QUALITY ASSURANCE PROJECT PLAN

125 3RD STREET
Brooklyn, New York

Prepared For:

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LANGAN

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1.0 PROJECT DESCRIPTION

1.1 INTRODUCTION

This Quality Assurance Project Plan (QAPP) is for the about 20,300-square-foot (0.47-acre) property located at 125 3rd Street in the Gowanus neighborhood of Brooklyn, New York (the site), and is identified as Block 462, Lot 6 (former lots 6, 8, 42, 44, and part of [p/o] 9) on the Kings County Tax Map. The site is currently undergoing a lot merger. The site is bound by 2nd Street followed by a 12-story residential building to the north, a one-story commercial building and parking lot followed by the Gowanus Canal to the east, 3rd Street followed by a vacant three-story building to the south, and several multi-story mixed-use buildings followed by Bond Street to the west. The site is improved with the structures and uses described below:

- One-story warehouse with open air parking to the north and south (former Lot 6)
- Vacant one-story warehouse (former Lot 8)
- Two-story warehouse occupied by a moving company (former Lot 44)
- One-story building occupied by a van rental company (former Lot 42 and p/o Lot 9).

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

1.2 PROJECT OBJECTIVES

The objective of the proposed sampling is to investigate and characterize the nature and extent of the contamination at and emanating from the site, per Environmental Conservation Law Article 27, Title 14 (Brownfield Cleanup Program). The sampling plan was developed in accordance with the process and requirements identified in the NYSDEC Division of Environmental Remediation (DER)-10 *Technical Guidance for Site Investigation and Remediation* (May 2010) and the New York State Department of Health (NYSDOH) "Guidance for Evaluating Soil Vapor Intrusion in the State of New York, with updates" (October 2006, last updated May 2017).

1.3 SCOPE OF WORK

The scope of work covered in this QAPP is detailed in the SRDIWP. In general, the SRDIWP proposes soil boring installation and sampling, groundwater monitoring well installation and sampling, and soil vapor sampling. A dust, odor, and organic vapor control and monitoring plan will be implemented during ground intrusive activities. The following investigation activities will be performed as part of the RIWP:

- Completion of a geophysical survey to clear sample locations and identify potential subsurface utilities and structures, including USTs - sampling locations may be relocated as necessary based on the findings of the geophysical survey

- Advancement of 14 soil borings to about 20 feet below grade surface (bgs) or until a confining (clay) layer is encountered, whichever is shallower. Collection of up to three soil samples from each soil boring, for a total of up to 42 soil samples (plus quality assurance/quality control [QA/QC] samples) for laboratory analysis

- Advancement of four petroleum delineation borings to about 8 feet bgs. Collection of up to two soil samples from each delineation boring, for a total of up to 8 soil samples (plus quality assurance/quality control [QA/QC] samples) for laboratory analysis

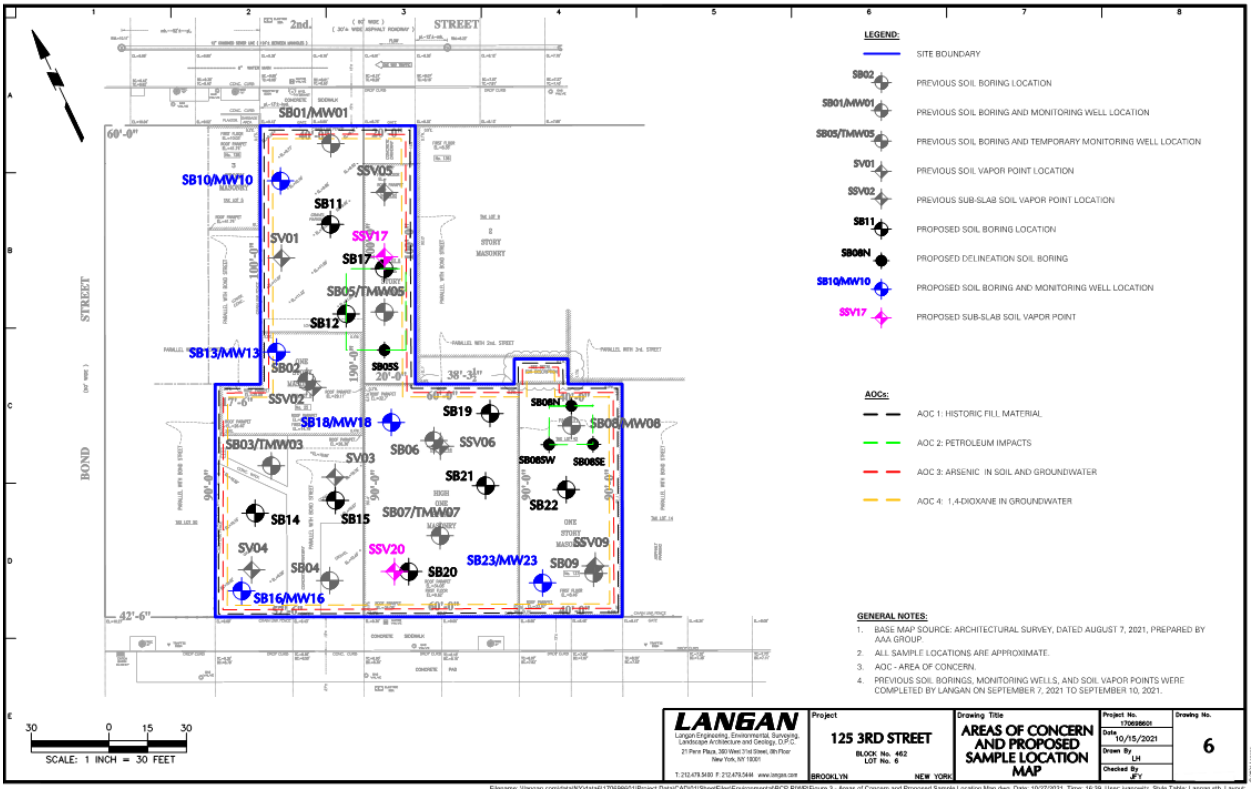
- Installation and development of five monitoring wells and collection of one groundwater sample from each newly installed monitoring well and two previously installed monitoring wells (plus QA/QC samples) for laboratory analysis

- Installation of two sub-slab vapor points immediately below the existing concrete slab and collection of two sub-slab vapor samples and one ambient air sample for laboratory analysis

- Implementation of a community air monitoring plan (CAMP)

A plan showing the proposed sample locations is included as Figure 1.1

Figure 1.1 Areas of Concern and Proposed Sample Location Map



2.0 DATA QUALITY OBJECTIVES AND PROCESS

Data Quality Objectives (DQOs) are qualitative and quantitative statements to help ensure that data of known and appropriate quality are obtained during the project. The quality of the data must be sufficient to fulfill the overall objective of the RI. The overall objective is to investigate and characterize the nature and extent of environmental impacts at and emanating from the site and to provide sufficient information to evaluate remedial alternatives, as required. The Remedial Investigation Work Plan (RIWP) specifies the intended use of the data, the required constituents of interest, limits of detection, level of data assessment, and data deliverables. All data shall be defined as definitive data.

The DQO process is an iterative process where various options for implementing a project are explored, dissected, and recombined. The feasibility and costs of various options are estimated, and then the most advantageous option is selected and developed into project work plans that will be implemented.

DQOs for sampling activities are determined by evaluating five factors:

- Data needs and uses: The types of data required and how the data will be used after it is obtained.
- Parameters of Interest: The types of chemical or physical parameters required for the intended use.
- Level of Concern: Levels of constituents, which may require remedial actions or further investigations, based on comparison to Title 6 of the Official Compilation of New York Codes, Rules and Regulations Part 375 NYSDEC Unrestricted Use Soil Cleanup Objectives for soil samples and to the October 2006 (updated in May 2017) New York State Department of Health (NYSDOH) Guidance for Evaluating Soil Vapor Intrusion in the State of New York Air Guideline Values and Decision Matrices for soil vapor samples.
- Required Analytical Level: The level of data quality, data precision, and QA/QC documentation required for chemical analysis.
- Required Detection Limits: The detection limits necessary based on the above information.

The investigation will be evaluated using the DQO process on an individual, task-specific basis. DQOs and the required level of review will be determined during this process.

3.0 PROJECT ORGANIZATION

Lagan will arrange data analysis and reporting tasks related to the site sampling. The analytical services will be performed by an Environmental Laboratory Approval Program (ELAP)-certified laboratory. Data validation services will be performed by approved data validation contractor(s).

The required sampling will be conducted by Langan; the analytical services will be performed by Alpha Analytical, Inc. of Westborough, Massachusetts (NYSDOH ELAP certification number 11148). Data validation services will be performed by Marla Miller of Langan.

Resumes for Langan personnel can be found in Attachment B; key contacts for this project are as follows:

Street Gowanus Owner LLC:	Andrew Bradfield Telephone: (212) 431-5900
Langan Project Manager:	Joseph Yanowitz Telephone: (212) 479-5496
Langan Field Team Leader:	Lexi Haley Telephone: (212) 479-5656
Langan Health & Safety Officer:	Tony Moffa, CHMM Telephone: (215) 491-6500
Langan Quality Assurance Manager:	Ryan Manderbach, CHMM Telephone: (212) 479-5582
Langan Data Validator:	Marla Miller, P.E., BCEE Telephone: (480) 383-2221
Laboratory Representative:	Alpha Analytical, Inc. Ben Rao Telephone: (201) 812-2633

4.0 QUALITY ASSURANCE OBJECTIVES FOR COLLECTION OF DATA

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

4.1 PRECISION

Precision is a measure of the degree to which two or more measurements are in agreement. Field precision is assessed through the collection and measurement of field duplicates. Laboratory precision and sample heterogeneity also contribute to the uncertainty of field duplicate measurements. This uncertainty is taken into account during the data assessment process. The following field duplicate precision criteria will be applied:

Aqueous and Canister Air Samples

- Results greater than 5 times the laboratory reporting limit (RL) must have a relative percent difference (RPD) $\leq 30\%$.
- Results less than 5 times the RL must have an absolute difference $\leq \pm$RL.

Soil Samples

- Results greater than 5 times the laboratory RL must have a RPD $\leq 50\%$.
- Results less than 5 times the RL must have an absolute difference $\leq 2\times \pm$RL.

Soil Vapor Samples

- Results greater than 5 times the laboratory RL must have a RPD $\leq 50\%$.
- Results less than 5 times the RL must have an absolute difference $\leq 2\times \pm$RL.

RLs and method detection limits (MDL) are provided in Attachment A.

Laboratory precision is assessed through the analysis of matrix spike/matrix spike duplicates (MS/MSD), laboratory control sample/laboratory control sample duplicates (LCS/LCSD) and subsequent calculation of RPD. For outliers, if additional sample volume is present, the MS/MSD

should be reanalyzed and the RPD recomputed. If additional volume is not present, an evaluation will be performed to determine the extent of potential matrix interference.

4.2 ACCURACY

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

Accuracy in the field is assessed through the use of field and trip blanks and through compliance to all sample handling, preservation, and holding time requirements. All field and trip blanks should be non-detect when analyzed by the laboratory. Any contaminant detected in an associated field blank will be evaluated against laboratory blanks (preparation or method) and evaluated against field samples collected on the same day to determine potential for bias.

Laboratory accuracy is assessed by evaluating the percent recoveries of MS/MSD samples, LCS/LCSD, surrogate compound recoveries, internal standard area counts, initial and continuing calibrations, and the results of method, initial and continuing calibration blanks. MS/MSD, LCS/LCSD, and surrogate percent recoveries will be compared to either method-specific control limits or laboratory-derived control limits. Sample volume permitting, samples displaying outliers should be reanalyzed. All associated method blanks should be non-detect when analyzed by the laboratory.

4.3 REPRESENTATIVENESS

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

Representativeness in the laboratory is ensured by compliance with nationally-recognized analytical methods, meeting sample holding times, and maintaining sample integrity while the samples are in the laboratory's possession. This is performed by following all applicable analytical

methods, laboratory-issued SOPs, the laboratory's Quality Assurance Manual, and this QAPP. The laboratory is required to be properly certified and accredited.

4.4 COMPLETENESS

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

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

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

4.5 COMPARABILITY

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

4.6 SENSITIVITY

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

Field equipment will be used that can achieve the required levels of detection for analytical measurements in the field. In addition, the field sampling staff will collect and submit full volumes of samples as required by the laboratory for analysis, whenever possible. Full volume aliquots will help ensure achievement of the required limits of detection and allow for reanalysis if necessary.

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

Site-specific MS and MSD samples will be prepared and analyzed by the analytical laboratory by spiking an aliquot of submitted sample volume with analytes of interest. A MS/MSD analysis will be analyzed at a rate of 1 out of every 20 samples, or one per analytical batch. MS/MSD samples are only required for soil and groundwater samples.

5.0 SAMPLE COLLECTION AND FIELD DATA ACQUISITION PROCEDURES

Soil and groundwater sampling will be conducted in accordance with the established NYSDEC protocols contained in DER-10/Technical Guidance for Site Investigation and Remediation (May 2010). Sub-slab and soil vapor sampling will be conducted in accordance with NYSDOH Guidance for Evaluating Soil Vapor Intrusion in the State of New York (October 2006). The following sections describe procedures to be followed for specific tasks.

5.1 FIELD DOCUMENTATION PROCEDURES

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

5.1.1 Field Data and Notes

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

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

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

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

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

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

5.1.2 Sample Labeling

Each sample collected will be assigned a unique identification number and abbreviation in accordance with the sample nomenclature guidance provided in the following table and the Standard Operating Procedure provided in Attachment D.

Sample Nomenclature Summary	
AA	Ambient Air
IA	Indoor Air
DUP	Field Duplicate
EB	Environmental Boring
LB	Langan Boring
SB	Soil Boring
FB	Field Blank
MW	Monitoring Well
SV	Soil Vapor
SSV	Sub-Slab Soil Vapor
TB	Trip Blank
(#-#)	Depth Interval
MMDDYY	Date of Sampling

Each sample container will have a sample label affixed to the outside with the date and time of sample collection and project name. In addition, the label will contain the sample identification number, analysis required and chemical preservatives added, if any. All documentation will be completed in waterproof ink.

5.2 EQUIPMENT CALIBRATION AND PREVENTATIVE MAINTENANCE

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

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

A water quality meter (Horiba U-52 or similar) will be used during purging of groundwater to measure pH, specific conductance, temperature, dissolved oxygen, turbidity and oxidation-reduction-potential (ORP), every five minutes, or, depending on pump flow rate, after at least one full volume of the water quality meter flow through cell has passed through. A portable turbidity meter (LaMotte or similar) may also be used to measure turbidity. Water-quality meters should be calibrated and the results documented before use each day using standardized field calibration procedures and calibration checks.

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

Off-site calibration and maintenance of field instruments will be conducted as appropriate throughout the duration of project activities. All field instrumentation, sampling equipment and accessories will be maintained in accordance with the manufacturer's recommendations and

specifications and established field equipment practice. Off-site calibration and maintenance will be performed by qualified personnel. A logbook will be kept to document that established calibration and maintenance procedures have been followed. Documentation will include both scheduled and unscheduled maintenance.

5.3 SAMPLE COLLECTION

Soil Samples

Soil samples will be visually classified and field screened using a PID to assess potential impacts from VOCs and for health and safety monitoring. Soil samples collected for analysis of VOCs will be collected using either En Core® or Terra Core® sampling equipment. For analysis of non-volatile parameters, samples will be homogenized and placed into glass jars. Samples will be collected with unused sterile sampling scoops or spoons and homogenized in unused sterile polyethylene zipper bags. After collection, all sample jars will be capped and securely tightened, and placed in iced coolers and maintained at 4°C ±2°C until they are transferred to the laboratory for analysis, in accordance with the procedures outlined in Sections 5.4 and 5.6. Analysis and/or extraction and digestion of collected soil samples will meet the holding times required for each analyte as specified in Attachment C. In addition, analysis of collected soil samples will meet all quality assurance criteria set forth by this QAPP and DER-10.

Groundwater Samples

Groundwater sampling will be conducted using low-flow sampling procedures following USEPA guidance ("Low Stress [low flow] Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells", EQASOP-GW4, dated September 19, 2017).

During purging, field parameters should be measured, including: water level drawdown, purge rate, pH, specific conductance, temperature, dissolved oxygen, turbidity and oxidation-reduction-potential (ORP), every five minutes using a water quality meter (YSI 6820 or similar) and a depth-to-water interface probe that should be decontaminated between wells. Samples should generally not be collected until the field parameters have stabilized. Field parameters will be considered stable once three sets of measurements are within ±0.1 standard units for pH, ±3% for conductivity and temperature, ±10 millivolts for ORP, and ±10% for turbidity and dissolved oxygen. Purge rates should be adjusted to keep the drawdown in the well to less than 0.3 feet, as practical. Additionally, an attempt should be made to achieve a stable turbidity reading of less than 10 Nephelometric Turbidity Units (NTU) prior to sampling. If the turbidity reading does not stabilize at reading of less than 10 NTU for a given well, then both filtered and unfiltered samples should be collected from that well. If necessary, field filtration should be performed using a 0.45 micron disposable in-line filter. Groundwater samples should be collected after parameters have

stabilized as noted above or the readings are within the precision of the meter. Deviations from the stabilization and drawdown criteria, if any, should be noted on the sampling logs.

Samples should be collected directly into laboratory-supplied jars. After collection, all sample jars will be capped and securely tightened, and placed in iced coolers and maintained at 4°C ±2°C until they are transferred to the laboratory for analysis, in accordance with the procedures outlined in Sections 5.4 and 5.6. Analysis and/or extraction and digestion of collected groundwater samples will meet the holding times required for each analyte as specified in Attachment C. In addition, analysis of collected groundwater samples will meet all quality assurance criteria set forth by this QAPP and DER-10.

Soil Vapor, Ambient Air, Sub-Slab Soil Vapor, and Indoor Air Samples

Prior to soil vapor and ambient air sample collection, a pre-sampling inspection will be conducted to document chemicals and potential subsurface pathways at the site. The pre-sampling inspection will assess the potential for impacts from any chemical or petroleum storage within the on-site buildings. Soil vapor and ambient air samples will be collected into laboratory-supplied, batch certified-clean Summa® canisters calibrated for a sampling rate of eight hours. Sub-slab soil vapor and indoor air samples will be collected into laboratory-supplied, individual certified-clean Summa® canisters calibrated for a sampling rate of eight hours. The pressure gauges on each calibrated flow controller should be monitored throughout sample collection. Sample collection should be stopped when the pressure reading reaches -4 mmHg.

Emerging Contaminant Samples

Soil and groundwater samples collected for analysis of per- and polyfluoroalkyl substances (PFAS) and 1,4-dioxane will be collected in accordance with the specialized protocol outlined in this section and the *Guidelines for Sampling and Analysis of PFAS under Part 375 Remedial Programs*, issued by the NYSDEC in January 2021. Soil and groundwater samples collected from select sample locations will be analyzed for 1,4-dioxane by EPA Method 8270 SIM and for PFAS by EPA Method 573 Modified in accordance with the procedure outlined in Attachment E.

Soil samples will be homogenized and placed into glass jars. Samples will be collected with unused sterile sampling scoops or spoons. After collection, all sample jars will be capped and securely tightened, and placed in iced coolers and maintained at 4°C ±2°C until they are transferred to the laboratory for analysis.

Groundwater sampling will be performed using low-flow sampling procedures following USEPA guidance ("Low Stress [low flow] Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells", January 19, 2017). Groundwater samples will be collected using a peristaltic pump fitted with dedicated, non-Teflon high-density polyethylene

(HDPE) tubing and using low-flow purging techniques to minimize drawdown. A Horiba U-52 (or similar) will be used to monitor water quality parameters (pH, conductivity, temperature, dissolved oxygen, oxidation-reduction-potential (ORP), and turbidity. Groundwater samples will be collected after the parameters stabilized within about 10 percent of consecutive values, to the extent practical, and turbidity is below 10 nephelometric turbidity units (NTU).

Food and beverages will be prohibited near the sampling equipment. Additionally, no cosmetics, moisturizers, hand cream, sun screen or clothing materials containing Gore-Tex or Tyvek will be worn during sampling. Non-disposable components of the pump will be decontaminated with Alconox and water. Field personnel will wear nitrile gloves while collecting and handing soil and groundwater samples.

Sample Field Blanks, Equipment Blanks, Trip Blanks and Duplicates

Field blanks will be collected for quality assurance purposes at a rate of one per 20 investigative samples per matrix (soil and groundwater only). Field blanks will be obtained by pouring laboratory-demonstrated analyte-free water on or through a decontaminated sampling device following use and implementation of decontamination protocols. The water will be collected off of the sampling device into a laboratory-provided sample container for analysis. Field blank samples will be analyzed for the complete list of analytes on the day of sampling. To assess contamination resulting from sample transport, trip blanks will be collected at a rate of one per day if soil or groundwater samples are analyzed for VOCs during that day. Field blanks and equipment blanks collected for PFAS will be collected at a minimum of one per day or one per 20 investigative samples per matrix; whichever frequency is higher.

Equipment blanks will be collected for quality assurance purposes at a rate of one per day per matrix for soil and groundwater PFAS samples. Field blanks will be obtained by pouring laboratory-demonstrated PFAS-free water on or through a decontaminated sampling device following use and implementation of decontamination protocols. The water will be collected off of the sampling device into a laboratory-provided sample container for analysis.

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

5.4 SAMPLE CONTAINERS AND HANDLING

Certified, commercially clean sample containers will be obtained from the analytical laboratory. If soil samples or groundwater are being collected, the laboratory will also prepare and supply the required trip blanks and field blank sample containers and reagent preservatives. Sample bottle

containers, including the field blank containers, will be placed into plastic coolers by the laboratory. These coolers will be received by the field sampling team within 24 hours of their preparation in the laboratory. Prior to the commencement of field work, Langan field personnel will fill the plastic coolers with ice in Ziploc® bags (or equivalent) to maintain a temperature of 4° ±2° C.

Soil and/or groundwater samples collected in the field for laboratory analysis will be placed directly into the laboratory-supplied sample containers. Samples will then be placed and stored on-ice in laboratory provided coolers until shipment to the laboratory. The temperature in the coolers containing samples and associated field blanks will be maintained at a temperature of 4°±2°C while on-site and during sample shipment to the analytical laboratory.

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

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

5.5 SAMPLE PRESERVATION

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

5.6 SAMPLE SHIPMENT

5.6.1 Packaging

Soil and groundwater sample containers will be placed in plastic coolers. Ice in Ziploc® bags (or equivalent) will be placed around sample containers. Cushioning material will be added around the sample containers if necessary. Chains-of-custody and other paperwork will be placed in a Ziploc® bag (or equivalent) and placed inside the cooler. The cooler will be taped closed and

custody seals will be affixed to one side of the cooler at a minimum. If the samples are being shipped by an express delivery company (e.g. FedEx) then laboratory address labels will be placed on top of the cooler.

5.6.2 Shipping

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

- All environmental samples will be transported to the laboratory by a laboratory-provided courier under the chain-of-custody protocols described in Section 5.9.
- Prior notice will be provided to the laboratory regarding when to expect shipped samples. If the number, type or date of shipment changes due to site constraints or program changes, the laboratory will be informed.

5.7 DECONTAMINATION PROCEDURES

5.7.1 Decontamination General Sample Collection

Decontamination procedures will be used for non-dedicated sampling equipment. Decontamination of field personnel is discussed in the site-specific sample Health and Safety Plan (HASP) included in Appendix A of the RIWP. Field sampling equipment that is to be reused will be decontaminated in the field in accordance with the following procedures:

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

5.7.2 Decontamination for PFAS Sample Collection

In addition to general decontamination procedures are outlined in Section 5.7.1, sampling equipment will be thoroughly decontaminated before mobilization and between sample locations. Field sampling equipment, including water level indicators and other non-dedicated equipment, requires cleaning between uses. Non-dedicated equipment used for PFAS sampling will be rinsed using a three bucket rinse procedure. An about 3-gallon solution of decontamination fluid consisting of Alconox or Citranox and deionized (DI) water will be prepared in a 5-gallon bucket for the first equipment rinse. A second 5-gallon bucket will be filled with about 3 gallons of DI water for the second rinse. A third 5-gallon bucket will be filled with about 3 gallons of DI water for the final rinse. Powderless nitrile (non-latex) gloves will be donned during the handling of

sampling equipment and sample containers. The Safety Data Sheets of detergents used in decontamination procedures will be reviewed to ensure fluoro-surfactants and 1,4-dioxane are not listed as ingredients. Laboratory-verified PFAS-free water will be used as the final rinse during decontamination of sampling equipment

5.8 RESIDUALS MANAGEMENT

Debris (e.g., paper, plastic and disposable personal protective equipment) will be collected in plastic garbage bags and disposed of as non-hazardous industrial waste. Soil cuttings with no apparent staining, odors, or elevated PID readings will be used to backfill boring holes. Soil to be disposed off-site will be placed in 55-gallon, UN/Department of Transportation (DOT) approved drums. Decontamination and well development/purging fluids will be placed in DOT-approved fluid drums with closed tops. All drums will be properly labeled, sealed, and characterized as necessary.

If initial analytical data is insufficient to gain disposal facility acceptance, waste characterization samples will be analyzed for parameters that are typically required by disposal facilities, such as target compounds list (TCL) VOCs, semivolatile organic compounds (SVOCs), Resource Conservation and Recovery Act (RCRA) metals, polychlorinated biphenyls (PCBs), pesticides, herbicides, Toxicity Characteristic Leaching Procedure (TCLP) VOCs, TCLP SVOCs, TCLP metals, ignitability, corrosivity, reactivity, and paint filter. Additional sampling and analyses may be required based on the selected disposal facility.

Samples will be collected in accordance with the selected disposal facility's requirements and will be collected to be representative of the material requiring disposal at a frequency consistent with disposal facility requirements. It is anticipated that all drummed material will be transported off-site and disposed of at a permitted facility.

5.9 CHAIN OF CUSTODY PROCEDURES

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

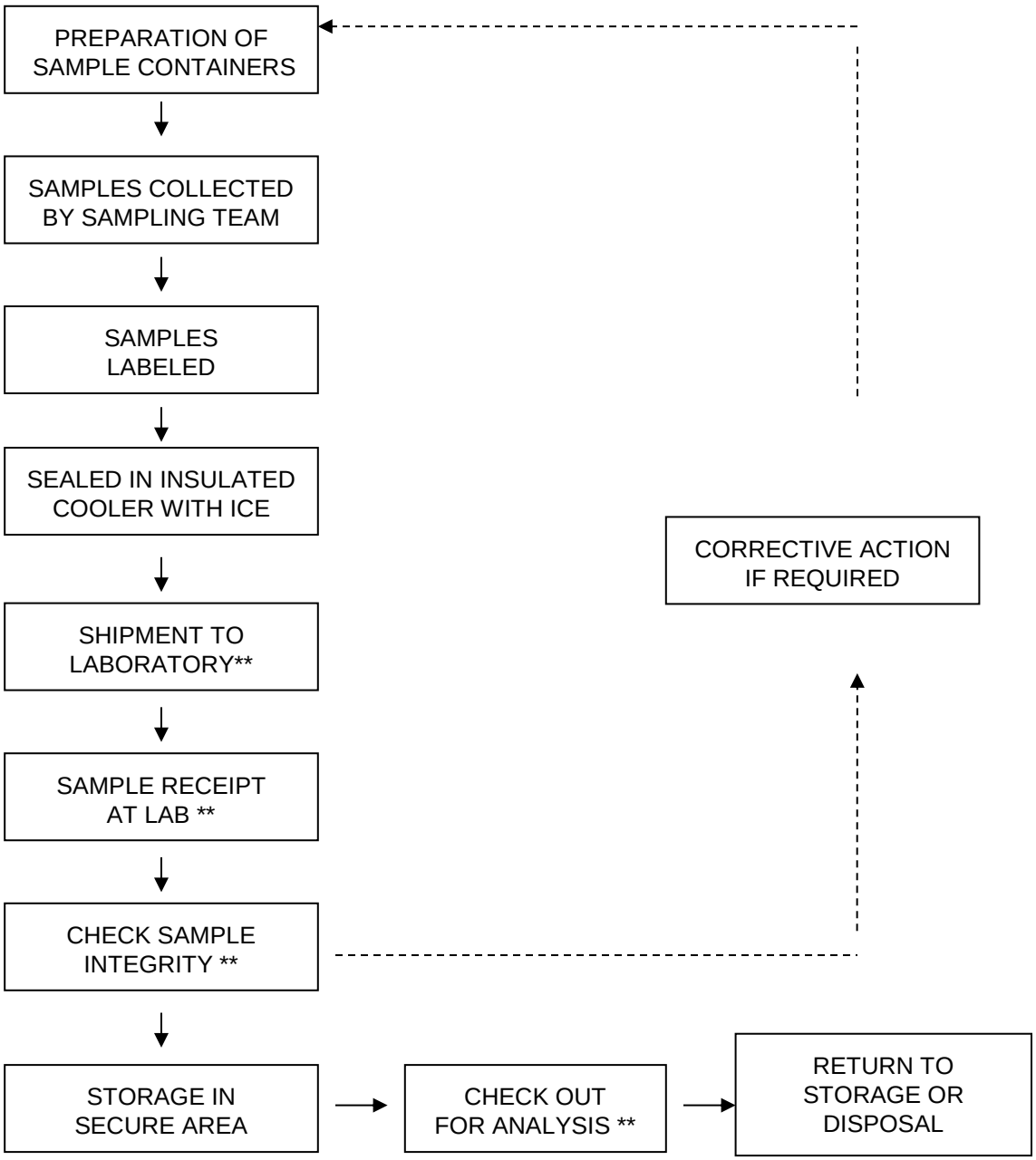
- Chain-of-custody will be initiated by the laboratory supplying the pre-cleaned and prepared sample containers. Chain-of-custody forms will accompany the sample containers.

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

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

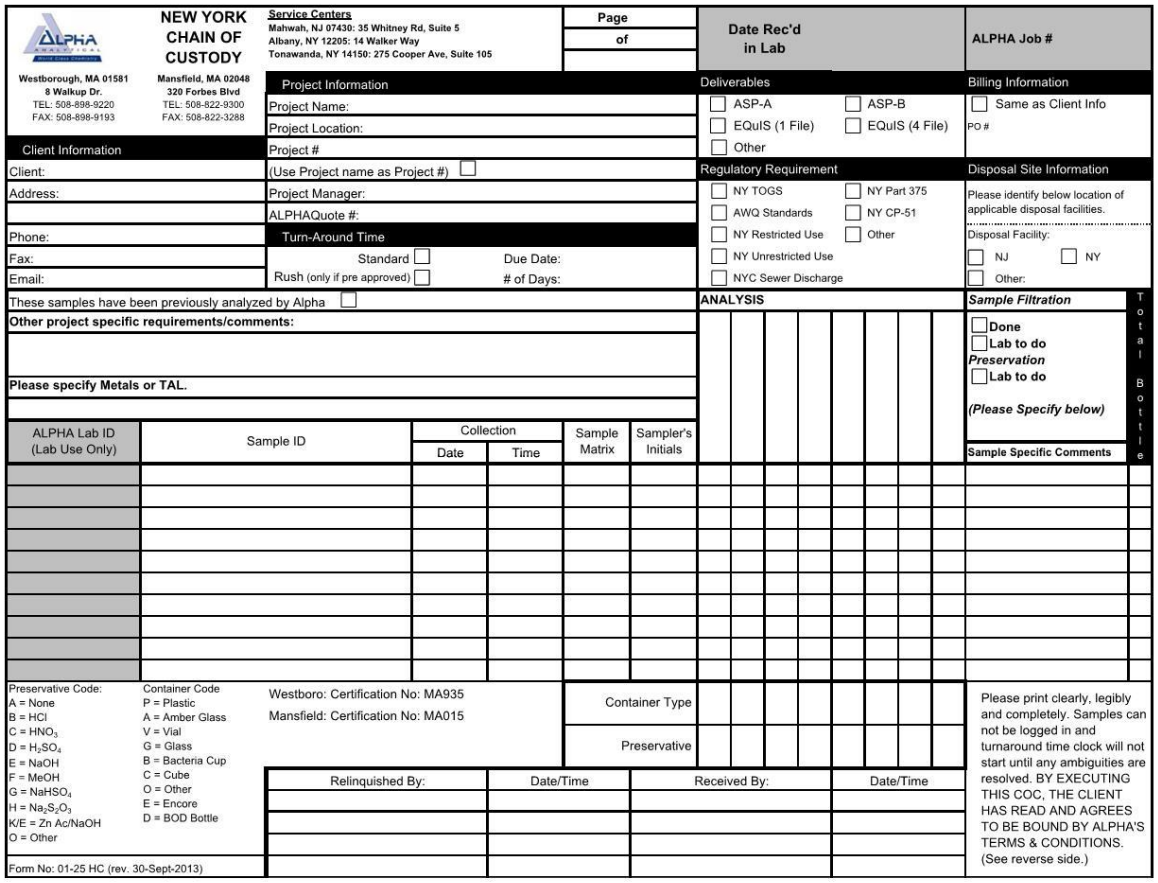
Samples will be packaged for shipment to the laboratory with the appropriate chain-of-custody form. A copy of the form will be retained by the sampling team for the project file and the original will be sent to the laboratory with the samples. Bills of lading will also be retained as part of the documentation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

Figure 5.1 Sample Custody



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

Figure 5.2 Sample Chain-of-Custody Form – Soil and Groundwater Samples



ALPHA

NEW YORK CHAIN OF CUSTODY

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

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

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

Page
of

Date Rec'd in Lab

ALPHA Job #

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

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

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

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

Billing Information
☐ Same as Client Info
PO #

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

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

These samples have been previously analyzed by Alpha ☐

Other project specific requirements/comments:

Please specify Metals or TAL.

ANALYSIS

Sample Filtration
☐ Done
☐ Lab to do
Preservation
☐ Lab to do
(Please Specify below)

Total Bottle

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

Container Type
Preservative

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

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

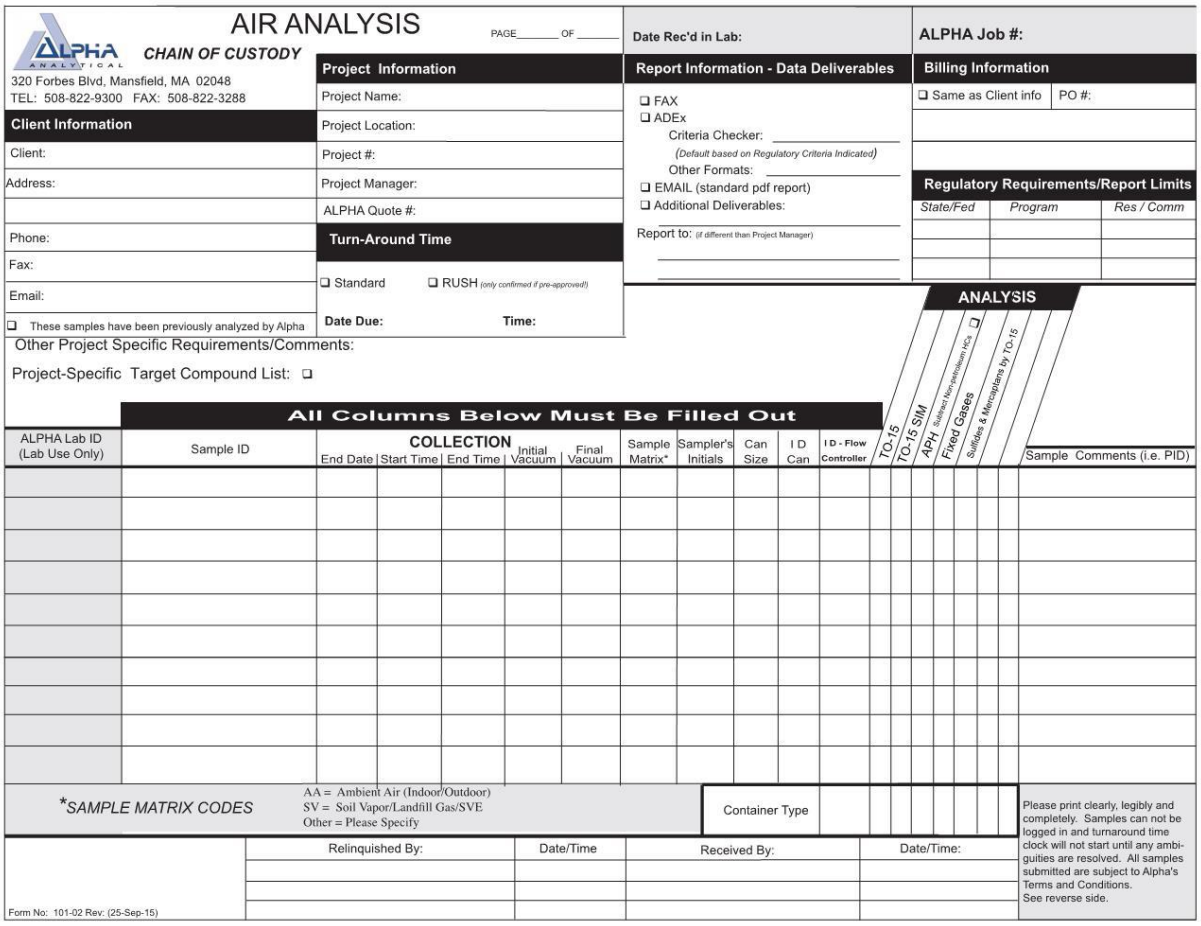
Westboro: Certification No: MA935
Mansfield: Certification No: MA015

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

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

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

Figure 5.3 Sample Chain-of-Custody Form – Soil Vapor and Ambient Air Samples



AIR ANALYSIS — PAGE_____ OF _____

ALPHA ANALYTICAL — CHAIN OF CUSTODY

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

Client Information

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

Project Information

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

Turn-Around Time

❑ Standard ❑ RUSH (only confirmed if pre-approved!)
Date Due: Time:

Date Rec'd in Lab:

Report Information - Data Deliverables

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

ALPHA Job #:

Billing Information

❑ Same as Client info PO #:

Regulatory Requirements/Report Limits

State/Fed	Program	Res / Comm

Other Project Specific Requirements/Comments:

Project-Specific Target Compound List: ❑

ANALYSIS

❑
TO-15
TO-15 SIM
APH (Subject Non-petroleum HCs)
Fixed Gases
Sulfides & Mercaptans by TO-15

All Columns Below Must Be Filled Out

ALPHA Lab ID (Lab Use Only)	Sample ID	COLLECTION End Date	Start Time	End Time	Initial Vacuum	Final Vacuum	Sample Matrix*	Sampler's Initials	Can Size	I D Can	I D - Flow Controller	Sample Comments (i.e. PID)

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

Container Type

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

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

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

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

5.10 LABORATORY SAMPLE STORAGE PROCEDURES

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

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

5.11 SPECIAL CONSIDERATIONS FOR PFAS SAMPLE COLLECTION

Soil and groundwater samples collected for analysis of PFAS will be collected in accordance with the specialized protocol outlined in this section. Soil and groundwater samples collected from select sample locations will be analyzed for 1,4-dioxane by EPA Method 8270 SIM, and for PFAS by EPA Method 573 Modified in accordance with the procedure outlined in Attachment E.

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

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

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

PFAS compound sampling protocols and laboratory SOP are provided in Attachment E.

5.12 PFAS TARGET ANALYTE LIST

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

Group	Analyte Name	Abbreviation	CAS #
Perfluoroalkyl carboxylates	Perfluorobutanoic acid	PFBA	375-22-4
	Perfluoropentanoic acid	PFPeA	2706-90-3
	Perfluorohexanoic acid	PFHxA	307-24-4
	Perfluoroheptanoic acid	PFHpA	375-85-9
	Perfluorooctanoic acid	PFOA	335-67-1
	Perfluorononanoic acid	PFNA	375-95-1
	Perfluorodecanoic acid	PFDA	335-76-2
	Perfluoroundecanoic acid	PFUA/PFUdA	2058-94-8
	Perfluorododecanoic acid	PFDoA	307-55-1
	Perfluorotridecanoic acid	PFTriA/PFTrDA	72629-94-8
	Perfluorotetradecanoic acid	PFTA/PFTeDA	376-06-7
Perfluoroalkyl sulfonates	Perfluorobutanesulfonic acid	PFBS	375-73-5
	Perfluorohexanesulfonic acid	PFHxS	355-46-4
	Perfluoroheptanesulfonic acid	PFHpS	375-92-8
	Perfluorooctanessulfonic acid	PFOS	1763-23-1
	Perfluorodecanesulfonic acid	PFDS	335-77-3
Fluorinated Telomer Sulfonates	6:2 Fluorotelomer sulfonate	6:2 FTS	27619-97-2
	8:2 Fluorotelomer sulfonate	8:2 FTS	39108-34-4
Perfluorooctane-sulfonamides	Perfluroroctanesulfonamide	FOSA	754-91-6
Perfluorooctane-sulfonamidoacetic acids	N-methyl perfluorooctanesulfonamidoacetic acid	N-MeFOSAA	2355-31-9
	N-ethyl perfluorooctanesulfonamidoacetic acid	N-EtFOSAA	2991-50-6

6.0 DATA REDUCTION, VALIDATION, AND REPORTING

6.1 INTRODUCTION

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

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

6.2 DATA REDUCTION

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

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

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

6.3 DATA VALIDATION

Data validation will be performed in accordance with the USEPA Region 2 SOPs for data validation and USEPA's National Functional Guidelines for Organic and Inorganic Data Review. Tier 1 data validation (the equivalent of USEPA's Stage 2A validation) will be performed to evaluate data quality. Tier 1 data validation is based on completeness and compliance checks of sample-related QC results including:

- Holding times;
- Sample preservation;
- Blank results (method, trip, and field blanks);
- Surrogate recovery compounds and extracted internal standards (as applicable);
- LCS and LCSD recoveries and RPDs;
- MS and MSD recoveries and RPDs;
- Laboratory duplicate RPDs; and
- Field duplicate RPDs

A DUSR will be prepared by the data validator and reviewed by the Quality Assurance Manager before issuance. The DUSR will present the results of data validation, including a summary assessment of laboratory data packages, sample preservation and chain-of-custody procedures, and a summary assessment of precision, accuracy, representativeness, comparability, and completeness for each analytical method.

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

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

7.0 QUALITY ASSURANCE PERFORMANCE AUDITS AND SYSTEM AUDITS

7.1 INTRODUCTION

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

7.2 SYSTEM AUDITS

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

7.3 PERFORMANCE AUDITS

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

7.4 FORMAL AUDITS

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

Audit reports will be written by auditors who have performed the site audit after gathering and evaluating all data. Items, activities, and documents determined by lead auditors to be in noncompliance shall be identified at exit interviews conducted with the involved management.

Non-compliances will be logged, and documented through audit findings, which are attached to and are a part of the integral audit report. These audit-finding forms are directed to management to satisfactorily resolve the noncompliance in a specified and timely manner.

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

8.0 CORRECTIVE ACTION

8.1 INTRODUCTION

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

8.2 PROCEDURE DESCRIPTION

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

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

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

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

Personnel assigned to quality assurance functions will have the responsibility to issue and control Corrective Action Request (CAR) Forms (Figure 8.1 or similar by email). The CAR identifies the out-of-compliance condition, reference document(s), and recommended corrective action(s) to be administered. The CAR is issued to the personnel responsible for the affected item or activity. A copy is also submitted to the Project Manager. The individual to whom the CAR is addressed returns the requested response promptly to the quality assurance personnel, affixing his/her signature and date to the corrective action block, after stating the cause of the conditions and corrective action to be taken. The quality assurance personnel maintain the log for status of CARs, confirms the adequacy of the intended corrective action, and verifies its implementation. CARs will be retained in the project file for the records.

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

Figure 8.1

CORRECTIVE ACTION REQUEST

Number: _____ Date: _____

TO: _____

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

CONDITION:

REFERENCE DOCUMENTS:

RECOMMENDED CORRECTIVE ACTIONS:

_____ _____ _____ _____ _____ _____

Originator Date Approval Date Approval Date

RESPONSE

CAUSE OF CONDITION

CORRECTIVE ACTION

(A) RESOLUTION

(B) PREVENTION

(C) AFFECTED DOCUMENTS

C.A. FOLLOWUP:

CORRECTIVE ACTION VERIFIED BY: _____ DATE:_____

9.0 REFERENCES

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

USEPA, 2016. Low/Medium Volatile Data Validation. SOP No. HW-33A, Revision 1, dated September 2016. USEPA Region II.

USEPA, 2015. PCB Aroclor Data Validation. SOP No. HW-37A, Revision 0, dated July 2015. USEPA Region II.

USEPA, 2016. ICP-AES Data Validation. SOP No. HW-3a, Revision 1, dated September 2016. USEPA Region II.

USEPA, 2016. Mercury and Cyanide Data Validation. SOP No. HW-3c, Revision 1, dated September 2016. USEPA Region II.

USEPA, 2016. Pesticide Data Validation. SOP No. HW-36A, Revision 1, dated October 2016. USEPA Region II.

USEPA, 2016. Semivolatile Data Validation. SOP No. HW-35A, Revision 1, dated September 2016. USEPA Region II.

USEPA, 2016. Analysis of Volatile Organic Compounds in Air Contained in Canisters by Method TO-15, Revision 6, dated September 2016. USEPA Region II.

USEPA 2017. National Functional Guidelines for Superfund Organic Methods Data Review, Office of Superfund Remediation and Technology Innovation, EPA-540-R-2017-002, January 2017.

USEPA 2017b. National Functional Guidelines for Superfund Inorganic Methods Data Review, Office of Superfund Remediation and Technology Innovation, EPA-540-R-201 7-001, January 2017.

ATTACHMENT A

LABORATORY REPORTING LIMITS AND METHOD DETECTION LIMITS

Date Created: 05/14/20
Created By: Cynthia Romero
File: PM8518-1
Page: 1

Langan Engineering & Environmental

TCL Volatiles - EPA 8260C/5035 High&Low (SOIL)

Holding Time: 14 days
Container/Sample Preservation: 1 - 1 Vial MeOH/2 Vial Water

Analyte	CAS #	RL	MDL	Units	LCS Criteria	LCS RPD	MS Criteria	MS RPD	Duplicate RPD	Surrogate Criteria		
Methylene chloride	75-09-2	0.005	0.00229	mg/kg	70-130	30	70-130	30	30			
1,1-Dichloroethane	75-34-3	0.001	0.000145	mg/kg	70-130	30	70-130	30	30			
Chloroform	67-66-3	0.0015	0.00014	mg/kg	70-130	30	70-130	30	30			
Carbon tetrachloride	56-23-5	0.001	0.00023	mg/kg	70-130	30	70-130	30	30			
1,2-Dichloropropane	78-87-5	0.001	0.000125	mg/kg	70-130	30	70-130	30	30			
Dibromochloromethane	124-48-1	0.001	0.00014	mg/kg	70-130	30	70-130	30	30			
1,1,2-Trichloroethane	79-00-5	0.001	0.000267	mg/kg	70-130	30	70-130	30	30			
Tetrachloroethene	127-18-4	0.0005	0.000196	mg/kg	70-130	30	70-130	30	30			
Chlorobenzene	108-90-7	0.0005	0.000127	mg/kg	70-130	30	70-130	30	30			
Trichlorofluoromethane	75-69-4	0.004	0.000695	mg/kg	70-139	30	70-139	30	30			
1,2-Dichloroethane	107-06-2	0.001	0.000257	mg/kg	70-130	30	70-130	30	30			
1,1,1-Trichloroethane	71-55-6	0.0005	0.000167	mg/kg	70-130	30	70-130	30	30			
Bromodichloromethane	75-27-4	0.0005	0.000109	mg/kg	70-130	30	70-130	30	30			
trans-1,3-Dichloropropene	10061-02-6	0.001	0.000273	mg/kg	70-130	30	70-130	30	30			
cis-1,3-Dichloropropene	10061-01-5	0.0005	0.000158	mg/kg	70-130	30	70-130	30	30			
1,3-Dichloropropene, Total	542-75-6	0.0005	0.000158	mg/kg				30	30			
1,1-Dichloropropene	563-58-6	0.0005	0.000159	mg/kg	70-130	30	70-130	30	30			
Bromoform	75-25-2	0.004	0.000246	mg/kg	70-130	30	70-130	30	30			
1,1,2,2-Tetrachloroethane	79-34-5	0.0005	0.000166	mg/kg	70-130	30	70-130	30	30			
Benzene	71-43-2	0.0005	0.000166	mg/kg	70-130	30	70-130	30	30			
Toluene	108-88-3	0.001	0.000543	mg/kg	70-130	30	70-130	30	30			
Ethylbenzene	100-41-4	0.001	0.000141	mg/kg	70-130	30	70-130	30	30			
Chloromethane	74-87-3	0.004	0.000932	mg/kg	52-130	30	52-130	30	30			
Bromomethane	74-83-9	0.002	0.000581	mg/kg	57-147	30	57-147	30	30			
Vinyl chloride	75-01-4	0.001	0.000335	mg/kg	67-130	30	67-130	30	30			
Chloroethane	75-00-3	0.002	0.000452	mg/kg	50-151	30	50-151	30	30			
1,1-Dichloroethene	75-35-4	0.001	0.000238	mg/kg	65-135	30	65-135	30	30			
trans-1,2-Dichloroethene	156-60-5	0.0015	0.000137	mg/kg	70-130	30	70-130	30	30			
Trichloroethene	79-01-6	0.0005	0.000137	mg/kg	70-130	30	70-130	30	30			
1,2-Dichlorobenzene	95-50-1	0.002	0.000144	mg/kg	70-130	30	70-130	30	30			
1,3-Dichlorobenzene	541-73-1	0.002	0.000148	mg/kg	70-130	30	70-130	30	30			
1,4-Dichlorobenzene	106-46-7	0.002	0.000171	mg/kg	70-130	30	70-130	30	30			
Methyl tert butyl ether	1634-04-4	0.002	0.000201	mg/kg	66-130	30	66-130	30	30			
p/m-Xylene	179601-23-1	0.002	0.00056	mg/kg	70-130	30	70-130	30	30			
o-Xylene	95-47-6	0.001	0.000291	mg/kg	70-130	30	70-130	30	30			
Xylene (Total)	1330-20-7	0.001	0.000291	mg/kg				30	30			
cis-1,2-Dichloroethene	156-59-2	0.001	0.000175	mg/kg	70-130	30	70-130	30	30			
1,2-Dichloroethene (total)	540-59-0	0.001	0.000137	mg/kg				30	30			
Dibromomethane	74-95-3	0.002	0.000238	mg/kg	70-130	30	70-130	30	30			
Styrene	100-42-5	0.001	0.000196	mg/kg	70-130	30	70-130	30	30			
Dichlorodifluoromethane	75-71-8	0.01	0.000915	mg/kg	30-146	30	30-146	30	30			
Acetone	67-64-1	0.01	0.004811	mg/kg	54-140	30	54-140	30	30			

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TCL Volatiles - EPA 8260C/5035 High&Low (SOIL)

Holding Time: 14 days
Container/Sample Preservation: 1 - 1 Vial MeOH/2 Vial Water

Analyte	CAS #	RL	MDL	Units	LCS Criteria	LCS RPD	MS Criteria	MS RPD	Duplicate RPD	Surrogate Criteria		
Carbon disulfide	75-15-0	0.01	0.00455	mg/kg	59-130	30	59-130	30	30			
2-Butanone	78-93-3	0.01	0.00222	mg/kg	70-130	30	70-130	30	30			
Vinyl acetate	108-05-4	0.01	0.00215	mg/kg	70-130	30	70-130	30	30			
4-Methyl-2-pentanone	108-10-1	0.01	0.00128	mg/kg	70-130	30	70-130	30	30			
1,2,3-Trichloropropane	96-18-4	0.002	0.000127	mg/kg	68-130	30	68-130	30	30			
2-Hexanone	591-78-6	0.01	0.00118	mg/kg	70-130	30	70-130	30	30			
Bromochloromethane	74-97-5	0.002	0.000205	mg/kg	70-130	30	70-130	30	30			
2,2-Dichloropropane	594-20-7	0.002	0.000202	mg/kg	70-130	30	70-130	30	30			
1,2-Dibromoethane	106-93-4	0.001	0.000279	mg/kg	70-130	30	70-130	30	30			
1,3-Dichloropropane	142-28-9	0.002	0.000167	mg/kg	69-130	30	69-130	30	30			
1,1,1,2-Tetrachloroethane	630-20-6	0.0005	0.000132	mg/kg	70-130	30	70-130	30	30			
Bromobenzene	108-86-1	0.002	0.000145	mg/kg	70-130	30	70-130	30	30			
n-Butylbenzene	104-51-8	0.001	0.000167	mg/kg	70-130	30	70-130	30	30			
sec-Butylbenzene	135-98-8	0.001	0.000146	mg/kg	70-130	30	70-130	30	30			
tert-Butylbenzene	98-06-6	0.002	0.000118	mg/kg	70-130	30	70-130	30	30			
o-Chlorotoluene	95-49-8	0.002	0.000191	mg/kg	70-130	30	70-130	30	30			
p-Chlorotoluene	106-43-4	0.002	0.000108	mg/kg	70-130	30	70-130	30	30			
1,2-Dibromo-3-chloropropane	96-12-8	0.003	0.000998	mg/kg	68-130	30	68-130	30	30			
Hexachlorobutadiene	87-68-3	0.004	0.000169	mg/kg	67-130	30	67-130	30	30			
Isopropylbenzene	98-82-8	0.001	0.000109	mg/kg	70-130	30	70-130	30	30			
p-Isopropyltoluene	99-87-6	0.001	0.000109	mg/kg	70-130	30	70-130	30	30			
Naphthalene	91-20-3	0.004	0.00065	mg/kg	70-130	30	70-130	30	30			
Acrylonitrile	107-13-1	0.004	0.00115	mg/kg	70-130	30	70-130	30	30			
n-Propylbenzene	103-65-1	0.001	0.000171	mg/kg	70-130	30	70-130	30	30			
1,2,3-Trichlorobenzene	87-61-6	0.002	0.000322	mg/kg	70-130	30	70-130	30	30			
1,2,4-Trichlorobenzene	120-82-1	0.002	0.000272	mg/kg	70-130	30	70-130	30	30			
1,3,5-Trimethylbenzene	108-67-8	0.002	0.000193	mg/kg	70-130	30	70-130	30	30			
1,2,4-Trimethylbenzene	95-63-6	0.002	0.000334	mg/kg	70-130	30	70-130	30	30			
1,4-Dioxane	123-91-1	0.08	0.0351	mg/kg	65-136	30	65-136	30	30			
1,4-Diethylbenzene	105-05-5	0.002	0.000177	mg/kg	70-130	30	70-130	30	30			
4-Ethyltoluene	622-96-8	0.002	0.000384	mg/kg	70-130	30	70-130	30	30			
1,2,4,5-Tetramethylbenzene	95-93-2	0.002	0.000191	mg/kg	70-130	30	70-130	30	30			
Ethyl ether	60-29-7	0.002	0.000341	mg/kg	67-130	30	67-130	30	30			
trans-1,4-Dichloro-2-butene	110-57-6	0.005	0.00142	mg/kg	70-130	30	70-130	30	30			
1,2-Dichloroethane-d4	*17060-07-0*									*70-130*		
2-Chloroethoxyethane												
Toluene-d8	*2037-26-5*									*70-130*		
4-Bromofluorobenzene	*460-00-4*									*70-130*		
Dibromofluoromethane	*1868-53-7*									*70-130*		

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TCL Volatiles - EPA 8260C/5035 High (SOIL)

Holding Time: 14 days
Container/Sample Preservation: 1 - Vial MeOH preserved

Analyte	CAS #	RL	MDL	Units	LCS Criteria	LCS RPD	MS Criteria	MS RPD	Duplicate RPD	Surrogate Criteria		
Methylene chloride	75-09-2	0.25	0.1145	mg/kg	70-130	30	70-130	30	30			
1,1-Dichloroethane	75-34-3	0.05	0.00725	mg/kg	70-130	30	70-130	30	30			
Chloroform	67-66-3	0.075	0.007	mg/kg	70-130	30	70-130	30	30			
Carbon tetrachloride	56-23-5	0.05	0.0115	mg/kg	70-130	30	70-130	30	30			
1,2-Dichloropropane	78-87-5	0.05	0.00625	mg/kg	70-130	30	70-130	30	30			
Dibromochloromethane	124-48-1	0.05	0.007	mg/kg	70-130	30	70-130	30	30			
1,1,2-Trichloroethane	79-00-5	0.05	0.01335	mg/kg	70-130	30	70-130	30	30			
Tetrachloroethene	127-18-4	0.025	0.0098	mg/kg	70-130	30	70-130	30	30			
Chlorobenzene	108-90-7	0.025	0.00635	mg/kg	70-130	30	70-130	30	30			
Trichlorofluoromethane	75-69-4	0.2	0.03475	mg/kg	70-139	30	70-139	30	30			
1,2-Dichloroethane	107-06-2	0.05	0.01285	mg/kg	70-130	30	70-130	30	30			
1,1,1-Trichloroethane	71-55-6	0.025	0.00835	mg/kg	70-130	30	70-130	30	30			
Bromodichloromethane	75-27-4	0.025	0.00545	mg/kg	70-130	30	70-130	30	30			
trans-1,3-Dichloropropene	10061-02-6	0.05	0.01365	mg/kg	70-130	30	70-130	30	30			
cis-1,3-Dichloropropene	10061-01-5	0.025	0.0079	mg/kg	70-130	30	70-130	30	30			
1,3-Dichloropropene, Total	542-75-6	0.025	0.0079	mg/kg				30	30			
1,1-Dichloropropene	563-58-6	0.025	0.00795	mg/kg	70-130	30	70-130	30	30			
Bromoform	75-25-2	0.2	0.0123	mg/kg	70-130	30	70-130	30	30			
1,1,2,2-Tetrachloroethane	79-34-5	0.025	0.0083	mg/kg	70-130	30	70-130	30	30			
Benzene	71-43-2	0.025	0.0083	mg/kg	70-130	30	70-130	30	30			
Toluene	108-88-3	0.05	0.02715	mg/kg	70-130	30	70-130	30	30			
Ethylbenzene	100-41-4	0.05	0.00705	mg/kg	70-130	30	70-130	30	30			
Chloromethane	74-87-3	0.2	0.0466	mg/kg	52-130	30	52-130	30	30			
Bromomethane	74-83-9	0.1	0.02905	mg/kg	57-147	30	57-147	30	30			
Vinyl chloride	75-01-4	0.05	0.01675	mg/kg	67-130	30	67-130	30	30			
Chloroethane	75-00-3	0.1	0.0226	mg/kg	50-151	30	50-151	30	30			
1,1-Dichloroethene	75-35-4	0.05	0.0119	mg/kg	65-135	30	65-135	30	30			
trans-1,2-Dichloroethene	156-60-5	0.075	0.00685	mg/kg	70-130	30	70-130	30	30			
Trichloroethene	79-01-6	0.025	0.00685	mg/kg	70-130	30	70-130	30	30			
1,2-Dichlorobenzene	95-50-1	0.1	0.0072	mg/kg	70-130	30	70-130	30	30			
1,3-Dichlorobenzene	541-73-1	0.1	0.0074	mg/kg	70-130	30	70-130	30	30			
1,4-Dichlorobenzene	106-46-7	0.1	0.00855	mg/kg	70-130	30	70-130	30	30			
Methyl tert butyl ether	1634-04-4	0.1	0.01005	mg/kg	66-130	30	66-130	30	30			
p/m-Xylene	179601-23-1	0.1	0.028	mg/kg	70-130	30	70-130	30	30			
o-Xylene	95-47-6	0.05	0.01455	mg/kg	70-130	30	70-130	30	30			
Xylene (Total)	1330-20-7	0.05	0.01455	mg/kg				30	30			
cis-1,2-Dichloroethene	156-59-2	0.05	0.00875	mg/kg	70-130	30	70-130	30	30			
1,2-Dichloroethene (total)	540-59-0	0.05	0.00685	mg/kg				30	30			
Dibromomethane	74-95-3	0.1	0.0119	mg/kg	70-130	30	70-130	30	30			
Styrene	100-42-5	0.05	0.0098	mg/kg	70-130	30	70-130	30	30			
Dichlorodifluoromethane	75-71-8	0.5	0.04575	mg/kg	30-146	30	30-146	30	30			
Acetone	67-64-1	0.5	0.24055	mg/kg	54-140	30	54-140	30	30			

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TCL Volatiles - EPA 8260C/5035 High (SOIL)

Holding Time: 14 days
Container/Sample Preservation: 1 - Vial MeOH preserved

Analyte	CAS #	RL	MDL	Units	LCS Criteria	LCS RPD	MS Criteria	MS RPD	Duplicate RPD	Surrogate Criteria		
Carbon disulfide	75-15-0	0.5	0.2275	mg/kg	59-130	30	59-130	30	30			
2-Butanone	78-93-3	0.5	0.111	mg/kg	70-130	30	70-130	30	30			
Vinyl acetate	108-05-4	0.5	0.1075	mg/kg	70-130	30	70-130	30	30			
4-Methyl-2-pentanone	108-10-1	0.5	0.064	mg/kg	70-130	30	70-130	30	30			
1,2,3-Trichloropropane	96-18-4	0.1	0.00635	mg/kg	68-130	30	68-130	30	30			
2-Hexanone	591-78-6	0.5	0.059	mg/kg	70-130	30	70-130	30	30			
Bromochloromethane	74-97-5	0.1	0.01025	mg/kg	70-130	30	70-130	30	30			
2,2-Dichloropropane	594-20-7	0.1	0.0101	mg/kg	70-130	30	70-130	30	30			
1,2-Dibromoethane	106-93-4	0.05	0.01395	mg/kg	70-130	30	70-130	30	30			
1,3-Dichloropropane	142-28-9	0.1	0.00835	mg/kg	69-130	30	69-130	30	30			
1,1,1,2-Tetrachloroethane	630-20-6	0.025	0.0066	mg/kg	70-130	30	70-130	30	30			
Bromobenzene	108-86-1	0.1	0.00725	mg/kg	70-130	30	70-130	30	30			
n-Butylbenzene	104-51-8	0.05	0.00835	mg/kg	70-130	30	70-130	30	30			
sec-Butylbenzene	135-98-8	0.05	0.0073	mg/kg	70-130	30	70-130	30	30			
tert-Butylbenzene	98-06-6	0.1	0.0059	mg/kg	70-130	30	70-130	30	30			
o-Chlorotoluene	95-49-8	0.1	0.00955	mg/kg	70-130	30	70-130	30	30			
p-Chlorotoluene	106-43-4	0.1	0.0054	mg/kg	70-130	30	70-130	30	30			
1,2-Dibromo-3-chloropropane	96-12-8	0.15	0.0499	mg/kg	68-130	30	68-130	30	30			
Hexachlorobutadiene	87-68-3	0.2	0.00845	mg/kg	67-130	30	67-130	30	30			
Isopropylbenzene	98-82-8	0.05	0.00545	mg/kg	70-130	30	70-130	30	30			
p-Isopropyltoluene	99-87-6	0.05	0.00545	mg/kg	70-130	30	70-130	30	30			
Naphthalene	91-20-3	0.2	0.0325	mg/kg	70-130	30	70-130	30	30			
Acrylonitrile	107-13-1	0.2	0.0575	mg/kg	70-130	30	70-130	30	30			
n-Propylbenzene	103-65-1	0.05	0.00855	mg/kg	70-130	30	70-130	30	30			
1,2,3-Trichlorobenzene	87-61-6	0.1	0.0161	mg/kg	70-130	30	70-130	30	30			
1,2,4-Trichlorobenzene	120-82-1	0.1	0.0136	mg/kg	70-130	30	70-130	30	30			
1,3,5-Trimethylbenzene	108-67-8	0.1	0.00965	mg/kg	70-130	30	70-130	30	30			
1,2,4-Trimethylbenzene	95-63-6	0.1	0.0167	mg/kg	70-130	30	70-130	30	30			
1,4-Dioxane	123-91-1	4	1.755	mg/kg	65-136	30	65-136	30	30			
1,4-Diethylbenzene	105-05-5	0.1	0.00885	mg/kg	70-130	30	70-130	30	30			
4-Ethyltoluene	622-96-8	0.1	0.0192	mg/kg	70-130	30	70-130	30	30			
1,2,4,5-Tetramethylbenzene	95-93-2	0.1	0.00955	mg/kg	70-130	30	70-130	30	30			
Ethyl ether	60-29-7	0.1	0.01705	mg/kg	67-130	30	67-130	30	30			
trans-1,4-Dichloro-2-butene	110-57-6	0.25	0.071	mg/kg	70-130	30	70-130	30	30			
1,2-Dichloroethane-d4	*17060-07-0*									*70-130*		
2-Chloroethoxyethane												
Toluene-d8	*2037-26-5*									*70-130*		
4-Bromofluorobenzene	*460-00-4*									*70-130*		
Dibromofluoromethane	*1868-53-7*									*70-130*		

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NYTCL Semivolatiles - EPA 8270D (SOIL)

Holding Time: 14 days
Container/Sample Preservation: 1 - Glass 250ml/8oz unpreserved

Analyte	CAS #	RL	MDL	Units	LCS Criteria	LCS RPD	MS Criteria	MS RPD	Duplicate RPD	Surrogate Criteria		
Acenaphthene	83-32-9	0.1332	0.0172494	mg/kg	31-137	50	31-137	50	50			
1,2,4-Trichlorobenzene	120-82-1	0.1665	0.0190476	mg/kg	38-107	50	38-107	50	50			
Hexachlorobenzene	118-74-1	0.0999	0.018648	mg/kg	40-140	50	40-140	50	50			
Bis(2-chloroethyl)ether	111-44-4	0.14985	0.0225774	mg/kg	40-140	50	40-140	50	50			
2-Chloronaphthalene	91-58-7	0.1665	0.0165168	mg/kg	40-140	50	40-140	50	50			
1,2-Dichlorobenzene	95-50-1	0.1665	0.0299034	mg/kg	40-140	50	40-140	50	50			
1,3-Dichlorobenzene	541-73-1	0.1665	0.028638	mg/kg	40-140	50	40-140	50	50			
1,4-Dichlorobenzene	106-46-7	0.1665	0.0290709	mg/kg	28-104	50	28-104	50	50			
3,3'-Dichlorobenzidine	91-94-1	0.1665	0.044289	mg/kg	40-140	50	40-140	50	50			
2,4-Dinitrotoluene	121-14-2	0.1665	0.0333	mg/kg	40-132	50	40-132	50	50			
2,6-Dinitrotoluene	606-20-2	0.1665	0.0285714	mg/kg	40-140	50	40-140	50	50			
Fluoranthene	206-44-0	0.0999	0.0191142	mg/kg	40-140	50	40-140	50	50			
4-Chlorophenyl phenyl ether	7005-72-3	0.1665	0.0178155	mg/kg	40-140	50	40-140	50	50			
4-Bromophenyl phenyl ether	101-55-3	0.1665	0.0254079	mg/kg	40-140	50	40-140	50	50			
Bis(2-chloroisopropyl)ether	108-60-1	0.1998	0.0284382	mg/kg	40-140	50	40-140	50	50			
Bis(2-chloroethoxy)methane	111-91-1	0.17982	0.0166833	mg/kg	40-117	50	40-117	50	50			
Hexachlorobutadiene	87-68-3	0.1665	0.0243756	mg/kg	40-140	50	40-140	50	50			
Hexachlorocyclopentadiene	77-47-4	0.47619	0.150849	mg/kg	40-140	50	40-140	50	50			
Hexachloroethane	67-72-1	0.1332	0.0269397	mg/kg	40-140	50	40-140	50	50			
Isophorone	78-59-1	0.14985	0.0216117	mg/kg	40-140	50	40-140	50	50			
Naphthalene	91-20-3	0.1665	0.0202797	mg/kg	40-140	50	40-140	50	50			
Nitrobenzene	98-95-3	0.14985	0.024642	mg/kg	40-140	50	40-140	50	50			
NitrosoDiPhenylAmine(NDPA)/DPA	86-30-6	0.1332	0.0189477	mg/kg	36-157	50	36-157	50	50			
n-Nitrosodi-n-propylamine	621-64-7	0.1665	0.0257076	mg/kg	32-121	50	32-121	50	50			
Bis(2-Ethylhexyl)phthalate	117-81-7	0.1665	0.057609	mg/kg	40-140	50	40-140	50	50			
Butyl benzyl phthalate	85-68-7	0.1665	0.041958	mg/kg	40-140	50	40-140	50	50			
Di-n-butylphthalate	84-74-2	0.1665	0.0315684	mg/kg	40-140	50	40-140	50	50			
Di-n-octylphthalate	117-84-0	0.1665	0.05661	mg/kg	40-140	50	40-140	50	50			
Diethyl phthalate	84-66-2	0.1665	0.0154179	mg/kg	40-140	50	40-140	50	50			
Dimethyl phthalate	131-11-3	0.1665	0.034965	mg/kg	40-140	50	40-140	50	50			
Benzo(a)anthracene	56-55-3	0.0999	0.0187479	mg/kg	40-140	50	40-140	50	50			
Benzo(a)pyrene	50-32-8	0.1332	0.040626	mg/kg	40-140	50	40-140	50	50			
Benzo(b)fluoranthene	205-99-2	0.0999	0.0280386	mg/kg	40-140	50	40-140	50	50			
Benzo(k)fluoranthene	207-08-9	0.0999	0.02664	mg/kg	40-140	50	40-140	50	50			
Chrysene	218-01-9	0.0999	0.017316	mg/kg	40-140	50	40-140	50	50			
Acenaphthylene	208-96-8	0.1332	0.0257076	mg/kg	40-140	50	40-140	50	50			
Anthracene	120-12-7	0.0999	0.0324675	mg/kg	40-140	50	40-140	50	50			
Benzo(ghi)perylene	191-24-2	0.1332	0.0195804	mg/kg	40-140	50	40-140	50	50			
Fluorene	86-73-7	0.1665	0.0161838	mg/kg	40-140	50	40-140	50	50			
Phenanthrene	85-01-8	0.0999	0.0202464	mg/kg	40-140	50	40-140	50	50			
Dibenzo(a,h)anthracene	53-70-3	0.0999	0.0192474	mg/kg	40-140	50	40-140	50	50			
Indeno(1,2,3-cd)Pyrene	193-39-5	0.1332	0.0232101	mg/kg	40-140	50	40-140	50	50			

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NYTCL Semivolatiles - EPA 8270D (SOIL)

Holding Time: 14 days
Container/Sample Preservation: 1 - Glass 250ml/8oz unpreserved

Analyte	CAS #	RL	MDL	Units	LCS Criteria	LCS RPD	MS Criteria	MS RPD	Duplicate RPD	Surrogate Criteria		
Pyrene	129-00-0	0.0999	0.0165501	mg/kg	35-142	50	35-142	50	50			
Biphenyl	92-52-4	0.37962	0.038628	mg/kg	37-127	50	37-127	50	50			
4-Chloroaniline	106-47-8	0.1665	0.030303	mg/kg	40-140	50	40-140	50	50			
2-Nitroaniline	88-74-4	0.1665	0.0321012	mg/kg	47-134	50	47-134	50	50			
3-Nitroaniline	99-09-2	0.1665	0.0314019	mg/kg	26-129	50	26-129	50	50			
4-Nitroaniline	100-01-6	0.1665	0.068931	mg/kg	41-125	50	41-125	50	50			
Dibenzofuran	132-64-9	0.1665	0.0157509	mg/kg	40-140	50	40-140	50	50			
2-Methylnaphthalene	91-57-6	0.1998	0.0201132	mg/kg	40-140	50	40-140	50	50			
Acetophenone	98-86-2	0.1665	0.0206127	mg/kg	14-144	50	14-144	50	50			
2,4,6-Trichlorophenol	88-06-2	0.0999	0.0315684	mg/kg	30-130	50	30-130	50	50			
P-Chloro-M-Cresol	59-50-7	0.1665	0.0248085	mg/kg	26-103	50	26-103	50	50			
2-Chlorophenol	95-57-8	0.1665	0.0196803	mg/kg	25-102	50	25-102	50	50			
2,4-Dichlorophenol	120-83-2	0.14985	0.0267732	mg/kg	30-130	50	30-130	50	50			
2,4-Dimethylphenol	105-67-9	0.1665	0.054945	mg/kg	30-130	50	30-130	50	50			
2-Nitrophenol	88-75-5	0.35964	0.062604	mg/kg	30-130	50	30-130	50	50			
4-Nitrophenol	100-02-7	0.2331	0.067932	mg/kg	11-114	50	11-114	50	50			
2,4-Dinitrophenol	51-28-5	0.7992	0.077589	mg/kg	4-130	50	4-130	50	50			
4,6-Dinitro-o-cresol	534-52-1	0.4329	0.07992	mg/kg	10-130	50	10-130	50	50			
Pentachlorophenol	87-86-5	0.1332	0.03663	mg/kg	17-109	50	17-109	50	50			
Phenol	108-95-2	0.1665	0.0251415	mg/kg	26-90	50	26-90	50	50			
2-Methylphenol	95-48-7	0.1665	0.0258075	mg/kg	30-130.	50	30-130.	50	50			
3-Methylphenol/4-Methylphenol	108-39-4/106-44-5	0.23976	0.0260739	mg/kg	30-130	50	30-130	50	50			
2,4,5-Trichlorophenol	95-95-4	0.1665	0.0319014	mg/kg	30-130	50	30-130	50	50			
Benzoic Acid	65-85-0	0.53946	0.168498	mg/kg	10-110	50	10-110	50	50			
Benzyl Alcohol	100-51-6	0.1665	0.050949	mg/kg	40-140	50	40-140	50	50			
Carbazole	86-74-8	0.1665	0.0161838	mg/kg	54-128	50	54-128	50	50			
1,4-Dioxane	123-91-1	0.024975	0.007659	mg/kg	40-140	50	40-140	50	50			
2-Fluorophenol	*367-12-4*									*25-120*		
Phenol-d6	*13127-88-3*									*10-120*		
Nitrobenzene-d5	*4165-60-0*									*23-120*		
2-Fluorobiphenyl	*321-60-8*									*30-120*		
2,4,6-Tribromophenol	*118-79-6*									*10-136*		
4-Terphenyl-d14	*1718-51-0*									*18-120*		

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TCL Pesticides - EPA 8081B (SOIL)

Holding Time: 14 days
Container/Sample Preservation: 1 - Glass 250ml/8oz unpreserved

Analyte	CAS #	RL	MDL	Units	LCS Criteria	LCS RPD	MS Criteria	MS RPD	Duplicate RPD	Surrogate Criteria		
Delta-BHC	319-86-8	1.6008	0.31349	ug/kg	30-150	30	30-150	50	50			
Lindane	58-89-9	0.667	0.298149	ug/kg	30-150	30	30-150	50	50			
Alpha-BHC	319-84-6	0.667	0.189428	ug/kg	30-150	30	30-150	50	50			
Beta-BHC	319-85-7	1.6008	0.60697	ug/kg	30-150	30	30-150	50	50			
Heptachlor	76-44-8	0.8004	0.358846	ug/kg	30-150	30	30-150	50	50			
Aldrin	309-00-2	1.6008	0.563615	ug/kg	30-150	30	30-150	50	50			
Heptachlor epoxide	1024-57-3	3.0015	0.90045	ug/kg	30-150	30	30-150	50	50			
Endrin	72-20-8	0.667	0.27347	ug/kg	30-150	30	30-150	50	50			
Endrin aldehyde	7421-93-4	2.001	0.70035	ug/kg	30-150	30	30-150	50	50			
Endrin ketone	53494-70-5	1.6008	0.412206	ug/kg	30-150	30	30-150	50	50			
Dieldrin	60-57-1	1.0005	0.50025	ug/kg	30-150	30	30-150	50	50			
4,4'-DDE	72-55-9	1.6008	0.370185	ug/kg	30-150	30	30-150	50	50			
4,4'-DDD	72-54-8	1.6008	0.570952	ug/kg	30-150	30	30-150	50	50			
4,4'-DDT	50-29-3	3.0015	1.28731	ug/kg	30-150	30	30-150	50	50			
Endosulfan I	959-98-8	1.6008	0.378189	ug/kg	30-150	30	30-150	50	50			
Endosulfan II	33213-65-9	1.6008	0.534934	ug/kg	30-150	30	30-150	50	50			
Endosulfan sulfate	1031-07-8	0.667	0.317492	ug/kg	30-150	30	30-150	50	50			
Methoxychlor	72-43-5	3.0015	0.9338	ug/kg	30-150	30	30-150	50	50			
Toxaphene	8001-35-2	30.015	8.4042	ug/kg	30-150	30	30-150	50	50			
cis-Chlordane	5103-71-9	2.001	0.557612	ug/kg	30-150	30	30-150	50	50			
trans-Chlordane	5103-74-2	2.001	0.528264	ug/kg	30-150	30	30-150	50	50			
Chlordane	57-74-9	13.34	5.30265	ug/kg	30-150	30	30-150	50	50			
2,4,5,6-Tetrachloro-m-xylene	*877-09-8*									*30-150*		
Decachlorobiphenyl	*2051-24-3*									*30-150*		

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TCL PCBs - EPA 8082A (SOIL)

Holding Time: 14 days
Container/Sample Preservation: 1 - Glass 250ml/8oz unpreserved

Analyte	CAS #	RL	MDL	Units	LCS Criteria	LCS RPD	MS Criteria	MS RPD	Duplicate RPD	Surrogate Criteria		
Aroclor 1016	12674-11-2	33.5	2.9748	ug/kg	40-140	50	40-140	50	50			
Aroclor 1221	11104-28-2	33.5	3.3567	ug/kg	40-140	50	40-140	50	50			
Aroclor 1232	11141-16-5	33.5	7.102	ug/kg	40-140	50	40-140	50	50			
Aroclor 1242	53469-21-9	33.5	4.5158	ug/kg	40-140	50	40-140	50	50			
Aroclor 1248	12672-29-6	33.5	5.025	ug/kg	40-140	50	40-140	50	50			
Aroclor 1254	11097-69-1	33.5	3.6649	ug/kg	40-140	50	40-140	50	50			
Aroclor 1260	11096-82-5	33.5	6.1908	ug/kg	40-140	50	40-140	50	50			
Aroclor 1262	37324-23-5	33.5	4.2545	ug/kg	40-140	50	40-140	50	50			
Aroclor 1268	11100-14-4	33.5	3.4706	ug/kg	40-140	50	40-140	50	50			
PCBs, Total	1336-36-3	33.5	2.9748	ug/kg				50	50			
2,4,5,6-Tetrachloro-m-xylene	*877-09-8*									*30-150*		
Decachlorobiphenyl	*2051-24-3*									*30-150*		

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Herbicides -EPA 8151A (SOIL)

Holding Time: 14 days
Container/Sample Preservation: 1 - Glass 250ml/8oz unpreserved

Analyte	CAS #	RL	MDL	Units	LCS Criteria	LCS RPD	MS Criteria	MS RPD	Duplicate RPD	Surrogate Criteria		
2,4-D	94-75-7	0.1665	0.0104895	mg/kg	30-150	30	30-150	30	30			
2,4,5-T	93-76-5	0.1665	0.0051615	mg/kg	30-150	30	30-150	30	30			
2,4,5-TP (Silvex)	93-72-1	0.1665	0.0044289	mg/kg	30-150	30	30-150	30	30			
DCAA	*19719-28-9*									*30-150*		

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METALS by 6010D (SOIL)

Analyte	CAS #	RL	MDL	Units	LCS Criteria	LCS RPD	MS Criteria	MS RPD	Duplicate RPD	Surrogate Criteria	Holding Time	Container/Sample Preservation
Aluminum, Total	7429-90-5	4	1.08	mg/kg	48-151		75-125	20	20		180 days	Metals Only-Glass 60mL/2oz unpreserved
Antimony, Total	7440-36-0	2	0.152	mg/kg	1-208		75-125	20	20		180 days	Metals Only-Glass 60mL/2oz unpreserved
Arsenic, Total	7440-38-2	0.4	0.0832	mg/kg	79-121		75-125	20	20		180 days	Metals Only-Glass 60mL/2oz unpreserved
Barium, Total	7440-39-3	0.4	0.0696	mg/kg	83-117		75-125	20	20		180 days	Metals Only-Glass 60mL/2oz unpreserved
Beryllium, Total	7440-41-7	0.2	0.0132	mg/kg	83-117		75-125	20	20		180 days	Metals Only-Glass 60mL/2oz unpreserved
Cadmium, Total	7440-43-9	0.4	0.0392	mg/kg	83-117		75-125	20	20		180 days	Metals Only-Glass 60mL/2oz unpreserved
Calcium, Total	7440-70-2	4	1.4	mg/kg	81-119		75-125	20	20		180 days	Metals Only-Glass 60mL/2oz unpreserved
Chromium, Total	7440-47-3	0.4	0.0384	mg/kg	80-120		75-125	20	20		180 days	Metals Only-Glass 60mL/2oz unpreserved
Cobalt, Total	7440-48-4	0.8	0.0664	mg/kg	84-115		75-125	20	20		180 days	Metals Only-Glass 60mL/2oz unpreserved
Copper, Total	7440-50-8	0.4	0.1032	mg/kg	81-118		75-125	20	20		180 days	Metals Only-Glass 60mL/2oz unpreserved
Iron, Total	7439-89-6	2	0.3612	mg/kg	45-155		75-125	20	20		180 days	Metals Only-Glass 60mL/2oz unpreserved
Lead, Total	7439-92-1	2	0.1072	mg/kg	81-117		75-125	20	20		180 days	Metals Only-Glass 60mL/2oz unpreserved
Magnesium, Total	7439-95-4	4	0.616	mg/kg	76-124		75-125	20	20		180 days	Metals Only-Glass 60mL/2oz unpreserved
Manganese, Total	7439-96-5	0.4	0.0636	mg/kg	81-117		75-125	20	20		180 days	Metals Only-Glass 60mL/2oz unpreserved
Nickel, Total	7440-02-0	1	0.0968	mg/kg	83-117		75-125	20	20		180 days	Metals Only-Glass 60mL/2oz unpreserved
Potassium, Total	7440-09-7	100	5.76	mg/kg	71-129		75-125	20	20		180 days	Metals Only-Glass 60mL/2oz unpreserved
Selenium, Total	7782-49-2	0.8	0.1032	mg/kg	78-122		75-125	20	20		180 days	Metals Only-Glass 60mL/2oz unpreserved
Silver, Total	7440-22-4	0.4	0.1132	mg/kg	75-124		75-125	20	20		180 days	Metals Only-Glass 60mL/2oz unpreserved
Sodium, Total	7440-23-5	80	1.26	mg/kg	72-127		75-125	20	20		180 days	Metals Only-Glass 60mL/2oz unpreserved
Thallium, Total	7440-28-0	0.8	0.126	mg/kg	80-120		75-125	20	20		180 days	Metals Only-Glass 60mL/2oz unpreserved
Vanadium, Total	7440-62-2	0.4	0.0812	mg/kg	78-122		75-125	20	20		180 days	Metals Only-Glass 60mL/2oz unpreserved
Zinc, Total	7440-66-6	2	0.1172	mg/kg	82-118		75-125	20	20		180 days	Metals Only-Glass 60mL/2oz unpreserved

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METALS by 7471B (SOIL)

Analyte	CAS #	RL	MDL	Units	LCS Criteria	LCS RPD	MS Criteria	MS RPD	Duplicate RPD	Surrogate Criteria	Holding Time	Container/Sample Preservation
Mercury, Total	7439-97-6	0.08	0.05216	mg/kg	72-128		80-120	20	20		28 days	Metals Only-Glass 60mL/2oz unpreserved

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WETCHEM (SOIL)

Analyte	CAS #	RL	MDL	Units	LCS Criteria	LCS RPD	MS Criteria	MS RPD	Duplicate RPD	Method	Holding Time	Container/Sample Preservation
Chromium, Hexavalent	18540-29-9	0.8	0.16	mg/kg	80-120	20	75-125	20	20	7196A	30 days	1 - Glass 120ml/4oz unpreserved
Cyanide, Total	57-12-5	1	0.212	mg/kg	80-120	35	75-125	35	35	9010C/9012B	14 days	1 - Glass 250ml/8oz unpreserved

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NY PFAAs via LCMSMS-Isotope Dilution (SOIL)

Holding Time: 28 days
Container/Sample Preservation: 1 - Plastic 8oz unpreserved

Analyte	CAS #	RL	MDL	Units	LCS Criteria	LCS RPD	MS Criteria	MS RPD	Duplicate RPD	Surrogate Criteria		
Perfluorobutanoic Acid (PFBA)	375-22-4	1	0.0227	ug/kg	71-135	30	71-135	30	30			
Perfluoropentanoic Acid (PFPeA)	2706-90-3	1	0.046	ug/kg	69-132	30	69-132	30	30			
Perfluorobutanesulfonic Acid (PFBS)	375-73-5	1	0.039	ug/kg	72-128	30	72-128	30	30			
Perfluorohexanoic Acid (PFHxA)	307-24-4	1	0.0525	ug/kg	70-132	30	70-132	30	30			
Perfluoroheptanoic Acid (PFHpA)	375-85-9	1	0.0451	ug/kg	71-131	30	71-131	30	30			
Perfluorohexanesulfonic Acid (PFHxS)	355-46-4	1	0.0605	ug/kg	67-130	30	67-130	30	30			
Perfluorooctanoic Acid (PFOA)	335-67-1	1	0.0419	ug/kg	69-133	30	69-133	30	30			
1H,1H,2H,2H-Perfluorooctanesulfonic Acid (6:2FTS)	27619-97-2	1	0.1795	ug/kg	64-140	30	64-140	30	30			
Perfluoroheptanesulfonic Acid (PFHpS)	375-92-8	1	0.1365	ug/kg	70-132	30	70-132	30	30			
Perfluorononanoic Acid (PFNA)	375-95-1	1	0.075	ug/kg	72-129	30	72-129	30	30			
Perfluorooctanesulfonic Acid (PFOS)	1763-23-1	1	0.13	ug/kg	68-136	30	68-136	30	30			
Perfluorodecanoic Acid (PFDA)	335-76-2	1	0.067	ug/kg	69-133	30	69-133	30	30			
1H,1H,2H,2H-Perfluorodecanesulfonic Acid (8:2FTS)	39108-34-4	1	0.287	ug/kg	65-137	30	65-137	30	30			
N-Methyl Perfluorooctanesulfonamidoacetic Acid (NMeFOSA	2355-31-9	1	0.2015	ug/kg	63-144	30	63-144	30	30			
Perfluoroundecanoic Acid (PFUnA)	2058-94-8	1	0.0468	ug/kg	64-136	30	64-136	30	30			
Perfluorodecanesulfonic Acid (PFDS)	335-77-3	1	0.153	ug/kg	59-134	30	59-134	30	30			
Perfluorooctanesulfonamide (FOSA)	754-91-6	1	0.098	ug/kg	67-137	30	67-137	30	30			
N-Ethyl Perfluorooctanesulfonamidoacetic Acid (NEtFOSAA)	2991-50-6	1	0.0845	ug/kg	61-139	30	61-139	30	30			
Perfluorododecanoic Acid (PFDoA)	307-55-1	1	0.07	ug/kg	69-135	30	69-135	30	30			
Perfluorotridecanoic Acid (PFTrDA)	72629-94-8	1	0.2045	ug/kg	66-139	30	66-139	30	30			
Perfluorotetradecanoic Acid (PFTA)	376-06-7	1	0.054	ug/kg	69-133	30	69-133	30	30			
PFOA/PFOS, Total		1	0.0419	ug/kg				30	30			
Perfluoro[13C4]Butanoic Acid (MPFBA)	*NONE*									*60-153*		
Perfluoro[13C5]Pentanoic Acid (M5PFPEA)	*NONE*									*65-182*		
Perfluoro[2,3,4-13C3]Butanesulfonic Acid (M3PFBS)	*NONE*									*70-151*		
Perfluoro[1,2,3,4,6-13C5]Hexanoic Acid (M5PFHxA)	*NONE*									*61-147*		
Perfluoro[1,2,3,4-13C4]Heptanoic Acid (M4PFHpA)	*NONE*									*62-149*		
Perfluoro[1,2,3-13C3]Hexanesulfonic Acid (M3PFHxS)	*NONE*									*63-166*		
Perfluoro[13C8]Octanoic Acid (M8PFOA)	*NONE*									*62-152*		
1H,1H,2H,2H-Perfluoro[1,2-13C2]Octanesulfonic Acid (M2-	*NONE*									*32-182*		
Perfluoro[13C9]Nonanoic Acid (M9PFNA)	*NONE*									*61-154*		
Perfluoro[13C8]Octanesulfonic Acid (M8PFOS)	*NONE*									*65-151*		
Perfluoro[1,2,3,4,5,6-13C6]Decanoic Acid (M6PFDA)	*NONE*									*65-150*		
1H,1H,2H,2H-Perfluoro[1,2-13C2]Decanesulfonic Acid (M2-	*NONE*									*25-186*		
N-Deuteriomethylperfluoro-1-octanesulfonamidoacetic Acid	*NONE*									*45-137*		
Perfluoro[1,2,3,4,5,6,7-13C7]Undecanoic Acid (M7-PFUDA)	*NONE*									*64-158*		
Perfluoro[13C8]Octanesulfonamide (M8FOSA)	*NONE*									*1-125*		
N-Deuterioethylperfluoro-1-octanesulfonamidoacetic Acid (	*NONE*									*42-136*		
Perfluoro[1,2-13C2]Dodecanoic Acid (MPFDOA)	*NONE*									*56-148*		
Perfluoro[1,2-13C2]Tetradecanoic Acid (M2PFTEDA)	*NONE*									*26-160*		

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TCL Volatiles - EPA 8260C (WATER)

Holding Time: 14 days
Container/Sample Preservation: 3 - Vial HCl preserved

Analyte	CAS #	RL	MDL	Units	LCS Criteria	LCS RPD	MS Criteria	MS RPD	Duplicate RPD	Surrogate Criteria		
Methylene chloride	75-09-2	2.5	0.7	ug/l	70-130	20	70-130	20	20			
1,1-Dichloroethane	75-34-3	2.5	0.7	ug/l	70-130	20	70-130	20	20			
Chloroform	67-66-3	2.5	0.7	ug/l	70-130	20	70-130	20	20			
Carbon tetrachloride	56-23-5	0.5	0.134	ug/l	63-132	20	63-132	20	20			
1,2-Dichloropropane	78-87-5	1	0.137	ug/l	70-130	20	70-130	20	20			
Dibromochloromethane	124-48-1	0.5	0.149	ug/l	63-130	20	63-130	20	20			
1,1,2-Trichloroethane	79-00-5	1.5	0.5	ug/l	70-130	20	70-130	20	20			
Tetrachloroethene	127-18-4	0.5	0.181	ug/l	70-130	20	70-130	20	20			
Chlorobenzene	108-90-7	2.5	0.7	ug/l	75-130	20	75-130	20	20			
Trichlorofluoromethane	75-69-4	2.5	0.7	ug/l	62-150	20	62-150	20	20			
1,2-Dichloroethane	107-06-2	0.5	0.132	ug/l	70-130	20	70-130	20	20			
1,1,1-Trichloroethane	71-55-6	2.5	0.7	ug/l	67-130	20	67-130	20	20			
Bromodichloromethane	75-27-4	0.5	0.192	ug/l	67-130	20	67-130	20	20			
trans-1,3-Dichloropropene	10061-02-6	0.5	0.164	ug/l	70-130	20	70-130	20	20			
cis-1,3-Dichloropropene	10061-01-5	0.5	0.144	ug/l	70-130	20	70-130	20	20			
1,3-Dichloropropene, Total	542-75-6	0.5	0.144	ug/l				20	20			
1,1-Dichloropropene	563-58-6	2.5	0.7	ug/l	70-130	20	70-130	20	20			
Bromoform	75-25-2	2	0.65	ug/l	54-136	20	54-136	20	20			
1,1,2,2-Tetrachloroethane	79-34-5	0.5	0.167	ug/l	67-130	20	67-130	20	20			
Benzene	71-43-2	0.5	0.159	ug/l	70-130	20	70-130	20	20			
Toluene	108-88-3	2.5	0.7	ug/l	70-130	20	70-130	20	20			
Ethylbenzene	100-41-4	2.5	0.7	ug/l	70-130	20	70-130	20	20			
Chloromethane	74-87-3	2.5	0.7	ug/l	64-130	20	64-130	20	20			
Bromomethane	74-83-9	2.5	0.7	ug/l	39-139	20	39-139	20	20			
Vinyl chloride	75-01-4	1	0.0714	ug/l	55-140	20	55-140	20	20			
Chloroethane	75-00-3	2.5	0.7	ug/l	55-138	20	55-138	20	20			
1,1-Dichloroethene	75-35-4	0.5	0.169	ug/l	61-145	20	61-145	20	20			
trans-1,2-Dichloroethene	156-60-5	2.5	0.7	ug/l	70-130	20	70-130	20	20			
Trichloroethene	79-01-6	0.5	0.175	ug/l	70-130	20	70-130	20	20			
1,2-Dichlorobenzene	95-50-1	2.5	0.7	ug/l	70-130	20	70-130	20	20			
1,3-Dichlorobenzene	541-73-1	2.5	0.7	ug/l	70-130	20	70-130	20	20			
1,4-Dichlorobenzene	106-46-7	2.5	0.7	ug/l	70-130	20	70-130	20	20			
Methyl tert butyl ether	1634-04-4	2.5	0.7	ug/l	63-130	20	63-130	20	20			
p/m-Xylene	179601-23-1	2.5	0.7	ug/l	70-130	20	70-130	20	20			
o-Xylene	95-47-6	2.5	0.7	ug/l	70-130	20	70-130	20	20			
Xylene (Total)	1330-20-7	2.5	0.7	ug/l				20	20			
cis-1,2-Dichloroethene	156-59-2	2.5	0.7	ug/l	70-130	20	70-130	20	20			
1,2-Dichloroethene (total)	540-59-0	2.5	0.7	ug/l				20	20			
Dibromomethane	74-95-3	5	1	ug/l	70-130	20	70-130	20	20			
1,2,3-Trichloropropane	96-18-4	2.5	0.7	ug/l	64-130	20	64-130	20	20			
Acrylonitrile	107-13-1	5	1.5	ug/l	70-130	20	70-130	20	20			
Styrene	100-42-5	2.5	0.7	ug/l	70-130	20	70-130	20	20			

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Langan Engineering & Environmental

TCL Volatiles - EPA 8260C (WATER)

Holding Time: 14 days
Container/Sample Preservation: 3 - Vial HCl preserved

Analyte	CAS #	RL	MDL	Units	LCS Criteria	LCS RPD	MS Criteria	MS RPD	Duplicate RPD	Surrogate Criteria		
Dichlorodifluoromethane	75-71-8	5	1	ug/l	36-147	20	36-147	20	20			
Acetone	67-64-1	5	1.46	ug/l	58-148	20	58-148	20	20			
Carbon disulfide	75-15-0	5	1	ug/l	51-130	20	51-130	20	20			
2-Butanone	78-93-3	5	1.94	ug/l	63-138	20	63-138	20	20			
Vinyl acetate	108-05-4	5	1	ug/l	70-130	20	70-130	20	20			
4-Methyl-2-pentanone	108-10-1	5	1	ug/l	59-130	20	59-130	20	20			
2-Hexanone	591-78-6	5	1	ug/l	57-130	20	57-130	20	20			
Bromochloromethane	74-97-5	2.5	0.7	ug/l	70-130	20	70-130	20	20			
2,2-Dichloropropane	594-20-7	2.5	0.7	ug/l	63-133	20	63-133	20	20			
1,2-Dibromoethane	106-93-4	2	0.65	ug/l	70-130	20	70-130	20	20			
1,3-Dichloropropane	142-28-9	2.5	0.7	ug/l	70-130	20	70-130	20	20			
1,1,1,2-Tetrachloroethane	630-20-6	2.5	0.7	ug/l	64-130	20	64-130	20	20			
Bromobenzene	108-86-1	2.5	0.7	ug/l	70-130	20	70-130	20	20			
n-Butylbenzene	104-51-8	2.5	0.7	ug/l	53-136	20	53-136	20	20			
sec-Butylbenzene	135-98-8	2.5	0.7	ug/l	70-130	20	70-130	20	20			
tert-Butylbenzene	98-06-6	2.5	0.7	ug/l	70-130	20	70-130	20	20			
o-Chlorotoluene	95-49-8	2.5	0.7	ug/l	70-130	20	70-130	20	20			
p-Chlorotoluene	106-43-4	2.5	0.7	ug/l	70-130	20	70-130	20	20			
1,2-Dibromo-3-chloropropane	96-12-8	2.5	0.7	ug/l	41-144	20	41-144	20	20			
Hexachlorobutadiene	87-68-3	2.5	0.7	ug/l	63-130	20	63-130	20	20			
Isopropylbenzene	98-82-8	2.5	0.7	ug/l	70-130	20	70-130	20	20			
p-Isopropyltoluene	99-87-6	2.5	0.7	ug/l	70-130	20	70-130	20	20			
Naphthalene	91-20-3	2.5	0.7	ug/l	70-130	20	70-130	20	20			
n-Propylbenzene	103-65-1	2.5	0.7	ug/l	69-130	20	69-130	20	20			
1,2,3-Trichlorobenzene	87-61-6	2.5	0.7	ug/l	70-130	20	70-130	20	20			
1,2,4-Trichlorobenzene	120-82-1	2.5	0.7	ug/l	70-130	20	70-130	20	20			
1,3,5-Trimethylbenzene	108-67-8	2.5	0.7	ug/l	64-130	20	64-130	20	20			
1,2,4-Trimethylbenzene	95-63-6	2.5	0.7	ug/l	70-130	20	70-130	20	20			
1,4-Dioxane	123-91-1	250	60.8	ug/l	56-162	20	56-162	20	20			
1,4-Diethylbenzene	105-05-5	2	0.7	ug/l	70-130	20	70-130	20	20			
4-Ethyltoluene	622-96-8	2	0.7	ug/l	70-130	20	70-130	20	20			
1,2,4,5-Tetramethylbenzene	95-93-2	2	0.542	ug/l	70-130	20	70-130	20	20			
Ethyl ether	60-29-7	2.5	0.7	ug/l	59-134	20	59-134	20	20			
trans-1,4-Dichloro-2-butene	110-57-6	2.5	0.7	ug/l	70-130	20	70-130	20	20			
1,2-Dichloroethane-d4	*17060-07-0*									*70-130*		
Toluene-d8	*2037-26-5*									*70-130*		
4-Bromofluorobenzene	*460-00-4*									*70-130*		
Dibromofluoromethane	*1868-53-7*									*70-130*		

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NYTCL Semivolatiles - EPA 8270D (LVI) (WATER)

Holding Time: 7 days
Container/Sample Preservation: 2 - Amber 250ml unpreserved

Analyte	CAS #	RL	MDL	Units	LCS Criteria	LCS RPD	MS Criteria	MS RPD	Duplicate RPD	Surrogate Criteria		
Acenaphthene	83-32-9	2.002	0.44408	ug/l	37-111	30	37-111	30	30			
1,2,4-Trichlorobenzene	120-82-1	5.0232	0.49868	ug/l	39-98	30	39-98	30	30			
Hexachlorobenzene	118-74-1	2.002	0.46592	ug/l	40-140	30	40-140	30	30			
Bis(2-chloroethyl)ether	111-44-4	2.002	0.50596	ug/l	40-140	30	40-140	30	30			
2-Chloronaphthalene	91-58-7	2.002	0.4368	ug/l	40-140	30	40-140	30	30			
1,2-Dichlorobenzene	95-50-1	2.002	0.455	ug/l	40-140	30	40-140	30	30			
1,3-Dichlorobenzene	541-73-1	2.002	0.40404	ug/l	40-140	30	40-140	30	30			
1,4-Dichlorobenzene	106-46-7	2.002	0.43316	ug/l	36-97	30	36-97	30	30			
3,3'-Dichlorobenzidine	91-94-1	5.0232	1.62344	ug/l	40-140	30	40-140	30	30			
2,4-Dinitrotoluene	121-14-2	5.0232	1.1648	ug/l	48-143	30	48-143	30	30			
2,6-Dinitrotoluene	606-20-2	5.0232	0.93184	ug/l	40-140	30	40-140	30	30			
Fluoranthene	206-44-0	2.002	0.257348	ug/l	40-140	30	40-140	30	30			
4-Chlorophenyl phenyl ether	7005-72-3	2.002	0.48776	ug/l	40-140	30	40-140	30	30			
4-Bromophenyl phenyl ether	101-55-3	2.002	0.37856	ug/l	40-140	30	40-140	30	30			
Bis(2-chloroisopropyl)ether	108-60-1	2.002	0.5278	ug/l	40-140	30	40-140	30	30			
Bis(2-chloroethoxy)methane	111-91-1	5.0232	0.50232	ug/l	40-140	30	40-140	30	30			
Hexachlorobutadiene	87-68-3	2.002	0.65884	ug/l	40-140	30	40-140	30	30			
Hexachlorocyclopentadiene	77-47-4	20.02	0.68796	ug/l	40-140	30	40-140	30	30			
Hexachloroethane	67-72-1	2.002	0.58604	ug/l	40-140	30	40-140	30	30			
Isophorone	78-59-1	5.0232	1.20484	ug/l	40-140	30	40-140	30	30			
Naphthalene	91-20-3	2.002	0.46592	ug/l	40-140	30	40-140	30	30			
Nitrobenzene	98-95-3	2.002	0.77168	ug/l	40-140	30	40-140	30	30			
NitrosoDiPhenylAmine(NDPA)/DPA	86-30-6	2.002	0.4186	ug/l	40-140	30	40-140	30	30			
n-Nitrosodi-n-propylamine	621-64-7	5.0232	0.64428	ug/l	29-132	30	29-132	30	30			
Bis(2-Ethylhexyl)phthalate	117-81-7	3.003	1.53608	ug/l	40-140	30	40-140	30	30			
Butyl benzyl phthalate	85-68-7	5.0232	1.17208	ug/l	40-140	30	40-140	30	30			
Di-n-butylphthalate	84-74-2	5.0232	0.38948	ug/l	40-140	30	40-140	30	30			
Di-n-octylphthalate	117-84-0	5.0232	1.274	ug/l	40-140	30	40-140	30	30			
Diethyl phthalate	84-66-2	5.0232	0.3822	ug/l	40-140	30	40-140	30	30			
Dimethyl phthalate	131-11-3	5.0232	1.82	ug/l	40-140	30	40-140	30	30			
Benzo(a)anthracene	56-55-3	2.002	0.32578	ug/l	40-140	30	40-140	30	30			
Benzo(a)pyrene	50-32-8	2.002	0.40768	ug/l	40-140	30	40-140	30	30			
Benzo(b)fluoranthene	205-99-2	2.002	0.355264	ug/l	40-140	30	40-140	30	30			
Benzo(k)fluoranthene	207-08-9	2.002	0.37492	ug/l	40-140	30	40-140	30	30			
Chrysene	218-01-9	2.002	0.341068	ug/l	40-140	30	40-140	30	30			
Acenaphthylene	208-96-8	2.002	0.46592	ug/l	45-123	30	45-123	30	30			
Anthracene	120-12-7	2.002	0.32942	ug/l	40-140	30	40-140	30	30			
Benzo(ghi)perylene	191-24-2	2.002	0.296296	ug/l	40-140	30	40-140	30	30			
Fluorene	86-73-7	2.002	0.41496	ug/l	40-140	30	40-140	30	30			
Phenanthrene	85-01-8	2.002	0.33124	ug/l	40-140	30	40-140	30	30			
Dibenzo(a,h)anthracene	53-70-3	2.002	0.323232	ug/l	40-140	30	40-140	30	30			
Indeno(1,2,3-cd)Pyrene	193-39-5	2.002	0.39676	ug/l	40-140	30	40-140	30	30			

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Langan Engineering & Environmental

NYTCL Semivolatiles - EPA 8270D (LVI) (WATER)

Holding Time: 7 days
Container/Sample Preservation: 2 - Amber 250ml unpreserved

Analyte	CAS #	RL	MDL	Units	LCS Criteria	LCS RPD	MS Criteria	MS RPD	Duplicate RPD	Surrogate Criteria		
Pyrene	129-00-0	2.002	0.279552	ug/l	26-127	30	26-127	30	30			
Biphenyl	92-52-4	2.002	0.45864	ug/l	40-140	30	40-140	30	30			
4-Chloroaniline	106-47-8	5.0232	1.07016	ug/l	40-140	30	40-140	30	30			
2-Nitroaniline	88-74-4	5.0232	0.49868	ug/l	52-143	30	52-143	30	30			
3-Nitroaniline	99-09-2	5.0232	0.81536	ug/l	25-145	30	25-145	30	30			
4-Nitroaniline	100-01-6	5.0232	0.8008	ug/l	51-143	30	51-143	30	30			
Dibenzofuran	132-64-9	2.002	0.49868	ug/l	40-140	30	40-140	30	30			
2-Methylnaphthalene	91-57-6	2.002	0.455	ug/l	40-140	30	40-140	30	30			
Acetophenone	98-86-2	5.0232	0.5278	ug/l	39-129	30	39-129	30	30			
2,4,6-Trichlorophenol	88-06-2	5.0232	0.61152	ug/l	30-130	30	30-130	30	30			
P-Chloro-M-Cresol	59-50-7	2.002	0.35126	ug/l	23-97	30	23-97	30	30			
2-Chlorophenol	95-57-8	2.002	0.48048	ug/l	27-123	30	27-123	30	30			
2,4-Dichlorophenol	120-83-2	5.0232	0.41132	ug/l	30-130	30	30-130	30	30			
2,4-Dimethylphenol	105-67-9	5.0232	1.77996	ug/l	30-130	30	30-130	30	30			
2-Nitrophenol	88-75-5	10.01	0.84812	ug/l	30-130	30	30-130	30	30			
4-Nitrophenol	100-02-7	10.01	0.6734	ug/l	10-80	30	10-80	30	30			
2,4-Dinitrophenol	51-28-5	20.02	6.6612	ug/l	20-130	30	20-130	30	30			
4,6-Dinitro-o-cresol	534-52-1	10.01	1.81636	ug/l	20-164	30	20-164	30	30			
Pentachlorophenol	87-86-5	10.01	1.79452	ug/l	9-103	30	9-103	30	30			
Phenol	108-95-2	5.0232	0.56784	ug/l	12-110	30	12-110	30	30			
2-Methylphenol	95-48-7	5.0232	0.4914	ug/l	30-130	30	30-130	30	30			
3-Methylphenol/4-Methylphenol	108-39-4/106-44-5	5.0232	0.48048	ug/l	30-130	30	30-130	30	30			
2,4,5-Trichlorophenol	95-95-4	5.0232	0.77532	ug/l	30-130	30	30-130	30	30			
Benzoic Acid	65-85-0	50.232	2.66084	ug/l	10-164	30	10-164	30	30			
Benzyl Alcohol	100-51-6	2.002	0.58968	ug/l	26-116	30	26-116	30	30			
Carbazole	86-74-8	2.002	0.4914	ug/l	55-144	30	55-144	30	30			
2-Fluorophenol	*367-12-4*									*21-120*		
Phenol-d6	*13127-88-3*									*10-120*		
Nitrobenzene-d5	*4165-60-0*									*23-120*		
2-Fluorobiphenyl	*321-60-8*									*15-120*		
2,4,6-Tribromophenol	*118-79-6*									*10-120*		
4-Terphenyl-d14	*1718-51-0*									*41-149*		

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NYTCL Semivolatiles -EPA 8270D-SIM (LVI) (WATER)

Holding Time: 7 days
Container/Sample Preservation: 2 - Amber 250ml unpreserved

Analyte	CAS #	RL	MDL	Units	LCS Criteria	LCS RPD	MS Criteria	MS RPD	Duplicate RPD	Surrogate Criteria		
Acenaphthene	83-32-9	0.1001	0.01442168	ug/l	40-140	40	40-140	40	40			
2-Chloronaphthalene	91-58-7	0.2002	0.01804712	ug/l	40-140	40	40-140	40	40			
Fluoranthene	206-44-0	0.1001	0.02054052	ug/l	40-140	40	40-140	40	40			
Hexachlorobutadiene	87-68-3	0.5005	0.04674852	ug/l	40-140	40	40-140	40	40			
Naphthalene	91-20-3	0.1001	0.04882696	ug/l	40-140	40	40-140	40	40			
Benzo(a)anthracene	56-55-3	0.1001	0.0198198	ug/l	40-140	40	40-140	40	40			
Benzo(a)pyrene	50-32-8	0.1001	0.01493856	ug/l	40-140	40	40-140	40	40			
Benzo(b)fluoranthene	205-99-2	0.1001	0.01156792	ug/l	40-140	40	40-140	40	40			
Benzo(k)fluoranthene	207-08-9	0.1001	0.00889616	ug/l	40-140	40	40-140	40	40			
Chrysene	218-01-9	0.1001	0.01198288	ug/l	40-140	40	40-140	40	40			
Acenaphthylene	208-96-8	0.1001	0.01222676	ug/l	40-140	40	40-140	40	40			
Anthracene	120-12-7	0.1001	0.01450176	ug/l	40-140	40	40-140	40	40			
Benzo(ghi)perylene	191-24-2	0.1001	0.01365	ug/l	40-140	40	40-140	40	40			
Fluorene	86-73-7	0.1001	0.01456364	ug/l	40-140	40	40-140	40	40			
Phenanthrene	85-01-8	0.1001	0.02333604	ug/l	40-140	40	40-140	40	40			
Dibenzo(a,h)anthracene	53-70-3	0.1001	0.0127218	ug/l	40-140	40	40-140	40	40			
Indeno(1,2,3-cd)Pyrene	193-39-5	0.1001	0.01217216	ug/l	40-140	40	40-140	40	40			
Pyrene	129-00-0	0.1001	0.01902264	ug/l	40-140	40	40-140	40	40			
2-Methylnaphthalene	91-57-6	0.1001	0.02192372	ug/l	40-140	40	40-140	40	40			
Pentachlorophenol	87-86-5	0.8008	0.0143416	ug/l	40-140	40	40-140	40	40			
Hexachlorobenzene	118-74-1	0.8008	0.00938028	ug/l	40-140	40	40-140	40	40			
Hexachloroethane	67-72-1	0.8008	0.06320132	ug/l	40-140	40	40-140	40	40			
2-Fluorophenol	*367-12-4*									*21-120*		
Phenol-d6	*13127-88-3*									*10-120*		
Nitrobenzene-d5	*4165-60-0*									*23-120*		
2-Fluorobiphenyl	*321-60-8*									*15-120*		
2,4,6-Tribromophenol	*118-79-6*									*10-120*		
4-Terphenyl-d14	*1718-51-0*									*41-149*		

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Langan Engineering & Environmental

TCL Pesticides - EPA 8081B (WATER)

Holding Time: 7 days
Container/Sample Preservation: 2 - Amber 120ml unpreserved

Analyte	CAS #	RL	MDL	Units	LCS Criteria	LCS RPD	MS Criteria	MS RPD	Duplicate RPD	Surrogate Criteria		
Delta-BHC	319-86-8	0.02	0.00467	ug/l	30-150	20	30-150	30	30			
Lindane	58-89-9	0.02	0.00434	ug/l	30-150	20	30-150	30	30			
Alpha-BHC	319-84-6	0.02	0.00439	ug/l	30-150	20	30-150	30	30			
Beta-BHC	319-85-7	0.02	0.0056	ug/l	30-150	20	30-150	30	30			
Heptachlor	76-44-8	0.02	0.0031	ug/l	30-150	20	30-150	30	30			
Aldrin	309-00-2	0.02	0.00216	ug/l	30-150	20	30-150	30	30			
Heptachlor epoxide	1024-57-3	0.02	0.00415	ug/l	30-150	20	30-150	30	30			
Endrin	72-20-8	0.04	0.00429	ug/l	30-150	20	30-150	30	30			
Endrin aldehyde	7421-93-4	0.04	0.0081	ug/l	30-150	20	30-150	30	30			
Endrin ketone	53494-70-5	0.04	0.00477	ug/l	30-150	20	30-150	30	30			
Dieldrin	60-57-1	0.04	0.00429	ug/l	30-150	20	30-150	30	30			
4,4'-DDE	72-55-9	0.04	0.00381	ug/l	30-150	20	30-150	30	30			
4,4'-DDD	72-54-8	0.04	0.00464	ug/l	30-150	20	30-150	30	30			
4,4'-DDT	50-29-3	0.04	0.00432	ug/l	30-150	20	30-150	30	30			
Endosulfan I	959-98-8	0.02	0.00345	ug/l	30-150	20	30-150	30	30			
Endosulfan II	33213-65-9	0.04	0.00519	ug/l	30-150	20	30-150	30	30			
Endosulfan sulfate	1031-07-8	0.04	0.00481	ug/l	30-150	20	30-150	30	30			
Methoxychlor	72-43-5	0.2	0.00684	ug/l	30-150	20	30-150	30	30			
Toxaphene	8001-35-2	0.2	0.0627	ug/l	30-150	20	30-150	30	30			
cis-Chlordane	5103-71-9	0.02	0.00666	ug/l	30-150	20	30-150	30	30			
trans-Chlordane	5103-74-2	0.02	0.00627	ug/l	30-150	20	30-150	30	30			
Chlordane	57-74-9	0.2	0.0463	ug/l	30-150	20	30-150	30	30			
2,4,5,6-Tetrachloro-m-xylene	*877-09-8*									*30-150*		
Decachlorobiphenyl	*2051-24-3*									*30-150*		

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Langan Engineering & Environmental

TCL PCBs - EPA 8082A (LVI) (WATER)

Holding Time: 7 days
Container/Sample Preservation: 2 - Amber 120ml unpreserved

Analyte	CAS #	RL	MDL	Units	LCS Criteria	LCS RPD	MS Criteria	MS RPD	Duplicate RPD	Surrogate Criteria		
Aroclor 1016	12674-11-2	0.082824	0.0344148	ug/l	40-140	50	40-140	50	50			
Aroclor 1221	11104-28-2	0.082824	0.0664734	ug/l	40-140	50	40-140	50	50			
Aroclor 1232	11141-16-5	0.082824	0.0455532	ug/l	40-140	50	40-140	50	50			
Aroclor 1242	53469-21-9	0.082824	0.0387702	ug/l	40-140	50	40-140	50	50			
Aroclor 1248	12672-29-6	0.082824	0.048909	ug/l	40-140	50	40-140	50	50			
Aroclor 1254	11097-69-1	0.082824	0.0390558	ug/l	40-140	50	40-140	50	50			
Aroclor 1260	11096-82-5	0.082824	0.0320586	ug/l	40-140	50	40-140	50	50			
Aroclor 1262	37324-23-5	0.082824	0.0347718	ug/l	40-140	50	40-140	50	50			
Aroclor 1268	11100-14-4	0.082824	0.0334866	ug/l	40-140	50	40-140	50	50			
PCBs, Total	1336-36-3	0.082824	0.0320586	ug/l				50	50			
2,4,5,6-Tetrachloro-m-xylene	*877-09-8*									*30-150*		
Decachlorobiphenyl	*2051-24-3*									*30-150*		

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Herbicides -EPA 8151A (WATER)

Holding Time: 7 days
Container/Sample Preservation: 2 - Amber 1000ml unpreserved

Analyte	CAS #	RL	MDL	Units	LCS Criteria	LCS RPD	MS Criteria	MS RPD	Duplicate RPD	Surrogate Criteria		
2,4-D	94-75-7	10	0.498	ug/l	30-150	25	30-150	25	25			
2,4,5-T	93-76-5	2	0.531	ug/l	30-150	25	30-150	25	25			
2,4,5-TP (Silvex)	93-72-1	2	0.539	ug/l	30-150	25	30-150	25	25			
DCAA	*19719-28-9*									*30-150*		

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METALS by 6020B (WATER)

Analyte	CAS #	RL	MDL	Units	LCS Criteria	LCS RPD	MS Criteria	MS RPD	Duplicate RPD	Surrogate Criteria	Holding Time	Container/Sample Preservation
Aluminum, Total	7429-90-5	0.01	0.00327	mg/l	80-120		75-125	20	20		180 days	1 - Plastic 500ml HNO3 preserved
Antimony, Total	7440-36-0	0.004	0.000429	mg/l	80-120		75-125	20	20		180 days	1 - Plastic 500ml HNO3 preserved
Arsenic, Total	7440-38-2	0.0005	0.000165	mg/l	80-120		75-125	20	20		180 days	1 - Plastic 500ml HNO3 preserved
Barium, Total	7440-39-3	0.0005	0.000173	mg/l	80-120		75-125	20	20		180 days	1 - Plastic 500ml HNO3 preserved
Beryllium, Total	7440-41-7	0.0005	0.000107	mg/l	80-120		75-125	20	20		180 days	1 - Plastic 500ml HNO3 preserved
Cadmium, Total	7440-43-9	0.0002	0.0000599	mg/l	80-120		75-125	20	20		180 days	1 - Plastic 500ml HNO3 preserved
Calcium, Total	7440-70-2	0.1	0.0394	mg/l	80-120		75-125	20	20		180 days	1 - Plastic 500ml HNO3 preserved
Chromium, Total	7440-47-3	0.001	0.000178	mg/l	80-120		75-125	20	20		180 days	1 - Plastic 500ml HNO3 preserved
Cobalt, Total	7440-48-4	0.0005	0.000163	mg/l	80-120		75-125	20	20		180 days	1 - Plastic 500ml HNO3 preserved
Copper, Total	7440-50-8	0.001	0.000384	mg/l	80-120		75-125	20	20		180 days	1 - Plastic 500ml HNO3 preserved
Iron, Total	7439-89-6	0.05	0.0191	mg/l	80-120		75-125	20	20		180 days	1 - Plastic 500ml HNO3 preserved
Lead, Total	7439-92-1	0.001	0.000343	mg/l	80-120		75-125	20	20		180 days	1 - Plastic 500ml HNO3 preserved
Magnesium, Total	7439-95-4	0.07	0.0242	mg/l	80-120		75-125	20	20		180 days	1 - Plastic 500ml HNO3 preserved
Manganese, Total	7439-96-5	0.001	0.00044	mg/l	80-120		75-125	20	20		180 days	1 - Plastic 500ml HNO3 preserved
Nickel, Total	7440-02-0	0.002	0.000556	mg/l	80-120		75-125	20	20		180 days	1 - Plastic 500ml HNO3 preserved
Potassium, Total	7440-09-7	0.1	0.0309	mg/l	80-120		75-125	20	20		180 days	1 - Plastic 500ml HNO3 preserved
Selenium, Total	7782-49-2	0.005	0.00173	mg/l	80-120		75-125	20	20		180 days	1 - Plastic 500ml HNO3 preserved
Silver, Total	7440-22-4	0.0004	0.000163	mg/l	80-120		75-125	20	20		180 days	1 - Plastic 500ml HNO3 preserved
Sodium, Total	7440-23-5	0.1	0.0293	mg/l	80-120		75-125	20	20		180 days	1 - Plastic 500ml HNO3 preserved
Thallium, Total	7440-28-0	0.0005	0.000143	mg/l	80-120		75-125	20	20		180 days	1 - Plastic 500ml HNO3 preserved
Vanadium, Total	7440-62-2	0.005	0.00157	mg/l	80-120		75-125	20	20		180 days	1 - Plastic 500ml HNO3 preserved
Zinc, Total	7440-66-6	0.01	0.00341	mg/l	80-120		75-125	20	20		180 days	1 - Plastic 500ml HNO3 preserved

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METALS by 7470A (WATER)

Analyte	CAS #	RL	MDL	Units	LCS Criteria	LCS RPD	MS Criteria	MS RPD	Duplicate RPD	Surrogate Criteria	Holding Time	Container/Sample Preservation
Mercury, Total	7439-97-6	0.0002	0.0000915	mg/l	80-120		75-125	20	20		28 days	1 - Plastic 500ml HNO3 preserved

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WETCHEM (WATER)

Analyte	CAS #	RL	MDL	Units	LCS Criteria	LCS RPD	MS Criteria	MS RPD	Duplicate RPD	Method	Holding Time	Container/Sample Preservation
Chromium, Hexavalent	18540-29-9	0.01	0.003	mg/l	85-115	20	85-115	20	20	7196A	24 hours	1 - Plastic 500ml unpreserved
Cyanide, Total	57-12-5	0.005	0.0018	mg/l	85-115	20	80-120	20	20	9010C/9012B	14 days	1 - Plastic 250ml NaOH preserved

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1,4 Dioxane via EPA 8270D-SIM (WATER)

Holding Time: 7 days
Container/Sample Preservation: 2 - Amber 250ml unpreserved

Analyte	CAS #	RL	MDL	Units	LCS Criteria	LCS RPD	MS Criteria	MS RPD	Duplicate RPD	Surrogate Criteria		
1,4-Dioxane	123-91-1	150	33.9	ng/l	40-140	30	40-140	30	30			
1,4-Dioxane-d8	*17647-74-4*									*15-110*		
1,4-Dioxane-d8 (IS)	17647-74-4			ng/l								

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NY PFAAs via LCMSMS-Isotope Dilution (WATER)

Holding Time: 14 days
Container/Sample Preservation: 1 - 2 Plastic/1 Plastic/1 H20 Plastic

Analyte	CAS #	RL	MDL	Units	LCS Criteria	LCS RPD	MS Criteria	MS RPD	Duplicate RPD	Surrogate Criteria		
Perfluorobutanoic Acid (PFBA)	375-22-4	2	0.408	ng/l	67-148	30	67-148	30	30			
Perfluoropentanoic Acid (PFPeA)	2706-90-3	2	0.396	ng/l	63-161	30	63-161	30	30			
Perfluorobutanesulfonic Acid (PFBS)	375-73-5	2	0.238	ng/l	65-157	30	65-157	30	30			
Perfluorohexanoic Acid (PFHxA)	307-24-4	2	0.328	ng/l	69-168	30	69-168	30	30			
Perfluoroheptanoic Acid (PFHpA)	375-85-9	2	0.2252	ng/l	58-159	30	58-159	30	30			
Perfluorohexanesulfonic Acid (PFHxS)	355-46-4	2	0.376	ng/l	69-177	30	69-177	30	30			
Perfluorooctanoic Acid (PFOA)	335-67-1	2	0.236	ng/l	63-159	30	63-159	30	30			
1H,1H,2H,2H-Perfluorooctanesulfonic Acid (6:2FTS)	27619-97-2	2	1.332	ng/l	49-187	30	49-187	30	30			
Perfluoroheptanesulfonic Acid (PFHpS)	375-92-8	2	0.688	ng/l	61-179	30	61-179	30	30			
Perfluorononanoic Acid (PFNA)	375-95-1	2	0.312	ng/l	68-171	30	68-171	30	30			
Perfluorooctanesulfonic Acid (PFOS)	1763-23-1	2	0.504	ng/l	52-151	30	52-151	30	30			
Perfluorodecanoic Acid (PFDA)	335-76-2	2	0.304	ng/l	63-171	30	63-171	30	30			
1H,1H,2H,2H-Perfluorodecanesulfonic Acid (8:2FTS)	39108-34-4	2	1.212	ng/l	56-173	30	56-173	30	30			
N-Methyl Perfluorooctanesulfonamidoacetic Acid (NMeFOSA	2355-31-9	2	0.648	ng/l	60-166	30	60-166	30	30			
Perfluoroundecanoic Acid (PFUnA)	2058-94-8	2	0.26	ng/l	60-153	30	60-153	30	30			
Perfluorodecanesulfonic Acid (PFDS)	335-77-3	2	0.98	ng/l	38-156	30	38-156	30	30			
Perfluorooctanesulfonamide (FOSA)	754-91-6	2	0.58	ng/l	46-170	30	46-170	30	30			
N-Ethyl Perfluorooctanesulfonamidoacetic Acid (NEtFOSAA)	2991-50-6	2	0.804	ng/l	45-170	30	45-170	30	30			
Perfluorododecanoic Acid (PFDoA)	307-55-1	2	0.372	ng/l	67-153	30	67-153	30	30			
Perfluorotridecanoic Acid (PFTrDA)	72629-94-8	2	0.3272	ng/l	48-158	30	48-158	30	30			
Perfluorotetradecanoic Acid (PFTA)	376-06-7	2	0.248	ng/l	59-182	30	59-182	30	30			
PFOA/PFOS, Total		2	0.236	ng/l				30	30			
Perfluoro[13C4]Butanoic Acid (MPFBA)	*NONE*									*2-156*		
Perfluoro[13C5]Pentanoic Acid (M5PFPEA)	*NONE*									*16-173*		
Perfluoro[2,3,4-13C3]Butanesulfonic Acid (M3PFBS)	*NONE*									*31-159*		
Perfluoro[1,2,3,4,6-13C5]Hexanoic Acid (M5PFHxA)	*NONE*									*21-145*		
Perfluoro[1,2,3,4-13C4]Heptanoic Acid (M4PFHpA)	*NONE*									*30-139*		
Perfluoro[1,2,3-13C3]Hexanesulfonic Acid (M3PFHxS)	*NONE*									*47-153*		
Perfluoro[13C8]Octanoic Acid (M8PFOA)	*NONE*									*36-149*		
1H,1H,2H,2H-Perfluoro[1,2-13C2]Octanesulfonic Acid (M2-	*NONE*									*1-244*		
Perfluoro[13C9]Nonanoic Acid (M9PFNA)	*NONE*									*34-146*		
Perfluoro[13C8]Octanesulfonic Acid (M8PFOS)	*NONE*									*42-146*		
Perfluoro[1,2,3,4,5,6-13C6]Decanoic Acid (M6PFDA)	*NONE*									*38-144*		
1H,1H,2H,2H-Perfluoro[1,2-13C2]Decanesulfonic Acid (M2-	*NONE*									*7-170*		
N-Deuteriomethylperfluoro-1-octanesulfonamidoacetic Acid	*NONE*									*1-181*		
Perfluoro[1,2,3,4,5,6,7-13C7]Undecanoic Acid (M7-PFUDA)	*NONE*									*40-144*		
Perfluoro[13C8]Octanesulfonamide (M8FOSA)	*NONE*									*1-87*		
N-Deuterioethylperfluoro-1-octanesulfonamidoacetic Acid (	*NONE*									*23-146*		
Perfluoro[1,2-13C2]Dodecanoic Acid (MPFDOA)	*NONE*									*24-161*		
Perfluoro[1,2-13C2]Tetradecanoic Acid (M2PFTEDA)	*NONE*									*33-143*		

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Volatile Organics in Air: TO-15 (SOIL_VAPOR)

Holding Time: 30 days
Container/Sample Preservation: 1 - Canister - 2.7 Liter

Analyte	CAS #	RL	MDL	Units	LCS Criteria	LCS RPD	MS Criteria	MS RPD	Duplicate RPD	Surrogate Criteria		
1,1,1-Trichloroethane	71-55-6	0.2	0.0501	ppbV	70-130			25	25			
1,1,2,2-Tetrachloroethane	79-34-5	0.2	0.0614	ppbV	70-130			25	25			
1,1,2-Trichloroethane	79-00-5	0.2	0.067	ppbV	70-130			25	25			
1,1-Dichloroethane	75-34-3	0.2	0.0628	ppbV	70-130			25	25			
1,1-Dichloroethene	75-35-4	0.2	0.0643	ppbV	70-130			25	25			
1,2,3-Trimethylbenzene	526-73-8	0.2	0.0576	ppbV	70-130			25	25			
1,2,4-Trichlorobenzene	120-82-1	0.2	0.0674	ppbV	70-130			25	25			
1,2,4-Trimethylbenzene	95-63-6	0.2	0.0368	ppbV	70-130			25	25			
1,2,4,5-Tetramethylbenzene	95-93-2	0.2	0.0604	ppbV	70-130			25	25			
1,2-Dibromoethane	106-93-4	0.2	0.0561	ppbV	70-130			25	25			
1,2-Dichlorobenzene	95-50-1	0.2	0.0628	ppbV	70-130			25	25			
1,2-Dichloroethane	107-06-2	0.2	0.0602	ppbV	70-130			25	25			
1,2-Dichloropropane	78-87-5	0.2	0.061	ppbV	70-130			25	25			
1,3,5-Trimethylbenzene	108-67-8	0.2	0.0675	ppbV	70-130			25	25			
1,3-Butadiene	106-99-0	0.2	0.067	ppbV	70-130			25	25			
1,3-Dichlorobenzene	541-73-1	0.2	0.0627	ppbV	70-130			25	25			
1,4-Dichlorobenzene	106-46-7	0.2	0.0636	ppbV	70-130			25	25			
1,4-Dioxane	123-91-1	0.2	0.0805	ppbV	70-130			25	25			
2,2,4-Trimethylpentane	540-84-1	0.2	0.0361	ppbV	70-130			25	25			
2-Butanone	78-93-3	0.5	0.0482	ppbV	70-130			25	25			
2-Hexanone	591-78-6	0.2	0.0648	ppbV	70-130			25	25			
2-Methylthiophene	554-14-3	0.2	0.0524	ppbV	70-130			25	25			
3-Methylthiophene	616-44-4	0.2	0.0393	ppbV	70-130			25	25			
3-Chloropropene	107-05-1	0.2	0.0585	ppbV	70-130			25	25			
2-Ethylthiophene	872-55-9	0.2	0.0407	ppbV	70-130			25	25			
4-Ethyltoluene	622-96-8	0.2	0.037	ppbV	70-130			25	25			
Acetone	67-64-1	1	0.689	ppbV	40-160			25	25			
Benzene	71-43-2	0.2	0.0487	ppbV	70-130			25	25			
Benzyl chloride	100-44-7	0.2	0.0482	ppbV	70-130			25	25			
Benzothiophene	95-15-8	0.5	0.077	ppbV	70-130			25	25			
Bromodichloromethane	75-27-4	0.2	0.0504	ppbV	70-130			25	25			
Bromoform	75-25-2	0.2	0.0641	ppbV	70-130			25	25			
Bromomethane	74-83-9	0.2	0.0773	ppbV	70-130			25	25			
Carbon disulfide	75-15-0	0.2	0.0559	ppbV	70-130			25	25			
Carbon tetrachloride	56-23-5	0.2	0.0499	ppbV	70-130			25	25			
Chlorobenzene	108-90-7	0.2	0.0624	ppbV	70-130			25	25			
Chloroethane	75-00-3	0.2	0.0805	ppbV	70-130			25	25			
Chloroform	67-66-3	0.2	0.0633	ppbV	70-130			25	25			
Chloromethane	74-87-3	0.2	0.0689	ppbV	70-130			25	25			
cis-1,2-Dichloroethene	156-59-2	0.2	0.117	ppbV	70-130			25	25			
cis-1,3-Dichloropropene	10061-01-5	0.2	0.0409	ppbV	70-130			25	25			
Cyclohexane	110-82-7	0.2	0.0368	ppbV	70-130			25	25			

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Volatile Organics in Air: TO-15 (SOIL_VAPOR)

Holding Time: 30 days
Container/Sample Preservation: 1 - Canister - 2.7 Liter

Analyte	CAS #	RL	MDL	Units	LCS Criteria	LCS RPD	MS Criteria	MS RPD	Duplicate RPD	Surrogate Criteria		
Dibromochloromethane	124-48-1	0.2	0.0614	ppbV	70-130			25	25			
Dichlorodifluoromethane	75-71-8	0.2	0.0583	ppbV	70-130			25	25			
Ethyl Alcohol	64-17-5	5	0.733	ppbV	40-160			25	25			
Ethyl Acetate	141-78-6	0.5	0.122	ppbV	70-130			25	25			
Ethylbenzene	100-41-4	0.2	0.0432	ppbV	70-130			25	25			
1,1,2-Trichloro-1,2,2-Trifluoroethane	76-13-1	0.2	0.0656	ppbV	70-130			25	25			
1,2-Dichloro-1,1,2,2-tetrafluoroethane	76-14-2	0.2	0.0591	ppbV	70-130			25	25			
Hexachlorobutadiene	87-68-3	0.2	0.0529	ppbV	70-130			25	25			
iso-Propyl Alcohol	67-63-0	0.5	0.478	ppbV	40-160			25	25			
Methylene chloride	75-09-2	0.5	0.134	ppbV	70-130			25	25			
4-Methyl-2-pentanone	108-10-1	0.5	0.0421	ppbV	70-130			25	25			
Methyl tert butyl ether	1634-04-4	0.2	0.0525	ppbV	70-130			25	25			
Methyl Methacrylate	80-62-6	0.5	0.0697	ppbV	40-160			25	25			
p/m-Xylene	179601-23-1	0.4	0.091	ppbV	70-130			25	25			
o-Xylene	95-47-6	0.2	0.0453	ppbV	70-130			25	25			
Xylene (Total)	1330-20-7	0.2	0.0453	ppbV				25	25			
Heptane	142-82-5	0.2	0.047	ppbV	70-130			25	25			
n-Heptane	142-82-5	0.2	0.047	ppbV	70-130			25	25			
n-Hexane	110-54-3	0.2	0.0364	ppbV	70-130			25	25			
Propylene	115-07-1	0.5	0.0599	ppbV	70-130			25	25			
Styrene	100-42-5	0.2	0.0434	ppbV	70-130			25	25			
Tetrachloroethene	127-18-4	0.2	0.0655	ppbV	70-130			25	25			
Thiophene	110-02-1	0.2	0.0389	ppbV	70-130			25	25			
Tetrahydrofuran	109-99-9	0.5	0.0568	ppbV	70-130			25	25			
Toluene	108-88-3	0.2	0.052	ppbV	70-130			25	25			
trans-1,2-Dichloroethene	156-60-5	0.2	0.0643	ppbV	70-130			25	25			
1,2-Dichloroethene (total)	540-59-0	0.2	0.0643	ppbV				25	25			
trans-1,3-Dichloropropene	10061-02-6	0.2	0.0436	ppbV	70-130			25	25			
1,3-Dichloropropene, Total	542-75-6	0.2	0.0409	ppbV				25	25			
Trichloroethene	79-01-6	0.2	0.0505	ppbV	70-130			25	25			
Trichlorofluoromethane	75-69-4	0.2	0.0686	ppbV	70-130			25	25			
Vinyl acetate	108-05-4	1	0.0479	ppbV	70-130			25	25			
Vinyl bromide	593-60-2	0.2	0.0717	ppbV	70-130			25	25			
Vinyl chloride	75-01-4	0.2	0.0627	ppbV	70-130			25	25			
Naphthalene	91-20-3	0.2	0.0885	ppbV	70-130			25	25			
Total HC As Hexane	NONE	10	0.0364	ppbV	70-130			25	25			
Total VOCs As Toluene	NONE	10	0.052	ppbV	70-130			25	25			
Propane	74-98-6	0.5	0.132	ppbV	70-130			25	25			
Acrylonitrile	107-13-1	0.5	0.0555	ppbV	70-130			25	25			
Acrolein	107-02-8	0.5	0.0596	ppbV	70-130			25	25			
1,1,1,2-Tetrachloroethane	630-20-6	0.2	0.0561	ppbV	70-130			25	25			
Isopropylbenzene	98-82-8	0.2	0.0491	ppbV	70-130			25	25			

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Langan Engineering & Environmental

Volatile Organics in Air: TO-15 (SOIL_VAPOR)

Holding Time: 30 days
Container/Sample Preservation: 1 - Canister - 2.7 Liter

Analyte	CAS #	RL	MDL	Units	LCS Criteria	LCS RPD	MS Criteria	MS RPD	Duplicate RPD	Surrogate Criteria		
1,2,3-Trichloropropane	96-18-4	0.2	0.061	ppbV	70-130			25	25			
Acetonitrile	75-05-8	0.2	0.082	ppbV	70-130			25	25			
Bromobenzene	108-86-1	0.2	0.0613	ppbV	70-130			25	25			
Chlorodifluoromethane	75-45-6	0.2	0.0584	ppbV	70-130			25	25			
Dichlorofluoromethane	75-43-4	0.2	0.0807	ppbV	70-130			25	25			
Dibromomethane	74-95-3	0.2	0.0563	ppbV	70-130			25	25			
Pentane	109-66-0	0.2	0.0659	ppbV	70-130			25	25			
Octane	111-65-9	0.2	0.0445	ppbV	70-130			25	25			
Tertiary-Amyl Methyl Ether	994-05-8	0.2	0.0476	ppbV	70-130			25	25			
o-Chlorotoluene	95-49-8	0.2	0.0486	ppbV	70-130			25	25			
p-Chlorotoluene	106-43-4	0.2	0.056	ppbV	70-130			25	25			
2,2-Dichloropropane	594-20-7	0.2	0.0458	ppbV	70-130			25	25			
1,1-Dichloropropene	563-58-6	0.2	0.0457	ppbV	70-130			25	25			
Isopropyl Ether	108-20-3	0.2	0.0621	ppbV	70-130			25	25			
Ethyl-Tert-Butyl-Ether	637-92-3	0.2	0.0422	ppbV	70-130			25	25			
1,2,3-Trichlorobenzene	87-61-6	0.2	0.0715	ppbV	70-130			25	25			
Ethyl ether	60-29-7	0.2	0.0737	ppbV	70-130			25	25			
n-Butylbenzene	104-51-8	0.2	0.044	ppbV	70-130			25	25			
sec-Butylbenzene	135-98-8	0.2	0.0429	ppbV	70-130			25	25			
tert-Butylbenzene	98-06-6	0.2	0.042	ppbV	70-130			25	25			
1,2-Dibromo-3-chloropropane	96-12-8	0.2	0.0495	ppbV	70-130			25	25			
p-Isopropyltoluene	99-87-6	0.2	0.052	ppbV	70-130			25	25			
n-Propylbenzene	103-65-1	0.2	0.0419	ppbV	70-130			25	25			
1,3-Dichloropropane	142-28-9	0.2	0.106	ppbV	70-130			25	25			
Methanol	67-56-1	5	1.84	ppbV	70-130			25	25			
Acetaldehyde	75-07-0	2.5	0.444	ppbV	70-130			25	25			
Butane	106-97-8	0.2	0.0646	ppbV	70-130			25	25			
Nonane (C9)	111-84-2	0.2	0.0463	ppbV	70-130			25	25			
Decane (C10)	124-18-5	0.2	0.0404	ppbV	70-130			25	25			
Undecane	1120-21-4	0.2	0.0427	ppbV	70-130			25	25			
Indane	496-11-7	0.2	0.0507	ppbV	70-130			25	25			
Indene	95-13-6	0.2	0.0433	ppbV	70-130			25	25			
1-Methylnaphthalene	90-12-0	1	0.466	ppbV	70-130			25	25			
Dodecane (C12)	112-40-3	0.2	0.0658	ppbV	70-130			25	25			
Butyl Acetate	123-86-4	0.5	0.126	ppbV	70-130			25	25			
tert-Butyl Alcohol	75-65-0	0.5	0.0466	ppbV	70-130			25	25			
2-Methylnaphthalene	91-57-6	1	0.393	ppbV	70-130			25	25			
1,2-Dichloroethane-d4	*17060-07-0*									*70-130*		
Toluene-d8	*2037-26-5*									*70-130*		
Bromofluorobenzene	*460-00-4*									*70-130*		

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File: PM8519-1

Langan Engineering & Environmental

Volatile Organics in Air: TO-15 (AIR)

Holding Time: 30 days
Container/Sample Preservation: 1 - Canister - 2.7 Liter

Analyte	CAS #	RL	MDL	Units	LCS Criteria	LCS RPD	MS Criteria	MS RPD	Duplicate RPD	Surrogate Criteria		
1,1,1-Trichloroethane	71-55-6	0.2	0.0501	ppbV	70-130			25	25			
1,1,2,2-Tetrachloroethane	79-34-5	0.2	0.0614	ppbV	70-130			25	25			
1,1,2-Trichloroethane	79-00-5	0.2	0.067	ppbV	70-130			25	25			
1,1-Dichloroethane	75-34-3	0.2	0.0628	ppbV	70-130			25	25			
1,1-Dichloroethene	75-35-4	0.2	0.0643	ppbV	70-130			25	25			
1,2,3-Trimethylbenzene	526-73-8	0.2	0.0576	ppbV	70-130			25	25			
1,2,4-Trichlorobenzene	120-82-1	0.2	0.0674	ppbV	70-130			25	25			
1,2,4-Trimethylbenzene	95-63-6	0.2	0.0368	ppbV	70-130			25	25			
1,2,4,5-Tetramethylbenzene	95-93-2	0.2	0.0604	ppbV	70-130			25	25			
1,2-Dibromoethane	106-93-4	0.2	0.0561	ppbV	70-130			25	25			
1,2-Dichlorobenzene	95-50-1	0.2	0.0628	ppbV	70-130			25	25			
1,2-Dichloroethane	107-06-2	0.2	0.0602	ppbV	70-130			25	25			
1,2-Dichloropropane	78-87-5	0.2	0.061	ppbV	70-130			25	25			
1,3,5-Trimethylbenzene	108-67-8	0.2	0.0675	ppbV	70-130			25	25			
1,3-Butadiene	106-99-0	0.2	0.067	ppbV	70-130			25	25			
1,3-Dichlorobenzene	541-73-1	0.2	0.0627	ppbV	70-130			25	25			
1,4-Dichlorobenzene	106-46-7	0.2	0.0636	ppbV	70-130			25	25			
1,4-Dioxane	123-91-1	0.2	0.0805	ppbV	70-130			25	25			
2,2,4-Trimethylpentane	540-84-1	0.2	0.0361	ppbV	70-130			25	25			
2-Butanone	78-93-3	0.5	0.0482	ppbV	70-130			25	25			
2-Hexanone	591-78-6	0.2	0.0648	ppbV	70-130			25	25			
2-Methylthiophene	554-14-3	0.2	0.0524	ppbV	70-130			25	25			
3-Methylthiophene	616-44-4	0.2	0.0393	ppbV	70-130			25	25			
3-Chloropropene	107-05-1	0.2	0.0585	ppbV	70-130			25	25			
2-Ethylthiophene	872-55-9	0.2	0.0407	ppbV	70-130			25	25			
4-Ethyltoluene	622-96-8	0.2	0.037	ppbV	70-130			25	25			
Acetone	67-64-1	1	0.689	ppbV	40-160			25	25			
Benzene	71-43-2	0.2	0.0487	ppbV	70-130			25	25			
Benzyl chloride	100-44-7	0.2	0.0482	ppbV	70-130			25	25			
Benzothiophene	95-15-8	0.5	0.077	ppbV	70-130			25	25			
Bromodichloromethane	75-27-4	0.2	0.0504	ppbV	70-130			25	25			
Bromoform	75-25-2	0.2	0.0641	ppbV	70-130			25	25			
Bromomethane	74-83-9	0.2	0.0773	ppbV	70-130			25	25			
Carbon disulfide	75-15-0	0.2	0.0559	ppbV	70-130			25	25			
Carbon tetrachloride	56-23-5	0.2	0.0499	ppbV	70-130			25	25			
Chlorobenzene	108-90-7	0.2	0.0624	ppbV	70-130			25	25			
Chloroethane	75-00-3	0.2	0.0805	ppbV	70-130			25	25			
Chloroform	67-66-3	0.2	0.0633	ppbV	70-130			25	25			
Chloromethane	74-87-3	0.2	0.0689	ppbV	70-130			25	25			
cis-1,2-Dichloroethene	156-59-2	0.2	0.117	ppbV	70-130			25	25			
cis-1,3-Dichloropropene	10061-01-5	0.2	0.0409	ppbV	70-130			25	25			
Cyclohexane	110-82-7	0.2	0.0368	ppbV	70-130			25	25			

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Langan Engineering & Environmental

Volatile Organics in Air: TO-15 (AIR)

Holding Time: 30 days
Container/Sample Preservation: 1 - Canister - 2.7 Liter

Analyte	CAS #	RL	MDL	Units	LCS Criteria	LCS RPD	MS Criteria	MS RPD	Duplicate RPD	Surrogate Criteria		
Dibromochloromethane	124-48-1	0.2	0.0614	ppbV	70-130			25	25			
Dichlorodifluoromethane	75-71-8	0.2	0.0583	ppbV	70-130			25	25			
Ethyl Alcohol	64-17-5	5	0.733	ppbV	40-160			25	25			
Ethyl Acetate	141-78-6	0.5	0.122	ppbV	70-130			25	25			
Ethylbenzene	100-41-4	0.2	0.0432	ppbV	70-130			25	25			
1,1,2-Trichloro-1,2,2-Trifluoroethane	76-13-1	0.2	0.0656	ppbV	70-130			25	25			
1,2-Dichloro-1,1,2,2-tetrafluoroethane	76-14-2	0.2	0.0591	ppbV	70-130			25	25			
Hexachlorobutadiene	87-68-3	0.2	0.0529	ppbV	70-130			25	25			
iso-Propyl Alcohol	67-63-0	0.5	0.478	ppbV	40-160			25	25			
Methylene chloride	75-09-2	0.5	0.134	ppbV	70-130			25	25			
4-Methyl-2-pentanone	108-10-1	0.5	0.0421	ppbV	70-130			25	25			
Methyl tert butyl ether	1634-04-4	0.2	0.0525	ppbV	70-130			25	25			
Methyl Methacrylate	80-62-6	0.5	0.0697	ppbV	40-160			25	25			
p/m-Xylene	179601-23-1	0.4	0.091	ppbV	70-130			25	25			
o-Xylene	95-47-6	0.2	0.0453	ppbV	70-130			25	25			
Xylene (Total)	1330-20-7	0.2	0.0453	ppbV				25	25			
Heptane	142-82-5	0.2	0.047	ppbV	70-130			25	25			
n-Heptane	142-82-5	0.2	0.047	ppbV	70-130			25	25			
n-Hexane	110-54-3	0.2	0.0364	ppbV	70-130			25	25			
Propylene	115-07-1	0.5	0.0599	ppbV	70-130			25	25			
Styrene	100-42-5	0.2	0.0434	ppbV	70-130			25	25			
Tetrachloroethene	127-18-4	0.2	0.0655	ppbV	70-130			25	25			
Thiophene	110-02-1	0.2	0.0389	ppbV	70-130			25	25			
Tetrahydrofuran	109-99-9	0.5	0.0568	ppbV	70-130			25	25			
Toluene	108-88-3	0.2	0.052	ppbV	70-130			25	25			
trans-1,2-Dichloroethene	156-60-5	0.2	0.0643	ppbV	70-130			25	25			
1,2-Dichloroethene (total)	540-59-0	0.2	0.0643	ppbV				25	25			
trans-1,3-Dichloropropene	10061-02-6	0.2	0.0436	ppbV	70-130			25	25			
1,3-Dichloropropene, Total	542-75-6	0.2	0.0409	ppbV				25	25			
Trichloroethene	79-01-6	0.2	0.0505	ppbV	70-130			25	25			
Trichlorofluoromethane	75-69-4	0.2	0.0686	ppbV	70-130			25	25			
Vinyl acetate	108-05-4	1	0.0479	ppbV	70-130			25	25			
Vinyl bromide	593-60-2	0.2	0.0717	ppbV	70-130			25	25			
Vinyl chloride	75-01-4	0.2	0.0627	ppbV	70-130			25	25			
Naphthalene	91-20-3	0.2	0.0885	ppbV	70-130			25	25			
Total HC As Hexane	NONE	10	0.0364	ppbV	70-130			25	25			
Total VOCs As Toluene	NONE	10	0.052	ppbV	70-130			25	25			
Propane	74-98-6	0.5	0.132	ppbV	70-130			25	25			
Acrylonitrile	107-13-1	0.5	0.0555	ppbV	70-130			25	25			
Acrolein	107-02-8	0.5	0.0596	ppbV	70-130			25	25			
1,1,1,2-Tetrachloroethane	630-20-6	0.2	0.0561	ppbV	70-130			25	25			
Isopropylbenzene	98-82-8	0.2	0.0491	ppbV	70-130			25	25			

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Volatile Organics in Air: TO-15 (AIR)

Holding Time: 30 days
Container/Sample Preservation: 1 - Canister - 2.7 Liter

Analyte	CAS #	RL	MDL	Units	LCS Criteria	LCS RPD	MS Criteria	MS RPD	Duplicate RPD	Surrogate Criteria		
1,2,3-Trichloropropane	96-18-4	0.2	0.061	ppbV	70-130			25	25			
Acetonitrile	75-05-8	0.2	0.082	ppbV	70-130			25	25			
Bromobenzene	108-86-1	0.2	0.0613	ppbV	70-130			25	25			
Chlorodifluoromethane	75-45-6	0.2	0.0584	ppbV	70-130			25	25			
Dichlorofluoromethane	75-43-4	0.2	0.0807	ppbV	70-130			25	25			
Dibromomethane	74-95-3	0.2	0.0563	ppbV	70-130			25	25			
Pentane	109-66-0	0.2	0.0659	ppbV	70-130			25	25			
Octane	111-65-9	0.2	0.0445	ppbV	70-130			25	25			
Tertiary-Amyl Methyl Ether	994-05-8	0.2	0.0476	ppbV	70-130			25	25			
o-Chlorotoluene	95-49-8	0.2	0.0486	ppbV	70-130			25	25			
p-Chlorotoluene	106-43-4	0.2	0.056	ppbV	70-130			25	25			
2,2-Dichloropropane	594-20-7	0.2	0.0458	ppbV	70-130			25	25			
1,1-Dichloropropene	563-58-6	0.2	0.0457	ppbV	70-130			25	25			
Isopropyl Ether	108-20-3	0.2	0.0621	ppbV	70-130			25	25			
Ethyl-Tert-Butyl-Ether	637-92-3	0.2	0.0422	ppbV	70-130			25	25			
1,2,3-Trichlorobenzene	87-61-6	0.2	0.0715	ppbV	70-130			25	25			
Ethyl ether	60-29-7	0.2	0.0737	ppbV	70-130			25	25			
n-Butylbenzene	104-51-8	0.2	0.044	ppbV	70-130			25	25			
sec-Butylbenzene	135-98-8	0.2	0.0429	ppbV	70-130			25	25			
tert-Butylbenzene	98-06-6	0.2	0.042	ppbV	70-130			25	25			
1,2-Dibromo-3-chloropropane	96-12-8	0.2	0.0495	ppbV	70-130			25	25			
p-Isopropyltoluene	99-87-6	0.2	0.052	ppbV	70-130			25	25			
n-Propylbenzene	103-65-1	0.2	0.0419	ppbV	70-130			25	25			
1,3-Dichloropropane	142-28-9	0.2	0.106	ppbV	70-130			25	25			
Methanol	67-56-1	5	1.84	ppbV	70-130			25	25			
Acetaldehyde	75-07-0	2.5	0.444	ppbV	70-130			25	25			
Butane	106-97-8	0.2	0.0646	ppbV	70-130			25	25			
Nonane (C9)	111-84-2	0.2	0.0463	ppbV	70-130			25	25			
Decane (C10)	124-18-5	0.2	0.0404	ppbV	70-130			25	25			
Undecane	1120-21-4	0.2	0.0427	ppbV	70-130			25	25			
Indane	496-11-7	0.2	0.0507	ppbV	70-130			25	25			
Indene	95-13-6	0.2	0.0433	ppbV	70-130			25	25			
1-Methylnaphthalene	90-12-0	1	0.466	ppbV	70-130			25	25			
Dodecane (C12)	112-40-3	0.2	0.0658	ppbV	70-130			25	25			
Butyl Acetate	123-86-4	0.5	0.126	ppbV	70-130			25	25			
tert-Butyl Alcohol	75-65-0	0.5	0.0466	ppbV	70-130			25	25			
2-Methylnaphthalene	91-57-6	1	0.393	ppbV	70-130			25	25			
1,2-Dichloroethane-d4	*17060-07-0*									*70-130*		
Toluene-d8	*2037-26-5*									*70-130*		
Bromofluorobenzene	*460-00-4*									*70-130*		

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Volatile Organics in Air by TO-15 SIM (AIR)

Holding Time: 30 days
Container/Sample Preservation: 1 - Canister - 2.7 Liter

Analyte	CAS #	RL	MDL	Units	LCS Criteria	LCS RPD	MS Criteria	MS RPD	Duplicate RPD	Surrogate Criteria		
1,1,1-Trichloroethane	71-55-6	0.02	0.0083	ppbV	70-130	25		25	25			
1,1-Dichloroethene	75-35-4	0.02	0.0084	ppbV	70-130	25		25	25			
Carbon tetrachloride	56-23-5	0.02	0.01	ppbV	70-130	25		25	25			
cis-1,2-Dichloroethene	156-59-2	0.02	0.0096	ppbV	70-130	25		25	25			
Tetrachloroethene	127-18-4	0.02	0.0078	ppbV	70-130	25		25	25			
Trichloroethene	79-01-6	0.02	0.0062	ppbV	70-130	25		25	25			
Vinyl chloride	75-01-4	0.02	0.0072	ppbV	70-130	25		25	25			
1,2-Dichloroethane-d4	*17060-07-0*									*70-130*		
Toluene-d8	*2037-26-5*									*70-130*		
Bromofluorobenzene	*460-00-4*									*70-130*		

Please Note that the RL information provided in this table is calculated using a 100% Solids factor (Soil/Solids only)
Please Note that the information provided in this table is subject to change at anytime at the discretion of Alpha Analytical, In

ATTACHMENT B

RESUMES

ALEXIS HALEY

STAFF ENGINEER

ENVIRONMENTAL ENGINEERING

Ms. Haley is an environmental engineer with experience in air permitting and compliance, construction monitoring, environmental site assessments, sample collection, report writing, and due diligence.

SELECTED PROJECTS

- Astoria Steel, Quarterly Groundwater Sampling, Astoria, NY
- 1400 Ferris Place, MOSF Decommissioning Oversight, Bronx, NY
- Hudson Highlands Fjord Trail, Site Reconnaissance and Limited Subsurface Investigation, Beacon, NY
- 473 President Street, AS/SVE Pilot Testing, Brooklyn, NY
- 1095 Southern Boulevard, Phase I ESA Report, Emerging Contaminant Sampling and Letter Report, Bronx, NY
- 24 Woodward Avenue, Tank Closure Report and Remedial Oversight, Ridgewood, NY
- Block 4 Parcel, Tank Closure Report, New York, NY
- 250 Water Street, Remedial Investigation, New York, NY
- 50 Pennsylvania Avenue, Construction Oversight, Brooklyn, NY
- 126 Nassau Street, Waste Characterization Investigation, New York, NY
- 320 West 31st Street, Remedial Investigation Work Plan Report, New York, NY
- 160-02 Liberty Avenue, Phase I ESA Report, Jamaica, NY

SELECTED PUBLICATIONS, REPORTS, AND PRESENTATIONS

Beatty M.E.S., Gillette E.I., Haley A.T., “Controlling the Relative Fluxes of Protons and Oxygen to Electrocatalytic Buried Interfaces with Tunable Silicon Oxide Overlayers.” *Applied Energy Materials*.

EDUCATION

M.S., Chemical Engineering
Columbia University

B.S., Chemistry
(Physics and Mathematics Minors)
St. Lawrence University

PROFESSIONAL REGISTRATION

10-Hour OSHA

40-Hour OSHA
HAZWOPER

Anthony Moffa, Jr., ASP, CHMM, COSS

Associate/Corporate Health and Safety Manager

Anthony is Langan's Corporate Health & Safety Manager and is responsible for managing health and safety compliance in all Langan office locations. He has over 15 years experience in the health and safety field. He is responsible for ensuring compliance with all federal and state occupational health and safety laws and development and implementation of corporate health and safety policies. Responsibilities include reviewing and updating Langan's Corporate Health and Safety Program and assisting employees in the development of site specific Health & Safety Plans. He maintains and manages health and safety records for employees in all Langan office locations including medical evaluations, respirator fit testing, and Hazardous Waste Operations and Emergency Response training. He is also responsible for documentation and investigation of work-related injuries and incidents and sharing this information with employees to assist in the prevention of future incidents. He is also the chairman of the Corporate Health & Safety Committee and Health & Safety Leadership Team that meet periodically throughout the year. He is responsible for coordinating and providing health and safe training to Langan employees. He was formerly the Environmental, Health and Safety Coordinator at a chemical manufacturer. His experience included employee hazard communications, development of material safety data sheets for developed products, respirator fit testing and conducting required Occupational Health & Safety Association and Department of Transportation training.

Education

B.S., Physics
West Chester University

Professional Registration

Associate Safety Professional (ASP)

Certified Hazardous Material Manager (CHMM)

Certified Occupational Safety Specialist (COSS)

Affiliations

Pennsylvania Chamber of Business & Industry

Chemical Council of New Jersey

New Jersey Business & Industry Association

Geoprofessional Business Association

Certifications and Training

Hazardous Waste Operations and Emergency Response Training

OSHA Site Supervisor Training

10 & 30-Hour Construction Safety & Health Training

30-Hour Construction Safety & Health Training

10-Hour Industry Safety & Health Training

Confined Space Awareness & Entry

Competent Person in Excavations

Hazard Communications

Defensive Driving Training

LANGAN

WILLIAM BOHRER, PG

PROJECT GEOLOGIST

GEOLOGIST

Mr. Bohrer is an experienced geologist responsible for managing Langan's environmental standards and Health and Safety compliance for projects throughout New York City. His services include dissemination of environmental protocols, troubleshooting at project sites, in-house/field training, and maintenance of quality standards across the environmental discipline. Mr. Bohrer has a diverse and extensive background in geophysics, hydrogeology, mining and petroleum, and geotechnical engineering. He has developed conceptual site models for public, industrial and commercial facilities nationwide.

SELECTED PROJECTS

- NYU Poly – 122 Johnson Street, Brooklyn, NY
- Con Edison of New York at Governor's Island, NY, NY
- 535 4th Avenue, Brooklyn, NY
- 27 Wooster Street, New York, NY
- 42 West Street, Brooklyn, NY
- 455 West 19th Street, New York, NY
- Kings Plaza Mall, Brooklyn, NY
- Hudson Yards "Terra Firma," New York, NY
- Hudson Yards, Platform Special Inspection, New York, NY
- PSAC II, Bronx, NY
- 595-647 Smith Street, Brooklyn, NY
- New York University, 7-13 Washington Square North Investigation, New York, NY
- NYU 4 Washington Square Village, New York, NY
- 125th Street and Lenox Avenue, New York, NY
- Sullivan Street Development, New York, NY
- Hudson Crossing II, New York, NY
- New York Aquarium, Shark Tank & Animal Care Facility, Brooklyn, NY
- 209-219 Sullivan Street, New York, NY
- 261 Hudson Street, New York, NY
- 460 Washington Street, New York, NY
- 552 West 24th Street, New York, NY
- Brooklyn Bridge Park Pier 1, New York, NY
- International Leadership Bronx Charter School, Bronx, NY
- 203 East 92nd Street, New York, NY
- HighLine 28-29, New York, NY
- 539 Smith Street Bulkhead, Brooklyn, NY
- Willets Point, Corona, NY
- Plume Migration and Fracture Flow Aquifer Investigation, Brunswick, MD
- Plume Migration and Fracture Flow Aquifer Investigation, Fallston, MD
- Emergency Response Site Investigation & Remediation, Wappingers Falls, NY
- Emergency Response Site Investigation & Remediation, Allentown, PA

EDUCATION

Post Graduate Studies in Geophysics
Cornell University

B.S., Geology
Tufts University

PROFESSIONAL REGISTRATION

Professional Geologist (PG) in NY

40 Hour OSHA HazWOPER

OSHA Construction Safety & Health

OSHA Supervisory Certification Credential (TWIC)

Transportation Worker Identification

NYS DEC- Protecting New York's Natural Resources with Better Construction Site Management

AFFILIATIONS

American Association of Petroleum Geologists

National Groundwater Association

Geological Society of America

LANGAN

- Emergency Response Site Investigation & Remediation, Shamokin, PA
- Bermuda International Airport, Jet Fuel Release Investigation, Bermuda
- Little Missouri River Basin, Geotechnical Site Evaluation (Horizontal Drilling Pipeline Install), ND
- Seismic Susceptibility Evaluation (Class 2 Injection Wells), Litchfield, OH
- Bedrock Mapping, Bradford and Sullivan Counties, PA
- Soil Solidification, Carteret, NJ

PA Council of Professional Geologists

RYAN MANDERBACH, CHMM

SENIOR ASSOCIATE/VP

ENVIRONMENTAL ENGINEERING & SITE ASSESSMENTS

Mr. Manderbach has experience in New York, New Jersey, Massachusetts, Maine, Rhode Island, New Hampshire, and Connecticut. His recent experience includes New York State Department of Environmental Conservation (NYSDEC) Brownfield Cleanup, Voluntary Cleanup and Spill Programs, and New York City Office of Environmental Remediation (OER) E-designated site investigation, and remediation. He has managed and performed Phase I and II Environmental Site Assessments; Underground Storage Tank (UST) removals and closures; soil vapor intrusion investigations; and site investigations and remediation. He also has extensive experience with Hazard Ranking System (HRS) evaluations, site assessments, removal actions, and emergency response activities under the EPA Regions I and II Superfund program.

SELECTED PROJECTS

- Brownfield Redevelopment, 520 West 41st Street, New York, NY
- Waterline Square, Mixed-Use Development, New York, NY
- Brownfield Redevelopment, 267-273 West 87th Street, New York, NY
- Brownfield Redevelopment, 225 33rd Street, Brooklyn, NY
- River Place Residential, SMP Implementation, New York, NY
- Mixed-Use Educational/Residential Development, New York, NY
- Public Safety Answering Center (PSAC) II, Bronx, NY
- American Copper Buildings (616 First Avenue), New York, NY
- Environmental Assessments at 430 East 92nd Street, New York, NY
- Environmental Assessments at 125th Street and Lenox, New York, NY
- Hotel at 70 Park Avenue, New York, NY
- Environmental Due Diligence at Mixed-Use Development, 85 Jay Street, Brooklyn, NY
- 346 Broadway Due Diligence, New York, NY
- Liberty Brass Site, 38-01 Queens Boulevard, Long Island City, NY
- Environmental Remediation, 42 West Street Residential, Brooklyn, NY
- Brownfield Redevelopment, 335 Bond Street, Brooklyn, NY
- Residences at 540 West 21st Street, New York, NY
- International Leadership Bronx Charter School, Bronx, NY
- President Street Properties, Brooklyn, NY
- Residential Development, 43-30 24th Street, Long Island City, NY
- Mixed-Use Condominium, 505-513 West 43rd Street, New York, NY
- 685 First Avenue, New York, NY
- Columbia University, Manhattanville Development, New York, NY
- The Shops at Atlas Park, Glendale, NY
- 536 West 41st Street, New York, NY
- 100 West 125th Street, New York, NY
- 11 North Moore Street, New York, NY
- 290 West Street, New York, NY

EDUCATION

B.A., Environmental Analysis and Policy
Boston University

PROFESSIONAL REGISTRATION

Certified Hazardous Materials Manager (CHMM)

40 Hour HAZWOPER

AFFILIATIONS

New York Building Congress (NYBC), Young Professionals Committee

American Council of Engineering Companies of New York (ACEC NY) – Emerging Leaders Committee

- City University of New York (CUNY), John Jay College Expansion, New York, NY
- Queens West Development, Long Island City, NY
- United Nations Capital Master Plan, New York, NY
- Former Air Products and Chemicals, Inc. Facility, Middlesex, NJ
- Lower Manhattan Indoor Dust Test and Clean Program, New York, NY
- Former Buckbee-Mears Facility, Cortland, NY
- Old Landfill, Norton, MA
- Boulter Farm Area, Cumberland, RI
- Hollingsworth & Vose Co., Walpole, MA
- Chlor-Alkali Facility (Former), Berlin, NH
- Limerick Mill Complex, Limerick, ME
- Danielson Pike Chlorinated Solvent Sites, Scituate, RI
- Tiogue Lake Sediment Contamination Site, Coventry, RI
- Atlas Copco Sites, Holyoke, MA
- Fisherville Mill, Grafton MA
- Hurricane Katrina Federal Disaster Response, New Orleans, LA
- Hurricane Ike Federal Disaster Response, Pasadena, TX
- 1752 Shore Parkway, Brooklyn, NY
- 27 Wooster Street, Residential Building, New York, NY
- Innovation QNS, Mixed-Use Development, Astoria, NY
- 42 West Street, Brooklyn, NY

JOSEPH YANOWITZ

SENIOR STAFF ENGINEER

ENVIRONMENTAL ENGINEERING

Mr. Yanowitz is an environmental engineer working in the NY Metro area and has provided cleanup services for sites in New York and New Jersey. He has experience with projects in the New York State Department of Environmental Conservation (NYSDEC) Brownfield Cleanup Program (BCP), Voluntary Cleanup Program (VCP) and Spill Programs, and New York City Office of Environmental Remediation (NYCOER) "E" Designated and VCP sites. His field experience includes conducting Phase II Environmental Site Investigations (ESI), remedial investigations, and indoor air quality analysis Investigations, and performing remediation oversight. Mr. Yanowitz's most recent experience includes the preparation of Phase I Environmental Site Assessment (ESA), investigation reports, and investigation work plans, management of NYSDEC BCP remediation projects and NYSDEC spill remediation projects, design of submembrane depressurization systems (SMDS), and development of remediation work plans.

EDUCATION

B.S., Environmental Engineering
State University of New York at Buffalo

PROFESSIONAL REGISTRATION

40-Hour OSHA HAZWOPER

10-Hour OSHA

SELECTED PROJECTS

- The Shops at Atlas Park – Parcel B, NYSDEC BCP Site Management Plan Project Management, Queens, NY
- Columbia University Manhattanville, Chemical Injection Oversight and NYSDEC Spill Remediation Project Management, New York, NY
- 40-36 24th Street, Phase II ESI and NYCOER VCP Remedial Investigation, Remedial Investigation Report, Remedial Action Work Plan, and Site Remediation Project Management, Long Island City, NY
- 250 Water Street, Phase I ESA and NYSDEC BCP Application and Remedial Investigation Report, New York, NY
- 1 Huron Street, SMDS designs, Brooklyn, NY
- 27-01 Jackson Avenue, NYSDEC BCP Application, Remedial Investigation Report, and Remedial Action Work Plan, Long Island City, NY
- 26-32 Jackson Avenue, NYSDEC BCP Application, Remedial Investigation, Remedial Investigation Report, and Remedial Action Work Plan, Long Island City, NY
- Brooklyn Navy Yard Dock 72, Environmental Oversight in Accordance with NYSDEC VCP Site Management Plan, Brooklyn, NY
- Riverside Center Parcel 1, 3 and 4, NYCOER VCP Remediation/Construction Oversight and Community Air Monitoring Program New York, NY
- Confidential Client, Hexavalent Chromium and MGP Remediation Oversight and Project Management, Jersey City, NJ
- Buffalo River Sediment Dredging, Buffalo, NY
- Naval Weapons Industrial Reserve Plant (NWIR)–Bethpage Grumman Aerospace Corp., Northtrop Grumman Corporation, Bethpage, NY

MARLA MILLER, PE, BCEE

SENIOR PROJECT ENGINEER

ENVIRONMENTAL ENGINEERING

Ms. Miller has over 19 years of experience managing site characterization and remediation projects. She is a senior environmental engineer experienced in environmental permitting, industrial pretreatment, compliance monitoring, and water quality evaluation. She has a strong background in data validation, laboratory analyses, and sampling procedures for soil, water, and air matrices. Her expertise in data interpretation includes natural attenuation monitoring, petroleum hydrocarbon chromatography, and aqueous geochemistry.

SELECTED PROJECTS

Data Validation

- St. Joseph's Parish Redevelopment Data Quality Assessment (DQA) and Data Usability (DUE) preparation, New York, NY
- 175 – 225 3rd Street Data Usability Summary Report (DUSR), Brooklyn, NY
- 805 – 825 Atlantic Ave DUSR, Brooklyn, NY
- John Evans Superfund Site DUSR, Lansdale, PA
- 50 North Road (Nokia Chester), DQA and DUE preparation, Chester, NJ
- Data Validation/Data Management for Brownfields Site Assessment, Port St. Joe, FL*

Industrial Wastewater Pretreatment

- Industrial Wastewater Discharge Limit Development, Inland Empire Utilities Agency (IEUA), CA*
- Local Limits Study, Hopewell, VA*
- Local Limits Study, Mesa, AZ*
- Local Limits Development and Sewer Use Ordinance Development, Prescott, AZ*
- Implementation of Industrial Pretreatment Program, Prescott, AZ*
- Industrial Pretreatment Development, Queen Creek, AZ*
- Selenium Wastewater Treatment Options for Meat Packing Facility, Tolleson, AZ*
- Arizona Pollutant Discharge Elimination System (AZPDES) Permit Application Preparation, Phoenix, AZ
- Preparation of Sampling and Analysis Plan for Sub-Regional Operating Group (SROG) Local Limits Development, Phoenix and Surrounding Cities, AZ

EDUCATION

M.S., Environmental Engineering
University of California, Berkeley

B.S., Biology
Loyola Marymount University

PROFESSIONAL REGISTRATION

Professional Engineer (PE) in AZ

Board Certified Environmental Engineer (BCEE) – Hazardous Waste Management (09-10019)

CERTIFICATIONS

The Wastewater Treatment, Wastewater Collection, and Water Distribution Operator Certification

Grade 2
Water Treatment Operator Certification Grade 1

Backflow Tester Certification (AABP)

*Denotes projects performed prior to employment at Langan

Site Investigation/Remediation/Compliance

- Arizona Electric Power Cooperative (AEPCO) Apache Generating Station Arizona Protection Permit (APP), Wilcox, AZ
- Arizona Department of Environmental Quality (ADEQ) Water Quality Assurance Revolving Fund (WQARF) Projects, Phoenix and Gilbert, AZ
- Long-Term Monitoring Program and 5-Year CERCLA Review, Luke Air Force Base (AFB), Glendale, AZ*
- Development of Stormwater Prevention Pollution Plan (SWPPP) and Stormwater Flow Modeling, Luke AFB, Glendale, AZ*
- Site Investigation and Clean Closure for Confidential Industrial Client, Tempe, AZ*
- RCRA Facility Investigation/Corrective Measures Assessment, San Jose, CA*
- Technical Resource for X-Ray Fluorescence (XRF) Field Screening Program for Former Small Arms Firing Range, Nogales, AZ*
- Designed and Implemented Sampling Procedures for Volatile Emissions from Tailings Impoundment Using Flux Chambers, Henderson, CO*
- Conceptual Site Model and Statistical Evaluation for Water Treatment Plant, Denver, CO*

Mining Project

- Third-Party Construction Quality Assurance (CQA) for Geotextile-Lined Tailings Repository, Casa Grande, AZ*
- CQA For Reclamation at Smelter, Miami, AZ*
- XRF Field Screening for Excavation at Former Smelter Site, El Paso, TX*
- CQA for Reclamation Projects at Active Smelter, Miami, AZ

ATTACHMENT C

ANALYTICAL METHODS/
QUALITY ASSURANCE SUMMARY TABLE

ATTACHMENT C

ANALYTICAL METHODS/QUALITY ASSURANCE SUMMARY TABLE

Matrix Type	Field Parameters	Laboratory Parameters	Analytical Methods	Sample Preservation	Sample Container Volume and Type	Sample Hold Time	Field Duplicate Samples	Field Blank Samples	Trip Blank Samples	Ambient Air Samples	MS/MSD Samples
Soil	Total VOCs via PID	Part 375 + TCL VOCs	EPA 8260C	Cool to 4°C	Two 40-ml VOC vials with 5ml H_2O, one with MeOH or 3 En Core Samplers (separate container for % solids)	14 days if froze to -7 C° or extruded into methanol (vials); 48 hours otherwise (En Cores)	1 per 20 samples (minimum 1)	1 per 20 samples (minimum 1)	1 per Shipment of VOC samples	NA	1 per 20 samples
		Part 375 + TCL SVOCs	EPA 8270D	Cool to 4°C	4 oz. amber glass jar	14 days extract, 40 days after extraction to analysis			NA		
		Part 375 + TAL Metals	EPA 6010D, EPA 7471B, EPA 7196A	Cool to 4°C	2 oz. amber glass jar	6 months, except mercury 28 days					
		Hexavalent Chromium	EPA 7196A	Cool to 4°C	4 oz. amber glass jar	30 days					
		Cyanide	EPA 9010C/9012B	Cool to 4°C	8 oz. amber glass jar	14 days					
		Part 375 + TCL Pesticides	EPA 8081B	Cool to 4°C	4 oz. amber glass jar	14 days extract, 40 days after extraction to analysis					
		Part 375 + TCL Herbicides	EPA 8151A	Cool to 4°C	8 oz. amber glass jar	14 days					
		Part 375 + TCL PCBs	EPA 8082A	Cool to 4°C	4 oz. amber glass jar	14 days extract, 40 days after extraction to analysis					
Groundwater	Temperature, Turbidity, pH, ORP, Conductivity	Part 375 + TCL VOCs	EPA 8260C	Cool to 4°C; HCl to pH <2; no headspace	Three 40-mL VOC vials with Teflon® -lined cap	Analyze within 14 days of collection	1 per 20 samples (minimum 1)	1 per 20 samples (minimum 1)	1 per Shipment of VOC samples	NA	1 per 20 samples
		Part 375 + TCL SVOCs	EPA 8270D and 8270D with SIM	Cool to 4°C	Two 1-Liter Amber Glass	7 days to extract; 40 days after extraction to analysis			NA		
		1,4-Dioxane as SVOC	EPA 8270D With SIM	Cool to 4°C	Two 1-Liter Amber Glass	7 days to extract; 40 days after extraction to analysis					
		Part 375 + TAL Metals	EPA 6020B, 7470A	Cool to 4°C; HNO_3 to pH <2	250 mL plastic	6 months, except Mercury 28 days					
		Hexavalent Chromium	EPA 7196A	Cool to 4°C	250 mL plastic	24 Hours					
		Cyanide	EPA 9010CB/9012B	NaOH plus 0.6g ascorbic acid	250 mL plastic	14 days					
		Part 375 + TCL Pesticides	EPA 8081B	Cool to 4°C	Two 1-Liter Amber Glass	7 days to extract; 40 days after extraction to analysis					
		Part 375 + TCL Herbicides	EPA 8151A	Cool to 4°C	Two 1-Liter Amber Glass	7 days to extract; 40 days after extraction to analysis					
		PCBs	EPA 8082A	Cool to 4°C	Two 1-Liter Amber Glass	7 days to extract; 40 days after extraction to analysis					
		PFAS	EPA 537M	Cool to 4°C; Trizma	Three 250-mL HDPE or polypropylene container	14 days to extract; 28 days after extraction to analysis					
Soil Vapor	Total VOCs, Oxygen, LEL, CO, and H_2S, with MultiGas Meter	TO-15 Listed VOCs	EPA TO-15	Ambient Temperature	2.7-Liter or 6-Liter Summa Canister	Analyze within 30 days of collection	NA	NA	NA	1 per 10 samples (minimum 1)	NA
Ambient Air	Total VOCs via PID									NA	

Notes:

1. PID - Photoionization Detector
2. VOC - Volatile organic compound
3. EPA - Environmental Protection Agency
4. TCL - Target compound list
5. TAL - Target analyte list
6. ORP - Oxidation reduction potential
7. DO - Dissolved oxygen
8. LEL - Lower explosive limit
9. CO -Carbon monoxide
10. H_2S - Hydrogen sulfide
11. NA - Not applicable

ATTACHMENT D

SAMPLE NOMENCLATURE STANDARD OPERATING PROCEDURE

SOP #01 – Sample Nomenclature

INTRODUCTION

The Langan Environmental Group conducts an assortment of site investigations where samples (Vapor, Solids, and Aqueous) are collected and submitted to analytical laboratories for analysis. The results of which are then evaluated and entered into a data base allowing quick submittal to the state regulatory authority (New York State Division of Environmental Conservation [NYSDEC]). In addition, Langan is linking their data management system to graphic and analytical software to enable efficient evaluation of the data as well as creating client-ready presentational material.

SCOPE AND APPLICATION

This Standard Operating Procedure (SOP) is applicable to the general framework for labeling vapor, solid (soil) and aqueous (groundwater) samples that will be submitted for laboratory analysis. The nomenclature being introduced is designed to meet the NYSDEC EQuIS standard and has been incorporated into Langan software scripts to assist project personnel in processing the data. While this SOP is applicable to all site investigation; unanticipated conditions may arise which may require considerable flexibility in complying with this SOP. Therefore, guidance provided in this SOP is presented in terms of general steps and strategies that should be applied; but deviation from this SOP must be reported to the Project Manager (PM) immediately.

GENERAL SAMPLE IDENTIFICATION CONSIDERATIONS

Sample Labels

All sample ware must have a label. Recall that when you are using the Encore™ samples (see below); they are delivered in plastic lined foil bags. You are to label the bags[1]:

All other samples containers including Terra Cores™ must be labeled with laboratory provided self-adhesive labels.

Quick Breakdown of Sample Format

The general format for sample nomenclature is:

[1]Both Alpha and York laboratories permit the combining of the three Encore™ into a single bag. This may not be appropriate for all laboratories so please confirm with the labs themselves

LLNN_ID

Where

LL is a grouping of two (2) to four (4) letters signifying the sample media source. In older nomenclature SOPs this portion of the sample identification is commonly referred to as the *Sample Investigation Code*

NN represents a two digit number identifying the specific sample location or sample sequence number

_ ***(underscore)*** is required between the sample lettering and numeric identification and additional modifying data that determines the date of sampling or the depth of the sample interval

ID is a modifier specific to the sample type media (depth of soil sample or date of groundwater sample)

LL – Sample Investigation Code

Langan has devised a list of two to four letters to insure a quick ability to identify the sample investigation.

Code	Investigation
AA	Ambient Air
DS	Drum
EPB	Endpoint Location - Bottom (Excavation)
EPSW	Endpoint Location - Sidewall (Excavation)
FP	Free Product
IA	Indoor Air
IDW	Investigation Derived Waste (Soil Pile)
MW	Monitoring Well (Permanent)
SB	Soil Boring
SG	Staff Gauge (Stream Gauging)
SL	Sludge
SV	Soil Vapor Point
SVE	Soil Vapor Extraction Well
SW	Surface Water
TMW	Temporary Monitoring Well
TP	Test Pit (Excavated Material from Test Pit Not Associated With Sidewall or Bottom Samples)
WC	Waste Characterization Boring
COMP	Composite Sample
TB	Trip Blank (QA/QC Sampling – All Investigations)
FB	Field Blank (QA/QC Sampling – All Investigations)
DUP	Duplicate (QA/QC Sampling – All Investigations)

NN – Numeric Identifier

The two digit number that follows the sample investigation code (LL) identifies the specific sample based on the soil boring, monitoring well, endpoint or other location identification. For a subset of samples

where there is no specific location identifier, the two digit number is the sequence number for the sample submitted. For example, an aqueous sample from a monitoring well identified as MW-1 would have the sample investigation code of MW and the numeric identifier as 01. Note there is no hyphen. The same can be done for soil borings, a soil sample collected from soil boring 9 (SB-9) would be have the LLNN identification of SB09 (again, no hyphen).

Note however that there is a subset of samples related to laboratory analytical quality assurance, among these includes TB, FB, and DUP. On many investigations, the Scope will require multiple collections of these types of samples, therefore the numerical number represents the sequence sample count where the first sample is 01, the second sample is 02, and the third sample is 03 and so on.

_ Underscore
The underscore is required. It separates the investigation code and numeric identifier from the modifier specific to the sample itself. Note that every effort should be made to insure that the underscore is clear on the sample label and chain of custody (COC).

ID – Modifier Specific to Type Media
Each sample investigation code and numeric identifier is further modified by an ID specific to the sample type media. In general, soil samples (soil borings or endpoint samples) use an ID that indicates the depth at which the sample was taken. Aqueous samples (groundwater or surface water samples) are identified by the date the sample was collected. Other types of samples including quality control (TB, FB, and DUP), Vapor samples (AA, IA, SV or SVE), other soil type samples (IDW, sludge, free product, drum, and others) are also identified by a date. The following rules apply to the ID when using sample depth or sample date.

Sample Depth
The sample depth must be whole numbers (no fractions) separated by a hyphen. Thus for a soil sample collected from the soil boring SB-1 from a depth of 6 feet to 8 feet, the sample would be identified as:

SB01_6-8

Unfortunately, the NYSDEC EQuIS system does not accept fractions. Therefore, if your sample interval is a fraction of a foot (6.5-7.5), round up to the larger interval (6-8).

Sample Date
The sample date is always in the format of MMDDYY. Note that the year is two digits. Thus for a groundwater sample collected on July 1, 2015 from the monitoring well MW-1, the sample would be identified as:

MW01_070115

Special Cases
There are a couple of specific sample types that require further explanation.

Endpoint Sampling
End point sidewall samples are sometimes modified by magnetic direction (N, S, E, and W). For example, the first sidewall endpoint sample from the north wall of an excavation at a depth of 5 feet would be written as:

EPSW01_N_5

Again, note that the N in the identification refers to north and is separated from the prefix investigation code/numeric identifier and ID modifier suffix by underscores.

Vapor Extraction Well Sample
As with the sidewall endpoint samples, the sample name is altered by inserting a middle modifier between the prefix and suffix of the sample name. The middle modifier is used to identify the source of the sample (inlet sample port, midpoint sample port or outlet sample port). For example the midpoint port of the vapor extraction well number 1 sampled on July 1, 2015 would be written as;

SVE01_MID_070115

Matrix Spike and Matrix Spike Duplicate
On occasion, a Langan investigation will collect a sample to be used to provide the lab with a site specific medium to spike to determine the quality of the analytical method. This special case of sampling requires additional information to be used in the sample name, specifically, a suffix specifying whether the sample is the matrix spike (MS) or the matrix spike duplicate (MSD). In the following example, the sample is collected from soil boring number 1 at a depth of 2-4 feet. For the matrix spike sample:

SB01_2-4_MS

and for the matrix spike duplicate sample:

SB01_2-4_MSD

Multiple Interval Groundwater Sampling
Although not currently a common practice, low flow sampling facilitates stratigraphic sampling of a monitoring well. If the scope requires stratigraphic sampling then groundwater samples will be labeled with a lower case letter following the well number. For example, placing the pump or sampling tube at 10 feet below surface in MW01 on July 1, 2015 would require the sample to be labeled as:

MW01a_070115

While a second sample where the pump or tubing intake is placed at 20 feet would be labeled as:

MW01b_070115

Note that it is important that you record what depth the intake for each sample represents in your field notes; as this information is going to be critical to interpreting the results.

ATTACHMENT E

PFAS SAMPLING PROTOCOL

Collection of Groundwater Samples for Perfluorooctanoic Acid (PFOA) and Perfluorinated Compounds (PFCs) from Monitoring Wells Sample Protocol

Samples collected using this protocol are intended to be analyzed for perfluorooctanoic acid (PFOA) and other perfluorinated compounds by Modified (Low Level) Test Method 537.

The procedure used must be consistent with the NYSDEC March 1991 Sampling Guidelines and Protocols http://www.dec.ny.gov/docs/remediation_hudson_pdf/sgpsect5.pdf with the following materials limitations.

At this time acceptable materials for sampling include: stainless steel, high density polyethylene (HDPE), PVC, silicone, acetate and polypropylene. Equipment blanks should be generated at least daily. Additional materials may be acceptable if pre-approved by NYSDEC. Requests to use alternate equipment should include clean equipment blanks. **NOTE: Grunfos pumps and bladder pumps are known to contain PFC materials (e.g. Teflon™ washers for Grunfos pumps and LDPE bladders for bladder pumps).** All sampling equipment components and sample containers should not come in contact with aluminum foil, low density polyethylene (LDPE), glass or polytetrafluoroethylene (PTFE, Teflon™) materials including sample bottle cap liners with a PTFE layer. Standard two step decontamination using detergent and clean water rinse will be performed for equipment that does come in contact with PFC materials. Clothing that contains PTFE material (including GORE-TEX®) or that have been waterproofed with PFC materials must be avoided. Many food and drink packaging materials and “plumbers thread seal tape” contain PFCs.

All clothing worn by sampling personnel must have been laundered multiple times. The sampler must wear nitrile gloves while filling and sealing the sample bottles.

Pre-cleaned sample bottles with closures, coolers, ice, sample labels and a chain of custody form will be provided by the laboratory.

1. Fill two pre-cleaned 500 mL HDPE or polypropylene bottle with the sample.
2. Cap the bottles with an acceptable cap and liner closure system.
3. Label the sample bottles.
4. Fill out the chain of custody.
5. Place in a cooler maintained at 4 ± 2º Celsius.

Collect one equipment blank for every sample batch, not to exceed 20 samples.

Collect one field duplicate for every sample batch, not to exceed 20 samples.

Collect one matrix spike / matrix spike duplicate (MS/MSD) for every sample batch, not to exceed 20 samples.

Request appropriate data deliverable (Category A or B) and an electronic data deliverable.

Groundwater Sampling for Emerging Contaminants

February 2018

Issue: NYSDEC has committed to analyzing representative groundwater samples at remediation sites for emerging contaminants (1,4-dioxane and PFAS) as described in the below guidance.

Implementation

NYSDEC project managers will be contacting site owners to schedule sampling for these chemicals. Only groundwater sampling is required. The number of samples required will be similar to the number of samples where "full TAL/TCL sampling" would typically be required in a remedial investigation. If sampling is not feasible (e.g., the site no longer has any monitoring wells in place), sampling may be waived on a site-specific basis after first considering potential sources of these chemicals and whether there are water supplies nearby.

Upon a new site being brought into any program (i.e., SSF, BCP), PFAS and 1,4-dioxane will be incorporated into the investigation of groundwater as part of the standard "full TAL/TCL" sampling. Until an SCO is established for PFAS, soil samples do not need to be analyzed for PFAS unless groundwater contamination is detected. Separate guidance will be developed to address sites where emerging contaminants are found in the groundwater. The analysis currently performed for SVOCs in soil is adequate for evaluation of 1,4-dioxane, which already has an established SCO.

Analysis and Reporting

Labs should provide a full category B deliverable, and a DUSR should be prepared by a data validator.

The work plan should explicitly describe analysis and reporting requirements.

PFAS sample analysis: Samples should be analyzed by an environmental laboratory certified by ELAP to use EPA method 537 or ISO 25101. ELAP does not currently offer certification for PFAS analysis of non-drinking water samples (including groundwater, soil and sediment), so there is no requirement to use an ELAP certified method. The preferred method is the modified EPA Method 537. Labs have been able to achieve reporting limits for PFOA and PFOS of 2 ng/l (part per trillion). If labs are not able to achieve similar reporting limits, the NYSDEC project manager will make case-by-case decisions as to whether the analysis can meet the needs for the specific site.

PFAS sample reporting: DER has developed a PFAS target analyte list (below) with the intent of achieving reporting consistency between labs for commonly reportable analytes. It is expected that reported results for PFAS will include, at a minimum, all the compounds listed. This list may be updated in the future as new information is learned and as labs develop new capabilities. If lab and/or matrix specific issues are encountered for any particular compounds, the NYSDEC project manager will make case-by-case decisions as to whether particular analytes may be temporarily or permanently discontinued from analysis for each site. Any technical lab issues should be brought to the attention of a NYSDEC chemist.

Some sampling using this full PFAS target analyte list is needed to understand the nature of contamination. It may also be critical to differentiate PFAS compounds associated with a site from other sources of these chemicals. Like routine refinements to parameter lists based on investigative findings, the full PFAS target analyte list may not be needed for all sampling intended to define the extent of

contamination. Project managers may approve a shorter analyte list (e.g., just the UCMR3 list) for some reporting on a case by case basis.

1,4-Dioxane Analysis and Reporting: The method detection limit (MDL) for 1,4-dioxane should be no higher than 0.28 µg/l (ppb). ELAP offers certification for both EPA Methods 8260 and 8270. In order to get the appropriate detection limits, the lab would need to run either of these methods in "selective ion monitoring" (SIM) mode. DER is advising PMS to use 8270, since this method provides a more robust extraction procedure, uses a larger sample volume, and is less vulnerable to interference from chlorinated solvents (we acknowledge that 8260 has been shown to have a higher recovery in some studies).

Full PFAS Target Analyte List

Group	Chemical Name	Abbreviation	CAS Number
Perfluoroalkyl sulfonates	**Perfluorobutanesulfonic acid**	**PFBS**	**375-73-5**
	Perfluorohexanesulfonic acid	**PFHxS**	**355-46-4**
	Perfluoroheptanesulfonic acid	PFHpS	375-92-8
	Perfluorooctanessulfonic acid	**PFOS**	**1763-23-1**
	Perfluorodecanesulfonic acid	PFDS	335-77-3
Perfluoroalkyl carboxylates	Perfluorobutanoic acid	PFBA	375-22-4
	Perfluoropentanoic acid	PFPeA	2706-90-3
	Perfluorohexanoic acid	PFHxA	307-24-4
	Perfluoroheptanoic acid	**PFHpA**	**375-85-9**
	Perfluorooctanoic acid	**PFOA**	**335-67-1**
	Perfluorononanoic acid	**PFNA**	**375-95-1**
	Perfluorodecanoic acid	PFDA	335-76-2
	Perfluoroundecanoic acid	PFUA/PFUdA	2058-94-8
	Perfluorododecanoic acid	PFDoA	307-55-1
	Perfluorotridecanoic acid	PFTriA/PFTrDA	72629-94-8
	Perfluorotetradecanoic acid	PFTA/PFTeDA	376-06-7
Fluorinated Telomer Sulfonates	6:2 Fluorotelomer sulfonate	6:2 FTS	27619-97-2
	8:2 Fluorotelomer sulfonate	8:2 FTS	39108-34-4
Perfluorooctane-sulfonamides	Perfluroroctanesulfonamide	FOSA	754-91-6
Perfluorooctane-sulfonamidoacetic acids	N-methyl perfluorooctanesulfonamidoacetic acid	N-MeFOSAA	2355-31-9
	N-ethyl perfluorooctanesulfonamidoacetic acid	N-EtFOSAA	2991-50-6

Bold entries depict the 6 original UCMR3 chemicals

Determination of Selected Perfluorinated Alkyl Substances by Solid Phase Extraction and Liquid Chromatography/Tandem Mass Spectrometry Isotope Dilution (LC/MS/MS)

Reference: EPA Method 537, Version 1.1, September 2009, EPA Document #: EPA/600/R-08/09

EPA Method 537.1, Version 1, November 2018, EPA Document #: EPA/600/R-18/352

Department of Defense, Quality Systems Manual for Environmental Laboratories, Version 5.2, .2019

1. Scope and Application

Matrices: Drinking water, Non-potable Water, and Soil Matrices

Definitions: Refer to Alpha Analytical Quality Manual.

1.1 This is a liquid chromatography/tandem mass spectrometry (LC/MS/MS) method for the determination of selected perfluorinated alkyl substances (PFAS) in Non-Drinking Water and soil Matrices. Accuracy and precision data have been generated in reagent water, and finished ground and surface waters for the compounds listed in Table 1.

1.2 The data report packages present the documentation of any method modification related to the samples tested. Depending upon the nature of the modification and the extent of intended use, the laboratory may be required to demonstrate that the modifications will produce equivalent results for the matrix. Approval of all method modifications is by one or more of the following laboratory personnel before performing the modification: Area Supervisor, Department Supervisor, Laboratory Director, or Quality Assurance Officer.

1.3 This method is restricted to use by or under the supervision of analysts experienced in the operation of the LC/MS/MS and in the interpretation of LC/MS/MS data. Each analyst must demonstrate the ability to generate acceptable results with this method by performing an initial demonstration of capability.

2. Summary of Method

2.1 A 250-mL water sample is fortified with extracted internal standards (EIS) and passed through a solid phase extraction (WAX) cartridge containing a mixed mode, Weak Anion Exchange, reversed phase, water-wettable polymer to extract the method analytes and isotopically-labeled compounds. The compounds are eluted from the solid phase in two fractions with methanol followed by a small amount of 2% ammonium hydroxide in methanol solution. The extract is concentrated with nitrogen in a heated water bath, and then adjusted to a 1-mL volume with 80:20% (vol/vol) methanol:water. A 3 µl injection is made into an LC equipped with a C18 column that is interfaced to an MS/MS. The analytes are separated and identified by comparing the acquired mass spectra and retention times to reference spectra and retention times for calibration standards acquired under identical LC/MS/MS conditions. The concentration of each analyte is determined by using the isotope dilution technique. Extracted Internal Standards (EIS) analytes are used to monitor the extraction efficiency of the method analytes.

2.2 Method Modifications from Reference

None.

Table 1

Parameter	Acronym	CAS
PERFLUOROALKYL ETHER CARBOXYLIC ACIDS (PFECAs)		
Tetrafluoro-2-(heptafluoropropoxy)propanoic acid	HFPO-DA	62037-80-3
4,8-dioxa-3H-perfluorononanoic acid	ADONA	919005-14-4
PERFLUOROALKYLCARBOXILIC ACIDS (PFCAs)		
Perfluorobutanoic acid	PFBA	375-22-4
Perfluoropentanoic acid	PFPeA	2706-90-3
Perfluorohexanoic acid	PFHxA *	307-24-4
Perfluoroheptanoic acid	PFHpA *	375-85-9
Perfluorooctanoic acid	PFOA *	335-67-1
Perfluorononanoic acid	PFNA *	375-95-1
Perfluorodecanoic acid	PFDA *	335-76-2
Perfluoroundecanoic acid	PFUnA *	2058-94-8
Perfluorododecanoic acid	PFDoA *	307-55-1
Perfluorotridecanoic acid	PFTrDA *	72629-94-8
Perfluorotetradecanoic acid	PFTA *	376-06-7
Perfluorohexadecanoic acid	PFHxDA	67905-19-5
Perfluorooctadecanoic acid	PFODA	16517-11-6
PERFLUOROALKYLSULFONATES (PFASs)		
Perfluorobutanesulfonic acid	PFBS *	375-73-5
Perfluoropentanesulfonic acid	PFPeS	2706-91-4
Perfluorohexanesulfonic acid	PFHxS *	355-46-4
Perfluoroheptanesulfonic acid	PFHpS	375-92-8
Perfluorooctanesulfonic acid	PFOS *	1763-23-1
Perfluorononanesulfonic acid	PFNS	68259-12-1
Perfluorodecanesulfonic acid	PFDS	335-77-3
Perfluorododecanesulfonic acid	PFDoS	79780-39-5

*** also reportable via the standard 537 method**

Table 1 Cont.

Parameter	Acronym	CAS
CHLORO-PERFLUOROALKYLSULFONATE		
11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid	11Cl-PF3OUdS	763051-92-9
9-chlorohexadecafluoro-3-oxanone-1-sulfonic acid	9Cl-PF3ONS	756426-58-1
PERFLUOROOCTANESULFONAMIDES (FOSAs)		
Perfluorooctanesulfonamide	PFOSA	754-91-6
N-methylperfluoro-1-octanesulfonamide	NMeFOSA	31506-32-8
N-ethylperfluoro-1-octanesulfonamide	NEtFOSA	4151-50-2
TELOMER SULFONATES		
1H,1H,2H,2H-perfluorohexane sulfonate (4:2)	4:2FTS	27619-93-8
1H,1H,2H,2H-perfluorooctane sulfonate (6:2)	6:2FTS	27619-97-2
1H,1H,2H,2H-perfluorodecane sulfonate (8:2)	8:2FTS	39108-34-4
1H,1H,2H,2H-perfluorododecane sulfonate (10:2)	10:2FTS	120226-60-0
PERFLUOROOCTANESULFONAMIDOACETIC ACIDS		
N-methyl perfluorooctanesulfonamidoacetic acid	NMeFOSAA *	2355-31-9
N-ethyl perfluorooctanesulfonamidoacetic acid	NEtFOSAA *	2991-50-6
NATIVE PERFLUOROOCTANESULFONAMIDOETHANOLS (FOSEs)		
2-(N-methylperfluoro-1-octanesulfonamido)-ethanol	NMeFOSE	24448-09-7
2-(N-ethylperfluoro-1-octanesulfonamido)-ethanol	NEtFOSE	1691-99-2

*** also reportable via the standard 537 method**

3. Reporting Limits

The reporting limit for PFAS's is 2 ng/L for aqueous samples (20 ng/L for HFPO-DA) and 1 ng/g (10 ng/g for HFPO-DA) for soil samples.

4. Interferences

4.1 PFAS standards, extracts and samples should not come in contact with any glass containers or pipettes as these analytes can potentially adsorb to glass surfaces. PFAS analyte and EIS standards commercially purchased in glass ampoules are acceptable; however, all subsequent transfers or dilutions performed by the analyst must be prepared and stored in polypropylene containers.

4.2 Method interferences may be caused by contaminants in solvents, reagents (including reagent water), sample bottles and caps, and other sample processing hardware that lead to discrete artifacts and/or elevated baselines in the chromatograms. The method analytes in this method can also be found in many common laboratory supplies and equipment, such

as PTFE (polytetrafluoroethylene) products, LC solvent lines, methanol, aluminum foil, SPE sample transfer lines, etc. All items such as these must be routinely demonstrated to be free from interferences (less than 1/3 the RL for each method analyte) under the conditions of the analysis by analyzing laboratory reagent blanks as described in Section 9.2. **Subtracting blank values from sample results is not permitted.**

4.3 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. Humic and/or fulvic material can be co-extracted during SPE and high levels can cause enhancement and/or suppression in the electrospray ionization source or low recoveries on the SPE sorbent. Total organic carbon (TOC) is a good indicator of humic content of the sample.

4.4 SPE cartridges can be a source of interferences. The analysis of field and laboratory reagent blanks can provide important information regarding the presence or absence of such interferences. Brands and lots of SPE devices should be tested to ensure that contamination does not preclude analyte identification and quantitation.

5. Health and Safety

5.1 The toxicity or carcinogenicity of each reagent and standard used in this method is not fully established; however, each chemical compound should be treated as a potential health hazard. From this viewpoint, exposure to these chemicals must be reduced to the lowest possible level by whatever means available. A reference file of material safety data sheets is available to all personnel involved in the chemical analysis. Additional references to laboratory safety are available in the Chemical Hygiene Plan.

5.2 All personnel handling environmental samples known to contain or to have been in contact with municipal waste must follow safety practices for handling known disease causative agents.

5.3 PFOA has been described as "likely to be carcinogenic to humans." Pure standard materials and stock standard solutions of these method analytes should be handled with suitable protection to skin and eyes, and care should be taken not to breathe the vapors or ingest the materials.

6. Sample Collection, Preservation, Shipping and Handling

6.1 Sample Collection for Aqueous Samples

6.1.1 Samples must be collected in two (2) 250-mL high density polyethylene (HDPE) container with an unlined plastic screw cap.

6.1.2 The sample handler must wash their hands before sampling and wear nitrile gloves while filling and sealing the sample bottles. PFAS contamination during sampling can occur from a number of common sources, such as food packaging and certain foods and beverages. Proper hand washing and wearing nitrile gloves will aid in minimizing this type of accidental contamination of the samples.

6.1.3 Open the tap and allow the system to flush until the water temperature has stabilized (approximately 3 to 5 min). Collect samples from the flowing system.

6.1.4 Fill sample bottles. Samples do not need to be collected headspace free.

6.1.5 After collecting the sample and cap the bottle. Keep the sample sealed from time of collection until extraction.

6.1.6 Field Reagent Blank (FRB)

6.1.6.1 A FRB 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 and preservatives, seal, and ship to the sampling site along with the sample bottles. For each FRB shipped, an empty sample bottle (no preservatives) must also be shipped. At the sampling site, the sampler must open the shipped FRB and pour the reagent water into the empty shipped sample bottle, seal and label this bottle as the FRB. The FRB is shipped back to the laboratory along with the samples and analyzed to ensure that PFAS's were not introduced into the sample during sample collection/handling.

The reagent water used for the FRBs must be initially analyzed for method analytes as a MB and must meet the MB criteria in Section 9.2.1 prior to use. This requirement will ensure samples are not being discarded due to contaminated reagent water rather than contamination during sampling.

6.2 Sample Collection for Soil and Sediment samples.

Grab samples are collected in polypropylene containers. Sample containers and contact surfaces containing PTFE shall be avoided.

6.3 Sample Preservation

Not applicable.

6.4 Sample Shipping

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.

6.5 Sample Handling

6.5.1 Holding Times

6.5.1.1 Water samples should be extracted as soon as possible but must be extracted within 14 days. Soil samples should be extracted within 28 days. Extracts are stored at < 10 ° C and analyzed within 28 days after extraction.

7. Equipment and Supplies

7.1 SAMPLE CONTAINERS – 250-mL high density polyethylene (HDPE) bottles fitted with unlined screw caps. Sample bottles must be discarded after use.

7.2 POLYPROPYLENE BOTTLES – 4-mL narrow-mouth polypropylene bottles.

7.3 CENTRIFUGE TUBES – 50-mL conical polypropylene tubes with polypropylene screw caps for storing standard solutions and for collection of the extracts.

7.4 AUTOSAMPLER VIALS – Polypropylene 0.7-mL autosampler vials with polypropylene caps.

7.4.1 NOTE: Polypropylene vials and caps are necessary to prevent contamination of the sample from PTFE coated septa. However, polypropylene caps do not reseal, so evaporation occurs after injection. Thus, multiple injections from the same vial are not possible.

7.5 POLYPROPYLENE GRADUATED CYLINDERS – Suggested sizes include 25, 50, 100 and 1000-mL cylinders.

7.6 Auto Pipets – Suggested sizes include 5, 10, 25, 50, 100, 250, 500, 1000, 5000 and 10,000-µls.

7.7 PLASTIC PIPETS – Polypropylene or polyethylene disposable pipets.

7.8 ANALYTICAL BALANCE – Capable of weighing to the nearest 0.0001 g.

7.9 SOLID PHASE EXTRACTION (SPE) APPARATUS FOR USING CARTRIDGES

7.9.1 SPE CARTRIDGES – 0.5 g SPE cartridges containing a reverse phase copolymer characterized by a weak anion exchanger (WAX) sorbent phase.

7.9.2 VACUUM EXTRACTION MANIFOLD – A manual vacuum manifold with large volume sampler for cartridge extractions, or an automatic/robotic sample preparation system designed for use with SPE cartridges, may be used if all QC requirements discussed in Section 9 are met. Extraction and/or elution steps may not be changed or omitted to accommodate the use of an automated system. Care must be taken with automated SPE systems to ensure the PTFE commonly used in these systems does not contribute to unacceptable analyte concentrations in the MB (Sect. 9.2.1).

7.9.3 SAMPLE DELIVERY SYSTEM – Use of a polypropylene transfer tube system, which transfers the sample directly from the sample container to the SPE cartridge, is recommended, but not mandatory. Standard extraction manifolds come equipped with PTFE transfer tube systems. These can be replaced with 1/8" O.D. x 1/16" I.D. polypropylene or polyethylene tubing cut to an appropriate length to ensure no sample contamination from the sample transfer lines. Other types of non-PTFE tubing may be used provided it meets the MB (Sect. 9.2.1) and LCS (Sect. 9.3) QC requirements. The PTFE transfer tubes may be used, but an MB must be run on each PFTE transfer tube and the QC requirements in Section 13.2.2 must be met. In the case of automated SPE, the removal of PTFE lines may not be feasible; therefore, MBs will need to be rotated among the ports and must meet the QC requirements of Sections 13.2.2 and 9.2.1.

7.10 Extract Clean-up Cartridge – 250 mg 6ml SPE Cartridge containing graphitized polymer carbon

7.11 EXTRACT CONCENTRATION SYSTEM – Extracts are concentrated by evaporation with nitrogen using a water bath set no higher than 65 °C.

7.12 LABORATORY OR ASPIRATOR VACUUM SYSTEM – Sufficient capacity to maintain a vacuum of approximately 10 to 15 inches of mercury for extraction cartridges.

7.13 LIQUID CHROMATOGRAPHY (LC)/TANDEM MASS SPECTROMETER (MS/MS) WITH DATA SYSTEM

7.13.1 LC SYSTEM – Instrument capable of reproducibly injecting up to 10-µL aliquots, and performing binary linear gradients at a constant flow rate near the flow rate used for development of this method (0.4 mL/min). The LC must be capable of pumping the water/methanol mobile phase without the use of a degasser which pulls vacuum on the mobile phase bottle (other types of degassers are acceptable). Degassers which pull vacuum on the mobile phase bottle will volatilize the ammonium acetate mobile phase causing the analyte peaks to shift to earlier retention times over the course of the analysis batch. The usage of a column heater is optional.

NOTE: During the course of method development, it was discovered that while idle for more than one day, PFAS's built up in the PTFE solvent transfer lines. To prevent long delays in purging high levels of PFAS's from the LC solvent lines, they were replaced with PEEK tubing and the PTFE solvent frits were replaced with stainless steel frits. It is not possible to remove all PFAS background contamination, but these measures help to minimize their background levels.

7.13.2 LC/TANDEM MASS SPECTROMETER – The LC/MS/MS must be capable of negative ion electrospray ionization (ESI) near the suggested LC flow rate of 0.4 mL/min. The system must be capable of performing MS/MS to produce unique product ions for the method analytes within specified retention time segments. A minimum of 10 scans across the chromatographic peak is required to ensure adequate precision.

7.13.3 DATA SYSTEM – An interfaced data system is required to acquire, store, reduce, and output mass spectral data. The computer software should have the capability of processing stored LC/MS/MS data by recognizing an LC peak within any given retention time window. The software must allow integration of the ion abundance of any specific ion within specified time or scan number limits. The software must be able to calculate relative response factors, construct linear regressions or quadratic calibration curves, and calculate analyte concentrations.

7.13.4 ANALYTICAL COLUMN – An LC BEH C_{18} column (2.1 x 50 mm) packed with 1.7 µm d_p C_{18} solid phase particles was used. Any column that provides adequate resolution, peak shape, capacity, accuracy, and precision (Sect. 9) may be used.

8. Reagents and Standards

8.1 GASES, REAGENTS, AND SOLVENTS – Reagent grade or better chemicals should be used.

8.1.1 REAGENT WATER – Purified water which does not contain any measurable quantities of any method analytes or interfering compounds greater than 1/3 the RL for each method analyte of interest. Prior to daily use, at least 3 L of reagent water should be flushed from the purification system to rinse out any build-up of analytes in the system's tubing.

8.1.2 METHANOL (CH_3OH, CAS#: 67-56-1) – High purity, demonstrated to be free of analytes and interferences.

8.1.3 AMMONIUM ACETATE ($NH_4C_2H_3O_2$, CAS#: 631-61-8) – High purity, demonstrated to be free of analytes and interferences.

8.1.4 ACETIC ACID (H_3CCOOH, CAS#: 64-19-7) - High purity, demonstrated to be free of analytes and interferences.

8.1.5 1M AMMONIUM ACETATE/REAGENT WATER – High purity, demonstrated to be free of analytes and interferences.

8.1.6 2mM AMMONIUM ACETATE/METHANOL:WATER (5:95) – To prepare, mix 2 ml of 1M AMMONIUM ACETATE,1 ml ACETIC ACID and 50 ml METHANOL into l Liter of REAGENT WATER.

8.1.7 Methanol/Water (80:20) – To prepare a 1 Liter bottle, mix 200 ml of REAGENT WATER with 800 ml of METHANOL.

8.1.8 AMMONIUM HYDROXIDE (NH_3, CAS#: 1336-21-6) – High purity, demonstrated to be free of analytes and interferences.

8.1.9 Sodium Acetate ($NaOOCCH_3$, CAS#: 127-09-3) – High purity, demonstrated to be free of analytes and interferences.

8.1.10 25 mM Sodium Acetate Buffer – To prepare 250mls, dissolve .625 grams of sodium acetate into 100 mls of reagent water. Add 4 mls Acetic Acid and adjust the final volume to 250 mls with reagent water.

8.1.11 NITROGEN – Used for the following purposes: Nitrogen aids in aerosol generation of the ESI liquid spray and is used as collision gas in some MS/MS instruments. The nitrogen used should meet or exceed instrument manufacturer's specifications. In addition, Nitrogen is used to concentrate sample extracts (Ultra High Purity or equivalent).

8.1.12 ARGON – Used as collision gas in MS/MS instruments. Argon should meet or exceed instrument manufacturer's specifications. Nitrogen gas may be used as the collision gas provided sufficient sensitivity (product ion formation) is achieved.

8.2 STANDARD SOLUTIONS – When a compound purity is assayed to be 96% or greater, the weight can be used without correction to calculate the concentration of the stock standard. PFAS analyte and IS standards commercially purchased in glass ampoules are acceptable; however, all subsequent transfers or dilutions performed by the analyst must be prepared and stored in polypropylene containers. Standards for sample fortification generally should be prepared in the smallest volume that can be accurately measured to minimize the addition of excess organic solvent to aqueous samples.

NOTE: Stock standards and diluted stock standards are stored at ≤4 °C.

8.2.1 ISOTOPE DILUTION Extracted Internal Standard (ID EIS) STOCK SOLUTIONS - ID EIS stock standard solutions are stable for at least 6 months when stored at 4 °C. The stock solution is purchased at a concentration of 1000 ng/mL.

8.2.2 ISOTOPE DILUTION Extracted Internal Standard PRIMARY DILUTION STANDARD (ID EIS PDS) – Prepare the ID EIS PDS at a concentration of 500 ng/mL. The ID PDS is prepared in 80:20% (vol/vol) methanol:water. The ID PDS is stable for 6 months when stored at ≤4 °C.

Table 2

Isotope Labeled Standard	Conc. of EIS Stock (ng/mL)	Vol. of EIS Stock (mL)	Final Vol. of EIS PDS (mL)	Final Conc. of EIS PDS (ng/mL)
M4PFBA	1000	1.0	2.0	500
M5PFPeA	1000	1.0	2.0	500
M5PFHxA	1000	1.0	2.0	500
M4PFHpA	1000	1.0	2.0	500
M8PFOA	1000	1.0	2.0	500
M9PFNA	1000	1.0	2.0	500
M6PFDA	1000	1.0	2.0	500
M7PFUdA	1000	1.0	2.0	500
MPFDoA	1000	1.0	2.0	500
M2PFTeDA	1000	1.0	2.0	500
M2PFHxDA	50,000	.02	2.0	500
d3-N-MeFOSA	50,000	.02	2.0	500
d5-N-EtFOSA	50,000	.02	2.0	500
d7-N-MeFOSE	50,000	.02	2.0	500
d9-N-EtFOSE	50,000	.02	2.0	500
M8FOSA	1000	1.0	2.0	500
d3-N-MeFOSAA	1000	1.0	2.0	500
d5-N-EtFOSAA	1000	1.0	2.0	500
M3PFBS	929	1.0	2.0	464.5
M3PFHxS	946	1.0	2.0	473
M8PFOS	957	1.0	2.0	478.5
M2-4:2FTS	935	1.0	2.0	467.5
M2-6:2FTS	949	1.0	2.0	474.5
M2-8:2FTS	958	1.0	2.0	479
M3HFPO-DA	50,000	.4	2.0	10,000

8.2.3 ANALYTE STOCK STANDARD SOLUTION – Analyte stock standards are stable for at least 6 months when stored at 4 °C. When using these stock standards to prepare a PDS, care must be taken to ensure that these standards are at room temperature and adequately vortexed.

8.2.4 Analyte Secondary Spiking Standard Prepare the spiking solution of additional add on components for project specific requirements only. ANALYTE PRIMARY SPIKING STANDARD – Prepare the spiking standard at a concentration of 500 ng/mL in methanol. The spiking standard is stable for at least two months when stored in polypropylene centrifuge tubes at room temperature.

Table 3

Analyte	Conc. of IS Stock (ng/mL)	Vol. of IS Stock (mL)	Final Vol. of IS PDS (mL)	Final Conc. of IS PDS (ng/mL)
PFBA	2000	1	4	500
PFPeA	2000	1	4	500
PFHxA	2000	1	4	500
PFHpA	2000	1	4	500
PFOA	2000	1	4	500
PFNA	2000	1	4	500
PFDA	2000	1	4	500
PFUdA	2000	1	4	500
PFDoA	2000	1	4	500
PFTrDA	2000	1	4	500
PFTeDA	2000	1	4	500
FOSA	2000	1	4	500
N-MeFOSAA	2000	1	4	500
N-EtFOSAA	2000	1	4	500
L-PFBS	1770	1	4	442.5
L-PFPeS	1880	1	4	470
L-PFHxSK	1480	1	4	370
Br-PFHxSK	344	1	4	86
L-PFHpS	1900	1	4	475
L-PFOSK	1460	1	4	365
Br-PFOSK	391	1	4	97.75
L-PFNS	1920	1	4	480
L-PFDS	1930	1	4	482.5
4:2FTS	1870	1	4	467.5
6:2FTS	1900	1	4	475
8:2FTS	1920	1	4	480

8.2.5 Analyte Secondary Spiking Standard Prepare the spiking solution of additional add on components for project specific requirements only.

Table 4

Analyte	Conc. of IS Stock (ng/mL)	Vol. of IS Stock (mL)	Final Vol. of IS PDS (mL)	Final Conc. of IS PDS (ng/mL)
ADONA	2000	1	4	500
PFHxDA	2000	1	4	500
PFODA	2000	1	4	500
HFPO-DA	100,000	.4	4	10,000
9ClPF3ONS	50,000	0.04	4	500
11ClPF3OUdS	50,000	0.04	4	500

8.2.6 LOW, MEDIUM AND HIGH LEVEL LCS – The LCS's will be prepared at the following concentrations and rotated per batch; 2 ng/L, 40 ng/L, 500 ng/l for drinking waters. The analyte PDS contains all the method analytes of interest at various concentrations in methanol. The analyte PDS has been shown to be stable for six months when stored at ≤4 °C.

8.2.7 Isotope Dilution Labeled Recovery Stock Solutions (ID REC) – ID REC Stock solutions are stable for at least 6 months when stored at 4 °C. The stock solution is purchased at a concentration of 1000 ng/mL.

8.2.8 Isotope Dilution Labeled Recovery Primary Dilution Standard (ID REC PDS) - Prepare the ID REC PDS at a concentration of 500 ng/mL. The ID REC PDS is prepared in 80:20% (vol/vol) methanol:water. The ID REC PDS is stable for at least six months when stored in polypropylene centrifuge tubes at ≤4 °C.

Table 5

Analyte	Conc. of REC Stock (ng/mL)	Vol. of REC Stock (mL)	Final Vol. of REC PDS (mL)	Final Conc. of REC PDS (ng/mL)
M2PFOA	2000	1	4	500
M2PFDA	2000	1	4	500
M3PFBA	2000	1	4	500
M4PFOS	2000	1	4	500

8.2.9 CALIBRATION STANDARDS (CAL) –

Current Concentrations (ng/mL): 0.5, 1.0, 5.0, 10.0, 50.0, 125, 150, 250, 500

Prepare the CAL standards over the concentration range of interest from dilutions of the analyte PDS in methanol containing 20% reagent water. 20 µl of the EIS PDS and REC PDS are added to the CAL standards to give a constant concentration of 10 ng/ml. The lowest concentration CAL standard must be at or below the RL (2 ng/L), which may depend on system sensitivity. The CAL standards may also be used as CCVs (Sect. 9.8). To make calibration stock standards:

Table 6

Calibration Standard Concentration	Final Aqueous Cal STD Level Concentration	Final Soil Cal STD Level Concentration	24 compound stock added (ul)	PFHxDA Stock added (ul)	500 ng/ml PFHxDA dilution added (ul)	PFODA Stock added (ul)	500 ng/ml PFODA dilution added (ul)	ADONA, HFPO-DA, 11Cl-PF3OUdS, 9Cl-PF3ONS Stock added (ul)	500 ng/ml ADONA dilution added (ul)	Final Volume in MeOH/H_2O (82:20)
.5 ng/ml	2 ng/L	.25 ng/g	6.25		25		25		25	25 mls
1 ng/ml	4 ng/L	.5 ng/g	5		20		20		20	10 mls
5 ng/ml	20 ng/L	1 ng/g	25		100		100		100	10 mls
10 ng/ml	40 ng/L	5 ng/g	125	5		5		5		25 mls

50 ng/ml	200 ng/L	25 ng/g	250	10		10		10		10 mls
125 ng/ml	500 ng/L	62.5 ng/g	625	25		25		25		10 mls
150 ng/ml	600 ng/L	75 ng/g	750	30		30		30		10 mls
250 ng/ml	1000 ng/L	125 ng/g	625							5 mls
500 ng/ml	2000 ng/L	250 ng/g	1250							5 mls

9. Quality Control

The laboratory must maintain records to document the quality of data that is generated. Ongoing data quality checks are compared with established performance criteria to determine if the results of analyses meet the performance characteristics of the method.

9.1 MINIMUM REPORTING LIMIT (MRL) CONFIRMATION

9.1.1 Fortify, extract, and analyze seven replicate LCSs at 2 ng/l. Calculate the mean measured concentration (*Mean*) and standard deviation for these replicates. Determine the Half Range for the prediction interval of results (HR_{PIR}) using the equation below

$$HR_{PIR} = 3.963s$$

Where:

s = the standard deviation
3.963 = a constant value for seven replicates.

9.1.2 Confirm that the upper and lower limits for the Prediction Interval of Result ($PIR = Mean \pm HR_{PIR}$) meet the upper and lower recovery limits as shown below

The Upper PIR Limit must be ≤150% recovery.

$$\frac{Mean + HR_{PIR}}{Fortified\ Concentration} \times 100\% \leq 150\%$$

The Lower PIR Limit must be ≥ 50% recovery.

$$\frac{Mean - HR_{PIR}}{Fortified\ Concentration} \times 100\% \geq 50\%$$

9.1.3 The RL is validated if both the Upper and Lower PIR Limits meet the criteria described above. If these criteria are not met, the RL has been set too low and must be determined again at a higher concentration.

9.2 Blank(s)

9.2.1 **METHOD BLANK (MB)** - A Method Blank (MB) is required with each extraction batch to confirm that potential background contaminants are not interfering with the identification or quantitation of method analytes. Prep and analyze a MB for every 20 samples. If the MB produces a peak within the retention time window of any analyte that would prevent the determination of that analyte, determine the source of contamination and eliminate the interference before processing samples. Background contamination must be reduced to an acceptable level before proceeding. Background from method analytes or other contaminants that

interfere with the measurement of method analytes must be below the RL. If the method analytes are detected in the MB at concentrations equal to or greater than this level, then all data for the problem analyte(s) must be considered invalid for all samples in the extraction batch. Because background contamination is a significant problem for several method analytes, it is highly recommended that the analyst maintain a historical record of MB data.

9.2.2 **FIELD REAGENT BLANK (FRB)** - The purpose of the FRB is to ensure that PFAS's measured in the Field Samples were not inadvertently introduced into the sample during sample collection/handling. Analysis of the FRB is required only if a Field Sample contains a method analyte or analytes at or above the RL. The FRB is processed, extracted and analyzed in exactly the same manner as a Field Sample.

9.3 Laboratory Control Sample (LCS) and Laboratory Control Sample Duplicates (LCSD)

9.3.1 An LCS is required with each extraction batch. The fortified concentration of the LCS may be rotated between low, medium, and high concentrations from batch to batch. Default limits of 50-150% of the true value may be used for analytes until sufficient replicates have been analyzed to generate proper control limits. Calculate the percent recovery (%*R*) for each analyte using the equation

$$\%R = \frac{A \times 100}{B}$$

Where:

A = measured concentration in the fortified sample
B =fortification concentration.

9.3.2 Where applicable, LCSD's are to be extracted and analyzed. The concentration and analyte recovery criteria for the LCSD must be the same as the batch LCS The RSD's must fall within ≤30% of the true value for medium and high level replicates, and ≤50% for low level replicates. Calculate the relative percent difference (RPD) for duplicate MSs (MS and MSD) using the equation

$$RPD = \frac{|LCS - LCSD|}{(LCS + LCSD) / 2} \times 100$$

9.3.3 **If the LCS and or LCSD results do not meet these criteria for method analytes, then all data for the problem analyte(s) must be considered invalid for all samples in the extraction batch.**

9.4 Labeled Recovery Standards (REC)

The analyst must monitor the peak areas of the REC(s) in all injections during each analysis day.

9.5 Extracted Internal Standards (EIS)

9.5.1 The EIS standard is fortified into all samples, CCVs, MBs, LCSs, MSs, MSDs, FD, and FRB prior to extraction. It is also added to the CAL standards. The EIS is a means of assessing method performance from extraction to final

chromatographic measurement. Calculate the recovery (%R) for the EIS using the following equation

$$\%R = (A / B) \times 100$$

Where:

A = calculated EIS concentration for the QC or Field Sample
B = fortified concentration of the EIS.

9.5.2 Default limits of 50-150% may be used for analytes until sufficient replicates have been analyzed to generate proper control limits. A low or high percent recovery for a sample, blank, or CCV does not require discarding the analytical data but it may indicate a potential problem with future analytical data. When EIS recovery from a sample, blank, or CCV are outside control limits, check 1) calculations to locate possible errors, 2) standard solutions for degradation, 3) contamination, and 4) instrument performance. For CCVs and QC elements spiked with all target analytes, if the recovery of the corresponding target analytes meet the acceptance criteria for the EIS in question, the data can be used but all potential biases in the recovery of the EIS must be documented in the sample report. If the associated target analytes do not meet the acceptance criteria,the data must be reanalyzed.

9.6 Matrix Spike (MS)

9.6.1 Analysis of an MS is required in each extraction batch and is used to determine that the sample matrix does not adversely affect method accuracy. Assessment of method precision is accomplished by analysis of a Field Duplicate (FD) (Sect. 9.6); however, infrequent occurrence of method analytes would hinder this assessment. If the occurrence of method analytes in the samples is infrequent, or if historical trends are unavailable, a second MS, or MSD, must be prepared, extracted, and analyzed from a duplicate of the Field Sample. Extraction batches that contain MSDs will not require the extraction of a field sample duplicate. If a variety of different sample matrices are analyzed regularly, for example, drinking water from groundwater and surface water sources, method performance should be established for each. Over time, MS data should be documented by the laboratory for all routine sample sources.

9.6.2 Within each extraction batch, a minimum of one Field Sample is fortified as an MS for every 20 Field Samples analyzed. The MS is prepared by spiking a sample with an appropriate amount of the Analyte Stock Standard (Sect. 8.2.3). Use historical data and rotate through the low, mid and high concentrations when selecting a fortifying concentration. Calculate the percent recovery (%*R*) for each analyte using the equation

$$\%R = \frac{(A - B)}{C} \times 100$$

Where:

A = measured concentration in the fortified sample
B = measured concentration in the unfortified sample
C = fortification concentration.

9.6.3 Analyte recoveries may exhibit matrix bias. For samples fortified at or above their native concentration, recoveries should range between 50-150%. If the accuracy of any analyte falls outside the designated range, and the laboratory performance for that analyte is shown to be in control in the LCS, the recovery is judged to be

matrix biased. The result for that analyte in the unfortified sample is labeled suspect/matrix to inform the data user that the results are suspect due to matrix effects.

9.7 Laboratory Duplicate

9.7.1 FIELD DUPLICATE OR LABORATORY FORTIFIED SAMPLE MATRIX DUPLICATE (FD or MSD) – Within each extraction batch (not to exceed 20 Field Samples), a minimum of one FD or MSD must be analyzed. Duplicates check the precision associated with sample collection, preservation, storage, and laboratory procedures. If method analytes are not routinely observed in Field Samples, an MSD should be analyzed rather than an FD.

9.7.2 Calculate the relative percent difference (*RPD*) for duplicate measurements (*FD1* and *FD2*) using the equation

$$RPD = \frac{|FD1 - FD2|}{(FD1 + FD2) / 2} \times 100$$

9.7.3 RPDs for FDs should be ≤30%. Greater variability may be observed when FDs have analyte concentrations that are within a factor of 2 of the RL. At these concentrations, FDs should have RPDs that are ≤50%. If the RPD of any analyte falls outside the designated range, and the laboratory performance for that analyte is shown to be in control in the CCV, the recovery is judged to be matrix biased. The result for that analyte in the unfortified sample is labeled suspect/matrix to inform the data user that the results are suspect due to matrix effects.

9.7.4 If an MSD is analyzed instead of a FD, calculate the relative percent difference (RPD) for duplicate MSs (MS and MSD) using the equation

$$RPD = \frac{|MS - MSD|}{(MS + MSD) / 2} \times 100$$

9.7.5 RPDs for duplicate MSs should be ≤30% for samples fortified at or above their native concentration. Greater variability may be observed when MSs are fortified at analyte concentrations that are within a factor of 2 of the RL. MSs fortified at these concentrations should have RPDs that are ≤50% for samples fortified at or above their native concentration. If the RPD of any analyte falls outside the designated range, and the laboratory performance for that analyte is shown to be in control in the LCSD where applicable, the result is judged to be matrix biased. If no LCSD is present, the associated MS and MSD are to be re-analyzed to determine if any analytical has occurred. If the resulting RPDs are still outside control limits, the result for that analyte in the unfortified sample is labeled suspect/matrix to inform the data user that the results are suspect due to matrix effects.

9.8 Initial Calibration Verification (ICV)

9.8.1 As part of the IDC (Sect. 13.2), and after each ICAL, analyze a QCS sample from a source different from the source of the CAL standards. If a second vendor is not available, then a different lot of the standard should be used. The QCS should be prepared and analyzed just like a CCV. Acceptance criteria for the QCS are identical to the CCVs; the calculated amount for each analyte must be ±

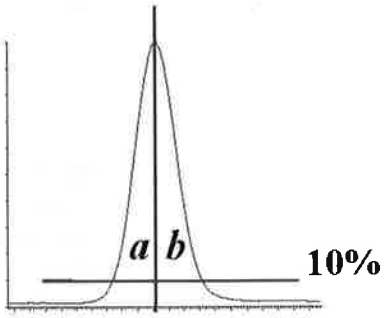
30% of the expected value. If measured analyte concentrations are not of acceptable accuracy, check the entire analytical procedureto locate and correct the problem.

9.9 Continuing Calibration Verification (CCV)

9.9.1 CCV Standards are analyzed at the beginning of each analysis batch, after every 10 Field Samples, and at the end of the analysis batch. See Section 10.7 for concentration requirements and acceptance criteria.

9.10 Method-specific Quality Control Samples

9.10.1 PEAK ASYMMETRY FACTOR – A peak asymmetry factor must be calculated using the equation below during the IDL and every time a calibration curve is generated. The peak asymmetry factor for the first two eluting peaks in a midlevel CAL standard (if only two analytes are being analyzed, both must be evaluated) must fall in the range of 0.8 to 1.5. Modifying the standard or extract composition to more aqueous content to prevent poor shape is not permitted. See guidance in Section 10.6.4.1 if the calculated peak asymmetry factors do not meet the criteria.



$$A_s = b / a$$

Where:

A_s = peak asymmetry factor .
b = width of the back half of the peak measured (at 10% peak height) from the trailing edge of the peak to a line dropped perpendicularly from the peak apex
a = the width of the front half of the peak measured (at 10% peak height) from the leading edge of the peak to a line dropped perpendicularly from the apex.

9.11 Method Sequence

- CCV-LOW
- MB
- LCS
- LCSD
- MS
- Duplicate or MSD
- Field Samples (1-10)
- CCV-MID
- Field Samples (11-20)
- CCV-LOW

10. Procedure

10.1 Equipment Set-up

10.1.1 This procedure may be performed manually or in an automated mode using a robotic or automatic sample preparation device. If an automated system is used to prepare samples, follow the manufacturer's operating instructions, but all extraction and elution steps must be the same as in the manual procedure. Extraction and/or elution steps may not be changed or omitted to accommodate the use of an automated system. If an automated system is used, the MBs should be rotated among the ports to ensure that all the valves and tubing meet the MB requirements (Sect. 9.2).

10.1.2 Some of the PFAS's adsorb to surfaces, including polypropylene. Therefore, the aqueous sample bottles must be rinsed with the elution solvent (Sect 10.3.4) whether extractions are performed manually or by automation. The bottle rinse is passed through the cartridge to elute the method analytes and is then collected (Sect. 10.3.4).

10.1.3 **NOTE:** The SPE cartridges and sample bottles described in this section are designed as single use items and should be discarded after use. They may not be refurbished for reuse in subsequent analyses.

10.2 Sample Preparation and Extraction of Aqueous Samples

10.2.1 Samples are preserved, collected and stored as presented in Section 6.

The entire sample that is received must be sent through the SPE cartridge. In addition, the bottle must be solvent rinsed and this rinse must be sent through the SPE cartridge as well. The method blank (MB) and laboratory control sample (LCS) must be extracted in exactly the same manner (i.e., must include the bottle solvent rinse). It should be noted that a water rinse alone is not sufficient. This does not apply to samples with high concentrations of PFAS that are prepared using serial dilution and not SPE.

10.2.2 Determine sample volume. Weigh all samples to the nearest 1g. If visible sediment is present, centrifuge and decant into a new 250mL HDPE bottle and record the weight of the new container.

NOTE: Some of the PFAS's adsorb to surfaces, thus the sample volume may **NOT** be transferred to a graduated cylinder for volume measurement.

10.2.3 The MB, LCS and FRB may be prepared by measuring 250 mL of reagent water with a polypropylene graduated cylinder or filling a 250-mL sample bottle to near the top.

10.2.4 Adjust the QC and sample pH to 3 by adding acetic acid in water dropwise

10.2.5 Add 20 µL of the EIS PDS (Sect. 8.2.2) to each sample and QC, cap and invert to mix.

10.2.6 If the sample is an LCS, LCSD, MS, or MSD, add the necessary amount of analyte PDS (Sect. 8.2.3). Cap and invert each sample to mix.

10.3 Cartridge SPE Procedure

10.3.1 CARTRIDGE CLEAN-UP AND CONDITIONING – DO NOT allow cartridge packing material to go dry during any of the conditioning steps. Rinse each cartridge with 3 X 5 mL of 2% ammonium hydroxide in methanol, followed by 5mls of methanol. Next, rinse each cartridge with 5 mls of the 25 mM acetate buffer, followed by 15 mL of reagent water, without allowing the water to drop below the top edge of the packing. If the cartridge goes dry during the conditioning phase, the conditioning must be started over. Add 4-5 mL of reagent water to each cartridge, attach the sample transfer tubes (Sect. 7.9.3), turn on the vacuum, and begin adding sample to the cartridge.

10.3.2 SAMPLE EXTRACTON – Adjust the vacuum so that the approximate flow rate is approximately 4 mL/min. Do not allow the cartridge to go dry before all the sample has passed through.

10.3.3 SAMPLE BOTTLE AND CARTRIDGE RINSE – After the entire sample has passed through the cartridge, rinse the sample bottles with 4 ml reagent water followed by 4 ml 25 mM acetate buffer at pH 4 and draw the aliquot through the sample transfer tubes and the cartridges. Draw air or nitrogen through the cartridge for 5-10 min at high vacuum (10-15 in. Hg). **NOTE: If empty plastic reservoirs are used in place of the sample transfer tubes to pass the samples through the cartridges, these reservoirs must be treated like the transfer tubes. After the entire sample has passed through the cartridge, the reservoirs must be rinsed to waste with reagent water.**

10.3.4 SAMPLE BOTTLE AND CARTRIDGE ELUTION, Fraction 1 – Turn off and release the vacuum. Lift the extraction manifold top and insert a rack with collection tubes into the extraction tank to collect the extracts as they are eluted from the cartridges. Rinse the sample bottles with 12 mls of methanol and draw the aliquot through the sample transfer tubes and cartridges. Use a low vacuum such that the solvent exits the cartridge in a dropwise fashion.

SAMPLE BOTTLE AND CARTRIDGE ELUTION, Fraction 2 In a separate collection vial, rinse the sample bottles with 12 mL of 2% ammonium hydroxide in methanol and elute the analytes from the cartridges by pulling the 4 mL of methanol through the sample transfer tubes and the cartridges. Use a low vacuum such that the solvent exits the cartridge in a dropwise fashion. To the final extract, add 50 ul of acetic acid.

NOTE: If empty plastic reservoirs are used in place of the sample transfer tubes to pass the samples through the cartridges, these reservoirs must be treated like the transfer tubes. After the reservoirs have been rinsed in Section 10.3.3, the elution solvent used to rinse the sample bottles must be swirled down the sides of the reservoirs while eluting the cartridge to ensure that any method analytes on the surface of the reservoirs are transferred to the extract.

CLEAN-UP CARTRIDGE ELUTION, Elute the clean-up cartridge with 8 additional mls of methanol and draw the aliquot through the cartridge. Use a low vacuum such that the solvent exits the cartridge in a dropwise fashion.

10.3.5 Fractions 1 and 2 are to be combined during the concentration stage (section10.6)

10.4 Sample Prep and Extraction Protocol for Soils

10.4.1 Homogenize and weigh 2 grams of sample (measured to the nearest hundredth of a gram) intoa 50 ml polypropylene centrifuge tube. For laboratory control blanks and spikes, 2 grams of clean sand is used.

10.4.2 Add 20 µL of the EIS PDS (Sect. 8.2.2) to each sample and QC.

10.4.3 If the sample is an LCS, LCSD, MS, or MSD, add the necessary amount of analyte PDS (Sect. 8.2.3). Cap and invert each sample to mix.

10.4.4 To all samples, add 10 mls of methanol, cap, vortex for 25 seconds at 3000RPM and mix for 30 minutes using a shaker table of tumbler at 120RPM.

10.4.5 Following mixing, sonicate each sample for 30 minutes and let samples sit overnight (at least 2 hours is required for RUSH samples).

10.4.6 Centrifuge each sample at 3500RPM for 10 minutes.

10.4.7 Remove supernatant, and reserve for clean-up.

10.5 Extract Clean-up

10.5.1 CARTRIDGE CLEAN-UP AND CONDITIONING –. Rinse each cartridge with 15 mL of methanol and discard. If the cartridge goes dry during the conditioning phase, the conditioning must be started over. Attach the sample transfer tubes (Sect. 7.9.3), turn on the vacuum, and begin adding sample to the cartridge.

10.5.2 Adjust the vacuum so that the approximate flow rate is 1-2 mL/min. Do not allow the cartridge to go dry before all the sample has passed through.

10.5.3 SAMPLE BOTTLE AND CARTRIDGE RINSE – After the entire sample has passed through the cartridge, rinse the sample collection vial with two 1-mL aliquots of methanol and draw each aliquot through the cartridges. Draw air or nitrogen through the cartridge for 5 min at high vacuum (10-15 in. Hg).

10.5.4 If extracts are not to be immediately evaporated, cover collection tubes and store at ambient temperature till concentration.

10.6 Extract Concentration

10.6.1 Concentrate the extract to dryness under a gentle stream of nitrogen in a heated water bath (60-65 °C) to remove all the water/methanol mix. Add the appropriate amount of 80:20% (vol/vol) methanol:water solution and 20 µl of the ID REC PDS (Sect. 8.2.7) to the collection vial to bring the volume to 1 mL and vortex. Transfer two aliquots with a plastic pipet (Sect. 7.6) into 2 polypropylene autosampler vials.

NOTE: It is recommended that the entire 1-mL aliquot not be transferred to the autosampler vial because the polypropylene autosampler caps do not reseal after injection. Therefore, do not store the extracts in the autosampler vials as evaporation losses can occur occasionally in these autosampler vials. Extracts can be split between 2 X 700 µl vials (Sect. 7.4).

10.7 Sample Volume Determination

10.7.1 If the level of the sample was marked on the sample bottle, use a graduated cylinder to measure the volume of water required to fill the original sample bottle to the mark made prior to extraction. Determine to the nearest 10 mL.

10.7.2 If using weight to determine volume, weigh the empty bottle to the nearest 10 g and determine the sample weight by subtraction of the empty bottle weight from the original sample weight (Sect. 10.2.2). Assume a sample density of 1.0 g/mL. In either case, the sample volume will be used in the final calculations of the analyte concentration (Sect. 11.2).

10.8 Initial Calibration - Demonstration and documentation of acceptable initial calibration is required before any samples are analyzed. After the initial calibration is successful, a CCV is required at the beginning and end of each period in which analyses are performed, and after every tenth Field Sample.

10.8.1 ESI-MS/MS TUNE

10.8.1.1 Calibrate the mass scale of the MS with the calibration compounds and procedures prescribed by the manufacturer.

10.8.1.2 Optimize the [M-H]- for each method analyte by infusing approximately 0.5-1.0 µg/mL of each analyte (prepared in the initial mobile phase conditions) directly into the MS at the chosen LC mobile phase flow rate (approximately 0.4 mL/min). This tune can be done on a mix of the method analytes. The MS parameters (voltages, temperatures, gas flows, etc.) are varied until optimal analyte responses are determined. The method analytes may have different optima requiring some compromise between the optima.

10.8.1.3 Optimize the product ion for each analyte by Infusing approximately 0.5-1.0 µg/mL of each analyte (prepared in the initial mobile phase conditions) directly into the MS at the chosen LC mobile phase flow rate (approximately 0.4 mL/min). This tune can be done on a mix of the method analytes. The MS/MS parameters (collision gas pressure, collision energy, etc.) are varied until optimal analyte responses are determined. Typically, the carboxylic acids have very similar MS/MS conditions and the sulfonic acids have similar MS/MS conditions.

10.8.2 Establish LC operating parameters that optimize resolution and peak shape. Modifying the standard or extract composition to more aqueous content to prevent poor shape is not permitted.

Cautions: LC system components, as well as the mobile phase constituents, contain many of the method analytes in this method. Thus, these PFAS's will build up on the head of the LC column during mobile phase equilibration. To minimize the background PFAS peaks and to keep background levels constant, the time the LC column sits at initial conditions must be kept constant and as short as possible (while ensuring reproducible retention times). In addition, prior to daily use, flush the column with 100% methanol for at least 20 min before initiating a sequence. It may be necessary on some systems to flush other LC components such as wash syringes, sample needles or any other system components before daily use.

10.8.3 Inject a mid-level CAL standard under LC/MS conditions to obtain the retention times of each method analyte. If analyzing for PFTA, ensure that the LC

conditions are adequate to prevent co-elution of PFTA and the mobile phase interferants. These interferants have the same precursor and products ions as PFTA, and under faster LC conditions may co-elute with PFTA. Divide the chromatogram into retention time windows each of which contains one or more chromatographic peaks. During MS/MS analysis, fragment a small number of selected precursor ions ([M-H]-) for the analytes in each window and choose the most abundant product ion. For maximum sensitivity, small mass windows of ±0.5 daltons around the product ion mass were used for quantitation.

10.8.4 Inject a mid-level CAL standard under optimized LC/MS/MS conditions to ensure that each method analyte is observed in its MS/MS window and that there are at least 10 scans across the peak for optimum precision.

10.8.4.1 If broad, split or fronting peaks are observed for the first two eluting chromatographic peaks (if only two analytes are being analyzed, both must be evaluated), change the initial mobile phase conditions to higher aqueous content until the peak asymmetry ratio for each peak is 0.8 – 1.5. The peak asymmetry factor is calculated as described in Section 9.9.1 on a mid-level CAL standard. The peak asymmetry factor must meet the above criteria for the first two eluting peaks during the IDL and every time a new calibration curve is generated. Modifying the standard or extract composition to more aqueous content to prevent poor shape is not permitted.

NOTE: PFHxS, PFOS, NMeFOSAA, and NEtFOSAA have multiple chromatographic peaks using the LC conditions in Table 5 due to chromatographic resolution of the linear and branched isomers of these compounds. Most PFAS's are produced by two different processes. One process gives rise to linear PFAS's only while the other process produces both linear and branched isomers. Thus, both branched and linear PFAS's can potentially be found in the environment. For the aforementioned compounds that give rise to more than one peak, all the chromatographic peaks observed in the standard must be integrated and the areas totaled. Chromatographic peaks in a sample must be integrated in the same way as the CAL standard.

10.8.5 Prepare a set of CAL standards as described in Section 8.2.5. The lowest concentration CAL standard must be at or below the RL (2 ng/L), which may depend on system sensitivity.

10.8.6 The LC/MS/MS system is calibrated using the IS technique. Use the LC/MS/MS data system software to generate a linear regression or quadratic calibration curve for each of the analytes. This curve **must always** be forced through zero and may be concentration weighted, if necessary. Forcing zero allows for a better estimate of the background levels of method analytes. A minimum of 5 levels are required for a linear calibration model and a minimum of 6 levels are required for a quadratic calibration model.

10.8.7 CALIBRATION ACCEPTANCE CRITERIA – A linear fit is acceptable if the coefficient of determination (r^2) is greater than 0.99. When quantitated using the initial calibration curve, each calibration point, except the lowest point, for each analyte should calculate to be within 70-130% of its true value. The lowest CAL point should calculate to be within 50-150% of its true value. If these criteria cannot be met, the analyst will have difficulty meeting ongoing QC criteria. It is

recommended that corrective action is taken to reanalyze the CAL standards, restrict the range of calibration, or select an alternate method of calibration (forcing the curve through zero is still required).

10.8.7.1 CAUTION: When acquiring MS/MS data, LC operating conditions must be carefully reproduced for each analysis to provide reproducible retention times. If this is not done, the correct ions will not be monitored at the appropriate times. As a precautionary measure, the chromatographic peaks in each window must not elute too close to the edge of the segment time window.

10.9 CONTINUING CALIBRATION CHECK (CCV) – Minimum daily calibration verification is as follows. Verify the initial calibration at the beginning and end of each group of analyses, and after every tenth sample during analyses. In this context, a "sample" is considered to be a Field Sample. MBs, CCVs, LCSs, MSs, FDs FRBs and MSDs are not counted as samples. The beginning CCV of each analysis batch must be at or below the RL in order to verify instrument sensitivity prior to any analyses. If standards have been prepared such that all low CAL points are not in the same CAL solution, it may be necessary to analyze two CAL standards to meet this requirement. Alternatively, the analyte concentrations in the analyte PDS may be customized to meet these criteria. Subsequent CCVs should alternate between a medium and Low concentration CAL standard.

10.9.1 Inject an aliquot of the appropriate concentration CAL standard and analyze with the same conditions used during the initial calibration.

10.9.2 Calculate the concentration of each analyte and EIS in the CCV. The calculated amount for each analyte for medium level CCVs must be within ± 30% of the true value with an allowance of 10% of the reported analytes to be greater than 30%, but less than 40%. The calculated amount for each EIS must be within ± 50% of the true value. The calculated amount for the lowest calibration point for each analyte must be within ± 50%. If these conditions do not exist, then all data for the problem analyte must be considered invalid, and remedial action should be taken (Sect. 10.7.4) which may require recalibration. Any Field or QC Samples that have been analyzed since the last acceptable calibration verification should be reanalyzed after adequate calibration has been restored, with the following exception. **If the CCV fails because the calculated concentration is greater than 130% (150% for the low-level CCV) for a particular method analyte, and Field Sample extracts show no detection for that method analyte, non-detects may be reported without re-analysis.**

10.9.3 REMEDIAL ACTION – Failure to meet CCV QC performance criteria may require remedial action. Major maintenance, such as cleaning the electrospray probe, atmospheric pressure ionization source, cleaning the mass analyzer, replacing the LC column, etc., requires recalibration (Sect 10.6) and verification of sensitivity by analyzing a CCV at or below the RL (Sect 10.7).

10.10 EXTRACT ANALYSIS

10.10.1 Establish operating conditions equivalent to those summarized in Tables 6-8 of Section 16. Instrument conditions and columns should be optimized prior to the initiation of the IDC.

10.10.2 Establish an appropriate retention time window for each analyte. This should be based on measurements of actual retention time variation for each method analyte in CAL standard solutions analyzed on the LC over the course of time. A value of plus or minus three times the standard deviation of the retention time obtained for each method analyte while establishing the initial calibration and completing the IDC can be used to calculate a suggested window size. However, the experience of the analyst should weigh heavily on the determination of the appropriate retention window size.

10.10.3 Calibrate the system by either the analysis of a calibration curve (Sect. 10.6) or by confirming the initial calibration is still valid by analyzing a CCV as described in Section 10.7. If establishing an initial calibration, complete the IDC as described in Section 13.2.

10.10.4 Begin analyzing Field Samples, including QC samples, at their appropriate frequency by injecting the same size aliquots under the same conditions used to analyze the CAL standards.

10.10.5 At the conclusion of data acquisition, use the same software that was used in the calibration procedure to identify peaks of interest in predetermined retention time windows. Use the data system software to examine the ion abundances of the peaks in the chromatogram. Identify an analyte by comparison of its retention time with that of the corresponding method analyte peak in a reference standard.

10.10.6 The analyst must not extrapolate beyond the established calibration range. If an analyte peak area exceeds the range of the initial calibration curve, the sample should be re-extracted with a reduced sample volume in order to bring the out of range target analytes into the calibration range. If a smaller sample size would not be representative of the entire sample, the following options are recommended. Re-extract an additional aliquot of sufficient size to insure that it is representative of the entire sample. Spike it with a higher concentration of internal standard. Prior to LC/MS analysis, dilute the sample so that it has a concentration of internal standard equivalent to that present in the calibration standard. Then, analyze the diluted extract.

11. Data Evaluation, Calculations and Reporting

11.1 Complete chromatographic resolution is not necessary for accurate and precise measurements of analyte concentrations using MS/MS. In validating this method, concentrations were calculated by measuring the product ions listed in Table 7.

11.2 Calculate analyte concentrations using the multipoint calibration established in Section 10.6. Do not use daily calibration verification data to quantitate analytes in samples. Adjust final analyte concentrations to reflect the actual sample volume determined in Section 10.6 where:

C_{ex} = (Area of target analyte * Concentration of Labeled analog) / (area of labeled analog * CF)

C_s = (C_{ex} / sample volume in ml) * 1000

C_{ex} = The concentration of the analyte in the extract
CF = calibration factor from calibration.

11.3 Prior to reporting the data, the chromatogram should be reviewed for any incorrect peak identification or poor integration.

11.4 PFHxS, PFOS, PFOA, NMeFOSAA, and NEtFOSAA have multiple chromatographic peaks using the LC conditions in Table 5 due to the linear and branch isomers of these compounds (Sect. 10.6.4.1). The areas of all the linear and branched isomer peaks observed in the CAL standards for each of these analytes must be summed and the concentrations reported as a total for each of these analytes.

11.5 Calculations must utilize all available digits of precision, but final reported concentrations should be rounded to an appropriate number of significant figures (one digit of uncertainty), typically two, and not more than three significant figures.

12. Contingencies for Handling Out-of-Control Data or Unacceptable Data

12.1 Section 9.0 outlines sample batch QC acceptance criteria. If non-compliant organic compound results are to be reported, the Organic Section Head and/or the Laboratory Director, and the Operations Manager must approve the reporting of these results. The laboratory Project Manager shall be notified, and may choose to relay the non-compliance to the client, for approval, or other corrective action, such as re-sampling and re-analysis. The analyst, Data Reviewer, or Department Supervisor performing the secondary review initiates the project narrative, and the narrative must clearly document the non-compliance and provide a reason for acceptance of these results.

12.2 All results for the organic compounds of interest are reportable without qualification if extraction and analytical holding times are met, preservation requirements (including cooler temperatures) are met, all QC criteria are met, and matrix interference is not suspected during extraction or analysis of the samples. If any of the below QC parameters are not met, all associated samples must be evaluated for re-extraction and/or re-analysis.

13. Method Performance

13.1 Detection Limit Study (DL) / Limit of Detection Study (LOD) / Limit of Quantitation (LOQ)

13.1.1 The laboratory follows the procedure to determine the DL, LOD, and/or LOQ as outlined in Alpha SOP ID 1732. These studies performed by the laboratory are maintained on file for review.

13.2 Demonstration of Capability Studies

13.2.1 The IDC must be successfully performed prior to analyzing any Field Samples. Prior to conducting the IDC, the analyst must first generate an acceptable Initial Calibration following the procedure outlined in Section 10.6.

13.2.2 INITIAL DEMONSTRATION OF LOW SYSTEM BACKGROUND – Any time a new lot of SPE cartridges, solvents, centrifuge tubes, disposable pipets, and autosampler vials are used, it must be demonstrated that an MB is reasonably free of contamination and that the criteria in Section 9.2.1 are met. If an automated extraction system is used, an MB should be extracted on each port to ensure that all the valves and tubing are free from potential PFAS contamination.

13.2.3 INITIAL DEMONSTRATION OF PRECISION (IDP) – Prepare, extract, and analyze four to seven replicate LCSs fortified near the midrange of the initial calibration curve according to the procedure described in Section 10. Sample preservatives as described in Section 6.2.1 must be added to these samples. The relative standard deviation (RSD) of the results of the replicate analyses must be less than 20%.

13.2.4 INITIAL DEMONSTRATION OF ACCURACY (IDA) – Using the same set of replicate data generated for Section 13.2.3, calculate average recovery. The average recovery of the replicate values must be within ± 30% of the true value.

13.2.5 INITIAL DEMONSTRATION OF PEAK ASYMMETRY FACTOR – Peak asymmetry factors must be calculated using the equation in Section 9.10.1 for the first two eluting peaks (if only two analytes are being analyzed, both must be evaluated) in a mid-level CAL standard. The peak asymmetry factors must fall in the range of 0.8 to 1.5. See guidance in Section 10.6.4.1 if the calculated peak asymmetry factors do not meet the criteria.

13.2.6 Refer to Alpha SOP ID 1739 for further information regarding IDC/DOC Generation.

13.2.7 The analyst must make a continuing, annual, demonstration of the ability to generate acceptable accuracy and precision with this method.

14. Pollution Prevention and Waste Management

14.1 Refer to Alpha's Chemical Hygiene Plan and Hazardous Waste Management and Disposal SOP for further pollution prevention and waste management information.

14.2 This method utilizes SPE to extract analytes from water. It requires the use of very small volumes of organic solvent and very small quantities of pure analytes, thereby minimizing the potential hazards to both the analyst and the environment as compared to the use of large volumes of organic solvents in conventional liquid-liquid extractions.

14.3 The analytical procedures described in this method generate relatively small amounts of waste since only small amounts of reagents and solvents are used. The matrices of concern are finished drinking water or source water. However, laboratory waste management practices must be conducted consistent with all applicable rules and regulations, and that laboratories protect the air, water, and land by minimizing and controlling all releases from fume hoods and bench operations. Also, compliance is required with any sewage discharge permits and regulations, particularly the hazardous waste identification rules and land disposal restrictions.

15. Referenced Documents

Chemical Hygiene Plan – ID 2124

SOP ID 1732 Detection Limit (DL), Limit of Detection (LOD) & Limit of Quantitation (LOQ) SOP

SOP ID 1739 Demonstration of Capability (DOC) Generation SOP

SOP ID 1728 Hazardous Waste Management and Disposal SOP

16. Attachments

Table 7: LC Method Conditions

Time (min)	2 mM Ammonium Acetate (5:95 MeOH/H_2O)	100% Methanol
Initial	100.0	0.0
1.0	100.0	0.0
2.2	85.0	15.0
11	20.0	80.0
11.4	0.0	100.0
12.4	100.0	00.0
15.5	100.0	0.0
Waters Aquity UPLC ® BEHC_{18} 2.1 x 50 mm packed with 1.7 µm BEH C_{18} stationary phase Flow rate of 0.4 mL/min 2-5 µL injection		

Table 8: ESI-MS Method Conditions

ESI Conditions	
Polarity	Negative ion
Capillary needle voltage	.5 kV
Cone Gas Flow	25 L/hr
Nitrogen desolvation gas	1000 L/hr
Desolvation gas temp.	500 °C

Table 9: Method Analyte Source, Retention Times (RTs), and EIS References

#	Analyte	Transition	RT	IS	Type
1	M3PBA	216>171	2.65		REC
2	PFBA	213 > 169	2.65	2: M4PFBA	
3	M4PFBA	217 > 172	2.65	1: M3PBA	EIS
4	PFPeA	263 > 219	5.67	4: M5PFPEA	
5	M5PFPEA	268 > 223	5.66	1: M3PBA	EIS
6	PFBS	299 > 80	6.35	6: M3PFBS	
7	M3PFBS	302 > 80	6.35	29:M4PFOS	EIS
8	FtS 4:2	327 > 307	7.47	9: M2-4:2FTS	

#	Analyte	Transition	RT	IS	Type
9	M2-4:2FTS	329 > 81	7.47	29:M4PFOS	EIS
10	PFHxA	303 > 269	7.57	10: M5PFHxA	
11	M5PFHxA	318 > 273	7.57	19:M2PFOA	EIS
12	PFPeS	349 > 80	7.88	18: M3PFHxS	
13	PFHpA	363 > 319	8.80	14: M4PFHpA	
14	M4PFHpA	367 > 322	8.80	19:M2PFOA	EIS
15	L-PFHxS	399 > 80	8.94	18: M3PFHxS	
16	br-PFHxS	399 > 80	8.72	18: M3PFHxS	
17	PFHxS Total	399 > 80	8.94	18: M3PFHxS	
18	M3PFHxS	402 > 80	8.94	29:M4PFOS	EIS
19	MPFOA	415 > 370	9.7		REC
20	PFOA	413 > 369	9.7	23: M8PFOA	
21	br-PFOA	413 > 369	9.48	23: M8PFOA	
22	PFOA Total	413 > 369	9.7	23: M8PFOA	
23	M8PFOA	421 > 376	9.7	19: M2PFOA	EIS
24	FtS 6:2	427 > 407	9.66	25: M2-6:2FTS	
25	M2-6:2FTS	429 > 409	9.66	29:M4PFOS	EIS
26	PFHpS	449 > 80	9.78	33: M8PFOS	
27	PFNA	463 > 419	10.41	33: M8PFOS	
28	M9PFNA	472 > 427	10.41	19: M2PFOA	EIS
29	M4PFOS	501 > 80	10.45		REC
30	PFOS	499 > 80	10.45	33: M8PFOS	
31	br-PFOS	499 > 80	10.27	33: M8PFOS	
32	PFOS Total	499 > 80	10.45	33: M8PFOS	
33	M8PFOS	507 > 80	10.45	29: M4PFOS	EIS
34	FtS 8:2	527 > 507	10.99	38: M2-8:2FTS	
35	M2-8:2FTS	529 > 509	10.99	29:M4PFOS	EIS
36	M2PFDA	515 > 470	11.00		REC
37	PFDA	513 > 469	11.00	38: M6PFDA	
38	M6PFDA	519 > 474	11.00	36: M2PFDA	EIS
39	PFNS	549 > 80	11.02	33:M8PFOS	
40	NMeFOSAA	570 > 419	11.41	41: D3-NMeFOSAA	
41	d3-NMeFOSAA	573 > 419	11.41	36: M2PFDA	EIS
42	PFOSA	498 > 78	11.48	29: M8FOSA	
43	M8FOSA	506 > 78	11.48	19: M2PFOA	EIS
44	PFUnDA	563 > 519	11.51	41: M7-PFUDA	
45	M7-PFUDA	570 > 525	11.51	36: M2PFDA	EIS
46	PFDS	599 > 80	11.51	33:M8PFOS	
47	NEtFOSAA	584 > 419	11.68	48: d5-NEtFOSAA	

#	Analyte	Transition	RT	IS	Type
48	d5-NEtFOSAA	589 > 419	11.68	36: M2PFDA	EIS
49	PFDoA	613 > 569	11.96	50: MPFDOA	
50	MPFDOA	615 > 570	11.96	36: M2PFDA	EIS
51	PFTriA	663 > 619	12.34	50: MPFDOA	
52	PFTeA	713 > 669	12.6	53: M2PFTEDA	
53	M2PFTEDA	715 > 670	12.6	36: M2PFDA	EIS
54	M3HFPO-DA	329>285	7.97	19: M2PFOA	EIS
55	HFPO-DA	332>287	7.97	54: M3HFPO-DA	
56	ADONA	377>251	8.00	23: M8PFOA	
57	PFHxDA	813>769	13.20	59: M2PFHxDA	
58	PFODA	913>869	13.50	59: M2PFHxDA	
59	M2PFHxDA	815>770	13.20	36:M2PFDA	EIS
60	NEtFOSA	526>169	11.00	61: NMeFOSA	
61	NMeFOSA	512>169	10.50	63: d3-NMeFOSA	
62	d3-NMeFOSA	515>169	10.50	29: M4PFOS	EIS
63	d5-NEtFOSA	531>169	11.00	29: M4PFOS	EIS
64	NMeFOSE	556>122	11.25	66: d7-NMeFOSE	
65	NEtFOSE	570>136	10.75	67: d9-NEtFOSE	
66	d7-NMeFOSE	563>126	11.25	29: M4PFOS	EIS
67	d9-NEtFOSE	579>142	10.75	29: M4PFOS	EIS
68	FtS 10:2	627>607	11.50	25: M2-6:2FTS	
69	PFDoS	699>99	12.50	33: M8PFOS	