposed or concerned: Get medical attention. IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing. Call a POISON CENTER or physician if you feel unwell. IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water or shower. IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. If eye irritation persists: Get medical attention.

Storage : Store locked up. Store in a well-ventilated place. Keep cool.

Disposal : Dispose of contents and container in accordance with all local, regional, national and international regulations.

Hazards not otherwise classified : None known.

Section 3. Composition/information on ingredients

Substance/mixture : Substance

Chemical name : n-hexane

Other means of identification : Hexane; Hexane (n-Hexane)

CAS number/other identifiers

CAS number : 110-54-3

Product code : 001060

Ingredient name	%	CAS number
n-hexane	100	110-54-3

There are no additional ingredients present which, within the current knowledge of the supplier and in the concentrations applicable, are classified as hazardous to health or the environment and hence require reporting in this section.

Occupational exposure limits, if available, are listed in Section 8.

Section 4. First aid measures

Description of necessary first aid measures

Eye contact : Immediately flush eyes with plenty of water, occasionally lifting the upper and lower eyelids. Check for and remove any contact lenses. Continue to rinse for at least 10 minutes. Get medical attention following exposure or if feeling unwell.

Inhalation : Remove victim to fresh air and keep at rest in a position comfortable for breathing. If it is suspected that fumes are still present, the rescuer should wear an appropriate mask or self-contained breathing apparatus. If not breathing, if breathing is irregular or if respiratory arrest occurs, provide artificial respiration or oxygen by trained personnel. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation. Get medical attention. If necessary, call a poison center or physician. If unconscious, place in recovery position and get medical attention immediately. Maintain an open airway. Loosen tight clothing such as a collar, tie, belt or waistband.

Section 4. First aid measures

Skin contact : Wash contaminated skin with soap and water. Remove contaminated clothing and shoes. Continue to rinse for at least 10 minutes. Get medical attention. Wash clothing before reuse. Clean shoes thoroughly before reuse.

Ingestion : Wash out mouth with water. Remove dentures if any. Remove victim to fresh air and keep at rest in a position comfortable for breathing. If material has been swallowed and the exposed person is conscious, give small quantities of water to drink. Stop if the exposed person feels sick as vomiting may be dangerous. Do not induce vomiting unless directed to do so by medical personnel. If vomiting occurs, the head should be kept low so that vomit does not enter the lungs. Get medical attention. If necessary, call a poison center or physician. Never give anything by mouth to an unconscious person. If unconscious, place in recovery position and get medical attention immediately. Maintain an open airway. Loosen tight clothing such as a collar, tie, belt or waistband.

- ost important symptomsveffects, acute and delayed

Potential acute health effects

Eye contact : Causes eye irritation.

Inhalation : Can cause central nervous system (CNS) depression. May cause drowsiness and dizziness.

Skin contact : No known significant effects or critical hazards.

Frostbite : Try to warm up the frozen tissues and seek medical attention.

Ingestion : Can cause central nervous system (CNS) depression. May be irritating to mouth, throat and stomach.

OReNexposure signsvsymptoms

Eye contact : Adverse symptoms may include the following:
irritation
watering
redness

Inhalation : Adverse symptoms may include the following:
nausea or vomiting
headache
drowsiness/fatigue
dizziness/vertigo
unconsciousness
reduced fetal weight
increase in fetal deaths
skeletal malformations

Skin contact : Adverse symptoms may include the following:
reduced fetal weight
increase in fetal deaths
skeletal malformations

Ingestion : Adverse symptoms may include the following:
reduced fetal weight
increase in fetal deaths
skeletal malformations

Indication of immediate medical attention and special treatment needed, if necessary

Notes to physician : Treat symptomatically. Contact poison treatment specialist immediately if large quantities have been ingested or inhaled.

Specific treatments : No specific treatment.

Section 4. First aid measures

Protection of first-aiders : No action shall be taken involving any personal risk or without suitable training. If it is suspected that fumes are still present, the rescuer should wear an appropriate mask or self-contained breathing apparatus. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation.

See toxicological information (Section 11)

Section 5. Fire-fighting measures

Extinguishing media

Suitable extinguishing media : Use dry chemical, CO_2, water spray (fog) or foam.

Unsuitable extinguishing media : Do not use water jet.

Specific hazards arising from the chemical : Highly flammable liquid and vapor. In a fire or if heated, a pressure increase will occur and the container may burst, with the risk of a subsequent explosion. The vapor/gas is heavier than air and will spread along the ground. Vapors may accumulate in low or confined areas or travel a considerable distance to a source of ignition and flash back. Runoff to sewer may create fire or explosion hazard. This material is toxic to aquatic life with long lasting effects. Fire water contaminated with this material must be contained and prevented from being discharged to any waterway, sewer or drain.

Hazardous thermal decomposition products : Decomposition products may include the following materials:
carbon dioxide
carbon monoxide

Special protective actions for fire-fighters : Promptly isolate the scene by removing all persons from the vicinity of the incident if there is a fire. No action shall be taken involving any personal risk or without suitable training. Move containers from fire area if this can be done without risk. Use water spray to keep fire-exposed containers cool.

Special protective equipment for fire-fighters : Fire-fighters should wear appropriate protective equipment and self-contained breathing apparatus (SCBA) with a full face-piece operated in positive pressure mode.

Section 6. Accidental release measures

Personal precautions, protective equipment and emergency procedures

For non-emergency personnel : No action shall be taken involving any personal risk or without suitable training. Evacuate surrounding areas. Keep unnecessary and unprotected personnel from entering. Do not touch or walk through spilled material. Shut off all ignition sources. No flares, smoking or flames in hazard area. Avoid breathing vapor or mist. Provide adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Put on appropriate personal protective equipment.

For emergency responders : If specialised clothing is required to deal with the spillage, take note of any information in Section 8 on suitable and unsuitable materials. See also the information in "For non-emergency personnel".

Environmental precautions : Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers. Inform the relevant authorities if the product has caused environmental pollution (sewers, waterways, soil or air). Water polluting material. May be harmful to the environment if released in large quantities. Collect spillage.

- ethods and materials for containment and cleaning up

Section 6. Accidental release measures

Small spill : Stop leak if without risk. Move containers from spill area. Use spark-proof tools and explosion-proof equipment. Dilute with water and mop up if water-soluble. Alternatively, or if water-insoluble, absorb with an inert dry material and place in an appropriate waste disposal container. Dispose of via a licensed waste disposal contractor.

Large spill : Stop leak if without risk. Move containers from spill area. Use spark-proof tools and explosion-proof equipment. Approach release from upwind. Prevent entry into sewers, water courses, basements or confined areas. Wash spillages into an effluent treatment plant or proceed as follows. Contain and collect spillage with non-combustible, absorbent material e.g. sand, earth, vermiculite or diatomaceous earth and place in container for disposal according to local regulations (see Section 13). Dispose of via a licensed waste disposal contractor. Contaminated absorbent material may pose the same hazard as the spilled product. Note: see Section 1 for emergency contact information and Section 13 for waste disposal.

Section 7. Handling and storage

Precautions for safe handling

Protective measures : Put on appropriate personal protective equipment (see Section 8). Avoid exposure - obtain special instructions before use. Avoid exposure during pregnancy. Do not handle until all safety precautions have been read and understood. Do not get in eyes or on skin or clothing. Do not breathe vapor or mist. Do not ingest. Avoid release to the environment. Use only with adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Do not enter storage areas and confined spaces unless adequately ventilated. Keep in the original container or an approved alternative made from a compatible material, kept tightly closed when not in use. Store and use away from heat, sparks, open flame or any other ignition source. Use explosion-proof electrical (ventilating, lighting and material handling) equipment. Use only non-sparking tools. Take precautionary measures against electrostatic discharges. Empty containers retain product residue and can be hazardous. Do not reuse container.

Advice on general occupational hygiene : Eating, drinking and smoking should be prohibited in areas where this material is handled, stored and processed. Workers should wash hands and face before eating, drinking and smoking. Remove contaminated clothing and protective equipment before entering eating areas. See also Section 8 for additional information on hygiene measures.

Conditions for safe storage, including any incompatibilities : Store in accordance with local regulations. Store in a segregated and approved area. Store in original container protected from direct sunlight in a dry, cool and well-ventilated area, away from incompatible materials (see Section 10) and food and drink. Store locked up. Eliminate all ignition sources. Separate from oxidizing materials. Keep container tightly closed and sealed until ready for use. Containers that have been opened must be carefully resealed and kept upright to prevent leakage. Do not store in unlabeled containers. Use appropriate containment to avoid environmental contamination.

Section 8. Exposure controls/personal protection

Control parameters

Occupational exposure limits

Section 8. Exposure controls/personal protection

Ingredient name	Exposure limits
n-hexane	**ACGIH TLV (United States, 3/2012).** **Absorbed through skin.** TWA: 50 ppm 8 hours. **NIOSH REL (United States, 1/2013).** TWA: 180 mg/m³ 10 hours. TWA: 50 ppm 10 hours. **OSHA PEL (United States, 6/2010).** TWA: 1800 mg/m³ 8 hours. TWA: 500 ppm 8 hours. **OSHA PEL 1989 (United States, 3/1989).** TWA: 180 mg/m³ 8 hours. TWA: 50 ppm 8 hours.

Appropriate engineering controls : Use only with adequate ventilation. Use process enclosures, local exhaust ventilation or other engineering controls to keep worker exposure to airborne contaminants below any recommended or statutory limits. The engineering controls also need to keep gas, vapor or dust concentrations below any lower explosive limits. Use explosion-proof ventilation equipment.

Environmental exposure controls : Emissions from ventilation or work process equipment should be checked to ensure they comply with the requirements of environmental protection legislation. In some cases, fume scrubbers, filters or engineering modifications to the process equipment will be necessary to reduce emissions to acceptable levels.

Individual protection measures

Hygiene measures : Wash hands, forearms and face thoroughly after handling chemical products, before eating, smoking and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.

Eye/face protection : Safety eyewear complying with an approved standard should be used when a risk assessment indicates this is necessary to avoid exposure to liquid splashes, mists, gases or dusts. If contact is possible, the following protection should be worn, unless the assessment indicates a higher degree of protection: chemical splash goggles.

Skin protection

Hand protection : Chemical-resistant, impervious gloves complying with an approved standard should be worn at all times when handling chemical products if a risk assessment indicates this is necessary. Considering the parameters specified by the glove manufacturer, check during use that the gloves are still retaining their protective properties. It should be noted that the time to breakthrough for any glove material may be different for different glove manufacturers. In the case of mixtures, consisting of several substances, the protection time of the gloves cannot be accurately estimated.

Body protection : Personal protective equipment for the body should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product. When there is a risk of ignition from static electricity, wear anti-static protective clothing. For the greatest protection from static discharges, clothing should include anti-static overalls, boots and gloves.

Other skin protection : Appropriate footwear and any additional skin protection measures should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product.

Respiratory protection : Use a properly fitted, air-purifying or air-fed respirator complying with an approved standard if a risk assessment indicates this is necessary. Respirator selection must be based on known or anticipated exposure levels, the hazards of the product and the safe working limits of the selected respirator.

Section 9. Physical and chemical properties

Appearance

Physical state : Liquid. [COLORLESS LIQUID WITH A MILD GASOLINE-LIKE ODOR]

Color : Colorless.

- olecular weight : 86.18 g/mole

- olecular formula : C6-H14

Boilingvcondensation point : 68.73°C (155.7°F)

- eltingvfreezing point : -95.35°C (-139.6°F)

Critical temperature : 234.25°C (453.6°F)

Odor : Characteristic.

Odor threshold : Not available.

pH : Not available.

Flash point : Closed cup: -22°C (-7.6°F)

Burning time : Not applicable.

Burning rate : Not applicable.

ERaporation rate : 6.82 (butyl acetate = 1)

Flammability (solid, gas) : Extremely flammable in the presence of the following materials or conditions: oxidizing materials.

Lower and upper explosiRe (flammable) limits : Lower: 1.1%
Upper: 7.5%

Vapor pressure : 17 kPa (127.510360216 mm Hg) [room temperature]

Vapor density : 3 (Air = 1)

Specific Volume (ft ^{3}Vlb) : 1.5138

Gas Density (lbvft ^{3}) : 0.6606 (25°C / 77 to °F)

/ elatiRe density : 0.7

Solubility : Not available.

Solubility in water : 0.0098 g/l

Partition coefficient: nN octanolwater : 4

AutoNgnition temperature : 225°C (437°F)

Decomposition temperature : Not available.

SADT : Not available.

Viscosity : Dynamic (room temperature): 0.3 mPa·s (0.3 cP)

Section 10. Stability and reactiRity

/ eactiRity : No specific test data related to reactivity available for this product or its ingredients.

Chemical stability : The product is stable.

Possibility of hazardous reactions : Under normal conditions of storage and use, hazardous reactions will not occur.

Conditions to aRoid : Avoid all possible sources of ignition (spark or flame). Do not pressurize, cut, weld, braze, solder, drill, grind or expose containers to heat or sources of ignition. Do not allow vapor to accumulate in low or confined areas.

Section 10. Stability and reactivity

Incompatibility with various substances : Extremely reactive or incompatible with the following materials: oxidizing materials.

Hazardous decomposition products : Under normal conditions of storage and use, hazardous decomposition products should not be produced.

Hazardous polymerization : Under normal conditions of storage and use, hazardous polymerization will not occur.

Section 11. Toxicological information

Information on toxicological effects

Acute toxicity

Product/ingredient name	Result	Species	Dose	Exposure
n-hexane	LC50 Inhalation Gas. LC50 Inhalation Vapor LD50 Oral	Rat Rat Rat	48000 ppm 96000 ppm 15840 mg/kg	4 hours 1 hours -

Irritation/Corrosion

Product/ingredient name	Result	Species	Score	Exposure	Observation
n-hexane	Eyes - Mild irritant	Rabbit	-	10 milligrams	-

Sensitization

Not available.

Mutagenicity

Not available.

Carcinogenicity

Not available.

Reproductive toxicity

Not available.

Teratogenicity

Not available.

Specific target organ toxicity (single exposure)

Name	Category	Route of exposure	Target organs
n-hexane	Category 3	Not applicable.	Narcotic effects

Specific target organ toxicity (repeated exposure)

Name	Category	Route of exposure	Target organs
n-hexane	Category 2	Not determined	Not determined

Aspiration hazard

Not available.

Information on the likely routes of exposure : Not available.

Potential acute health effects

Section 11. Toxicological information

Eye contact : Causes eye irritation.

Inhalation : Can cause central nervous system (CNS) depression. May cause drowsiness and dizziness.

Skin contact : No known significant effects or critical hazards.

Ingestion : Can cause central nervous system (CNS) depression. May be irritating to mouth, throat and stomach.

Symptoms related to the physical, chemical and toxicological characteristics

Eye contact : Adverse symptoms may include the following:
irritation
watering
redness

Inhalation : Adverse symptoms may include the following:
nausea or vomiting
headache
drowsiness/fatigue
dizziness/vertigo
unconsciousness
reduced fetal weight
increase in fetal deaths
skeletal malformations

Skin contact : Adverse symptoms may include the following:
reduced fetal weight
increase in fetal deaths
skeletal malformations

Ingestion : Adverse symptoms may include the following:
reduced fetal weight
increase in fetal deaths
skeletal malformations

Delayed and immediate effects and also chronic effects from short and long term exposure

Short term exposure

Potential immediate effects : Not available.

Potential delayed effects : Not available.

Long term exposure

Potential immediate effects : Not available.

Potential delayed effects : Not available.

Potential chronic health effects

Not available.

General : May cause damage to organs through prolonged or repeated exposure.

Carcinogenicity : No known significant effects or critical hazards.

- utagenicity : No known significant effects or critical hazards.

Teratogenicity : No known significant effects or critical hazards.

DeRelopmental effects : No known significant effects or critical hazards.

Fertility effects : Suspected of damaging fertility.

Mumerical measures of toxicity

Acute toxicity estimates

Section 11. Toxicological information

Not available.

Section 12. Ecological information

Toxicity

Product/ingredient name	Result	Species	Exposure
n-hexane	Acute LC50 113000 µg/l Fresh water	Fish - Oreochromis mossambicus	96 hours

Persistence and degradability

Not available.

Bioaccumulative potential

Product/ingredient name	$LogP_{ow}$	BCF	Potential
n-hexane	4	501.187	high

Mobility in soil

Soil/water partition coefficient (K_{OC}) : Not available.

Other adverse effects : No known significant effects or critical hazards.

Section 13. Disposal considerations

Disposal methods : The generation of waste should be avoided or minimized wherever possible. Disposal of this product, solutions and any by-products should at all times comply with the requirements of environmental protection and waste disposal legislation and any regional local authority requirements. Dispose of surplus and non-recyclable products via a licensed waste disposal contractor. Waste should not be disposed of untreated to the sewer unless fully compliant with the requirements of all authorities with jurisdiction. Waste packaging should be recycled. Incineration or landfill should only be considered when recycling is not feasible. This material and its container must be disposed of in a safe way. Care should be taken when handling emptied containers that have not been cleaned or rinsed out. Empty containers or liners may retain some product residues. Vapor from product residues may create a highly flammable or explosive atmosphere inside the container. Do not cut, weld or grind used containers unless they have been cleaned thoroughly internally. Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers.

Section 14. Transport information

	DOT	TDG	Mexico	IMDG	IATA
UN number	UN1208	UN1208	UN1208	UN1208	UN1208
UN proper shipping name	Hexanes	Hexanes	Hexanes	Hexanes	Hexanes
Transport hazard class(es)	3 	3 	3 	3 	3 

Section 14. Transport information

Packing group	II	II	II	II	II
Environment	No.	No.	No.	Yes.	No.
Additional information	**Reportable quantity** 5000 lbs / 2270 kg [907.77 gal / 3436.3 L] Package sizes shipped in quantities less than the product reportable quantity are not subject to the RQ (reportable quantity) transportation requirements.	**Explosive Limit and Limited Quantity Index** 1 **Passenger Carrying Ship Index** Forbidden **Passenger Carrying Road or Rail Index** 5	-	The marine pollutant mark is not required when transported in sizes of ≤5 L or ≤5 kg.	The environmentally hazardous substance mark may appear if required by other transportation regulations.

"Refer to CFR 49 (or authority having jurisdiction) to determine the information required for shipment of the product."

Special precautions for user : **Transport within user's premises:** always transport in closed containers that are upright and secure. Ensure that persons transporting the product know what to do in the event of an accident or spillage.

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code : Not available.

Section 15. Regulatory information

U.S. Federal regulations : **TSCA 8(a) CDR Exempt/Partial exemption**: Not determined

United States inventory (TSCA 8b): This material is listed or exempted.

Clean Air Act Section 112 (b) Hazardous Air Pollutants (HAPs) : Listed

Clean Air Act Section 602 Class I Substances : Not listed

Clean Air Act Section 602 Class II Substances : Not listed

DEA List I Chemicals (Precursor Chemicals) : Not listed

DEA List II Chemicals (Essential Chemicals) : Not listed

SARA 302/304

Composition/information on ingredients

No products were found.

SARA 304 RQ : Not applicable.

SARA 311/312

Classification : Fire hazard
Immediate (acute) health hazard
Delayed (chronic) health hazard

Composition/information on ingredients

Section 15. / egulatory information

Mame	%	Fire hazard	Sudden release of pressure	/ eactiRe	Immediate (acute) health hazard	Delayed (chronic) health hazard
n-hexane	100	Yes.	No.	No.	Yes.	Yes.

SA/ A 313

	Product name	CAS number	%
Form / N/ eporting requirements	n-hexane	110-54-3	100
Supplier notification	n-hexane	110-54-3	100

SARA 313 notifications must not be detached from the SDS and any copying and redistribution of the SDS shall include copying and redistribution of the notice attached to copies of the SDS subsequently redistributed.

State regulations

- assachusetts : This material is listed.
Mew York : This material is listed.
Mew Jersey : This material is listed.
PennsylRania : This material is listed.

Canada inRentory : This material is listed or exempted.

International regulations

International lists : **Australia inRentory (AICS)**: This material is listed or exempted.
China inRentory (IECSC): This material is listed or exempted.
Japan inRentory: This material is listed or exempted.
Korea inRentory: This material is listed or exempted.
- alaysia InRentory (EHS / egister)**: Not determined.
Mew Zealand InRentory of Chemicals (MZIoC): This material is listed or exempted.
Philippines inRentory (PICCS): This material is listed or exempted.
Taiwan inRentory (CSMM): Not determined.

Chemical Weapons ConRention List Schedule I Chemicals : Not listed

Chemical Weapons ConRention List Schedule II Chemicals : Not listed

Chemical Weapons ConRention List Schedule III Chemicals : Not listed

Canada

WH- IS (Canada) : Class B-2: Flammable liquid
Class D-2A: Material causing other toxic effects (Very toxic).
Class D-2B: Material causing other toxic effects (Toxic).

CEPA Toxic substances: This material is not listed.
Canadian A/ ET: This material is not listed.
Canadian MP/ I: This material is listed.
Alberta Designated Substances: This material is not listed.
Ontario Designated Substances: This material is not listed.
Quebec Designated Substances: This material is not listed.

Section 16. Other information

Canada Label requirements : Class B-2: Flammable liquid
Class D-2A: Material causing other toxic effects (Very toxic).
Class D-2B: Material causing other toxic effects (Toxic).

Hazardous - aterial Information System (U.S.A.)

Health	*	2
Flammability		3
Physical hazards		0

Caution: H- IS® ratings are based on a 0N4 rating scale, with 0 representing minimal hazards or risks, and 4 representing significant hazards or risks Although H- IS® ratings are not required on SDSs under 29 CF/ 1910. 1200, the preparer may choose to proRide them. H- IS® ratings are to be used with a fully implemented H- IS® program. H- IS® is a registered mark of the Mational Paint & Coatings Association (MPCA). H- IS® materials may be purchased exclusiRely from J. J. Keller (800) 327N6868.

The customer is responsible for determining the PPE code for this material.

Mational Fire Protection Association (U.S.A.)

/ eprinted with permission from MFPA 704N2001, Identification of the Hazards of - aterials for Emergency / esponse Copyright ©1997, Mational Fire Protection Association, Quincy, - A 02269. This reprinted material is not the complete and official position of the Mational Fire Protection Association, on the referenced subject which is represented only by the standard in its entirety.

Copyright ©2001, Mational Fire Protection Association, Quincy, - A 02269. This warning system is intended to be interpreted and applied only by properly trained indiRiduals to identify fire, health and reactiRity hazards of chemicals. The user is referred to certain limited number of chemicals with recommended classifications in MFPA 49 and MFPA 325, which would be used as a guideline only. Whether the chemicals are classified by MFPA or not, anyone using the 704 systems to classify chemicals does so at their own risk.

History

Date of printing : 5/20/2015.

Date of issueVDate of reRision : 5/20/2015.

Date of preRious issue : 10/16/2014.

Version : 0.03

Key to abbreRiations : ATE = Acute Toxicity Estimate
BCF = Bioconcentration Factor
GHS = Globally Harmonized System of Classification and Labelling of Chemicals
IATA = International Air Transport Association
IBC = Intermediate Bulk Container
IMDG = International Maritime Dangerous Goods
LogPow = logarithm of the octanol/water partition coefficient
MARPOL 73/78 = International Convention for the Prevention of Pollution From Ships, 1973 as modified by the Protocol of 1978. ("Marpol" = marine pollution)
UN = United NationsACGIH – American Conference of Governmental Industrial Hygienists
AIHA – American Industrial Hygiene Association
CAS – Chemical Abstract Services
CEPA – Canadian Environmental Protection Act
CERCLA – Comprehensive Environmental Response, Compensation, and Liability Act (EPA)

Section 16. Other information

CFR – United States Code of Federal Regulations
CPR – Controlled Products Regulations
DSL – Domestic Substances List
GWP – Global Warming Potential
IARC – International Agency for Research on Cancer
ICAO – International Civil Aviation Organisation
Inh – Inhalation
LC – Lethal concentration
LD – Lethal dosage
NDSL – Non-Domestic Substances List
NIOSH – National Institute for Occupational Safety and Health
TDG – Canadian Transportation of Dangerous Goods Act and Regulations
TLV – Threshold Limit Value
TSCA – Toxic Substances Control Act
WEEL – Workplace Environmental Exposure Level
WHMIS – Canadian Workplace Hazardous Material Information System

/ eferences : Not available.

Indicates information that has changed from preRiously issued Rersion.

Motice to reader

To the best of our knowledge, the information contained herein is accurate. HoweRer, neither the aboRenamed supplier, nor any of its subsidiaries, assumes any liability whatsoeRer for the accuracy or completeness of the information contained herein.
Final determination of suitability of any material is the sole responsibility of the user. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that exist.

SAFETY DATA SHEET

Isopropyl Alcohol (Isopropanol)

Section 1. Identification

GHS product identifier : Isopropyl Alcohol (Isopropanol)

Chemical name : Isopropyl alcohol

Other means of identification : propan-2-ol; 2-Propanol; isopropanol; isopropyl alcohol

Product use : Synthetic/Analytical chemistry.

Synonym : propan-2-ol; 2-Propanol; isopropanol; isopropyl alcohol

SDS # : 001105

Supplier's details : Airgas USA, LLC and its affiliates
259 North Radnor-Chester Road
Suite 100
Radnor, PA 19087-5283
1-610-687-5253

Emergency telephone number (with hours of operation) : 1-866-734-3438

Section 2. Hazards identification

OSHA/HCS status : This material is considered hazardous by the OSHA Hazard Communication Standard (29 CFR 1910.1200).

Classification of the substance or mixture : FLAMMABLE LIQUIDS - Category 2
SERIOUS EYE DAMAGE/ EYE IRRITATION - Category 2
SPECIFIC TARGET ORGAN TOXICITY (SINGLE EXPOSURE) (Narcotic effects) - Category 3

GHS label elements

Hazard pictograms :

Signal word : Danger

Hazard statements : Highly flammable liquid and vapor.
May form explosive mixtures with air.
Causes serious eye irritation.
May cause drowsiness and dizziness.

Precautionary statements

General : Read label before use. Keep out of reach of children. If medical advice is needed, have product container or label at hand.

Prevention : Wear protective gloves. Wear eye or face protection. Keep away from heat, sparks, open flames and hot surfaces. - No smoking. Use explosion-proof electrical, ventilating, lighting and all material-handling equipment. Use only non-sparking tools. Take precautionary measures against static discharge. Keep container tightly closed. Use only outdoors or in a well-ventilated area. Avoid breathing vapor. Wash hands thoroughly after handling. Use and store only outdoors or in a well ventilated place.

Section 2. Hazards identification

/ esponse : IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing. Call a POISON CENTER or physician if you feel unwell. IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water or shower. IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. If eye irritation persists: Get medical attention.

Storage : Store locked up. Store in a well-ventilated place. Keep cool.

Disposal : Dispose of contents and container in accordance with all local, regional, national and international regulations.

Hazards not otherwise classified : None known.

Section 3. CompositionR nformation on ingredients

SubstanceR ixture : Substance

Chemical name : Isopropyl alcohol

Other means of identification : propan-2-ol; 2-Propanol; isopropanol; isopropyl alcohol

CAS numberR other identifiers

CAS number : 67-63-0

Product code : 001105

Ingredient name	%	CAS number
propan-2-ol	100	67-63-0

There are no additional ingredients present which, within the current knowledge of the supplier and in the concentrations applicable, are classified as hazardous to health or the environment and hence require reporting in this section.

Occupational exposure limits, if available, are listed in Section 8.

Section 4. First aid measures

Description of necessary first aid measures

Eye contact : Immediately flush eyes with plenty of water, occasionally lifting the upper and lower eyelids. Check for and remove any contact lenses. Continue to rinse for at least 10 minutes. Get medical attention.

Inhalation : Remove victim to fresh air and keep at rest in a position comfortable for breathing. If it is suspected that fumes are still present, the rescuer should wear an appropriate mask or self-contained breathing apparatus. If not breathing, if breathing is irregular or if respiratory arrest occurs, provide artificial respiration or oxygen by trained personnel. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation. Get medical attention. If necessary, call a poison center or physician. If unconscious, place in recovery position and get medical attention immediately. Maintain an open airway. Loosen tight clothing such as a collar, tie, belt or waistband.

Skin contact : Flush contaminated skin with plenty of water. Remove contaminated clothing and shoes. Get medical attention if symptoms occur. Wash clothing before reuse. Clean shoes thoroughly before reuse.

Ingestion : Wash out mouth with water. Remove dentures if any. Remove victim to fresh air and keep at rest in a position comfortable for breathing. If material has been swallowed and the exposed person is conscious, give small quantities of water to drink. Stop if the exposed person feels sick as vomiting may be dangerous. Do not induce vomiting unless directed to do so by medical personnel. If vomiting occurs, the head should be kept low so that vomit does not enter the lungs. Get medical attention. If necessary, call a poison center or physician. Never give anything by mouth to an unconscious person. If unconscious, place in recovery position and get medical attention

Section 4. First aid measures

immediately. Maintain an open airway. Loosen tight clothing such as a collar, tie, belt or waistband.

Most important symptoms/effects, acute and delayed

Potential acute health effects

Eye contact : Causes serious eye irritation.

Inhalation : Can cause central nervous system (CNS) depression. May cause drowsiness and dizziness.

Skin contact : No known significant effects or critical hazards.

Frostbite : Try to warm up the frozen tissues and seek medical attention.

Ingestion : Can cause central nervous system (CNS) depression. Irritating to mouth, throat and stomach.

Overexposure signs/symptoms

Eye contact : Adverse symptoms may include the following:
pain or irritation
watering
redness

Inhalation : Adverse symptoms may include the following:
nausea or vomiting
headache
drowsiness/fatigue
dizziness/vertigo
unconsciousness

Skin contact : No specific data.

Ingestion : No specific data.

Indication of immediate medical attention and special treatment needed, if necessary

Notes to physician : Treat symptomatically. Contact poison treatment specialist immediately if large quantities have been ingested or inhaled.

Specific treatments : No specific treatment.

Protection of first-aiders : No action shall be taken involving any personal risk or without suitable training. If it is suspected that fumes are still present, the rescuer should wear an appropriate mask or self-contained breathing apparatus. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation.

See toxicological information (Section 11)

Section 5. Fire-fighting measures

Extinguishing media

Suitable extinguishing media : Use dry chemical, CO_2, water spray (fog) or foam.

Unsuitable extinguishing media : Do not use water jet.

Specific hazards arising from the chemical : Highly flammable liquid and vapor. In a fire or if heated, a pressure increase will occur and the container may burst, with the risk of a subsequent explosion. The vapor/gas is heavier than air and will spread along the ground. Vapors may accumulate in low or confined areas or travel a considerable distance to a source of ignition and flash back. Runoff to sewer may create fire or explosion hazard.

Section 5. Fire-fighting measures

Hazardous thermal decomposition products : Decomposition products may include the following materials:
carbon dioxide
carbon monoxide

Special protective actions for fire-fighters : Promptly isolate the scene by removing all persons from the vicinity of the incident if there is a fire. No action shall be taken involving any personal risk or without suitable training. Move containers from fire area if this can be done without risk. Use water spray to keep fire-exposed containers cool.

Special protective equipment for fire-fighters : Fire-fighters should wear appropriate protective equipment and self-contained breathing apparatus (SCBA) with a full face-piece operated in positive pressure mode.

Section 6. Accidental release measures

Personal precautions, protective equipment and emergency procedures

For non-emergency personnel : No action shall be taken involving any personal risk or without suitable training. Evacuate surrounding areas. Keep unnecessary and unprotected personnel from entering. Do not touch or walk through spilled material. Shut off all ignition sources. No flares, smoking or flames in hazard area. Avoid breathing vapor or mist. Provide adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Put on appropriate personal protective equipment.

For emergency responders : If specialised clothing is required to deal with the spillage, take note of any information in Section 8 on suitable and unsuitable materials. See also the information in "For non-emergency personnel".

Environmental precautions : Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers. Inform the relevant authorities if the product has caused environmental pollution (sewers, waterways, soil or air).

Methods and materials for containment and cleaning up

Small spill : Stop leak if without risk. Move containers from spill area. Use spark-proof tools and explosion-proof equipment. Dilute with water and mop up if water-soluble. Alternatively, or if water-insoluble, absorb with an inert dry material and place in an appropriate waste disposal container. Dispose of via a licensed waste disposal contractor.

Large spill : Stop leak if without risk. Move containers from spill area. Use spark-proof tools and explosion-proof equipment. Approach release from upwind. Prevent entry into sewers, water courses, basements or confined areas. Wash spillages into an effluent treatment plant or proceed as follows. Contain and collect spillage with non-combustible, absorbent material e.g. sand, earth, vermiculite or diatomaceous earth and place in container for disposal according to local regulations (see Section 13). Dispose of via a licensed waste disposal contractor. Contaminated absorbent material may pose the same hazard as the spilled product. Note: see Section 1 for emergency contact information and Section 13 for waste disposal.

Section 7. Handling and storage

Precautions for safe handling

Protective measures : Put on appropriate personal protective equipment (see Section 8). Do not ingest. Avoid contact with eyes, skin and clothing. Avoid breathing vapor or mist. Use only with adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Do not enter storage areas and confined spaces unless adequately ventilated. Keep in the original container or an approved alternative made from a compatible material, kept tightly closed when not in use. Store and use away from heat, sparks, open flame or any other ignition source. Use explosion-proof electrical (ventilating, lighting and material handling) equipment. Use only non-sparking tools. Take precautionary measures against electrostatic discharges. Empty containers retain product residue and can be hazardous. Do not reuse container.

Section 7. Handling and storage

Advice on general occupational hygiene : Eating, drinking and smoking should be prohibited in areas where this material is handled, stored and processed. Workers should wash hands and face before eating, drinking and smoking. Remove contaminated clothing and protective equipment before entering eating areas. See also Section 8 for additional information on hygiene measures.

Conditions for safe storage, including any incompatibilities : Store in accordance with local regulations. Store in a segregated and approved area. Store in original container protected from direct sunlight in a dry, cool and well-ventilated area, away from incompatible materials (see Section 10) and food and drink. Store locked up. Eliminate all ignition sources. Separate from oxidizing materials. Keep container tightly closed and sealed until ready for use. Containers that have been opened must be carefully resealed and kept upright to prevent leakage. Do not store in unlabeled containers. Use appropriate containment to avoid environmental contamination.

Section 8. Exposure controls/personal protection

Control parameters

Occupational exposure limits

Ingredient name	Exposure limits
propan-2-ol	**ACGIH TLV (United States, 3/2012).** TWA: 200 ppm 8 hours. STEL: 400 ppm 15 minutes. **OSHA PEL 1989 (United States, 3/1989).** TWA: 400 ppm 8 hours. TWA: 980 mg/m³ 8 hours. STEL: 500 ppm 15 minutes. STEL: 1225 mg/m³ 15 minutes. **- IOSH / EL (United States, 1/2013).** TWA: 400 ppm 10 hours. TWA: 980 mg/m³ 10 hours. STEL: 500 ppm 15 minutes. STEL: 1225 mg/m³ 15 minutes. **OSHA PEL (United States, 6/2010).** TWA: 400 ppm 8 hours. TWA: 980 mg/m³ 8 hours.

Appropriate engineering controls : Use only with adequate ventilation. Use process enclosures, local exhaust ventilation or other engineering controls to keep worker exposure to airborne contaminants below any recommended or statutory limits. The engineering controls also need to keep gas, vapor or dust concentrations below any lower explosive limits. Use explosion-proof ventilation equipment.

Environmental exposure controls : Emissions from ventilation or work process equipment should be checked to ensure they comply with the requirements of environmental protection legislation. In some cases, fume scrubbers, filters or engineering modifications to the process equipment will be necessary to reduce emissions to acceptable levels.

Individual protection measures

Hygiene measures : Wash hands, forearms and face thoroughly after handling chemical products, before eating, smoking and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.

Section 8. Exposure controls/Personal protection

Eye/Face protection : Safety eyewear complying with an approved standard should be used when a risk assessment indicates this is necessary to avoid exposure to liquid splashes, mists, gases or dusts. If contact is possible, the following protection should be worn, unless the assessment indicates a higher degree of protection: chemical splash goggles.

Skin protection

Hand protection : Chemical-resistant, impervious gloves complying with an approved standard should be worn at all times when handling chemical products if a risk assessment indicates this is necessary. Considering the parameters specified by the glove manufacturer, check during use that the gloves are still retaining their protective properties. It should be noted that the time to breakthrough for any glove material may be different for different glove manufacturers. In the case of mixtures, consisting of several substances, the protection time of the gloves cannot be accurately estimated.

Body protection : Personal protective equipment for the body should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product. When there is a risk of ignition from static electricity, wear anti-static protective clothing. For the greatest protection from static discharges, clothing should include anti-static overalls, boots and gloves.

Other skin protection : Appropriate footwear and any additional skin protection measures should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product.

Respiratory protection : Use a properly fitted, air-purifying or air-fed respirator complying with an approved standard if a risk assessment indicates this is necessary. Respirator selection must be based on known or anticipated exposure levels, the hazards of the product and the safe working limits of the selected respirator.

Section 9. Physical and chemical properties

Appearance

Physical state : Liquid. [COLORLESS LIQUID WITH THE ODOR OF RUBBING ALCOHOL]

Color : Colorless.

Molecular weight : 60.11 g/mole

Molecular formula : C3-H8-O

Boiling/Condensation point : 83°C (181.4°F)

Melting/Freezing point : -90°C (-130°F)

Critical temperature : Not available.

Odor : Alcohol-like.

Odor threshold : Not available.

pH : Not available.

Flash point : Closed cup: 11.7°C (53.1°F)

Burning time : Not applicable.

Burning rate : Not applicable.

Evaporation rate : 1.7 (butyl acetate = 1)

Flammability (solid, gas) : Not available.

Lower and upper explosive (flammable) limits : Lower: 2%
Upper: 12%

Vapor pressure : 4.4 kPa (33.002681467 mm Hg) [room temperature]

Vapor density : 2.1 (Air = 1)

Specific Volume (ft^3/lb) : 1.2739

Gas Density (lb/ft^3) : 0.785

Relative density : 0.79

Section 9. Physical and chemical properties

Solubility : Not available.

Solubility in water : Not available.

Partition coefficient: nM octanolRwater : 0.05

AutoMgnition temperature : 456°C (852.8°F)

Decomposition temperature : Not available.

SADT : Not available.

Viscosity : Not available.

Section 10. Stability and reactivity

/ eactivity : No specific test data related to reactivity available for this product or its ingredients.

Chemical stability : The product is stable.

Possibility of hazardous reactions : Under normal conditions of storage and use, hazardous reactions will not occur.

Conditions to avoid : Avoid all possible sources of ignition (spark or flame). Do not pressurize, cut, weld, braze, solder, drill, grind or expose containers to heat or sources of ignition. Do not allow vapor to accumulate in low or confined areas.

Incompatibility with various substances : Highly reactive or incompatible with the following materials: acids and moisture.

Hazardous decomposition products : Under normal conditions of storage and use, hazardous decomposition products should not be produced.

Hazardous polymerization : Under normal conditions of storage and use, hazardous polymerization will not occur.

Section 11. Toxicological information

Information on toxicological effects

Acute toxicity

ProductRngredient name	/ esult	Species	Dose	Exposure
propan-2-ol	LC50 Inhalation Gas. LD50 Dermal LD50 Oral	Rat Rabbit Rat	45248 ppm 12800 mg/kg 5000 mg/kg	1 hours - -

IrritationRCorrosion

ProductRngredient name	/ esult	Species	Score	Exposure	Observation
propan-2-ol	Eyes - Moderate irritant Eyes - Moderate irritant Eyes - Severe irritant Skin - Mild irritant	Rabbit Rabbit Rabbit Rabbit	- - - -	24 hours 100 milligrams 10 milligrams 100 milligrams 500 milligrams	- - - -

Sensitization

Not available.

Section 11. Toxicological information

Mutagenicity

Not available.

Carcinogenicity

Not available.

Classification

Product/ingredient name	OSHA	IARC	NTP
propan-2-ol	-	3	-

Reproductive toxicity

Not available.

Teratogenicity

Not available.

Specific target organ toxicity (single exposure)

Name	Category	Route of exposure	Target organs
propan-2-ol	Category 3	Not applicable.	Narcotic effects

Specific target organ toxicity (repeated exposure)

Not available.

Aspiration hazard

Not available.

Information on the likely routes of exposure : Not available.

Potential acute health effects

Eye contact : Causes serious eye irritation.

Inhalation : Can cause central nervous system (CNS) depression. May cause drowsiness and dizziness.

Skin contact : No known significant effects or critical hazards.

Ingestion : Can cause central nervous system (CNS) depression. Irritating to mouth, throat and stomach.

Symptoms related to the physical, chemical and toxicological characteristics

Eye contact : Adverse symptoms may include the following:
pain or irritation
watering
redness

Inhalation : Adverse symptoms may include the following:
nausea or vomiting
headache
drowsiness/fatigue
dizziness/vertigo
unconsciousness

Skin contact : No specific data.

Ingestion : No specific data.

Delayed and immediate effects and also chronic effects from short and long term exposure

Section 11. Toxicological information

Short term exposure

Potential immediate effects : Not available.

Potential delayed effects : Not available.

Long term exposure

Potential immediate effects : Not available.

Potential delayed effects : Not available.

Potential chronic health effects

Not available.

General : No known significant effects or critical hazards.

Carcinogenicity : No known significant effects or critical hazards.

Nutagenicity : No known significant effects or critical hazards.

Teratogenicity : No known significant effects or critical hazards.

Developmental effects : No known significant effects or critical hazards.

Fertility effects : No known significant effects or critical hazards.

- umerical measures of toxicity

Acute toxicity estimates

Not available.

Section 12. Ecological information

Toxicity

Product/Ingredient name	/ esult	Species	Exposure
propan-2-ol	Acute LC50 1400000 to 1950000 µg/l Marine water Acute LC50 4200 mg/l Fresh water	Crustaceans - Crangon crangon Fish - Rasbora heteromorpha	48 hours 96 hours

Persistence and degradability

Not available.

Bioaccumulative potential

Product/Ingredient name	$LogP_{ow}$	BCF	Potential
propan-2-ol	0.05	-	low

Nobility in soil

Soil/water partition coefficient (K_{OC}) : Not available.

Other adverse effects : No known significant effects or critical hazards.

Section 13. Disposal considerations

Disposal methods : The generation of waste should be avoided or minimized wherever possible. Disposal of this product, solutions and any by-products should at all times comply with the requirements of environmental protection and waste disposal legislation and any regional local authority requirements. Dispose of surplus and non-recyclable products via a licensed waste disposal contractor. Waste should not be disposed of untreated to the sewer unless fully compliant with the requirements of all authorities with jurisdiction. Waste packaging should be recycled. Incineration or landfill should only be considered when recycling is not feasible. This material and its container must be disposed of in a safe way. Care should be taken when handling emptied containers that have not been cleaned or rinsed out. Empty containers or liners may retain some product residues. Vapor from product residues may create a highly flammable or explosive atmosphere inside the container. Do not cut, weld or grind used containers unless they have been cleaned thoroughly internally. Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers.

Section 14. Transport information

	DOT	TDG	Mexico	IMDG	IATA
U- number	UN1219	UN1219	UN1219	UN1219	UN1219
U- proper shipping name	ISOPROPANOL OR ISOPROPYL ALCOHOL	ISOPROPANOL; OR ISOPROPYL ALCOHOL	ISOPROPANOL OR ISOPROPYL ALCOHOL	ISOPROPANOL (ISOPROPYL ALCOHOL)	ISOPROPANOL
Transport hazard class(es)	3 	3 	3 	3 	3 
Packing group	II	II	II	II	II
Environment	No.	No.	No.	No.	No.
Additional information	**Limited quantity** Yes. **Packaging instruction** **Passenger aircraft** Quantity limitation: 5 L **Cargo aircraft** Quantity limitation: 60 L **Special provisions** IB2, T4, TP1	**Explosive Limit and Limited Quantity Index** 1 **Passenger Carrying / oad or / ail Index** 5	-	-	**Passenger and Cargo Aircraft**Quantity limitation: 5 L **Cargo Aircraft Only** Quantity limitation: 60 L **Limited Quantities M Passenger Aircraft** Quantity limitation: 1 L

"/ efer to CF/ 49 (or authority having jurisdiction) to determine the information required for shipment of the product."

Special precautions for user : **Transport within user's premises:** always transport in closed containers that are upright and secure. Ensure that persons transporting the product know what to do in the event of an accident or spillage.

Transport in bulk according to Annex II of MA/ POL 73R78 and the IBC Code : Not available.

Section 15. / egulatory information

U.S. Federal regulations : **TSCA 8(a) CD/ Exempt/Partial exemption**: Not determined
United States inventory (TSCA 8b): This material is listed or exempted.

Clean Air Act Section 112 (b) Hazardous Air Pollutants (HAPs) : Not listed

Clean Air Act Section 602 Class I Substances : Not listed

Clean Air Act Section 602 Class II Substances : Not listed

DEA List I Chemicals (Precursor Chemicals) : Not listed

DEA List II Chemicals (Essential Chemicals) : Not listed

SA/ A 302/304

Composition/information on ingredients

No products were found.

SA/ A 304 / Q : Not applicable.

SA/ A 311/312

Classification : Fire hazard
Immediate (acute) health hazard

Composition/information on ingredients

- ame	%	Fire hazard	Sudden release of pressure	/ eactive	Immediate (acute) health hazard	Delayed (chronic) health hazard
propan-2-ol	100	Yes.	No.	No.	Yes.	No.

SA/ A 313

	Product name	CAS number	%
Form / M/ eporting requirements	Isopropyl alcohol	67-63-0	100
Supplier notification	Isopropyl alcohol	67-63-0	100

SARA 313 notifications must not be detached from the SDS and any copying and redistribution of the SDS shall include copying and redistribution of the notice attached to copies of the SDS subsequently redistributed.

State regulations

Massachusetts : This material is listed.
- ew York : This material is not listed.
- ew Jersey : This material is listed.
Pennsylvania : This material is listed.

Canada inventory : This material is listed or exempted.

International regulations

Section 15. / egulatory information

International lists : **Australia inventory (AICS)**: This material is listed or exempted.
China inventory (IECSC): This material is listed or exempted.
Japan inventory: This material is listed or exempted.
Korea inventory: This material is listed or exempted.
N alaysia Inventory (EHS / egister): Not determined.
- ew Zealand Inventory of Chemicals (- ZIoC): This material is listed or exempted.
Philippines inventory (PICCS): This material is listed or exempted.
Taiwan inventory (CS- -): Not determined.

Chemical Weapons Convention List Schedule I Chemicals : Not listed

Chemical Weapons Convention List Schedule II Chemicals : Not listed

Chemical Weapons Convention List Schedule III Chemicals : Not listed

Canada

WHN IS (Canada) : Class B-2: Flammable liquid
Class D-2B: Material causing other toxic effects (Toxic).

CEPA Toxic substances: This material is not listed.
Canadian A/ ET: This material is not listed.
Canadian - P/ I: This material is listed.
Alberta Designated Substances: This material is not listed.
Ontario Designated Substances: This material is not listed.
Quebec Designated Substances: This material is not listed.

Section 16. Other information

Canada Label requirements : Class B-2: Flammable liquid
Class D-2B: Material causing other toxic effects (Toxic).

Hazardous N aterial Information System (U.S.A.)

Health	*	2
Flammability		3
Physical hazards		0

Caution: HN IS® ratings are based on a 0M4 rating scale, with 0 representing minimal hazards or risks, and 4 representing significant hazards or risks Although HN IS® ratings are not required on SDSs under 29 CF/ 1910. 1200, the preparer may choose to provide them. HN IS® ratings are to be used with a fully implemented HN IS® program. HN IS® is a registered mark of the - ational Paint & Coatings Association (- PCA). HN IS® materials may be purchased exclusively from J. J. Keller (800) 327M6868.

The customer is responsible for determining the PPE code for this material.

- ational Fire Protection Association (U.S.A.)

Section 16. Other information

/ eprinted with permission from - FPA 704M2001, Identification of the Hazards of N aterials for Emergency / esponse Copyright ©1997, - ational Fire Protection Association, Quincy, N A 02269. This reprinted material is not the complete and official position of the - ational Fire Protection Association, on the referenced subject which is represented only by the standard in its entirety.

Copyright ©2001, - ational Fire Protection Association, Quincy, N A 02269. This warning system is intended to be interpreted and applied only by properly trained individuals to identify fire, health and reactivity hazards of chemicals. The user is referred to certain limited number of chemicals with recommended classifications in - FPA 49 and - FPA 325, which would be used as a guideline only. Whether the chemicals are classified by - FPA or not, anyone using the 704 systems to classify chemicals does so at their own risk.

History

Date of printing : 5/20/2015.

Date of issue/Date of revision : 5/20/2015.

Date of previous issue : 10/28/2014.

Version : 0.02

Key to abbreviations :
ATE = Acute Toxicity Estimate
BCF = Bioconcentration Factor
GHS = Globally Harmonized System of Classification and Labelling of Chemicals
IATA = International Air Transport Association
IBC = Intermediate Bulk Container
IMDG = International Maritime Dangerous Goods
LogPow = logarithm of the octanol/water partition coefficient
MARPOL 73/78 = International Convention for the Prevention of Pollution From Ships, 1973 as modified by the Protocol of 1978. ("Marpol" = marine pollution)
UN = United NationsACGIH – American Conference of Governmental Industrial Hygienists
AIHA – American Industrial Hygiene Association
CAS – Chemical Abstract Services
CEPA – Canadian Environmental Protection Act
CERCLA – Comprehensive Environmental Response, Compensation, and Liability Act (EPA)
CFR – United States Code of Federal Regulations
CPR – Controlled Products Regulations
DSL – Domestic Substances List
GWP – Global Warming Potential
IARC – International Agency for Research on Cancer
ICAO – International Civil Aviation Organisation
Inh – Inhalation
LC – Lethal concentration
LD – Lethal dosage
NDSL – Non-Domestic Substances List
NIOSH – National Institute for Occupational Safety and Health
TDG – Canadian Transportation of Dangerous Goods Act and Regulations
TLV – Threshold Limit Value
TSCA – Toxic Substances Control Act
WEEL – Workplace Environmental Exposure Level
WHMIS – Canadian Workplace Hazardous Material Information System

/ eferences : Not available.

Indicates information that has changed from previously issued version.

- otice to reader

Section 16. Other information

To the best of our knowledge, the information contained herein is accurate. However, neither the above-named supplier, nor any of its subsidiaries, assumes any liability whatsoever for the accuracy or completeness of the information contained herein.
Final determination of suitability of any material is the sole responsibility of the user. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that exist.

Appendix C

Health and Safety Plan Acceptance and Training Acknowledgement

Instructions: This form is to be completed by each person that works on this project at the Subject Property and returned to the Site Safety and Health Officer.

I have read and agree to abide by the contents of the SITE-SPECIFIC HEALTH AND SAFETY PLAN for work activities at the site. I have completed the training requirements specified in the plan. I am currently participating in a medical surveillance program that satisfies the requirements of CFR 1910.120.

Signature:	Date:
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

Return to:

Site Safety and Health Officer at
Preferred Environmental Services
323 Merrick Avenue
North Merrick, New York 11566

Appendix D

Report of Accident/Injury Form

PREFERRED ENVIRONMENTAL SERVICES

323 Merrick Avenue, North Merrick, New York 11566

Accident / Injury Report Form

Name: _____ Sex: ___Male ___ Female

Address: _____
Street City State Zip Code

Telephone: _____ E-Mail: _____ Social Security Number: _____

Date of This Report: _____ Date of Accident: _____

Time of Accident: _____ a.m. ./ p.m. Place of Accident: _____

NATURE OF INJURY

Abrasion	_____	Fracture	_____
Aspxiation	_____	Laceration	_____
Bite	_____	Poisoning	_____
Bruise	_____	Puncture	_____
Burn	_____	Scalds	_____
Concussion	_____	Scratches	_____
Cut	_____	Shock (el.)	_____
Dislocation	_____	Sprain	_____

Other (specify) _____

PART OF BODY INJURIED

Abdoman	_____	Ankle	(____R / ____L)
Back	_____	Arm	(____R / ____L)
Chest	_____	Ear	(____R / ____L)
Face	_____	Elbow	(____R / ____L)
Finger	_____	Eye	(____R / ____L)
Head	_____	Foot	(____R / ____L)
Mouth	_____	Hand	(____R / ____L)
Nose	_____	Knee	(____R / ____L)
Scalp	_____	Leg	(____R / ____L)
Tooth	_____	Wrist	(____R / ____L)

Other (specify) _____

DESCRIPTION OF ACCIDENT

How did accident happen? What was the person doing? Where was the person? List any specifically unsafe acts and unsafe conditions existing? Specify any tool, machine or equipment involved? Additional space available on back

_____

_____

_____

IMMEDIATE ACTION TAKEN

First Aid Treatment Given: __ YES __ NO By Name: _____ Phone #: _____Email: _____

First Aid Rendered: _____

Contact 911 __YES __ NO By Name: _____ Phone #:_____ Email: ___

Referred to Health Services? ___YES ___NO Sent to Hospital? ___YES ___ NO

Transported to health care facility for further examination/treatment ? ___YES ___ NO

____Ambulance _____ Personal Vehicle _____ Friends Vehicle (name) _____

1. Witness: _____
   Address: _____
   Phone #: _____
   E-Mail: _____

2. Witness: _____
   Address: _____
   Phone #: _____
   E-Mail: _____

Date: _____ Acknowledgement of Injuried Party: _____

Form Submitted by: _____ Signature & Date: _____

Please attach additional comments / information on back of sheet

Appendix C

Community Air Monitoring Plan

New York State Department of Health Generic Community Air Monitoring Plan

A Community Air Monitoring Plan (CAMP) requires real-time monitoring for volatile organic compounds (VOCs) and particulates (i.e., dust) at the downwind perimeter of each designated work area and when certain activities are in progress at contaminated sites. The CAMP is not intended for use in establishing action levels for worker respiratory protection. Rather, its intent is to provide a measure of protection for the downwind community (i.e., off-site receptors including residences and businesses and on-site workers not directly involved with the subject work activities) from potential airborne contaminant releases as a direct result of investigative and remedial work activities. The action levels specified herein require increased monitoring, corrective actions to abate emissions, and/or work shutdown. Additionally, the CAMP helps to confirm that work activities did not spread contamination off-site through the air.

The generic CAMP presented below will be sufficient to cover many, if not most, sites. Specific requirements should be reviewed for each situation in consultation with NYSDOH to ensure proper applicability. In some cases, a separate site-specific CAMP or supplement may be required. Depending upon the nature of contamination, chemical specific monitoring with appropriately-sensitive methods may be required. Depending upon the proximity of potentially exposed individuals, more stringent monitoring or response levels than those presented below may be required. Special requirements will be necessary for work within 20 feet of potentially exposed individuals or structures and for indoor work with co-located residences or facilities. These requirements should be determined in consultation with NYSDOH.
Reliance on the CAMP should not preclude simple, common-sense measures to keep VOCs, dust, and odors at a minimum around the work areas.

Community Air Monitoring Plan

Depending upon the nature of known or potential contaminants at each site, real-time air monitoring for volatile organic compounds (VOCs) and/or particulate levels at the perimeter of the exclusion zone or work area will be necessary. Most sites will involve VOC and particulate monitoring; sites known to be contaminated with heavy metals alone may only require particulate monitoring. If radiological contamination is a concern, additional monitoring requirements may be necessary per consultation with appropriate NYSDEC/NYSDOH staff.

Continuous monitoring will be required at one upwind and two downwind stations for all ground intrusive activities and during the demolition of contaminated or potentially contaminated structures. Ground intrusive activities include, but are not limited to, soil/waste excavation and handling, test pitting or trenching, and the installation of soil borings or monitoring wells.

Periodic monitoring for VOCs will be required during non-intrusive activities such as the collection of soil and sediment samples or the collection of groundwater samples from existing monitoring wells. "Periodic" monitoring during sample collection might reasonably consist of taking a reading upon arrival at a sample location, monitoring while opening a well cap or overturning soil, monitoring during well baling/purging, and taking a reading prior to leaving a sample location. In some instances, depending upon the proximity of potentially exposed individuals, continuous monitoring may be required during sampling activities. Examples of such situations include groundwater sampling at wells on the curb of a busy urban street, in the midst of a public park, or adjacent to a school or residence.

VOC Monitoring, Response Levels, and Actions

Volatile organic compounds (VOCs) must be monitored at the downwind perimeter of the immediate work area (i.e., the exclusion zone) on a **continuous** bases or as otherwise specified. Upwind concentrations should be measured at the start of each workday and periodically thereafter to establish background

conditions. The monitoring work should be performed using equipment appropriate to measure the types of contaminants known or suspected to be present. The equipment should be calibrated at least daily for the contaminant(s) of concern or for an appropriate surrogate. The equipment should 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 must be temporarily halted and monitoring continued. If the total organic vapor level readily decreases (per instantaneous readings) below 5 ppm over background, work activities can 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 must be halted, the source of vapors identified, corrective actions taken to abate emissions, and monitoring continued. After these steps, work activities can resume provided that the total organic vapor level 200 feet 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 feet, 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 must be shutdown.

All 15-minute readings must be recorded and available for State (DEC and DOH) personnel to review. Instantaneous readings, if any, used for decision purposes should also be recorded.

Particulate Monitoring, Response Levels, and Actions

Particulate concentrations should be monitored **continuously** at the upwind and downwind perimeters of the exclusion zone at temporary particulate monitoring stations. The particulate monitoring should be performed using real-time monitoring equipment capable of measuring particulate matter less than 10 micrometers in size (PM-10) and capable of integrating over a period of 15 minutes (or less) for comparison to the airborne particulate action level. The equipment must be equipped with an audible alarm to indicate exceedance of the action level. In addition, fugitive dust migration should be visually assessed during all work activities.

- If the downwind PM-10 particulate level is 100 micrograms per cubic meter (mcg/m3) greater than background (upwind perimeter) for the 15-minute period or if airborne dust is observed leaving the work area, then dust suppression techniques must be employed. Work may continue with dust suppression techniques provided that downwind PM-10 particulate levels do not exceed 150 mcg/m3 above 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 mcg/m3 above the upwind level, work must be stopped and a re-evaluation of activities initiated. Work can resume provided that dust suppression measures and other controls are successful in reducing the downwind PM-10 particulate concentration to within 150 mcg/m3 of the upwind level and in preventing visible dust migration.

All readings must be recorded and be available for State (DEC and DOH) personnel to review.

Special Requirements for Work Within 20 Feet of Potentially Exposed Individuals or Structures

When work areas are within 20 feet of potentially exposed populations or occupied structures, the continuous monitoring locations for VOCs and particulates must reflect the nearest potentially exposed individuals and the location of ventilation system intakes for nearby structures. The use of engineering controls such as vapor/dust barriers, temporary negative-pressure enclosures, or special ventilation devices should be considered to prevent exposures related to the work activities and to control dust and odors. Consideration should be given to implementing the planned activities when potentially exposed populations are at a minimum, such as during weekends or evening hours in non-residential settings.

- If total VOC concentrations opposite the walls of occupied structures or next to intake vents exceed 1 ppm, monitoring should occur within the occupied structure(s). Background readings in the occupied spaces must be taken prior to commencement of the planned work. Any unusual background readings should be discussed with NYSDOH prior to commencement of the work.

- If total particulate concentrations opposite the walls of occupied structures or next to intake vents exceed 150 mcg/m3, work activities should be suspended until controls are implemented and are successful in reducing the total particulate concentration to 150 mcg/m3 or less at the monitoring point.

- Depending upon the nature of contamination and remedial activities, other parameters (e.g., explosivity, oxygen, hydrogen sulfide, carbon monoxide) may also need to be monitored. Response levels and actions should be pre-determined, as necessary, for each site.

Special Requirements for Indoor Work with Co-Located Residences or Facilities

Unless a self-contained, negative-pressure enclosure with proper emission controls will encompass the work area, all individuals not directly involved with the planned work must be absent from the room in which the work will occur. Monitoring requirements shall be as stated above under “Special Requirements for Work Within 20 Feet of Potentially Exposed Individuals or Structures” except that in this instance “nearby/occupied structures” would be adjacent occupied rooms. Additionally, the location of all exhaust vents in the room and their discharge points, as well as potential vapor pathways (openings conduits, etc.) relative to adjoining rooms, should be understood and the monitoring locations established accordingly. In these situations, it is strongly recommended that exhaust fans or other engineering controls be used to create negative air pressure within the work area during remedial activities. Additionally, it is strongly recommended that the planned work be implemented during hours (e.g. weekends or evenings) when building occupancy is at a minimum.