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REMEDIAL INVESTIGATION WORK PLAN

Site Name:	Former Refron Inc. Gas Reclamation Site
Site Address:	38-18 33rd Street and 32-20 38th Avenue, Queens, New York 11101
BCP Site Number:	C241285
Report Date:	April 2025

Prepared For:

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CERTIFICATION

I, Hilmi U. Aydin, certify that I am currently a Qualified Environmental Professional as defined in 6 New York Codes, Rules, and Regulations (NYCRR) Part 375 and that this Remedial Investigation Work Plan was prepared in accordance with all applicable statutes and regulations and in substantial conformance with the Division of Environmental Remediation (DER) Technical Guidance for Site Investigation and Remediation (DER-10) and Green Remediation (DER-31).

Hilmi U. Aydin, P.E., QEP
Principal Engineer

1.0 INTRODUCTION

This Remedial Investigation Work Plan (RIWP) was prepared on behalf of 38-18 33rd Street LLC and 32-20 38th Avenue LLC (the Applicant) for the Former Refron Inc. Gas Reclamation Site located at 38-18 33rd Street and 32-20 38th Avenue in the Long Island City section of Queens County, New York (the Site). The Applicant is enrolled in the New York State Brownfield Cleanup Program (BCP). A Brownfield Cleanup Agreement (BCA) was executed by the New York State Department of Environmental Conservation (NYSDEC) on March 11, 2025 (Site No. C241285), with the Applicant classified as a Volunteer.

The RIWP dated October 2024, which was submitted previously with the BCP application, is revised to address NYSDEC and New York State Department of Health (NYSDOH) comments received on March 12, 2025 and April 8, 2025.

The purpose of this RIWP is to investigate the Site to characterize the nature and extent of contamination associated with historic operations at the Site as well as identify the source area for chlorinated solvent contamination. The overall objectives of this project are to remediate and prepare the Site for its proposed residential use. This RIWP was prepared in accordance with the regulations and guidance applicable to the BCP, DER-10 Technical Guidance for Site Investigation and Remediation dated May 2010, DER-31 Technical Guidance for Green Remediation, and the New York State Department of Health (NYSDOH) Guidance for Evaluating Soil Vapor Intrusion in the State of New York, with revisions (October 2006).

2.0 SITE BACKGROUND

2.1 Site Location and Description

The Site, addressed as 38-18 33rd Street and 32-20 38th Avenue, is located on the southwest corner of the 38th Avenue and 33rd Street intersection in Queens County, New York. The Site consists of two adjacent tax lots totaling approximately 29,375 square feet. The legal description of the Subject Property is New York City Department of Finance Tax Block 381, Lots 5 and 16. Lot 5 is alternately addressed as 38-11 through 38-19 32nd Street, 38-12 through 38-20 33rd Street, and 32-12 through 32-18 38th Avenue. Lot 16 is alternately addressed as 38-02 through 38-10 33rd Street. A Site location map is provided in Figure 1.

According to the New York City Department of Finance's Automated City Register Information System (ACRIS), the ownership of Lot 5 is vested in Vecta Industries, LLC since November 24, 2020, and the ownership of Lot 16 is vested in Venta Industries, LLC since November 24, 2020.

Lot 5 of the Site consists of a 26,476 square feet parcel that is currently improved with a 30,000-square-foot two-story industrial and manufacturing building with a partial cellar in the northern portion. In addition to the current structure, a concrete paved parking lot is located to the north of the two-story building and contains a stormwater drain by the metal roll-up door entrance. Two floor drains are present in the utility room. Small utility manhole covers for municipal gas, sewer, and electric utilities are located along the sidewalk on 33rd Street.

Lot 16 of the Site consists of a 2,900-square-foot parcel that is currently improved with a 5,800-square-foot two-story industrial manufacturing building with a partial cellar. The on-site building on Lot 16 occupies the entirety of the tax parcel with no open spaces. A floor drain is present in the building's boiler room.

Both lots are vacant and not accessed on a regular basis. Entrances to both buildings are controlled by locked roll-up metal doors and typical doorways. The entrance to the parking lot is controlled by a locked gate. A site plan is provided in Figure 2. A map of drains and utility lines at the Site will be provided in the Remedial Investigation Report. The approximate locations of surveyed utilities are provided in Figure 2.

The Site is located within a mixed residential, commercial, industrial and manufacturing neighborhood of Queens County. The Site is zoned M1-3/R7X, M1-2/R6A and Special Long Island City Mixed Use District (LIC), denoting it as a light industrial, mixed residential/commercial, and special Long Island City Mixed Use district. This zoning allows for light industrial needs in areas that are adjacent to residential or commercial districts, and promotes the development and expansion, at varying densities, of the longstanding mix of residential, commercial, industrial, and cultural uses found in the four Long Island City subdistricts.

2.2 Surrounding Property Land Use

North	One six-story mixed-use building (32-04 38th Avenue); one three-story transportation and utility building (32-08 38th Avenue); four two-story residential use buildings (32-10 38th Avenue, 32-11 38th Avenue, 32-15 38th Avenue, 32-17 38th Avenue); one two-story parking garage (32-19 38th Avenue)
South	One ten-story mixed-use building (32-03 39th Avenue); a public facility and institution property (38-34 33rd Street)
West	One three-story commercial use building (33-01 Northern Boulevard); parking lot (33rd Street, Tax Block 380, Lot 3); one two-story mixed-use building (33-02 38th Avenue); one six-story residential use building (33-01 38th Avenue)
East	A two-story parking garage (38-24 32nd Street); two two-story residential use buildings (38-18 32nd Street, 38-14 32nd Street); one six-story mixed-use building; one two-story industrial and manufacturing building (31-18 38th Avenue)

The Site is bounded to the north by 38th Avenue, followed by four two-story residential use buildings, a six-story mixed residential and commercial use building, a three-story transportation and utility use building, and a two-story parking use building; to the south by a 10-story mixed residential and commercial use building and a public facility and institution property utilized as an MTA easement; to the east by 33rd Street, followed by a six-story residential use building, three-story commercial use building, two-story mixed residential and commercial use building, and a parking lot; to the west by 32nd Street, followed by a two-story industrial and manufacturing use building, a six-story mixed residential and commercial use building, two two-story residential use buildings, and a two-story parking garage.

The nearest ecological receptor is the Newtown Creek located approximately 0.8 miles southwest of the Site. Other sensitive receptors, as defined in DER-10, within a half mile of the Site include the following:

1. The New York Foundling Hospital at 33-00 Northern Boulevard
2. Citiview Connection at 33-24 Northern Boulevard

3. Living Positive- Queens at 34-18 Northern Boulevard
4. New York Counseling for Change Clinic at 30-46 Northern Boulevard
5. Queens Children Mobile Crisis team at 30-30 Northern Boulevard
6. Fortune Society OP at 29-76 Northern Boulevard
7. GED Restart- Adolescent Skills II School at 29-46 Northern Boulevard
8. Playhouse NYC Inc-Day Care and Pre-K at 29-22 Northern Boulevard
9. Consumer Officer Health Care at 42-09 28th Street
10. Transition Management Services at 42-09 28th Street CN #48
11. Atlas at 28-01 41st Avenue
12. Academy of American Studies at 40-11 28th Street
13. Growing Up Green Charter School at 39-27 28th Street
14. Windmill Community Garden at 39-22 29th Street
15. Our World Neighborhood MS at 38-27 30th Street
16. Evangel Christian School at 39-21 Crescent Street
17. SCO Family of Services at 38-11 27th Street
18. United Wire Metal and Machine Medical Center at 24-09 38th Avenue
19. P.S. 112 Dutch Kills at 25-05 37th Avenue
20. Dutch Kills Playground at 36-11 28th Street
21. Energy Tach Highschool at 36-41 28th Street
22. P.S. 166 Henry Gradstein at 33-05 35th Avenue
23. Astoria Dialysis Center at 34-01 35th Avenue
24. Baccalaureate School for Global Education at 34-12 36th Avenue
25. A.R.R.O.W. Field House at 35-38 35th Street
26. Frank Sinatra School of the Arts High School at 35-12 35th Avenue
27. Our World Neighborhood Charter at 36-12 35th Avenue

Surrounding property use, including residences located within a half mile of the Site, are shown in Figure 3.

2.3 Site Topography, Geology, and Hydrogeology

According to the United States Geological Survey (USGS) Topographic Quadrangle for "*Brooklyn, New York*" dated 2013, the subject property is located at approximately 95 feet above mean sea level (MSL). The contour lines in the subject property area indicate the area is sloping gently toward the south.

The subsurface materials beneath the Site are generally described from surface grade to 17 feet below grade surface as light brown fine-grained sand with varying amounts of fine gravel, concrete, asphalt, glass, fine to medium-grained sand, weathered rock, and silt. From 17 to 25 feet below grade is described as brown fine sand with varying amounts of fine gravel, silt, and clay. Based on the most recent investigation, the depth of groundwater was observed between approximately 14-15 feet below grade surface (bgs).

Groundwater flow direction may be impacted by several factors, including surface topography, hydrology, hydrogeology, characteristics of soil, and nearby wells. According to topographic map interpretation, the inferred groundwater flow direction in the vicinity of the Site is southwest towards Newtown Creek, located approximately 0.80 miles to the southwest of the Site.

2.4 Site History

Based on the available records, Lot 5 of the Site was developed as early as 1898 with three one-story dwellings. In 1949, it was redeveloped with the current warehouse in the southern portion, which was utilized for pipe cutting on the first floor and office use on the second floor. The northern portion was then developed with three one-story storage buildings. As of 1970, the warehouse on Lot 5 was identified as a plumbing supply warehouse. Sometime between 1980 and 1985, Lot 5 was configured as its current layout.

Lot 16 was undeveloped as early as 1898. It was developed to its current footprint in 1947 with a two-story structure identified as a Chemical Lab. Former Site uses were identified as a chemical laboratory from 1947 through at least 1950, manufacturing from 1970 to at least 2006, and has a history of operating as a chain manufacturing business, plumbing and heating supplies business, a refrigerant supply business, and an equipment supply business. Potential releases from these former uses could have impacted the subsurface conditions beneath the Site.

2.5 Summary of Previous Investigations

The previous investigations performed at the Site include the following:

Phase I Environmental Site Assessment at 32-20 38th Avenue, Queens, New York, by H2M Architects + Engineers, January 2023

- H2M architects + engineers (H2M) prepared this report for Lot 16 on behalf of Venta Industries, LLC, in accordance with ASTM Standard E1527-13 Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process.
- The following Recognized Environmental Conditions (RECs) were identified during the Phase I:
    - Presence of possibly impacted soil vapor beneath the Site and the potential soil vapor intrusion due to the reported petroleum-related releases, dry cleaning, and auto repair operations in the vicinity of the property.
    - Listing of the property on the NYC E-Designation database. Future development activities at the subject property will require formal environmental investigations, including soil vapor and soil and groundwater

sampling, and approvals obtained through the New York City Mayor's Office of Environmental Remediation.

- The following Business Environmental Risks (BERs) were identified during the Phase I ESA:
  - The building's historical uses as a chemical laboratory, a jewelry manufacturing company, and a storage and reclamation of refrigerant gases.
  - The building's floor drains are also reportedly capped due to stormwater runoff causing floods. H2M considered this a BER due to the unknown conditions of the bottom sediments within the floor drains.

__Phase I Environmental Site Assessment at 38-18 33rd Street, Queens, New York by H2M Architects + Engineers, January 2023__

- H2M architects + engineers (H2M) prepared this report for Lot 5 on behalf of Vecta Industries, LLC, in accordance with ASTM Standard E1527-13 Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process.
- The following Recognized Environmental Conditions (RECs) were identified during the Phase I:
  - Presence of possibly impacted soil vapor beneath the Site and the potential soil vapor intrusion due to the reported petroleum-related releases, dry cleaning, and auto repair operations in the vicinity of the property.
  - Listing of the property on the NYC E-Designation database. Future development activities at the subject property will require formal environmental investigations, including soil vapor and soil and groundwater sampling, and approvals obtained through the New York City Mayor's Office of Environmental Remediation.
- The following Historical Recognized Environmental Condition (HREC) was identified during the Phase I ESA:
  - Former spill on the property that occurred on March 20, 2019. According to the report, 25 gallons of diesel fuel were released due to a ruptured tank, and a large amount of absorbent was spread out to cover the fuel staining on the street. DEP's Division of Emergency Response and Technical Assessment (DERTA) verified that no underground structures were impacted by the fuel spill, and any remaining fuel was returned to the vehicle's gas tank. All materials regarding the fuel spill were removed from the location, and the New York City Department of Sanitation (DOS) was contacted for additional clean-up.
- The following Business Environmental Risks (BERs) were identified during the Phase I ESA:
  - The building's historical uses as storage and reclamation of refrigerant gases.

  - The subject building currently operates with a fuel oil aboveground storage tank in the basement to supply fuel for a backup generator. During the visual inspection of this system, no evidence of leaking or damage was noted. Therefore, the presence of an active fuel oil AST is considered a BER.
  - The building's floor drains are also reportedly capped due to stormwater runoff causing floods. H2M considers this a BER due to the unknown conditions of the bottom sediments within the floor drains.
- The following De Minimis Condition was identified during the Phase I ESA:
  - During the visual site inspection, pools of water were observed on the floor in both boiler rooms. Water was leaking overhead from the pipes in the boiler room located in the basement. No sheens or unusual odors indicative of a fuel oil release were observed.

Phase II Investigation Report at 38-18 33rd Street and 32-20 38th Avenue, Queens, New York by Vektor Consultants, September 2024

- Based on the review of available Phase I ESA Reports summarized above, Vektor recommended a limited Phase II Environmental Site Assessment to evaluate if the former industrial operations have adversely impacted the subsurface conditions beneath the Site prior to the acquisition of the Subject Property.
- A limited Phase II investigation consisting of performance of a geophysical survey, installation and sampling of eight soil borings, installation and sampling of two temporary groundwater monitoring wells, and the installation and sampling of five soil vapor points was conducted at the Site from July 18, 2024 to July 19, 2024. A supplemental investigation consisting of the installation and sampling of three monitoring wells and the installation and sampling of twelve soil vapor points was conducted at the Site from August 7, 2024 to August 8, 2024.
- The subsurface materials were generally described from surface grade to 17 feet below grade as light brown fine-grained sand with varying amounts of fine gravel, concrete, asphalt, glass, fine to medium-grained sand, weathered rock, and silt. From 17 to 25 feet below grade, brown fine sand with varying amounts of fine gravel, silt, and clay is described.
- The geophysical survey did not identify any anomalies or areas of concern indicative of underground storage tanks.
- Eight soil borings were installed, and eight soil samples were collected to be analyzed at the New York State Department of Health ELAP-certified laboratory for the presence of Part 375 Target Compound List (TCL) volatile organic compounds (VOCs) by EPA Method 8260, TCL semi-volatile organic compounds (SVOCs) by EPA Method 8270, and Target Analyte List (TAL) Metals by EPA Method 6000/7000.

    - No PID readings were detected in the soil samples, except for one soil boring, SB-2, at the 2-4 feet interval and 22-23 feet interval, which was detected at 19.1 and 0.5 parts per million (ppm), respectively.
    - No VOCs or SVOCs were detected in the soil samples above their respective NYSDEC Part 375 Unrestricted Use SCOs.
    - One heavy metal, arsenic, was detected in one soil sample at a concentration above its respective Part 375 Restricted Residential Use SCO.

- Groundwater was encountered at a range of approximately 13.8 to 15.2 feet.
- During the initial investigation in July 2024, two temporary monitoring wells were installed, and two groundwater samples were collected to be analyzed for the presence of TCL VOCs via USEPA Method 8260, TCL SVOCs via USEPA Method 8270, and Target Analyte Metals by EPA Methods 6000/7000. During the supplemental investigation in August 2024, three permanent groundwater monitoring wells were installed, and three groundwater samples were collected to be analyzed for TCL VOCs via USEPA Method 8260.
    - No SVOCs above their respective AWQS were identified in groundwater samples.
    - Chlorinated VOC impacts (PCE, TCE, and trans-1,2-dichloroethylene) were identified in the groundwater, specifically in the western portion of the Site.
- During the initial investigation in July 2024, five soil vapor points were installed to depths between 2.5 feet and 10 feet, and five soil vapor samples were collected. During the supplemental investigation in August 2024, twelve soil vapor points were installed to depths between 10 and 13 feet, and twelve soil vapor samples were collected.
    - Results showed low concentrations of petroleum-related VOCs and elevated concentrations of chlorinated VOCs (CVOCs) in all soil vapor samples. Furthermore, Freon was detected at elevated concentrations in almost all soil vapor samples. Although Freon does not have a regulatory standard, it was utilized during the historical operations at the Subject Property, and therefore, the results suggest a release from former uses of the properties.
- Based on the results of the Phase II Environmental Site Assessment, impacts to groundwater and soil vapor beneath the Subject Property are identified. Vektor recommended reporting the results to the NYSDEC and remediating the Subject Property under one of their available programs.

Phase I Environmental Site Assessment at 38-18 33rd Street and 32-20 38th Avenue, Queens, New York by Vektor Consultants, September 2024

- Vektor prepared this report for 38-18 33rd Street LLC and 38-18 33rd Street LLC in accordance with ASTM Standard E1527-21 Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process.
- The following Recognized Environmental Conditions (RECs) were identified during the Phase I:
  - Based on the available records, historical uses of the Subject Property include a chain manufacturing business, a refrigerant supply business, and a chemical laboratory. These facilities typically utilize hazardous substances or petroleum products as part of their operations, and potential historic releases from these facilities could have affected the subsurface conditions. The EDR database also indicates that the Subject Property has a history of generating sodium cyanide, ignitable, corrosive material, and halogenated solvents as waste. Therefore, the historical uses of the Subject Property is considered REC.
  - Based on the available records, the properties in the vicinity of the Subject Property were utilized as dry cleaners and auto repair operations. Therefore, the presence of possibly impacted soil vapor beneath the Site and the potential soil vapor intrusion) cannot be ruled out and is considered a REC.
  - A Phase II Environmental Site Assessment conducted at the Subject Property in July and August 2024 identified the presence of chlorinated volatile organic compounds (CVOCs) in groundwater beneath the Site at concentrations exceeding regulatory standards as well as the presence of elevated concentrations of CVOCs and Freon, likely associated with historical operations, in soil vapor across the Subject Property. The presence of contaminants exceeding regulatory standards and guidance limits is considered a REC.
- This Phase I ESA revealed the following historical recognized environmental conditions (HRECs) in connection with the Subject Property:
  - The Subject Property (Landstar Inway on Lot 5) is listed on the Spills database under Spill #1812448 due to an equipment failure that occurred on March 20, 2019. According to the regulatory database report, the spill incident was reported to the New York State Department of Environmental Conservation (NYSDEC) on March 20, 2019, when a saddle tank was punctured, and approximately 20 gallons of diesel fuel spilled onto the asphalt. First Environmental was reported to clean up the spill on March 28, 2019. No drains or soils were impacted. The NYSDEC closed the case on March 28, 2019, as no further action was required. Based on the regulatory status and the de minimis amount of oil spilled, this listing is considered an HREC.

- The Phase I ESA revealed the following environmental issues in connection with the Subject Property:

    - The Subject Property, identified as Tax Block 381, Lots 5 and 16, is listed on the E-designation database under E-number E-218 for hazardous materials regarding Phase I and Phase II testing protocol as a result of rezoning of the general surrounding area (Dutch Kills Rezoning and Related Actions (CEQR # 08DCP021Q)). An E-Designation is a New York City zoning map designation that indicates the presence of an environmental requirement pertaining to potential hazardous materials contamination. Any future redevelopment and/or alteration work must also be coordinated with the NYCOER in order to obtain construction permits from the New York City Department of Buildings (NYCDOB).
    - Based on the age of the building, building materials may contain asbestos-containing materials (ACM) and lead-based paint (LBP). Readily visible suspect ACMs and painted surfaces were observed to be in good condition. Should these materials be replaced, a pre-demolition survey would need to be conducted prior to any renovation or demolition activities.

- Vektor recommended the following:

    - Based on the results of the Phase II Environmental Site Assessment, impacts to groundwater and soil vapor beneath the Subject Property are identified. The results must be reported to the NYSDEC, and the Subject Property must be remediated in order to protect the public health and the environment.
    - Any future redevelopment and/or alteration work must be coordinated with the NYCOER in order to obtain construction permits from the New York City Department of Buildings (NYCDOB) due to the presence of E-Designation for hazardous materials on the Subject Property.
    - An Operations and Maintenance (O&M) Plan should be prepared and implemented in order to safely manage the suspect ACMs and LBP at the Subject Property. If redevelopment or renovation of the Subject Property is planned, suspect ACMs and LBP should be surveyed and abated in accordance with federal and NYC regulations.

Copies of the previous reports are provided as Appendix A.

Although January 2023 Phase I ESAs conducted at the Site stated all floor drains were capped, two floor drains were observed in the utility room of the building on Lot 5, and a floor drain was observed in the boiler room of Lot 16. The location of the floor drains are provided in Figure 2. No other differences were identified from the Phase I ESA findings.

2.5.1 Areas of Concern

Based on the prior investigation results, the areas of concern (AOC) for the Site are identified as the following:

- AOC 1: Metals in Soil

Total arsenic was identified above its Part 375 Restricted Residential SCO in soil in the central portion of Lot 16. The presence of this heavy metal in one soil sample could be a hot spot associated with urban fill.

- AOC-2: Chlorinated VOC Impacts in Groundwater

Chlorinated VOCs (CVOCs) (PCE, TCE, and trans-1,2-dichloroethylene) above their respective AWQS were identified in the western portion of Lot 5.

- AOC-3: Chlorinated VOC Impacts in Soil Vapor

Elevated concentrations of CVOCs in soil vapor samples were identified across the entire Site. The highest concentrations were identified along the south adjacent property boundary.

3.0 REMEDIAL INVESTIGATION

A Remedial Investigation (RI) proposed herein will supplement the prior assessments to characterize the nature and extent of contamination at the Site. The supplemental data will be analyzed to characterize the nature and extent of contamination at the Site and to evaluate remedial action alternatives.

The remedial investigation will consist of the following scope of work:

- Geophysical survey to locate unidentified underground storage tanks (USTs) and identify utilities in the vicinity of the proposed boring locations,
- Installation of fifteen soil borings to 15 feet below sidewalk grade, or refusal across the Site and collection of thirty-three (45) soil samples and additional quality assurance /quality control (QA/QC) samples,
- Installation of six monitoring wells and collection of nine groundwater samples and additional QA/QC samples from the newly installed monitoring wells and three existing groundwater monitoring wells.
- Installation of five soil vapor points and collection of five soil vapor samples and one duplicate soil vapor sample and one ambient air sample as the QA/QC samples.

Table 1 provides a summary of the sampling protocol and rationale.

If modifications to the scope of work are required due to site conditions, the NYSDEC and NYSDOH project managers will be notified. As part of future development and remedy at the Site, the on-site buildings will be demolished; however, the RI is planned to be performed prior to demolition activities. All deviations will be reported in the Remedial Investigation Report (RIR). Soil vapor data from Vektor's Phase II investigation dated September 2024 will be discussed and appended to the RIR to supplement soil vapor findings during this RI. The Phase II soil vapor results will be supplied in Analytical Services Protocol (ASP) Category B Data Packages, and all results will be provided in accordance with the NYSDEC Environmental Information Management System (EIMS) electronic data deliverable (EDD) format (EQuIS) by a New York State Department of Health (NYSDOH) Environmental Laboratory Approval Program (ELAP) certified laboratory [see Section 5.1 for further details on Data Submittals].

3.1 Geophysical Survey

A Ground Penetrating Radar (GPR) Survey will be conducted by a licensed geophysical surveyor to determine the locations of any potential USTs at the Site and to clear out the boring locations prior to drilling. A grid of north-south traverses will be established across the Site at five-foot intervals. The data will be processed on-site and used to create a contour map.

3.2 Soil Investigation

A total of fifteen soil borings (25SB-1 through 25SB-15) will be advanced to investigate potential impacts from the former uses of the Site. A direct push drill-rig (Geoprobe®) operated by a licensed driller subcontractor will be utilized for the installation of soil borings at the Site. The soil borings will be advanced continuously to 15 feet below sidewalk grade, or refusal (the "boring termination depth"), or immediately above the groundwater interface (anticipated between 14-15 feet below grade). However, if evidence of contamination is observed at 15 feet below the sidewalk grade or the water table interface, the boring shall be completed until no evidence of contamination is observed. Figure 7 shows proposed soil boring locations.

Soil samples will be retrieved using 1.5-inch diameters, 5-foot-long core sampler with disposable acetate liners. A Geologist will be on Site to log the soils, visually characterize them, and field screen them with a photo ionization detector (PID) for the presence of petroleum contamination.

From each of the 15 boring locations, a minimum of three soil samples (total of 45 samples) will be collected for laboratory analysis. At these borings, one soil sample will be collected from the fill layer at 0 to 2 feet bgs, one sample below the historic fill layer, and one sample immediately above the groundwater table. If historic fill extends to refusal depth, a soil sample will be collected above the interval immediately above refusal. If evidence of contamination is observed at 15 feet below the sidewalk grade or the water table interface, the boring shall be completed until no evidence of contamination is observed. If the highest levels of apparent contamination are present below the water table, a saturated zone soil sample should also be collected.

Additional samples will be collected, as needed, from any interval within the advanced borings which are observed to exhibit evidence of contamination (i.e., staining, odors, elevated PID readings).

Representative soil samples will immediately be containerized in pre-cleaned laboratory supplied glassware, stored in a chilled cooler (4°C), and submitted to a New York State Department of Health certified laboratory.

The soil samples from 25SB-1 through 25SB-15 will be analyzed for:

- Target Compound List (TCL) volatile organic compounds (VOCs) via Environmental Protection Agency (EPA) Method 8260C/5035
- TCL semi-volatile organic compounds (SVOCs) via EPA Method 8270D
- Total analyte list (TAL) metals via EPA Method 6010D

- Polychlorinated biphenyls (PCBs) via EPA Method 8082A
- TLC pesticides via EPA Method 8081B
- NYSDEC list per and polyfluoroalkyl substances (PFAS) (40 compounds) via EPA Method 1633
- 1,4-dioxane via EPA Method 8270 SIM.

Table 1 provides a sampling matrix, and Figure 7 shows the proposed locations for soil samples. Minimum laboratory reporting limits for the proposed analysis above compared to guidance levels can be found in Table 3.

3.3 Groundwater Investigation

Four 2-inch permanent groundwater monitoring wells, MW-4 through MW-7, will be installed to evaluate the groundwater quality beneath the Site utilizing a direct push drill rig within the central portion of the Site, southern portion of the Site, and northern portion of the Site. Two additional 2-inch permanent groundwater monitoring wells, MW-1I and MW-1D, will be installed to a depth of 25 feet below grade and 35 feet below grade, respectively, to further evaluate the CVOCs identified within MW-1 during the Phase II investigation. Based on gauging during the most recent investigation, the groundwater depth beneath the Site ranges from approximately 14 feet below grade to 15 feet below grade.

In addition to the newly installed monitoring wells, the existing well network on-site, consisting of MW-1, MW-2, and MW-3, will be sampled for full TCL parameters during the RI to assess groundwater quality beneath the Site.

The proposed monitoring wells will be constructed of 2-inch diameter PVC casing and 0.020-inch slotted PVC well screen or 2-inch pre-packed wells. The 10 feet screen will be set 5 feet below the groundwater table. Morrie No. 1 or equivalent clean sand will be used to fill the annular gap around the screen and above the top of the screened interval. A bentonite seal will be installed above the sand, and the remainder of the borehole will be backfilled to grade with non-petroleum impacted drill cuttings and/or clean sand. The monitoring wells will have stick-up risers above grade for visibility.

Monitoring wells will then be developed by surging a pump, bailer, or surge block inside the wells. The method will be repeated until sediment free water is produced, or water turbidity is 50 nephelometric turbidity units (NTU) or less.

All monitoring wells will be surveyed by a New York State licensed surveyor in order to determine the actual direction of groundwater beneath the Site.

Approximately one week after well development, one groundwater sample will be collected from each of the monitoring wells (total of six groundwater samples). Prior to sampling, each monitoring well will be gauged and purged until groundwater quality parameters such as temperature, dissolved oxygen, oxidation-reduction potential, pH and turbidity stabilize. Samples will then be collected using a submersible pump and dedicated tubing in accordance with low-flow sampling procedures. The pump will be decontaminated with Alconox® and water between each monitoring well.

Groundwater samples will be containerized in pre-cleaned laboratory-supplied glassware, stored in a chilled cooler (4°C), and submitted to a New York State Department of Health certified laboratory.

The groundwater samples will be analyzed for:

- Target Compound List (TCL) volatile organic compounds (VOCs) via Environmental Protection Agency (EPA) Method 8260C
- TCL semi-volatile organic compounds (SVOCs) via EPA Method 8270D
- Total analyte list (TAL) metals (filtered and unfiltered) via EPA Method 6010D/7471
- Polychlorinated biphenyls (PCBs) via EPA Method 8082A
- TLC pesticides via EPA Method 8081B
- NYSDEC list per and polyfluoroalkyl substances (PFAS) (40 compounds) via EPA Method 1633
- 1,4-dioxane via EPA Method 8270D SIM.

Table 1 provides a sampling matrix, and Figure 8 shows the proposed monitoring well locations. Minimum laboratory reporting limits for the proposed analysis above compared to guidance levels can be found in Table 3.

3.4 Soil Vapor Investigation

Soil vapor results collected during the prior Phase II investigation will be validated, and a Data Usability Summary Report (DUSR) will be prepared. To supplement the prior findings, the following scope of soil vapor investigation will be conducted:

Five (5) soil vapor points (25SV-1 through 25SV-5) will be installed using the same direct-push drill rig mentioned above. Soil vapor points will be installed and sampled in accordance with the Final Guidance for Evaluating Soil Vapor Intrusion in the State of New York (October 2006). Soil vapor points will be installed at approximately 12 feet below grade surface. If groundwater is encountered during the RI, soil vapor points will be installed 2 feet above the water table. Sample points will be constructed of a dedicated stainless-steel screen fitted with ¼-inch outer diameter inert polyethylene, Teflon lined tubing, which will be extended above ground surface to allow for purging and sampling. The points will be backfilled using glass beads followed by environmental grade silica sand and topped with a bentonite layer to seal the tubing in the hole.

Prior to testing, a tracer gas will be used in accordance with NYSDOH protocols to serve as a quality assurance/quality control (QA/QC) technique to verify the integrity of the soil vapor point seal. The integrity of vapor points will be tested by placing a plastic shroud over the vapor points to isolate them from ambient air. Then, a helium tracer gas will be applied to the shroud and will be screened utilizing a helium detector for the presence of helium. If no helium is detected in any of the vapor points, then sampling will occur. If helium is detected, then the points will be resealed properly prior to sampling.

After purging approximately three volumes of air from each vapor point at a flow rate less than 200 milliliters per minute, representative samples will be collected for laboratory analysis utilizing 6-liter SUMMA canisters fitted with 8-hour flow controllers set not to exceed 0.2 liters per minute, as established by the NYSDOH Guidance document. Upon completion of the vapor sampling, all canisters will be labeled properly with the sample ID numbers, and vacuum pressure readings in the canisters before and after the sample collection. The vapor samples will then be submitted to a NYSDOH ELAP-certified laboratory under proper chain of custody procedures to be analyzed for VOCs by EPA Method TO-15.

The QA/QC sample for soil vapor will include one blind duplicate sample from one of the five installed soil vapor points. The sample will be determined by Site logistics. One ambient air sample will be collected at a breathing height as a background sample. The outdoor air sample will be collected over an 8-hour sampling period concurrently with the soil vapor samples and analyzed for VOCs via EPA Method TO-15.

All soil vapor and ambient air sample analytical results will be reported in micrograms per cubic meter (ug/m^3).

Table 1 provides a sampling matrix, and Figure 9 shows the proposed soil vapor locations. Minimum laboratory reporting limits for the proposed analysis above compared to guidance levels can be found in Table 3.

3.4 Management of Investigation Derived Waste

As per the DER-10, soil cuttings from a depth below the fill layer and other soil generated on-site during remedial investigation will be returned to the borehole, unless:

- Free product, NAPL, or grossly contaminated soil, are present in the cuttings,
- The boreholes will be used for installation of a monitoring well,
- The borehole has an aquitard, or other confining layer,

- Backfilling the borehole with cuttings will create a significant path for vertical movement of contaminant
- Soil cannot fit into the borehole

Those soil cuttings needing to be managed on-site will be containerized in properly labeled Department of Transportation (DOT) approved 55-gallon drums for future off-site disposal at a permitted facility. All boreholes which require soil cuttings disposal would ultimately be filled with hydrated bentonite chips and asphalt/concrete capping.

Groundwater purged from the monitoring wells during development and sampling will be placed into DOT approved 55-gallon drums for future off-site disposal.

4.0 STANDARDS, CRITERIA, AND GUIDANCE (SCGS)

The results of the soil samples will be compared to 6 NYCRR Part 375 Unrestricted Use SCOs and Restricted Residential Use SCOs based on the reasonably anticipated residential use of the Site.

The results of the groundwater samples will be compared to the NYSDEC Class GA Ambient Water Quality Standards (AWQS), or Guidance Values (GVs) as specified in the Technical Operation and Guidance Series (TOGS 1.1.1) Ambient Water Quality Standards and Guidance Values, and Guidance Values published in “Sampling, Analysis and Assessment of PFAS under NYSDEC’s Part 375 Remedial Programs”.

Soil vapor results will be evaluated to determine the type and concentration of VOCs present and whether engineering controls are required to prevent future exposure of these chemicals to the new building's occupants.

5.0 QUALITY CONTROL/QUALITY ASSURANCE (QA/QC)

The accuracy, precision, and completeness of the samples will be addressed by the certified laboratory for all data generated. The QA/QC samples for soil and groundwater will include one matrix spike/matrix spike duplicate (MS/MSD), and one blind duplicate sample at a frequency of at least one sample per 20 field samples per media. One trip blank per cooler and one field blank per day per matrix collected will also be included. The field blank, blind duplicate, and MS/MSD samples will be analyzed for:

- TCL VOCs EPA Method 8260C/5035
- TCL SVOCs via EPA Method 8270D
- TAL metals via EPA Method 6010D
- PCBs via EPA Method 8082A
- TLC pesticides via EPA Method 8081B
- NYSDEC list PFAS via EPA Method 1633
- 1,4-dioxane via EPA Method 8270 SIM.

Laboratory-prepared trip blanks will be submitted for analysis of VOCs via EPA Method 8260.

The QA/QC sample for soil vapor will include one blind duplicate sample from one of the five installed soil vapor points. The sample will be determined by Site logistics. For soil vapor sampling, a tracer gas will be used prior to testing of each location in accordance with NYSDOH protocols to serve as a QA/QC technique to verify the integrity of each soil vapor point seal. The integrity of the soil vapor points will be tested by placing a plastic shroud over the vapor points to isolate them from ambient air. Then, a helium tracer gas will be applied into the shroud and will be screened utilizing a helium detector for presence of helium. If no helium is detected at any of the vapor points, then sampling will occur. If helium is detected, then the points will be resealed properly prior to sampling. One ambient air sample will be collected at a breathing height as a background QA/QC sample. The outdoor air sample will be collected over an 8-hour period concurrently with the soil vapor samples and will be analyzed for VOCs via EPA Method TO-15.

Table 1 provides a sampling matrix with estimated QA/QC samples. A Quality Assurance Project Plan that describes how QA/QC procedures will be implemented during the RI is provided as Appendix B.

5.1 Data Submittal

Analytical results will be provided by a New York State Department of Health (NYSDOH) Environmental Laboratory Approval Program (ELAP) certified laboratory. Data will be supplied in Analytical Services Protocol (ASP) Category B Data Packages, and all results will be provided in accordance with the NYSDEC Environmental Information Management System (EIMS) electronic data deliverable (EDD) format (EQuIS).

5.2 Data Validation

Data validation will be performed in accordance with the EPA validation guidelines for organic and inorganic data review. A Data Usability Summary Report (DUSR) will be prepared by a third-party contractor upon receipt of the analytical laboratory reports. The DUSR will present the results of the 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 of each analytical method.

6.0 HEALTH AND SAFETY PLAN (HASP)

A site-specific Health and Safety Plan (HASP) is prepared for this project. All field personnel involved in investigation activities will participate in training required under 29 CFR 1910.120, such as 40-hour hazardous waste operator training and annual 8-hour refresher training. Site Safety Officer will be responsible for maintaining workers training records. The Site Safety Coordinator will be Dominick Basilone. An emergency contact sheet is included in the site-specific HASP.

All investigative work performed under this RIWP will comply with all applicable health and safety laws and regulations, including OSHA worker safety requirements and HAZWOPER requirements. Site-specific training will be provided to field personnel. Additional safety training may be added depending on the tasks performed. Sub-contractors may choose to utilize their own site-specific HASP or adopt this HASP.

A copy of the site-specific Health and Safety Plan is provided as Appendix C.

7.0 COMMUNITY AIR MONITORING PLAN (CAMP)

Community air monitoring will be performed during this RI as required by the DER-10 (Appendix 1A, NYSDOH, Generic CAMP). Real-time air monitoring for volatile organic compounds (VOCs) and particulate levels will be performed during intrusive activities such as soil boring, monitoring well, and soil vapor point installation at an upwind and downwind locations. Background data will be collected prior to any intrusive activities. Continuous monitoring will be performed for all ground intrusive activities and during the handling of contaminated or potentially contaminated media.

Periodic monitoring for VOCs will be performed during non-intrusive activities such as the collection of soil samples or the collection of groundwater samples from existing monitoring wells. Periodic monitoring during sample collection, for instance, will consist of taking a reading upon arrival at a sample location, monitoring while opening a well cap or overturning soil, monitoring during well bailing/purging, and taking a reading prior to leaving a sample location. Depending upon the proximity of potentially exposed individuals, continuous monitoring may be performed during sampling activities.

Based on the information that public schools and a public playground are located east of the site, a robust CAMP will be implemented when intrusive remedial investigation activities are conducted along the eastern boundary area of the Site. Furthermore, an adjacent occupied building is located to the south of the subject property.

A Special Requirements CAMP (SR-CAMP) will need to be implemented when remedial investigation activities are occurring within 20 feet of the occupied southern and eastern adjacent buildings as follows:

Special Requirements for Work Within 20 Feet of Potentially Exposed Individuals or Structures

When work areas are within 20 feet of potentially exposed populations or occupied structures, the continuous monitoring locations for VOCs and particulates will reflect the nearest potentially exposed individuals and the location of ventilation system intakes for nearby structures. The use of engineering controls such as vapor/dust barriers, temporary negative-pressure enclosures, or special ventilation devices will be considered to prevent exposures related to the work activities and to control dust and odors. Consideration will also be given to implementing the planned activities when potentially exposed populations are at a minimum, such as during weekends or evening hours in non-residential settings.

- If total VOC concentrations opposite the walls of occupied structures or next to intake vents exceed 1 ppm, monitoring will occur within the occupied structure(s).

Depending upon the nature of contamination, chemical-specific colorimetric tubes of sufficient sensitivity may be necessary for comparing the exposure point concentrations with appropriate pre-determined response levels (response actions will be pre-determined). Background readings in the occupied spaces will be taken prior to commencement of the planned work. Any unusual background readings will be discussed with NYSDOH prior to commencement of the work.

- If total particulate concentrations opposite the walls of occupied structures or next to intake vents exceed 150 mcg/m^3, work activities will be suspended until controls are implemented and are successful in reducing the total particulate concentration to150 mcg/m3 or less at the monitoring point.
- Depending upon the nature of contamination and remedial activities, other parameters (e.g., explosivity, oxygen, hydrogen sulfide, carbon monoxide) may also need to be monitored. Response levels and actions will be pre-determined, as necessary.

A detailed Community Air Monitoring Plan is provided as Appendix D.

8.0 BEST MANAGEMENT PRACTICES

To improve the sustainability of the remedy, best management practices (BMPs) will be implemented regarding all equipment used on-site. All vehicles, including equipment, will be turned off when not in use, reducing idling emissions. The driller will choose the most effective tooling to minimize tooling switch outs. The ability to change out tooling for the proper application ultimately reduces waste. The drill rig used for the remedy will be appropriately maintained to ensure there are no fluid leaks.

Soil cuttings and other soil generated on-site during the RI are anticipated to be returned to the borehole, with the exception of conditions noted in Section 3.4, to reduce need of additional containerization and off-site disposal for waste. In the event that soil needs to be drummed, soil should be contained within the minimum number of drums as possible to reduce future waste. Other waste generated from the investigation, including drummed groundwater, will be removed from the site during a single pick-up event, along with any other waste (i.e. soil), to reduce mobilizations. The proposed disposal facilities' information for investigation derived waste, including their location, will be reported to the NYSDEC project manager upon the disposal activities. These practices are sustainable as less waste is produced.

Soil disturbance activities may release dust particles, affecting air quality. Dust particles will be monitored as part of a Community Air Monitoring Plan, and dust mitigation practices, including the use of fresh water to suppress dust and prevent fugitive dust, will be employed when necessary.

Emissions evaluation criteria, specific to this scope, includes sustainability metrics such as total energy consumption, greenhouse gases, and other air emissions, as well as water consumption, waste generation and disposal. The footprint analysis was conducted by utilizing the EPA's Spreadsheets for Environmental Footprint Evaluation (SEFA). The emissions associated with the equipment and the overall remedy will be analyzed through SEFA to track metrics throughout RI implementation. To complete the analysis, the metrics will be tracked by coordinating with the contractor, utilizing surveys, and using meters as necessary.

8.1 Green and Sustainable Remediation and Climate Resiliency

The evaluations of the RI activities consisted of human and environmental health considerations, which will be the basis of this Green and Sustainable Remediation and Climate Resiliency.

To reduce the environmental impact of the RI, the following Best Management Practices, in addition to the practices noted in the previous section, can be implemented:

1. To protect the local ecosystem and ecosystem services, minimally invasive technologies will be employed. Real-time data collecting technologies are minimally invasive, protecting the local ecosystem and ecosystem services. The BMPs implemented under this principle include:
    i. The Site's Community Air Monitoring Plan (CAMP). The Site will have portable Photo Ionization Detectors (PIDs) and portable dust monitors that protect the workers on-site and the surrounding community, while remaining minimally invasive on-site.
2. Reducing the amount of time and distance for transporting materials to and from the Site will reduce the fuel consumed and associated air emissions. The BMPs implemented under this principle include:
    i. Ensuring any heavy diesel trucks transporting materials have a Clean Idle Certification Label;
    ii. Requiring trucks and the drill rig(s) to turn off their engines when leaving the engine on is not necessary;
    iii. When applicable, the reuse of clean, recyclable materials reduces consumption of non-renewable virgin resources and can provide energy savings and greenhouse gas reduction since these materials can be locally-derived, thus reducing transportation and processing emissions;
    iv. Participating in OER's low-energy project management program. Under this program, whenever possible, meetings were held using remote communication technologies, such as videoconferencing and teleconferencing to reduce energy consumption and traffic congestion associated with personal transportation.
3. Reducing the amount of unnecessary material used both on-site or off-site will reduce both material consumption and waste generation, and will reduce the emissions associated with extraction, processing/production, use, and disposal. The BMPs implemented under this principle include:
    i. Reducing paper usage by using electronic copies of plans and drawings;
    ii. When applicable, the reuse of clean, recyclable materials reduces consumption of non-renewable virgin resources.
4. Requesting the Contractor tracks material use, material disposal, equipment use and associated emissions, water use, and transportation emissions of both material and personnel. The tracking data will be used in collaboration with the EPA's Spreadsheets for Environmental Footprint Analysis ("SEFA") to determine the footprint of activities on Site. Summaries of the activities are included in Table 1.

Based on DER-31, the RI is necessary to assess the extent of contamination beneath the site and if so, preparing a site conceptual model for the Remedial Action Report and Remedial Action Work Plan will result in a green cleanup, benefiting the people and ecosystems around the Site.

The footprint of the anticipated RI was calculated. Overall, approximately 3,163 pounds of greenhouse gas emissions (GHG) emissions (carbon dioxide equivalents of global warming potential), 14 pounds of NOx emissions, 1 pounds of SOx emissions, 1 pound of particulate matter (PM) emissions, and 1 pound of hazardous air pollutants (HAPs) are anticipated to be produced during the entirety of the RI based on the current scope. The tracking during the RI work will be used in collaboration with the EPA's SEFA spreadsheets to determine the approximate footprint of activities on Site after completion of work.

9.0 REMEDIAL INVESTIGATION REPORT (RIR)

Upon receipt of the analytical results, Vektor will prepare a Remedial Investigation Report (RIR) in accordance with DER-10. The RIR will include the following sections:

- Introduction,
- Summary of site history,
- Summary of previous environmental investigation,
- Field methods and observations,
- Laboratory results section,
- Conclusions, and recommendations, where necessary.

The report will also include scaled sampling plans showing all sample locations and exceedances, field logs, soil borings logs, monitoring well construction logs, summary tables with comparison to respective standards, laboratory results, and a Qualitative Human Health Exposure Assessment in accordance with DER-10 (Appendix 3B) as appendices. The Qualitative Human Health Exposure Assessment will discuss both on and off-site pathways. All results will be provided in accordance with the NYSDEC EIMS EDD format (EQuIS).

10.0 SCHEDULE

The RI will be implemented upon approval of this RIWP by the NYSDEC and completion of the 30-day public comment period. A 7-day notification will be provided to the NYSDEC and NYSDOH prior to RI. The table below shows the anticipated schedule for completing the RI:

Anticipated RI Schedule	
BCP Application and Submittal of RIWP	September 2024
Revised BCP Application and RIWP Submittal and 30-Day Public Comment Period	October 2024
Brownfield Cleanup Agreement Execution	January 2025
NYSDEC and NYSDOH Comments on RIWP	March 2025
NYSDEC Approval of RIWP	April 2025
RI Implementation	April 2025
RIR Submittal	May-June 2025
RAWP Submittal and 45-Day Public Comment Period	July-August 2025
NYSDEC Approval of RIR/RAWP	October-November 2025

TABLES

Table 1
Sampling Rationale and Summary
38-18 33rd Street and 32-20 38th Avenue, Queens, NY
Former Refron Inc. Gas Reclamation Site

Sample Matrix	Sample ID	Sample Interval (feet below surface grade)	Rationale	Estimated Number of Samples	Analysis
SOIL	25SB-1 (Depth)	0'-2' (historic fill)	To assess the extent of historic fill and overall soil quality beneath the Site	1	Target Compound List (TCL) volatile organic compounds (VOCs), TCL semivolatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs), Pesticides, Total Analyte List (TAL) Metals, hexavalent chromium, trivalent chromium, per- and poly-fluoroalkyl substances (PFAS), and 1,4-dioxane
	25SB-1 (Depth)	Collected from immediately below the historic fill layer		1	
	25SB-1 (Depth)	Collected from immediately above the groundwater table		1	
	25SB-2 (Depth)	0'-2' (historic fill)		1	
	25SB-2 (Depth)	Collected from immediately below the historic fill layer		1	
	25SB-2 (Depth)	Collected from immediately above the groundwater table		1	
	25SB-3 (Depth)	0'-2' (historic fill)		1	
	25SB-3 (Depth)	Collected from immediately below the historic fill layer		1	
	25SB-3 (Depth)	Collected from immediately above the groundwater table		1	
	25SB-4 (Depth)	0'-2' (historic fill)		1	
	25SB-4 (Depth)	Collected from immediately below the historic fill layer		1	
	25SB-4 (Depth)	Collected from immediately above the groundwater table		1	
	25SB-5 (Depth)	0'-2' (historic fill)		1	
	25SB-5 (Depth)	Collected from immediately below the historic fill layer		1	
	25SB-5 (Depth)	Collected from immediately above the groundwater table		1	
	25SB-6 (Depth)	0'-2' (historic fill)		1	
	25SB-6 (Depth)	Collected from immediately below the historic fill layer		1	
	25SB-6 (Depth)	Collected from immediately above the groundwater table		1	
	25SB-7 (Depth)	0'-2' (historic fill)		1	
	25SB-7 (Depth)	Collected from immediately below the historic fill layer		1	
	25SB-7 (Depth)	Collected from immediately above the groundwater table		1	
	25SB-8 (Depth)	0'-2' (historic fill)		1	
	25SB-8 (Depth)	Collected from immediately below the historic fill layer		1	
	25SB-8 (Depth)	Collected from immediately above the groundwater table		1	
	25SB-9 (Depth)	0'-2' (historic fill)		1	
	25SB-9 (Depth)	Collected from immediately below the historic fill layer		1	
	25SB-9 (Depth)	Collected from immediately above the groundwater table		1	
	25SB-10 (Depth)	0'-2' (historic fill)		1	
	25SB-10 (Depth)	Collected from immediately below the historic fill layer		1	
	25SB-10 (Depth)	Collected from immediately above the groundwater table		1	
	25SB-11 (Depth)	0'-2' (historic fill)		1	
	25SB-11 (Depth)	Collected from immediately below the historic fill layer		1	
	25SB-11 (Depth)	Collected from immediately above the groundwater table		1	
	25SB-12 (Depth)	0'-2' (historic fill)		1	
	25SB-12 (Depth)	Collected from immediately below the historic fill layer		1	
	25SB-12 (Depth)	Collected from immediately above the groundwater table		1	
	25SB-13 (Depth)	0'-2' (historic fill)		1	
	25SB-13 (Depth)	Collected from immediately below the historic fill layer		1	
	25SB-13 (Depth)	Collected from immediately above the groundwater table		1	
	25SB-14 (Depth)	0'-2' (historic fill)		1	
	25SB-14 (Depth)	Collected from immediately below the historic fill layer		1	
	25SB-14 (Depth)	Collected from immediately above the groundwater table		1	
	25SB-15 (Depth)	0'-2' (historic fill)		1	
	25SB-15 (Depth)	Collected from immediately below the historic fill layer		1	
	25SB-15 (Depth)	Collected from immediately above the groundwater table		1	
	25-SB-DUP (Depth)	Field Duplicate	QA/QC	2	
	25-SB-X-MS/MSD	Matrix Spike / Matrix Spike Duplicate	QA/QC	2	
	FB-X	Field Blank	QA/QC	3	
	TB-X	Trip Blank	QA/QC	3	TCL VOCs
			Total Quantity	55	

* Additional soil samples may be collected based on field conditions (i.e: elevated PID readings, odor, sheen, etc.)

Table 1
Sampling Rationale and Summary 38-18
33rd Street and 32-20 38th Avenue, Queens,
NY Former Refron Inc. Gas Reclamation Site

Sample Matrix	Sample ID	Sample Interval (feet below surface grade)	Rationale	Estimated Number of Samples	Analysis
GROUNDWATER	MW-1	10'-20' below grade	To assess groundwater quality beneath the Site	1	TCL VOCs, TCL SVOCs, PCBs, Pesticides, TAL Metals (filtered and unfiltered), hexavalent chromium, trivalent chromium, PFAS, and 1,4-dioxane
	MW-1I	15-25' below grade		1	
	MW-1D	25-35' below grade		1	
	MW-2	10'-20' below grade		1	
	MW-3	10'-20' below grade		1	
	MW-4	10'-20' below grade		1	
	MW-5	10'-20' below grade		1	
	MW-6	10'-20' below grade		1	
	MW-7	10'-20' below grade		1	
	MW-DUP-1	Blind Duplicate: One per 20 groundwater samples	QA/QC	1	
	MW-MS/MSD-1	One per 20 groundwater samples	QA/QC	1	
	FB-1	Field Blank	QA/QC	1	
	TB-1	Trip Blank: 1 per cooler per day (Lab-prepared)	QA/QC	1	TCL VOCs
			Total Quantity	13	

Table 1
Sampling Rationale and Summary 38-18 33rd Street and 32-20 38th Avenue, Queens, NY
Former Refron Inc. Gas Reclamation Site

Sample Matrix	Sample ID	Sample Interval (feet below surface grade)	Rationale	Estimated Number of Samples	Analysis
SOIL VAPOR	25SV-1	12 feet	To further evaluate soil vapor conditions beneath the Site	1	VOCs (TO-15)
	25SV-2	12 feet		1	
	25SV-3	12 feet		1	
	25SV-4	12 feet		1	
	25SV-5	12 feet		1	
	25OA-1	Background (Outdoor) Sample	QA/QC	1	
	25SV-DUP*	TBD	QA/QC	1	
	Total Quantity			7	

* A blind duplicate sample (24SV-X) will be collected at **one of the soil vapor locations** (determined by Site Logistics)

Table 2
GSR Summary
38-18 33rd Street and 32-20 38th Avenue, Queens, NY
Former Refron Inc. Gas Reclamation Site

Spreadsheets for Environmental Footprint Analysis (SEFA) Version 3.0, November 2019
32-20 38th Avenue and 33-18 33rd Street, Queens, NY - Anticipated Footprint

Environmental Footprint Summary

Core Element	Metric		Unit of Measure	Footprint		
				Anticipated Footprint	Remedial Investigation Footprint	Total
Materials & Waste	M&W-1	Refined materials used on-site	Tons	0.0	0.0	0.0
	M&W-2	% of refined materials from recycled or reused material	%			
	M&W-3	Unrefined materials used on-site	Tons	0.000	0.000	0.0
	M&W-4	% of unrefined materials from recycled or reused material	%			
	M&W-5	On-site hazardous waste disposed of off-site	Tons	0.0	0.0	0.0
	M&W-6	On-site non-hazardous waste disposed of off-site	Tons	375.0	0.0	375.0
	M&W-7	Recycled or reused waste	Tons	0.0	0.0	0.0
	M&W-8	% of total potential waste recycled or reused	%	0.0%		0.0%
Water (used on-site)	W-1	Public water use	MG	0.0	0.0	0.0
	W-2	Groundwater use	MG	0.0	0.0	0.0
	W-3	Surface water use	MG	0.0	0.0	0.0
	W-4	Reclaimed water use	MG	0.0	0.0	0.0
	W-5	Storm water use	MG	0.0	0.0	0.0
	W-6	User-defined water resource #1	MG	0.0	0.0	0.0
	W-7	User-defined water resource #2	MG	0.0	0.0	0.0
	W-8	Wastewater generated	MG	0.0	0.0	0.0
Energy	E-1	Total energy used (on-site and off-site)	MMBtu	86.5	0.0	86.5
	E-2	Energy voluntarily derived from renewable resources				
	E-2A	On-site renewable energy generation or use + on-site biodiesel use + biodiesel and other renewable resource use for transportation	MMBtu	0.0	0.0	0.0
	E-2B	Voluntary purchase of renewable electricity	MWh	0.0	0.0	0.0
	E-3	Voluntary purchase of RECs	MWh	0.0	0.0	0.0
	E-4	On-site grid electricity use	MWh	0.000	0.000	0.0
Air	A-1	On-site NOx, SOx, and PM emissions	Pounds	3.2	0.0	3.2
	A-2	On-site HAP emissions	Pounds	0.0	0.0	0.0
	A-3	Total NOx, SOx, and PM emissions	Pounds	261.2	0.0	261.2
	A-3A	Total NOx emissions	Pounds	80.2	0.0	80.2
	A-3B	Total SOx emissions	Pounds	29.9	0.0	29.9
	A-3C	Total PM emissions	Pounds	151.0	0.0	151.0
	A-4	Total HAP emissions	Pounds	0.7	0.0	0.7
	A-5	Total greenhouse gas emissions	Tons CO2e*	6.8	0.0	6.8
Land & Ecosystems	Qualitative Description					

** Total greenhouse gases emissions (in CO2e) include consideration of CO2, CH4, and N2O (Nitrous oxide) emissions.*

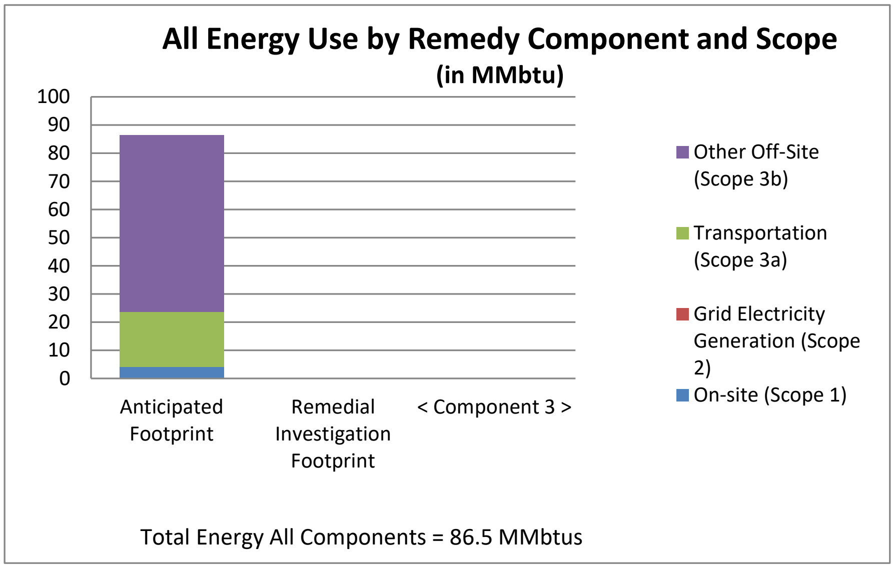
The above metrics are consistent with EPA's Methodology for Understanding and Reducing a Project's Environmental Footprint (EPA 542-R-12-002), February 2012

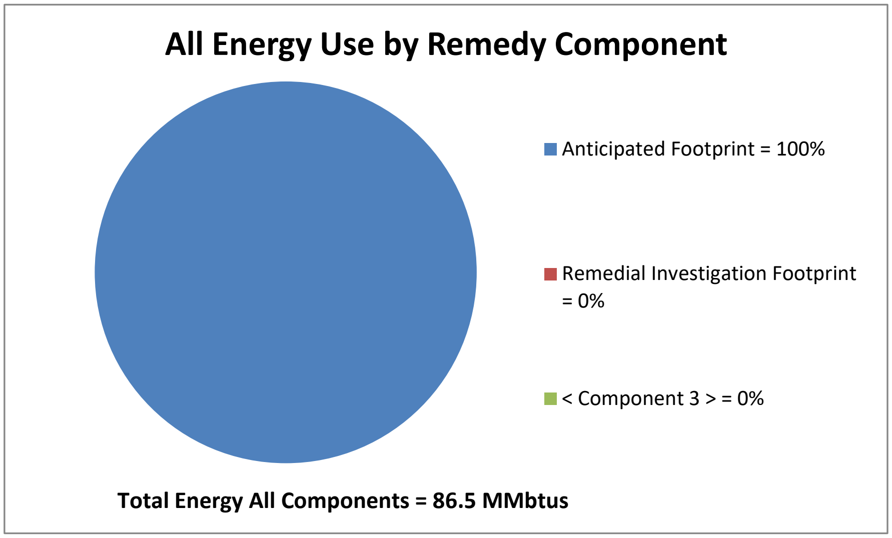
"MMBtu" = millions of Btus
"MG" = millions of gallons
"CO2e" = carbon dioxide equivalents of global warming potential
"MWh" = megawatt hours (i.e., thousands of kilowatt-hours or millions of Watt-hours)
"Tons" = short tons (2,000 pounds)

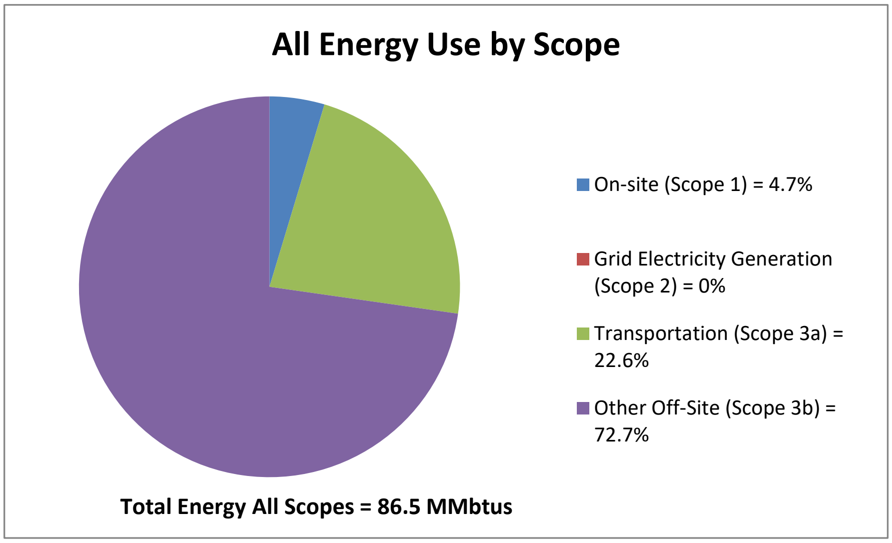
Notes:

Table 2
GSR Summary
38-18 33rd Street and 32-20 38th Avenue, Queens, NY
Former Refron Inc. Gas Reclamation Site

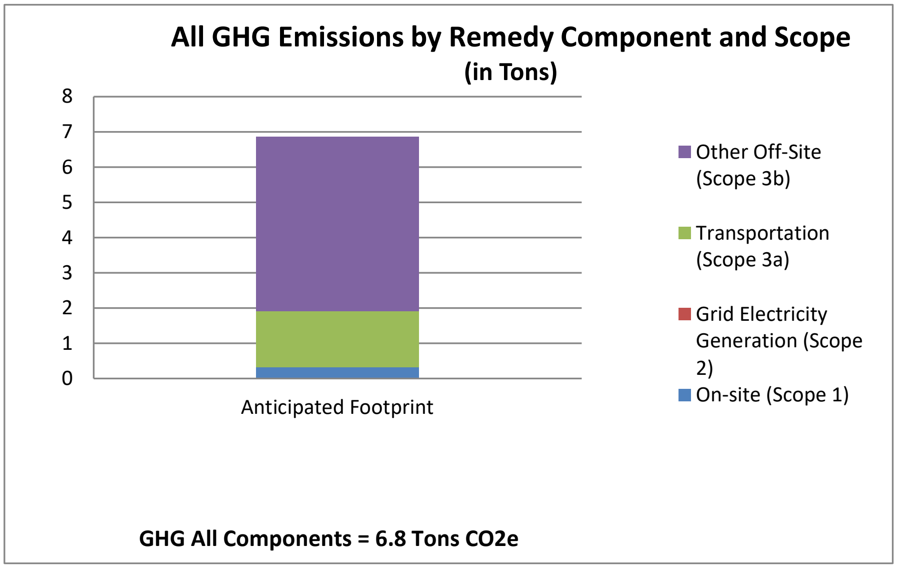
Spreadsheets for Environmental Footprint Analysis (SEFA) Version 3.0, November 2019
32-20 38th Avenue and 33-18 33rd Street, Queens, NY - Anticipated Footprint

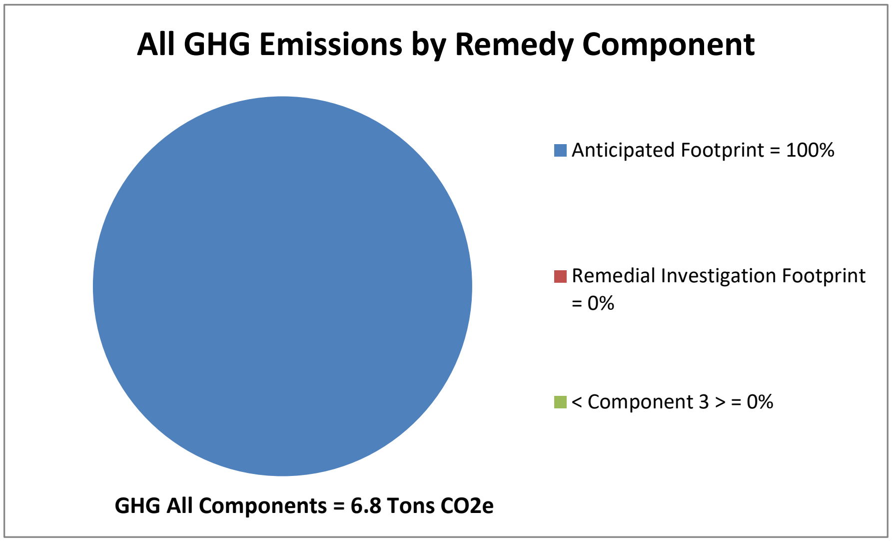


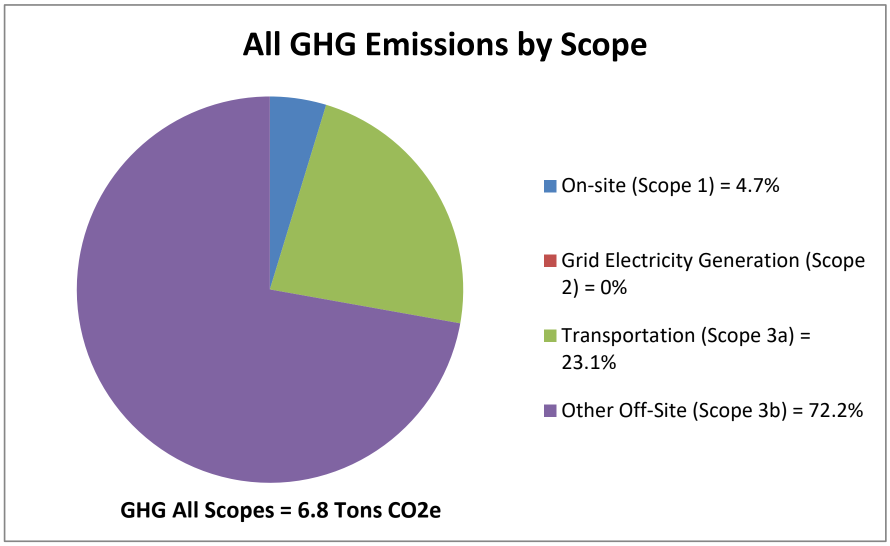




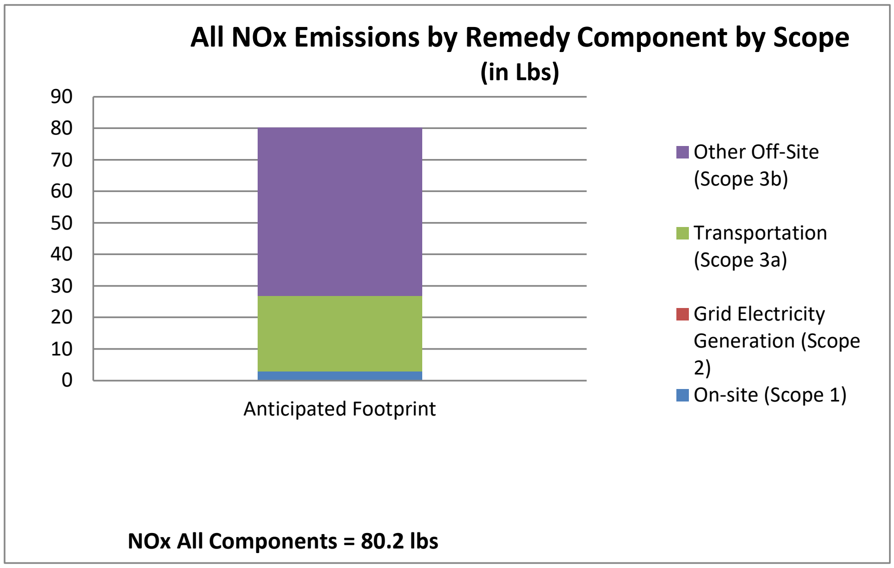
Spreadsheets for Environmental Footprint Analysis (SEFA) Version 3.0, November 2019
32-20 38th Avenue and 33-18 33rd Street, Queens, NY - Anticipated Footprint

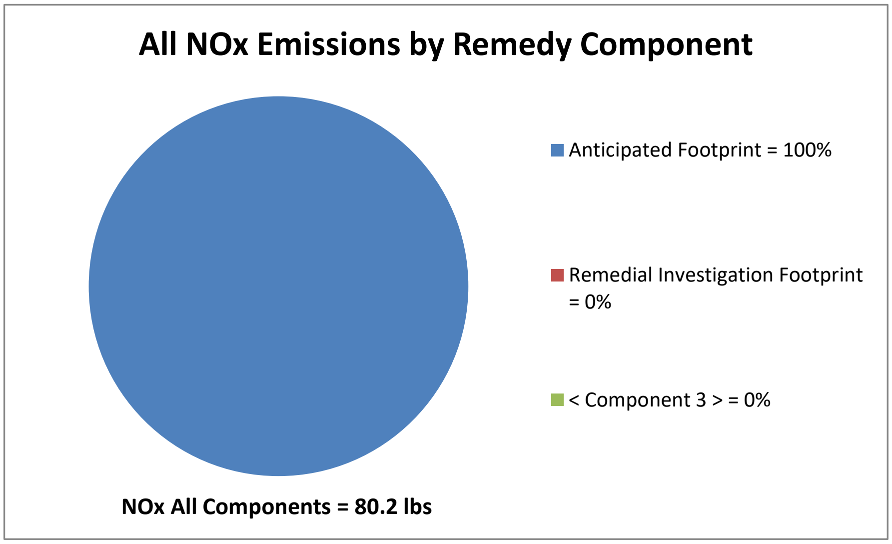






Spreadsheets for Environmental Footprint Analysis (SEFA) Version 3.0, November 2019
32-20 38th Avenue and 33-18 33rd Street, Queens, NY - Anticipated Footprint





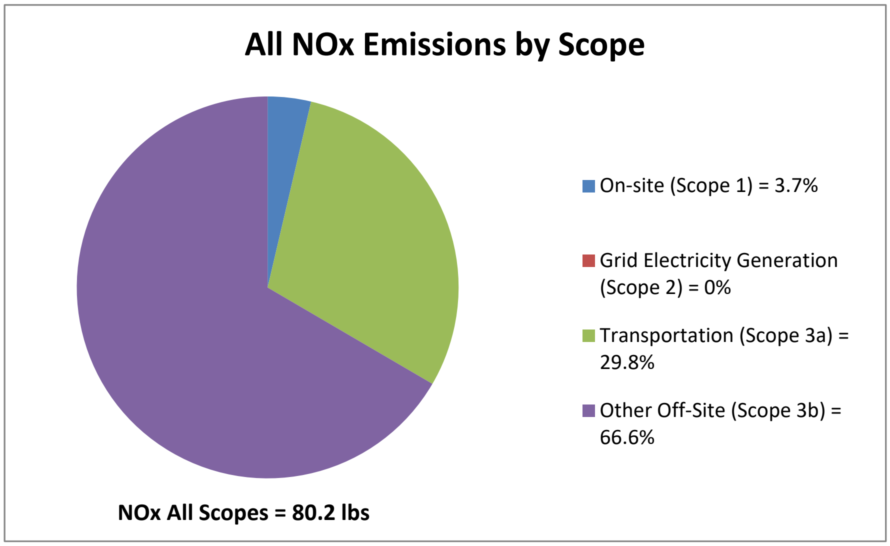
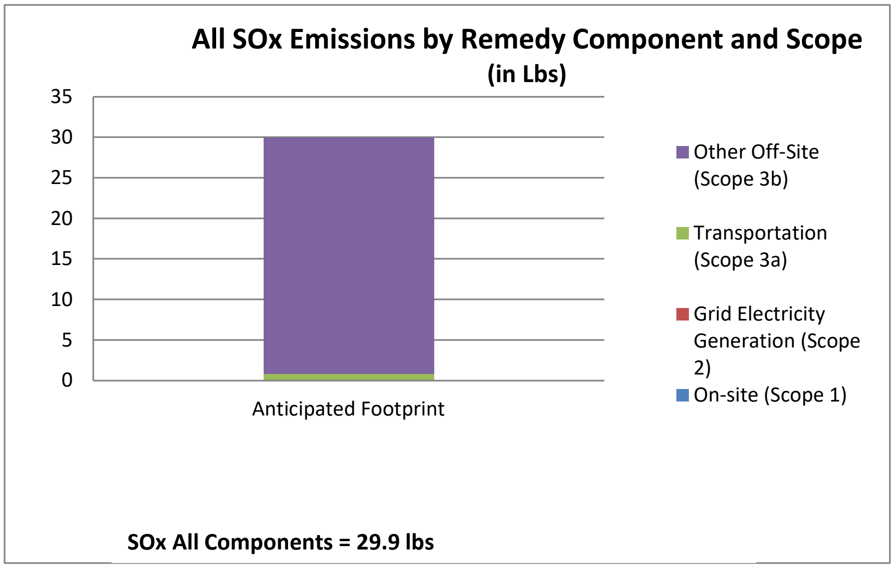
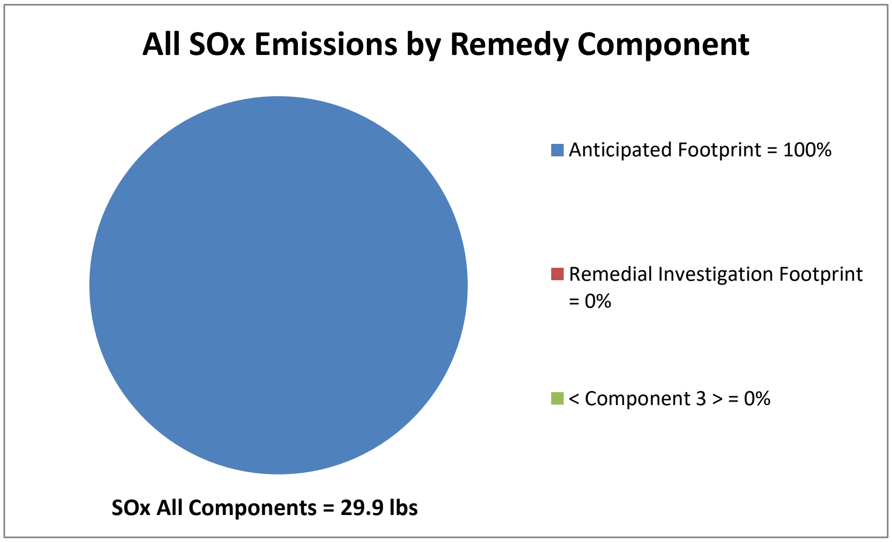
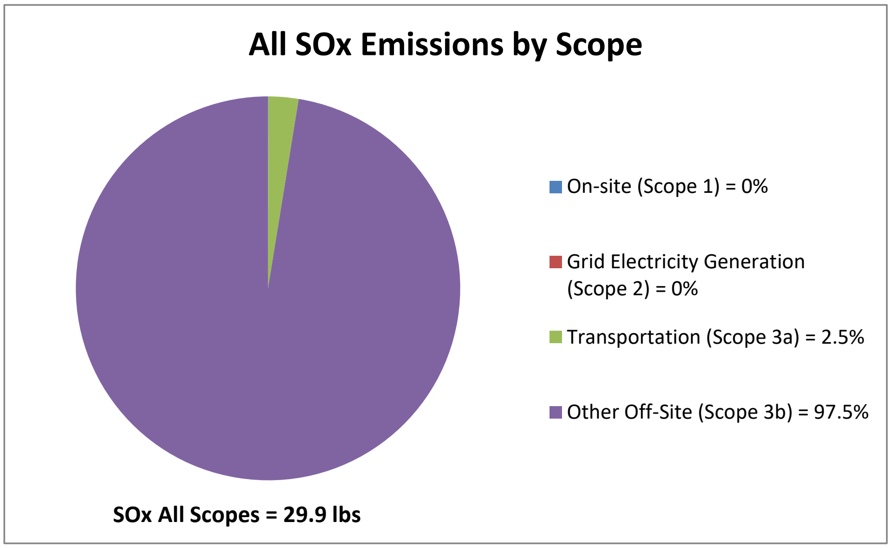


Table 2
GSR Summary
38-18 33rd Street and 32-20 38th Avenue, Queens, NY
Former Refron Inc. Gas Reclamation Site

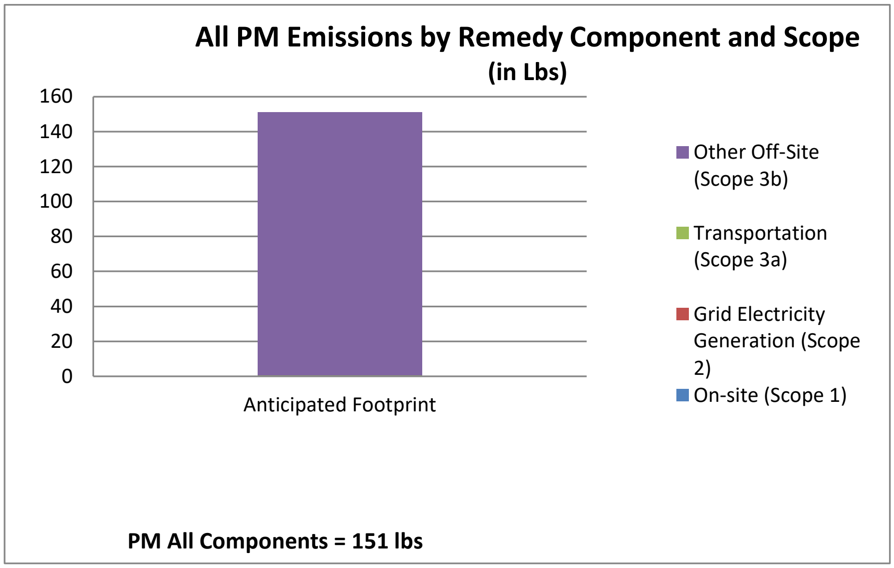
Spreadsheets for Environmental Footprint Analysis (SEFA) Version 3.0, November 2019
32-20 38th Avenue and 33-18 33rd Street, Queens, NY - Anticipated Footprint

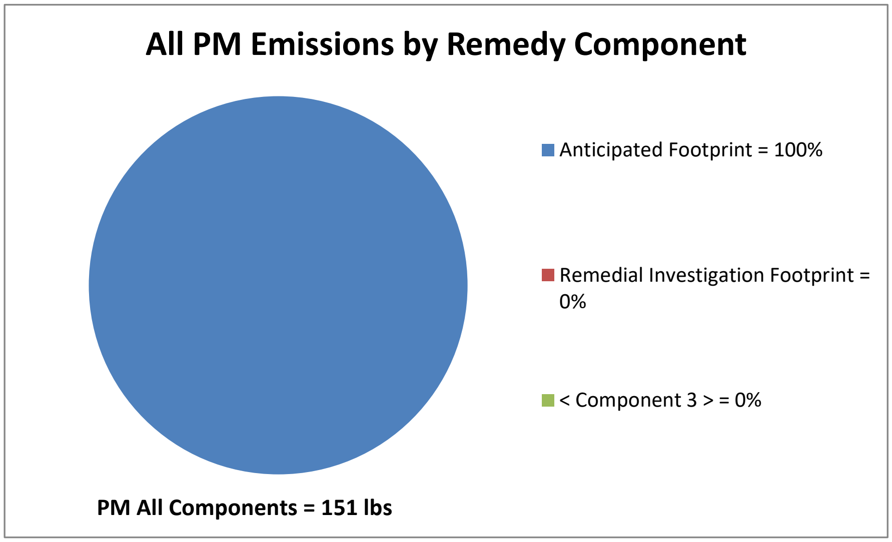


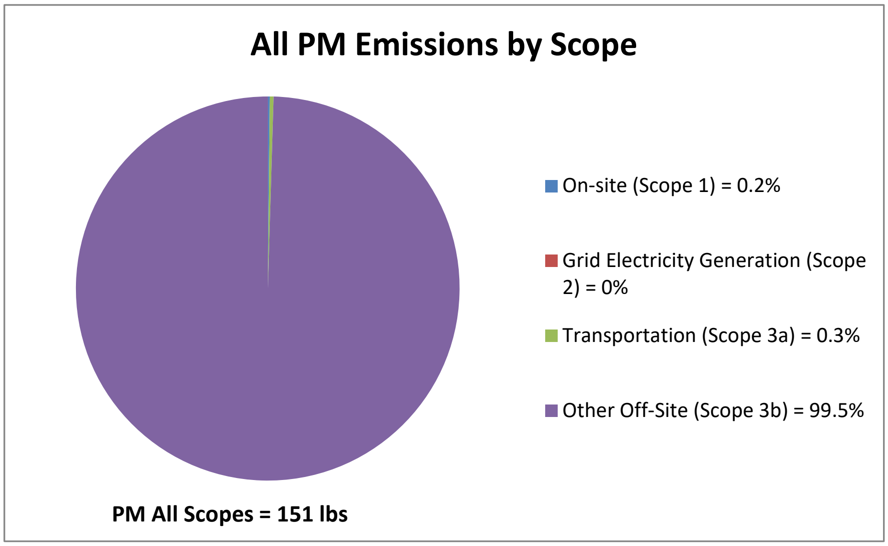




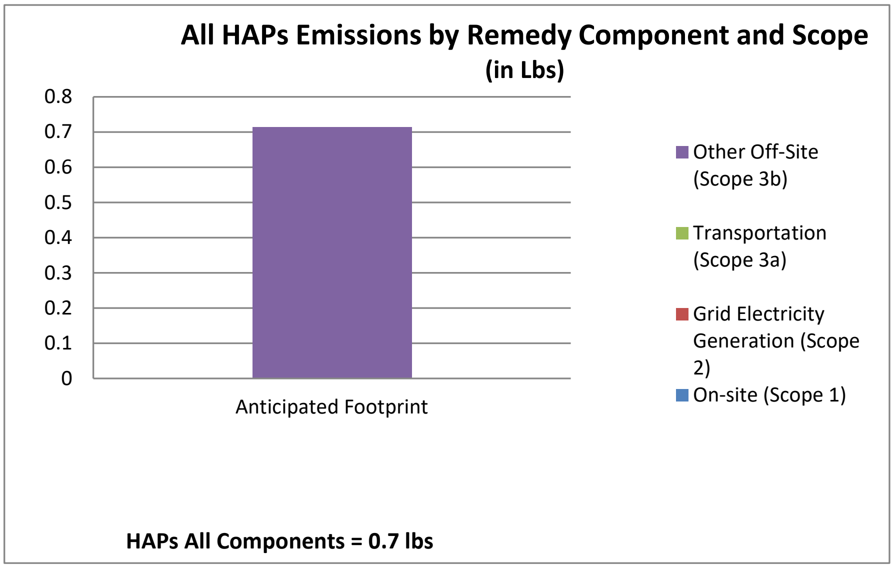
Spreadsheets for Environmental Footprint Analysis (SEFA) Version 3.0, November 2019
32-20 38th Avenue and 33-18 33rd Street, Queens, NY - Anticipated Footprint

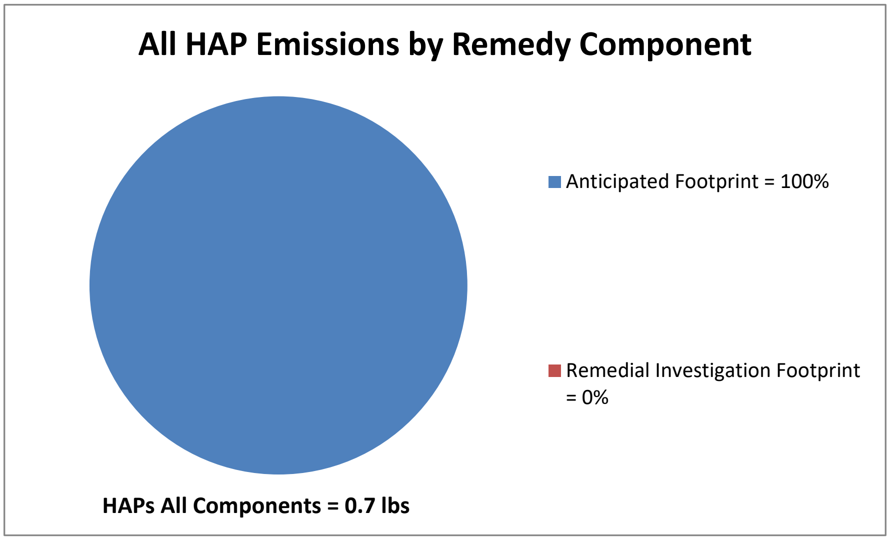


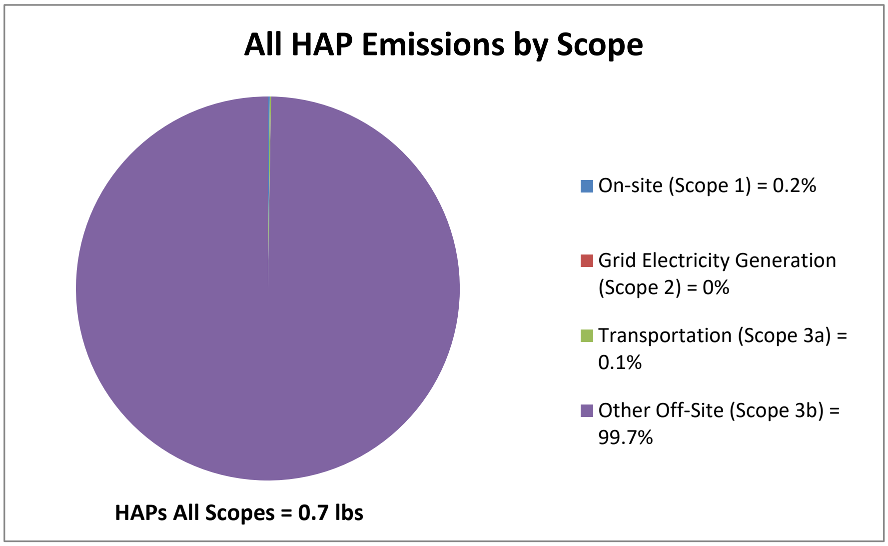




Spreadsheets for Environmental Footprint Analysis (SEFA) Version 3.0, November 2019
32-20 38th Avenue and 33-18 33rd Street, Queens, NY - Anticipated Footprint







Spreadsheets for Environmental Footprint Analysis (SEFA) Version 3.0, November 2019
32-20 38th Avenue and 33-18 33rd Street, Queens, NY - Anticipated Footprint

All - Energy & Air Compiled Results

Category	Total Energy	GHG	NOx	SOx	PM	NOx + SOx + PM	HAPs
	MMbtus	lbs CO2e	lbs	lbs	lbs	lbs	lbs
On-site (Scope 1)	**4**	**645**	**3**	**0**	**0**	**3**	**0**
Grid Electricity Generation (Scope 2)	**0.000**	**0**	**0**	**0**	**0**	**0**	**0**
Transportation (Scope 3a)	**20**	**3,161**	**24**	**1**	**0**	**25**	**0**
Other Off-Site (Scope 3b)	**63**	**9,892**	**53**	**29**	**150**	**233**	**1**
Remedy Totals	**86**	**13,698**	**80**	**30**	**151**	**261**	**1**

Values that are forwarded to the "Summary" tab are indicated in orange.

Voluntary Renewable Energy Use	Unit	Quantity
On-site renewable energy generation or use	MMBtu	**0**
On-site biodiesel use	MMBtu	**0**
Biodiesel and other renewable resource use for transportation	MMBtu	**0**
On-site renewable energy generation or use + on-site biodiesel use + biodiesel and other renewable resource use for transportation	MMBtu	**0**
Voluntary purchase of renewable electricity	MWh	**0**
Voluntary purchase of RECs	MWh	**0**

(This value is the sum of the three rows above)

This worksheet is not intended for user input. Values on this worksheet are obtained from the following file:
SEFA_calculations_(121718).xlsx

Table 3- Reporting Limits compared to Guidance Values
VOCs in Soil
38-18 33rd Street and 32-20 38th Avenue, Queens, NY
Former Refron Inc. Gas Reclamation Site

Analyte	MDL (ppm)	RL (ppm)	NYSDEC Part 375 UUSCOs (ppm)	NYSDEC Part 375 RRSCOs (ppm)
1,1,1,2-Tetrachloroethane	0.0025	0.005	~	~
1,1,1-Trichloroethane	0.0025	0.005	0.68	100
1,1,2,2-Tetrachloroethane	0.0025	0.005	~	~
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)	0.0025	0.005	~	~
1,1,2-Trichloroethane	0.0025	0.005	~	~
1,1-Dichloroethane	0.0025	0.005	0.27	26
1,1-Dichloroethylene	0.0025	0.005	0.33	100
1,2,3-Trichlorobenzene	0.0025	0.005	~	~
1,2,3-Trichloropropane	0.0025	0.005	~	~
1,2,4-Trichlorobenzene	0.0025	0.005	~	~
1,2,4-Trimethylbenzene	0.0025	0.005	3.6	52
1,2-Dibromo-3-chloropropane	0.0025	0.005	~	~
1,2-Dibromoethane	0.0025	0.005	~	~
1,2-Dichlorobenzene	0.0025	0.005	1.1	100
1,2-Dichloroethane	0.0025	0.005	0.02	3.1
1,2-Dichloropropane	0.0025	0.005	~	~
1,3,5-Trimethylbenzene	0.0025	0.005	8.4	52
1,3-Dichlorobenzene	0.0025	0.005	2.4	49
1,4-Dichlorobenzene	0.0025	0.005	1.8	13
1,4-Dioxane	0.05	0.1	0.1	13
2-Butanone	0.0025	0.005	0.12	100
2-Hexanone	0.0025	0.005	~	~
4-Methyl-2-pentanone	0.0025	0.005	~	~
Acetone	0.005	0.01	0.05	100
Acrolein	0.005	0.01	~	~
Acrylonitrile	0.0025	0.005	~	~
Benzene	0.0025	0.005	0.06	4.8
Bromochloromethane	0.0025	0.005	~	~
Bromodichloromethane	0.0025	0.005	~	~
Bromoform	0.0025	0.005	~	~
Bromomethane	0.0025	0.005	~	~
Carbon disulfide	0.0025	0.005	~	~
Carbon tetrachloride	0.0025	0.005	0.76	2.4
Chlorobenzene	0.0025	0.005	1.1	100
Chloroethane	0.0025	0.005	~	~
Chloroform	0.0025	0.005	0.37	49
Chloromethane	0.0025	0.005	~	~
cis-1,2-Dichloroethylene	0.0025	0.005	0.25	100
cis-1,3-Dichloropropylene	0.0025	0.005	~	~
Cyclohexane	0.0025	0.005	~	~
Dibromochloromethane	0.0025	0.005	~	~
Dibromomethane	0.0025	0.005	~	~
Dichlorodifluoromethane	0.0025	0.005	~	~
Ethyl Benzene	0.0025	0.005	1	41
Hexachlorobutadiene	0.0025	0.005	~	~
Isopropylbenzene	0.0025	0.005	~	~
Methyl acetate	0.0025	0.005	~	~
Methyl tert-butyl ether (MTBE)	0.0025	0.005	0.93	100
Methylcyclohexane	0.0025	0.005	~	~
Methylene chloride	0.005	0.01	0.05	100
Naphthalene	0.0025	0.01	~	~
n-Butylbenzene	0.0025	0.005	12	100
n-Propylbenzene	0.0025	0.005	3.9	100
o-Xylene	0.0025	0.005	~	~
p- & m- Xylenes	0.005	0.01	~	~
p-Diethylbenzene	0.0025	0.005	~	~
p-Ethyltoluene	0.0025	0.005	~	~
p-Isopropyltoluene	0.0025	0.005	~	~
sec-Butylbenzene	0.0025	0.005	11	100
Styrene	0.0025	0.005	~	~
tert-Butyl alcohol (TBA)	0.0025	0.005	~	~
tert-Butylbenzene	0.0025	0.005	5.9	100
Tetrachloroethylene	0.0025	0.005	1.3	19
Toluene	0.0025	0.005	0.7	100
trans-1,2-Dichloroethylene	0.0025	0.005	0.19	100
trans-1,3-Dichloropropylene	0.0025	0.005	~	~
Trichloroethylene	0.0025	0.005	0.47	21
Trichlorofluoromethane	0.0025	0.005	~	~
Vinyl Chloride	0.0025	0.005	0.02	0.9
Xylenes, Total	0.0075	0.015	0.26	100

MDL: Method Detection Limit
UUSCO: Unrestricted Use Soil Cleanup Objective
RRSCO: Restricted Residential Use Soil Cleanup Objective

Table 3- Reporting Limits compared to Guidance Values
SVOCs in Soil
38-18 33rd Street and 32-20 38th Avenue, Queens, NY
Former Refron Inc. Gas Reclamation Site

Analyte	MDL (ppm)	RL (ppm)	NYSDEC Part 375 UUSCOs (ppm)	NYSDEC Part 375 RRSCOs (ppm)
1,1-Biphenyl	0.0209	0.0417	~	~
1,2,4,5-Tetrachlorobenzene	0.0417	0.0833	~	~
1,2-Diphenylhydrazine	0.0209	0.0417	~	~
2,3,4,6-Tetrachlorophenol	0.0417	0.0833	~	~
2,4,5-Trichlorophenol	0.0209	0.0417	~	~
2,4,6-Trichlorophenol	0.0209	0.0417	~	~
2,4-Dichlorophenol	0.0209	0.0417	~	~
2,4-Dimethylphenol	0.0209	0.0417	~	~
2,4-Dinitrophenol	0.0417	0.0833	~	~
2,4-Dinitrotoluene	0.0209	0.0417	~	~
2,6-Dinitrotoluene	0.0209	0.0417	~	~
2-Chloronaphthalene	0.0209	0.0417	~	~
2-Chlorophenol	0.0209	0.0417	~	~
2-Methylnaphthalene	0.0209	0.0417	~	~
2-Methylphenol	0.0209	0.0417	0.33	100
2-Nitroaniline	0.0417	0.0833	~	~
2-Nitrophenol	0.0209	0.0417	~	~
3- & 4-Methylphenols	0.0209	0.0417	0.33	100
3,3-Dichlorobenzidine	0.0209	0.0417	~	~
3-Nitroaniline	0.0417	0.0833	~	~
4,6-Dinitro-2-methylphenol	0.0417	0.0833	~	~
4-Bromophenyl phenyl ether	0.0209	0.0417	~	~
4-Chloro-3-methylphenol	0.0209	0.0417	~	~
4-Chloroaniline	0.0209	0.0417	~	~
4-Chlorophenyl phenyl ether	0.0209	0.0417	~	~
4-Nitroaniline	0.0417	0.0833	~	~
4-Nitrophenol	0.0417	0.0833	~	~
Acenaphthene	0.0209	0.0417	20	100
Acenaphthylene	0.0209	0.0417	100	100
Acetophenone	0.0209	0.0417	~	~
Aniline	0.0835	0.167	~	~
Anthracene	0.0209	0.0417	100	100
Atrazine	0.0209	0.0417	~	~
Benzaldehyde	0.0209	0.0417	~	~
Benzidine	0.0835	0.167	~	~
Benzo(a)anthracene	0.0209	0.0417	1	1
Benzo(a)pyrene	0.0209	0.0417	1	1
Benzo(b)fluoranthene	0.0209	0.0417	1	1
Benzo(g,h,i)perylene	0.0209	0.0417	100	100
Benzo(k)fluoranthene	0.0209	0.0417	0.8	3.9
Benzoic acid	0.0209	0.0417	~	~
Benzyl alcohol	0.0209	0.0417	~	~
Benzyl butyl phthalate	0.0209	0.0417	~	~
Bis(2-chloroethoxy)methane	0.0209	0.0417	~	~
Bis(2-chloroethyl)ether	0.0209	0.0417	~	~
Bis(2-chloroisopropyl)ether	0.0209	0.0417	~	~
Bis(2-ethylhexyl)phthalate	0.0209	0.0417	~	~
Caprolactam	0.0417	0.0833	~	~
Carbazole	0.0209	0.0417	~	~
Chrysene	0.0209	0.0417	1	3.9
Dibenzo(a,h)anthracene	0.0209	0.0417	0.33	0.33
Dibenzofuran	0.0209	0.0417	7	59
Diethyl phthalate	0.0209	0.0417	~	~
Dimethyl phthalate	0.0209	0.0417	~	~
Di-n-butyl phthalate	0.0209	0.0417	~	~
Di-n-octyl phthalate	0.0209	0.0417	~	~
Diphenylamine	0.0417	0.0833	~	~
Fluoranthene	0.0209	0.0417	100	100
Fluorene	0.0209	0.0417	30	100
Hexachlorobenzene	0.0209	0.0417	0.33	1.2
Hexachlorobutadiene	0.0209	0.0417	~	~
Hexachlorocyclopentadiene	0.0209	0.0417	~	~
Hexachloroethane	0.0209	0.0417	~	~
Indeno(1,2,3-cd)pyrene	0.0209	0.0417	0.5	0.5
Isophorone	0.0209	0.0417	~	~
Naphthalene	0.0209	0.0417	12	100
Nitrobenzene	0.0209	0.0417	~	~
N-Nitrosodimethylamine	0.0209	0.0417	~	~
N-nitroso-di-n-propylamine	0.0209	0.0417	~	~
N-Nitrosodiphenylamine	0.0209	0.0417	~	~
Pentachlorophenol	0.0209	0.0417	0.8	6.7
Phenanthrene	0.0209	0.0417	100	100
Phenol	0.0209	0.0417	0.33	100
Pyrene	0.0209	0.0417	100	100
8270 SIM				
1, 4-dioxane	0.0037	0.02	0.1	13

MDL: Method Detection Limit
UUSCO: Unrestricted Use Soil Cleanup Objective
RRSCO: Restricted Residential Use Soil Cleanup Objective

Table 3- Reporting Limits compared to Guidance Values
Pesticides in Soil
38-18 33rd Street and 32-20 38th Avenue, Queens, NY
Former Refron Inc. Gas Reclamation Site

Analyte	MDL (ppm)	RL (ppm)	NYSDEC Part 375 UUSCOs (ppm)	NYSDEC Part 375 RRSCOs (ppm)
4,4'-DDD	0.00033	0.00033	0.0033	13
4,4'-DDE	0.00033	0.00033	0.0033	8.9
4,4'-DDT	0.00033	0.00033	0.0033	7.9
Aldrin	0.00033	0.00033	0.005	0.097
alpha-BHC	0.00033	0.00033	0.02	0.48
alpha-Chlordane	0.00033	0.00033	0.094	4.2
beta-BHC	0.00033	0.00033	0.036	0.36
Chlordane, total	0.00660	0.00660	~	~
delta-BHC	0.00033	0.00033	0.04	100
Dieldrin	0.00033	0.00033	0.005	0.2
Endosulfan I	0.00033	0.00033	2.4	24
Endosulfan II	0.00033	0.00033	2.4	24
Endosulfan sulfate	0.00033	0.00033	2.4	24
Endrin	0.00033	0.00033	0.014	11
Endrin aldehyde	0.00033	0.00033	~	~
Endrin ketone	0.00033	0.00033	~	~
gamma-BHC (Lindane)	0.00033	0.00033	0.1	1.3
gamma-Chlordane	0.00033	0.00033	~	~
Heptachlor	0.00033	0.00033	0.042	2.1
Heptachlor epoxide	0.00033	0.00033	~	~
Methoxychlor	0.00033	0.00033	~	~
Toxaphene	0.03300	0.03300	~	~

MDL: Method Detection Limit
UUSCO: Unrestricted Use Soil Cleanup Objective
RRSCO: Restricted Residential Use Soil Cleanup Objective

Table 3- Reporting Limits compared to Guidance Values
PCBs in Soil
38-18 33rd Street and 32-20 38th Avenue, Queens, NY
Former Refron Inc. Gas Reclamation Site

Analyte	MDL (ppm)	RL (ppm)	NYSDEC Part 375 UUSCOs (ppm)	NYSDEC Part 375 RRSCOs (ppm)
Aroclor 1016	0.0167	0.0167	~	~
Aroclor 1221	0.0167	0.0167	~	~
Aroclor 1232	0.0167	0.0167	~	~
Aroclor 1242	0.0167	0.0167	~	~
Aroclor 1248	0.0167	0.0167	~	~
Aroclor 1254	0.0167	0.0167	~	~
Aroclor 1260	0.0167	0.0167	~	~
Total PCBs	0.0167	0.0167	0.1	1

MDL: Method Detection Limit

UUSCO: Unrestricted Use Soil Cleanup Objective

RRSCO: Restricted Residential Use Soil Cleanup Objective

Table 3- Reporting Limits compared to Guidance Values
TAL Metals in Soil
38-18 33rd Street and 32-20 38th Avenue, Queens, NY
Former Refron Inc. Gas Reclamation Site

Analyte	MDL (ppm)	RL (ppm)	NYSDEC Part 375 UUSCOs (ppm)	NYSDEC Part 375 RRSCOs (ppm)
Aluminum	4.17	4.17	~	~
Antimony	2.08	2.08	~	~
Arsenic	1.25	1.25	13	16
Barium	2.08	2.08	350	400
Beryllium	0.0420	0.0420	7.2	72
Cadmium	0.250	0.250	2.5	4.3
Calcium	4.17	4.17	~	~
Chromium	0.417	0.417	~	~
Cobalt	0.333	0.333	~	~
Copper	1.67	1.67	50	270
Iron	20.8	20.8	~	~
Lead	0.417	0.417	63	400
Magnesium	4.17	4.17	~	~
Manganese	0.417	0.417	1600	2,000
Nickel	0.830	0.830	30	310
Potassium	4.17	4.17	~	~
Selenium	2.08	2.08	3.9	180
Silver	0.420	0.420	2	180
Sodium	41.7	41.7	~	~
Thallium	1.00	1.00	~	~
Vanadium	0.830	0.830	~	~
Zinc	2.08	2.08	109	10,000
Mercury	0.0300	0.0300	0.18	0.81

MDL: Method Detection Limit
UUSCO: Unrestricted Use Soil Cleanup Objective
RRSCO: Restricted Residential Use Soil Cleanup Objective

Table 3- Reporting Limits compared to Guidance Values
PFAS in Soil
38-18 33rd Street and 32-20 38th Avenue, Queens, NY
Former Refron Inc. Gas Reclamation Site

Analyte	**MDL (ppb)**	**RL (ppb)**	**NYSDEC Part 375 UUSCOs (ppb)**	**NYSDEC Part 375 RRSCOs (ppb)**
11CL-PF3OUdS	0.311	0.756	~	~
1H,1H,2H,2H-Perfluorodecanesulfonic acid	0.755	0.768	~	~
1H,1H,2H,2H-Perfluorohexanesulfonic acid	0.595	0.75	~	~
1H,1H,2H,2H-Perfluorooctanesulfonic acid	0.75	0.76	~	~
3-Perfluoroheptyl propanoic acid (FHpPA)	1.5	5	~	~
3-Perfluoropentyl propanoic acid (FPePA)	2.1	5	~	~
3-Perfluoropropyl propanoic acid (FPrPA)	0.634	1	~	~
9CL-PF3ONS	0.246	0.748	~	~
ADONA	0.174	0.756	~	~
HFPO-DA (Gen-X)	0.608	0.8	~	~
N-EtFOSA	0.198	0.2	~	~
N-EtFOSAA	0.194	0.2	~	~
N-EtFOSE	0.697	2	~	~
N-MeFOSA	0.18	0.2	~	~
N-MeFOSAA	0.148	0.2	~	~
N-MeFOSE	0.611	2	~	~
Perfluoro(2-ethoxyethane)sulfonic acid	0.139	0.356	~	~
Perfluoro-1-decanesulfonic acid (PFDS)	0.191	0.193	~	~
Perfluoro-1-heptanesulfonic acid (PFHpS)	0.155	0.2	~	~
Perfluoro-1-nonanesulfonic acid (PFNS)	0.124	0.192	~	~
Perfluoro-1-octanesulfonamide (FOSA)	0.146	0.2	~	~
Perfluoro-1-pentanesulfonate (PFPeS)	0.157	0.188	~	~
Perfluoro-3,6-dioxaheptanoic acid (NFDHA)	0.193	0.4	~	~
Perfluoro-4-oxapentanoic acid (PFMPA)	0.062	0.4	~	~
Perfluoro-5-oxahexanoic acid (PFMBA)	0.096	0.4	~	~
Perfluorobutanesulfonic acid (PFBS)	0.111	0.177	~	~
Perfluorodecanoic acid (PFDA)	0.191	0.2	~	~
Perfluorododecanesulfonic acid (PFDoS)	0.169	0.194	~	~
Perfluorododecanoic acid (PFDoA)	0.163	0.2	~	~
Perfluoroheptanoic acid (PFHpA)	0.105	0.2	~	~
Perfluorohexanesulfonic acid (PFHxS)	0.179	0.183	~	~
Perfluorohexanoic acid (PFHxA)	0.053	0.2	~	~
Perfluoro-n-butanoic acid (PFBA)	0.109	0.8	~	~
Perfluorononanoic acid (PFNA)	0.189	0.2	~	~
Perfluorooctanesulfonic acid (PFOS)	0.167	0.186	0.88	44
Perfluorooctanoic acid (PFOA)	0.172	0.2	0.66	33
Perfluoropentanoic acid (PFPeA)	0.109	0.4	~	~
Perfluorotetradecanoic acid (PFTA)	0.103	0.2	~	~
Perfluorotridecanoic acid (PFTrDA)	0.125	0.2	~	~
Perfluoroundecanoic acid (PFUnA)	0.198	0.2	~	~

MDL: Method Detection Limit
UUSCO: Unrestricted Use Soil Cleanup Objective
RRSCO: Restricted Residential Use Soil Cleanup Objective

Table 3- Reporting Limits Compared to Guidance Values
VOCs in Groundwater
38-18 33rd Street and 32-20 38th Avenue, Queens, NY
Former Refron Inc. Gas Reclamation Site

Analyte	MDL (ppb)	Reporting Limit (ppb)	NYSDEC TOGS Standards and Guidance Values (ppb)
1,1,1,2-Tetrachloroethane	0.2	0.5	5
1,1,1-Trichloroethane	0.2	0.5	5
1,1,2,2-Tetrachloroethane	0.2	0.5	5
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)	0.2	0.5	5
1,1,2-Trichloroethane	0.2	0.5	1
1,1-Dichloroethane	0.2	0.5	5
1,1-Dichloroethylene	0.2	0.5	5
1,2,3-Trichlorobenzene	0.2	0.5	5
1,2,3-Trichloropropane	0.2	0.5	0.04
1,2,4-Trichlorobenzene	0.2	0.5	5
1,2,4-Trimethylbenzene	0.2	0.5	5
1,2-Dibromo-3-chloropropane	0.2	0.5	0.04
1,2-Dibromoethane	0.2	0.5	0.0006
1,2-Dichlorobenzene	0.2	0.5	3
1,2-Dichloroethane	0.2	0.5	0.6
1,2-Dichloropropane	0.2	0.5	1
1,3,5-Trimethylbenzene	0.2	0.5	5
1,3-Dichlorobenzene	0.2	0.5	3
1,4-Dichlorobenzene	0.2	0.5	5
1,4-Dioxane	40	40	3
2-Butanone	0.2	0.5	50
2-Hexanone	0.2	0.5	50
4-Methyl-2-pentanone	0.2	0.5	~
Acetone	1	2	50
Acrolein	0.2	0.5	~
Acrylonitrile	0.2	0.5	~
Benzene	0.2	0.5	1
Bromochloromethane	0.2	0.5	5
Bromodichloromethane	0.2	0.5	50
Bromoform	0.2	0.5	50
Bromomethane	0.2	0.5	5
Carbon disulfide	0.2	0.5	~
Carbon tetrachloride	0.2	0.5	5
Chlorobenzene	0.2	0.5	5
Chloroethane	0.2	0.5	5
Chloroform	0.2	0.5	7
Chloromethane	0.2	0.5	5
cis-1,2-Dichloroethylene	0.2	0.5	5
cis-1,3-Dichloropropylene	0.2	0.5	0.4
Cyclohexane	0.2	0.5	~
Dibromochloromethane	0.2	0.5	50
Dibromomethane	0.2	0.5	~
Dichlorodifluoromethane	0.2	0.5	5
Ethyl Benzene	0.2	0.5	5
Hexachlorobutadiene	0.2	0.5	0.5
Isopropylbenzene	0.2	0.5	5
Methyl tert-butyl ether (MTBE)	0.2	0.5	~
Methylcyclohexane	0.2	0.5	10
Methylene chloride	1	2	~
n-Butylbenzene	0.2	0.5	5
n-Propylbenzene	0.2	0.5	5
o-Xylene	0.2	0.5	5
p- & m- Xylenes	0.5	1	5
p-Isopropyltoluene	0.2	0.5	~
sec-Butylbenzene	0.2	0.5	5
Styrene	0.2	0.5	5
tert-Butyl alcohol (TBA)	0.5	1	5
tert-Butylbenzene	0.2	0.5	~
Tetrachloroethylene	0.2	0.5	5
Toluene	0.2	0.5	5
trans-1,2-Dichloroethylene	0.2	0.5	5
trans-1,3-Dichloropropylene	0.2	0.5	5
trans-1,4-dichloro-2-butene	0.2	0.5	0.4
Trichloroethylene	0.2	0.5	5
Trichlorofluoromethane	0.2	0.5	5
Vinyl Chloride	0.2	0.5	2
Xylenes, Total	0.6	1.5	5

MDL: Method Detection Limit

Table 3- Reporting Limits compared to Guidance Values
SVOCs in Groundwater
38-18 33rd Street and 32-20 38th Avenue, Queens, NY
Former Refron Inc. Gas Reclamation Site

Analyte	MDL (ppb)	Reporting Limit (ppb)	NYSDEC TOGS Standards and Guidance Values (ppb)
1,1-Biphenyl	2.5	5	~
1,2,4,5-Tetrachlorobenzene	2.5	5	~
1,2,4-Trichlorobenzene	2.5	5	~
1,2-Dichlorobenzene	2.5	5	~
1,2-Diphenylhydrazine (as Azobenzene)	2.5	5	~
1,3-Dichlorobenzene	2.5	5	~
1,4-Dichlorobenzene	2.5	5	~
2,3,4,6-Tetrachlorophenol	1.25	1.25	~
2,4,5-Trichlorophenol	1.25	1.25	1
2,4,6-Trichlorophenol	1.25	1.25	1
2,4-Dichlorophenol	1.25	1.25	5
2,4-Dimethylphenol	1.25	1.25	50
2,4-Dinitrophenol	1.25	1.25	10
2,4-Dinitrotoluene	2.5	5	5
2,6-Dinitrotoluene	2.5	5	5
2-Chloronaphthalene	2.5	5	10
2-Chlorophenol	1.25	1.25	1
2-Methylnaphthalene	2.5	5	~
2-Methylphenol	1.25	1.25	1
2-Nitroaniline	2.5	5	5
2-Nitrophenol	1.25	1.25	1
3- & 4-Methylphenols	1.25	1.25	1
3,3-Dichlorobenzidine	2.5	5	5
3-Nitroaniline	2.5	5	5
4,6-Dinitro-2-methylphenol	1.25	1.25	~
4-Bromophenyl phenyl ether	2.5	5	~
4-Chloro-3-methylphenol	1.25	1.25	1
4-Chloroaniline	2.5	5	5
4-Chlorophenyl phenyl ether	2.5	5	~
4-Nitroaniline	2.5	5	5
4-Nitrophenol	1.25	1.25	1
Acenaphthene	0.05	0.05	20
Acenaphthylene	0.05	0.05	~
Acetophenone	2.5	5	~
Aniline	2.5	5	
Anthracene	0.05	0.05	50
Atrazine	0.5	0.5	~
Benzaldehyde	2.5	5	~
Benzidine	10	20	

Analyte	MDL (ppb)	Reporting Limit (ppb)	NYSDEC TOGS Standards and Guidance Values (ppb)
Benzo(a)anthracene	0.05	0.05	0.002
Benzo(a)pyrene	0.05	0.05	0.002
Benzo(b)fluoranthene	0.05	0.05	0.002
Benzo(g,h,i)perylene	0.05	0.05	~
Benzo(k)fluoranthene	0.05	0.05	0.002
Benzoic acid	25	50	~
Benzyl alcohol	2.5	5	~
Benzyl butyl phthalate	2.5	5	50
Bis(2-chloroethoxy)methane	2.5	5	5
Bis(2-chloroethyl)ether	1.25	1.25	1
Bis(2-chloroisopropyl)ether	2.5	5	5
Bis(2-ethylhexyl)phthalate	0.5	0.5	5
Caprolactam	2.5	5	~
Carbazole	2.5	5	~
Chrysene	0.05	0.05	0.002
Dibenzo(a,h)anthracene	0.05	0.05	~
Dibenzofuran	2.5	5	~
Diethyl phthalate	2.5	5	50
Dimethyl phthalate	2.5	5	50
Di-n-butyl phthalate	2.5	5	50
Di-n-octyl phthalate	2.5	5	50
Fluoranthene	0.05	0.05	50
Fluorene	0.05	0.05	50
Hexachlorobenzene	0.02	0.02	0.04
Hexachlorobutadiene	0.5	0.5	0.5
Hexachlorocyclopentadiene	2.5	5	5
Hexachloroethane	0.5	0.5	5
Indeno(1,2,3-cd)pyrene	0.05	0.05	0.002
Isophorone	2.5	5	50
Naphthalene	0.05	0.05	10
Nitrobenzene	0.25	0.25	0.4
N-Nitrosodimethylamine	0.5	0.5	~
N-nitroso-di-n-propylamine	2.5	5	~
N-Nitrosodiphenylamine	2.5	5	50
Pentachlorophenol	0.25	0.25	1
Phenanthrene	0.05	0.05	50
Phenol	1.25	1.25	1
Pyrene	0.05	0.05	50
Pyridine	2.5	5	50
Semi-Volatiles, 1,4-Dioxane 8270 SIM-Aqueous in Water (EPA 8270E SIM)			
1,4-dioxane	0.2	0.3	0.35

MDL: Method Detection Limit

Table 3- Reporting Limits compared to Guidance Values
Pesticides in Groundwater
38-18 33rd Street and 32-20 38th Avenue, Queens, NY
Former Refron Inc. Gas Reclamation Site

Analyte	**MDL (ppb)**	**Reporting Limit (ppb)**	**NYSDEC TOGS Standards and Guidance Values (ppb)**
4,4'-DDD	0.004	0.004	0.3
4,4'-DDE	0.004	0.004	0.2
4,4'-DDT	0.004	0.004	0.2
Aldrin	0.004	0.004	~
alpha-BHC	0.004	0.004	0.01
alpha-Chlordane	0.004	0.004	~
beta-BHC	0.004	0.004	0.04
Chlordane, total	0.02	0.02	0.05
delta-BHC	0.004	0.004	0.04
Dieldrin	0.002	0.002	0.004
Endosulfan I	0.004	0.004	~
Endosulfan II	0.004	0.004	~
Endosulfan sulfate	0.004	0.004	~
Endrin	0.004	0.004	~
Endrin aldehyde	0.01	0.01	5
Endrin ketone	0.01	0.01	5
gamma-BHC (Lindane)	0.004	0.004	0.05
gamma-Chlordane	0.01	0.01	~
Heptachlor	0.004	0.004	0.04
Heptachlor epoxide	0.004	0.004	0.03
Methoxychlor	0.004	0.004	35
Toxaphene	0.1	0.1	0.06

MDL: Method Detection Limit

Table 3- Reporting Limits compared to Guidance Values
PCBs in Groundwater
38-18 33rd Street and 32-20 38th Avenue, Queens, NY
Former Refron Inc. Gas Reclamation Site

Analyte	MDL (ppb)	Reporting Limit (ppb)	NYSDEC TOGS Standards and Guidance Values (ppb)
Aroclor 1016	0.05	0.05	~
Aroclor 1221	0.05	0.05	~
Aroclor 1232	0.05	0.05	~
Aroclor 1242	0.05	0.05	~
Aroclor 1248	0.05	0.05	~
Aroclor 1254	0.05	0.05	~
Aroclor 1260	0.05	0.05	~
Total PCBs	0.05	0.05	0.09

MDL: Method Detection Limit

Table 3- Reporting Limits compared to Guidance Values
TAL Metals in Groundwater
38-18 33rd Street and 32-20 38th Avenue, Queens, NY
Former Refron Inc. Gas Reclamation Site

Analyte	**MDL (ppb)**	**Reporting Limit (ppb)**	**NYSDEC TOGS Standards and Guidance Values (ppb)**
Mercury	0.2	0.2	0.7
Metals, Target Analyte, ICP in Water (EPA 6010D)			
Aluminum	50	50	~
Barium	25	25	1000
Calcium	50	50	~
Chromium	5	5	50
Cobalt	4	4	~
Copper	20	20	200
Iron	250	250	~
Lead	5	5	25
Magnesium	50	50	35000
Manganese	5	5	300
Nickel	10	10	100
Potassium	50	50	~
Silver	5	5	50
Sodium	500	500	20000
Vanadium	10	10	~
Zinc	25	25	2000
Metals, Target Analyte, ICPMS in Water (EPA 6020B)			
Antimony	1	1	3
Arsenic	1	1	25
Beryllium	0.3	0.3	3
Cadmium	0.5	0.5	5
Selenium	1	1	10
Thallium	1	1	~

MDL: Method Detection Limit

Table 3- Reporting Limits compared to Guidance Values
PFAS in Groundwater
38-18 33rd Street and 32-20 38th Avenue, Queens, NY
Former Refron Inc. Gas Reclamation Site

Analyte	MDL (ng/L)	Reporting Limit (ng/L)	NYSDEC TOGS Standards and Guidance Values (ng/L)
11CL-PF3OUdS	1.38	7.56	100
1H,1H,2H,2H-Perfluorodecanesulfonic acid (8:2 FTS)	2.05	7.68	100
1H,1H,2H,2H-Perfluorohexanesulfonic acid (4:2 FTS)	1.79	7.5	~
1H,1H,2H,2H-Perfluorooctanesulfonic acid (6:2 FTS)	7.5	7.6	100
3-Perfluoroheptyl propanoic acid (FHpPA)	9.47	25	~
3-Perfluoropentyl propanoic acid (FPePA)	7.33	25	~
3-Perfluoropropyl propanoic acid (FPrPA)	2.03	5	~
9CL-PF3ONS	0.7	7.48	100
ADONA	0.53	7.56	100
HFPO-DA (Gen-X)	3.23	8	100
N-EtFOSA	1.8	2	~
N-EtFOSAA	1.03	2	100
N-EtFOSE	3.99	20	~
N-MeFOSA	1.58	2	~
N-MeFOSAA	0.79	2	100
N-MeFOSE	3.99	20	~
Perfluoro(2-ethoxyethane)sulfonic acid (PFEESA)	0.5	3.56	~
Perfluoro-1-decanesulfonic acid (PFDS)	1.32	1.93	100
Perfluoro-1-heptanesulfonic acid (PFHpS)	0.91	1.91	100
Perfluoro-1-nonanesulfonic acid (PFNS)	0.86	1.92	~
Perfluoro-1-octanesulfonamide (FOSA)	0.88	2	100
Perfluoro-1-pentanesulfonate (PFPeS)	0.76	1.88	~
Perfluoro-3,6-dioxaheptanoic acid (NFDHA)	2.14	4	~
Perfluoro-4-oxapentanoic acid (PFMPA)	0.25	4	~
Perfluoro-5-oxahexanoic acid (PFMBA)	0.37	4	~
Perfluorobutanesulfonic acid (PFBS)	0.47	1.77	100
Perfluorodecanoic acid (PFDA)	0.75	2	100
Perfluorododecanesulfonic acid (PFDoS)	0.93	1.94	~
Perfluorododecanoic acid (PFDoA)	0.88	2	100
Perfluoroheptanoic acid (PFHpA)	0.71	2	100
Perfluorohexanesulfonic acid (PFHxS)	0.68	1.83	100
Perfluorohexanoic acid (PFHxA)	0.35	2	100
Perfluoro-n-butanoic acid (PFBA)	0.33	8	100
Perfluorononanoic acid (PFNA)	0.52	2	100
Perfluorooctanesulfonic acid (PFOS)	0.82	1.86	10
Perfluorooctanoic acid (PFOA)	0.42	2	10
Perfluoropentanoic acid (PFPeA)	0.23	4	100
Perfluorotetradecanoic acid (PFTA)	0.69	2	100
Perfluorotridecanoic acid (PFTrDA)	0.74	2	100
Perfluoroundecanoic acid (PFUnA)	1.13	2	100

MDL: Method Detection Limit

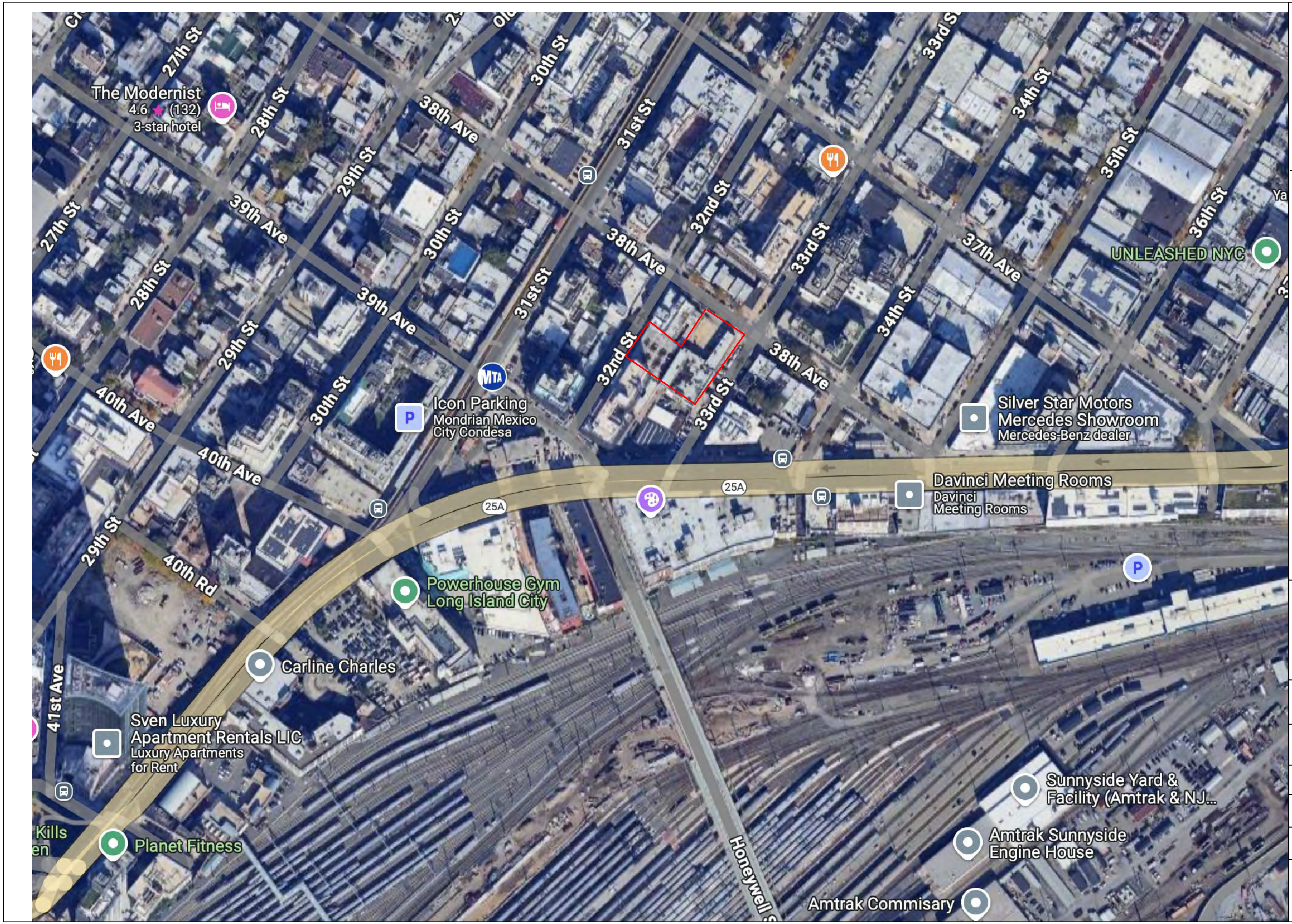
Table 3
Reporting Limits for Soil Vapor
38-18 33rd Street and 32-20 38th Avenue, Queens, NY
Former Refron Inc. Gas Reclamation Site

Analyte	**MDL (ug/m^3)**	**RL (ug/m3)**
1,1,1,2-Tetrachloroethane	0.70	0.70
1,1,1-Trichloroethane	0.55	0.55
1,1,2,2-Tetrachloroethane	0.70	0.70
1,1,2-Trichloro-1,2,2-trifluoroethane	0.78	0.78
1,1,2-Trichloroethane	0.55	0.55
1,1-Dichloroethane	0.41	0.41
1,1-Dichloroethylene	0.10	0.10
1,2,4-Trichlorobenzene	0.75	0.75
1,2,4-Trimethylbenzene	0.50	0.50
1,2-Dibromoethane	0.78	0.78
1,2-Dichlorobenzene	0.61	0.61
1,2-Dichloroethane	0.41	0.41
1,2-Dichloropropane	0.47	0.47
1,2-Dichlorotetrafluoroethane	0.71	0.71
1,3,5-Trimethylbenzene	0.50	0.50
1,3-Butadiene	0.68	0.68
1,3-Dichlorobenzene	0.61	0.61
1,3-Dichloropropane	0.47	0.47
1,4-Dichlorobenzene	0.61	0.61
1,4-Dioxane	0.73	0.73
2,2,4-Trimethylpentane	0.12	0.24
2-Butanone	0.30	0.30
2-Hexanone	0.83	0.83
3-Chloropropene	1.59	1.59
4-Methyl-2-pentanone	0.42	0.42
Acetone	0.48	1.93
Acrylonitrile	0.22	2.87
Benzene	0.32	0.32
Benzyl chloride	0.53	0.53
Bromodichloromethane	0.68	0.68
Bromoform	1.05	1.05
Bromomethane	0.39	0.39
Carbon disulfide	0.32	0.32
Carbon tetrachloride	0.16	0.16

Analyte	**MDL (ug/m^3)**	**RL (ug/m3)**
Chlorobenzene	0.47	0.47
Chloroethane	0.27	0.27
Chloroform	0.50	0.50
Chloromethane	0.21	0.21
cis-1,2-Dichloroethylene	0.10	0.10
cis-1,3-Dichloropropylene	0.46	0.46
Cyclohexane	0.35	0.35
Dibromochloromethane	0.87	0.87
Dichlorodifluoromethane	0.50	0.50
Ethyl acetate	0.73	0.73
Ethyl Benzene	0.44	0.44
Hexachlorobutadiene	1.08	1.08
Isopropanol	0.50	1.50
Methyl Methacrylate	0.42	0.42
Methyl tert-butyl ether (MTBE)	0.37	0.37
Methylene chloride	0.71	2.12
Naphthalene	1.07	1.07
n-Heptane	0.42	0.42
n-Hexane	0.36	0.36
o-Xylene	0.44	0.44
p- & m- Xylenes	0.88	0.88
p-Ethyltoluene	0.50	0.50
Propylene	0.18	0.18
Styrene	0.43	0.43
Tetrachloroethylene	0.69	0.69
Tetrahydrofuran	0.60	0.60
Toluene	0.38	0.38
trans-1,2-Dichloroethylene	0.40	0.40
trans-1,3-Dichloropropylene	0.46	0.46
Trichloroethylene	0.14	0.14
Trichlorofluoromethane (Freon 11)	0.57	0.57
Vinyl acetate	0.36	0.36
Vinyl bromide	0.44	0.44
Vinyl Chloride	0.13	0.13

MDL: Method Detection Limit
RL: Reporting Limit

FIGURES



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Legend:

🟥 Approximate BCP Site Boundary

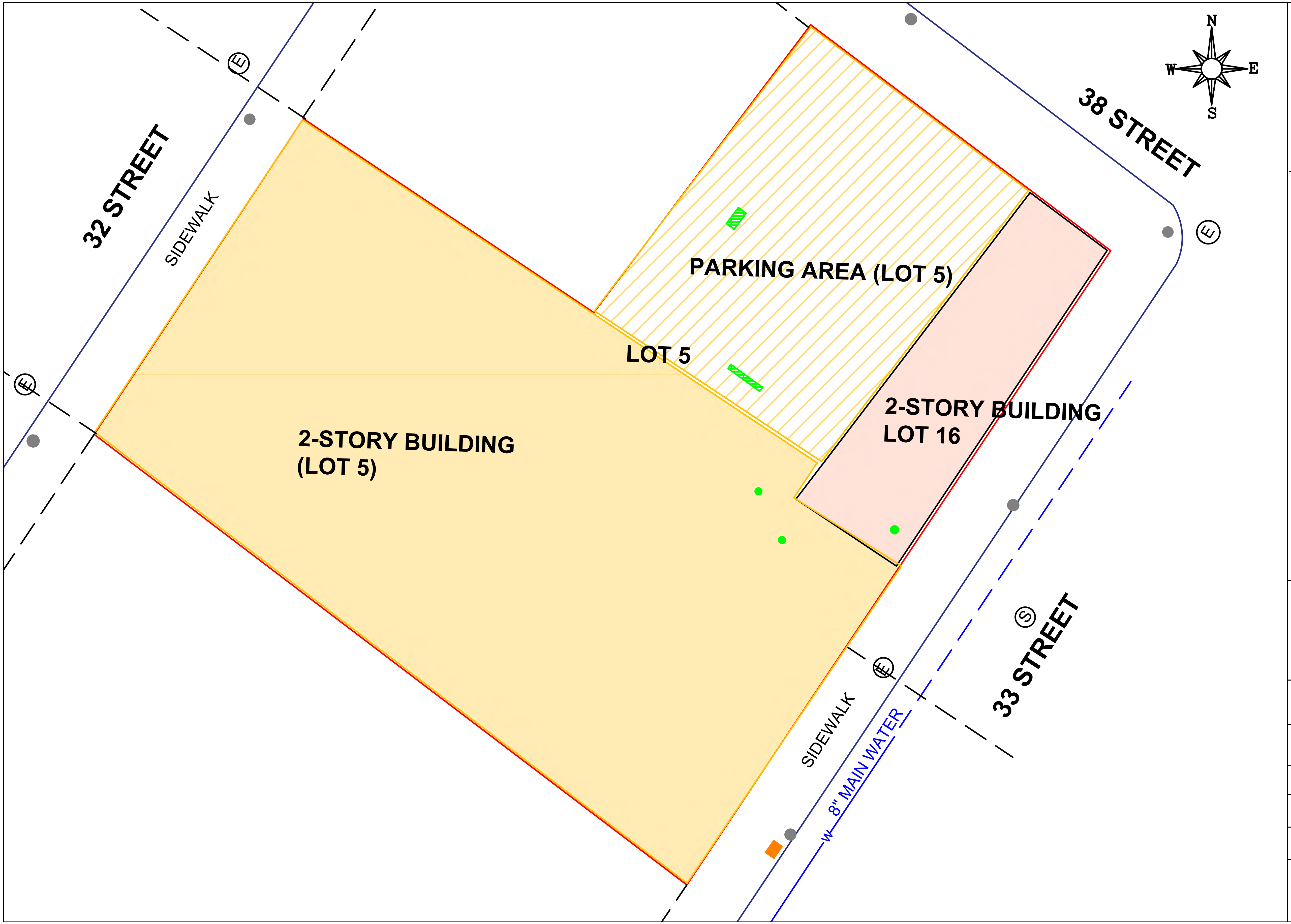
Notes:

1. Base Map provided by Google Earth

Scale:

NOT TO SCALE

Figure No.	1
Figure Name:	Site Location Map
Report:	RIWP
Date:	9/20/2024
Drawn By:	KB
Site Address:	32-20 38th Avenue and 38-18 33rd Street Queens, New York



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Legend:

▭	BCP Site Boundary
▭	Building Footprint on Lot 16
■	Building Footprint on Lot 5
▨	Paved Parking Footprint on Lot 5
Ⓔ	Electrical Manhole
Ⓢ	Sewer Manhole
●	Floor Drain
■	Metal Cover
●	Utility Pole

Notes:

1. All floor drains and pits will be cleaned out
2. Building on Lot 16 occupies the entirety of the parcel
3. Building on Lot 5 occupies the entirety of southern portion and parking in the northern portion

Scale:

0 50'

Figure No. 2

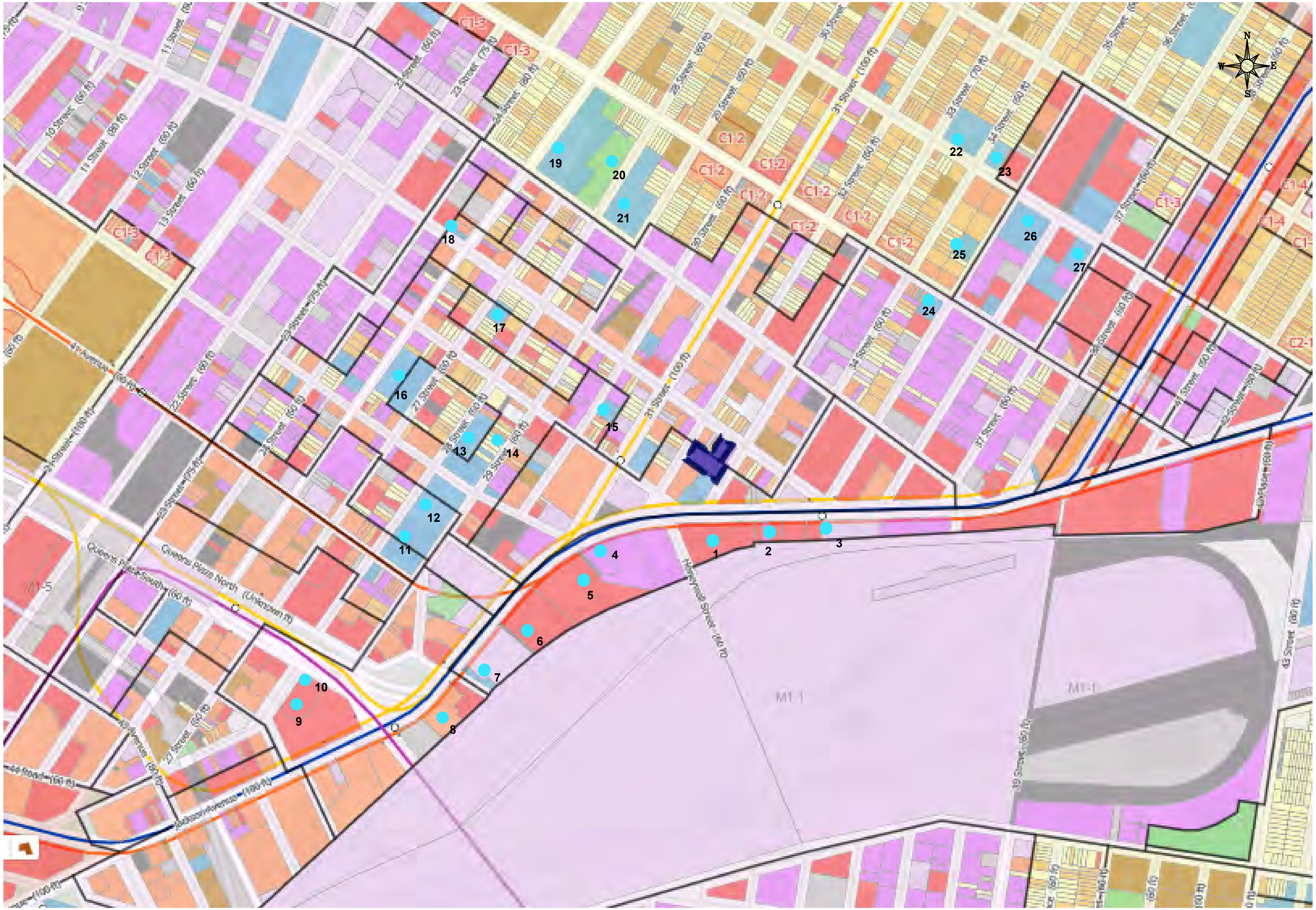
Figure Name: Site Plan

Report: RIWP

Date: 5/20/2022

Drawn By: EK

Site Address: 32-20 38TH AVENUE &
38-18 33RD STREET
QUEENS, NEW YORK



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Legend:

- 🟨 One and Two Family Buildings
- 🟧 Multi-Family Walk-Up Buildings
- 🟫 Multi-Family Elevator Buildings
- 🟧 Mixed Residential and Commercial Buildings
- 🟥 Commercial and Office Buildings
- 🟪 Industrial and Manufacturing
- 🟪 Transportation and Utility
- 🟦 Public Facilities and Institutions
- 🟩 Open Space and Outdoor Recreation
- ⬜ Parking Facilities
- ⬛ Vacant Land
- ⬜ Other
- Mandatory Inclusionary Housing Areas
- ● Sensitive Receptors and ID
- 🟦 Site Boundary

Base map provided by NYC Planning

Scale:

0 600' 1,200'

Figure No.	3
Figure Name:	Site Boundary and Surrounding Land Use
Report:	RIWP
Date:	3/20/25
Drawn By:	DK
Site Address:	32-20 38TH AVENUE & 38-18 33RD STREET QUEENS, NEW YORK

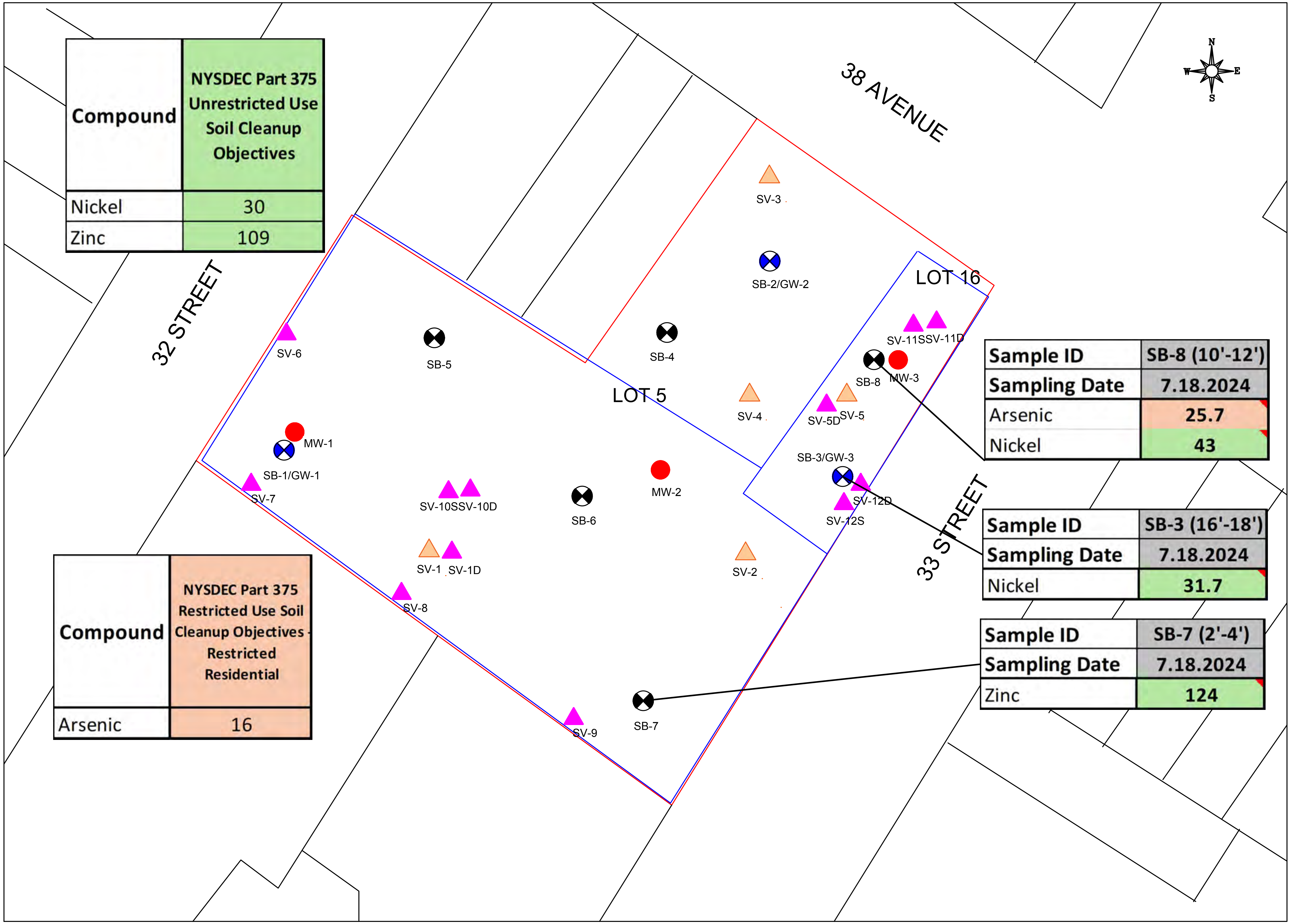
Site Name: FORMER REFRON GAS RECLAMATION SITE

Site Address: 32-20 38TH AVENUE & 38-18 33RD STREET QUEENS, NEW YORK

Figure 3: SENSITIVE RECEPTORS WITHIN HALF MILE OF THE SITE – LEGEND

No.	Facility Name	Address	Distance from Site
1	The New York Foundling Hospital	33-00 Northern Boulevard	~330 feet south
2	Citiview Connection	33-24 Northern Boulevard	~475 feet southeast
3	Living Positive	34-18 Northern Boulevard	~620 feet southeast
4	New York Counseling for Change Clinic	30-46 Northern Boulevard	~750 feet southwest
5	Queens Children Mobile Crisis Team	30-30 Northern Boulevard	~890 feet southwest
6	Fortune Society OP	29-76 Northern Boulevard	~1,400 feet southwest
7	GED Restart- Adolescent Skills II School	29-46 Northern Boulevard	~1,700 feet southwest
8	Playhouse NYC Inc-Day Care and Pre-K	29-22 Northern Boulevard	~1,900 feet southwest
9	Consumer Officer Health Care	42-09 28th Street	2,500 feet southwest
10	Transition Management Services	42-09 28th Street	~2,500 feet southwest
11	Atlas	28-01 41st Avenue	~1,387 feet southwest
12	Academy of American Studies	40-11 28th Street	~1,800 feet southwest

No.	Facility Name	Address	Distance from Site
13	Growing Up Green Charter School	39-27 28th Street	~1,300 feet southwest
14	Windmill Community Garden	39-22 29th Street	~1,100 feet west
15	Our World Neighborhood MS	38-27 30th Street	~600 feet northwest
16	Evangel Christian School	39-21 Crescent Street	~1,700 feet northwest
17	SCO Family of Services	38-11 27th Street	~1,400 feet northwest
18	United Wire Metal and Machine Medical Center	24-09 38th Avenue	~1,900 feet northwest
19	P.S. 112 Dutch Kills	25-05 37th Avenue	~1,800 feet northwest
20	Dutch Kills Playground	36-11 28th Street	~1,700 feet northwest
21	Energy Tach Highschool	36-41 28th Street	~1,400 feet northwest
22	P.S. 166 Henry Gradstein	33-05 35th Avenue	~2,200 feet northeast
23	Astoria Dialysis Center	34-01 35th Avenue	~2,200 feet northeast
24	Baccalaureate School for Global Education	34-12 36th Avenue	~1,400 feet northeast
25	A.R.R.O.W. Field House	35-38 35th Street	~1,600 feet northeast
26	Frank Sinatra School of the Arts High School	35-12 35th Avenue	~2,000 feet northeast
27	Our World Neighborhood Charter	36-12 35th Avenue	~2,200 feet northeast



Compound	NYSDEC Part 375 Unrestricted Use Soil Cleanup Objectives
Nickel	30
Zinc	109

Compound	NYSDEC Part 375 Restricted Use Soil Cleanup Objectives - Restricted Residential
Arsenic	16

Sample ID	SB-8 (10'-12')
Sampling Date	7.18.2024
Arsenic	25.7
Nickel	43

Sample ID	SB-3 (16'-18')
Sampling Date	7.18.2024
Nickel	31.7

Sample ID	SB-7 (2'-4')
Sampling Date	7.18.2024
Zinc	124

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Legend:

▭	Property Boundary
▭	Building Boundary
⊗ SB-X	Soil Boring Location and Designated ID (July 2024)
⊗ SB-X/GW-X	Soil Boring/Groundwater Sample Location and Designated ID (July 2024)
▲ SV-X	Soil Vapor Point Location and Designated ID (July 2024)
● MW-X	Monitoring Well Location and Designated ID (August 2024)
▲ SV-X	Soil Vapor Point Location and Designated ID (August 2024)

Notes:
1. All feature locations are approximate.
2. Concentrations are reported in parts per million (ppm)

Scale:
0 30

Figure No. 4

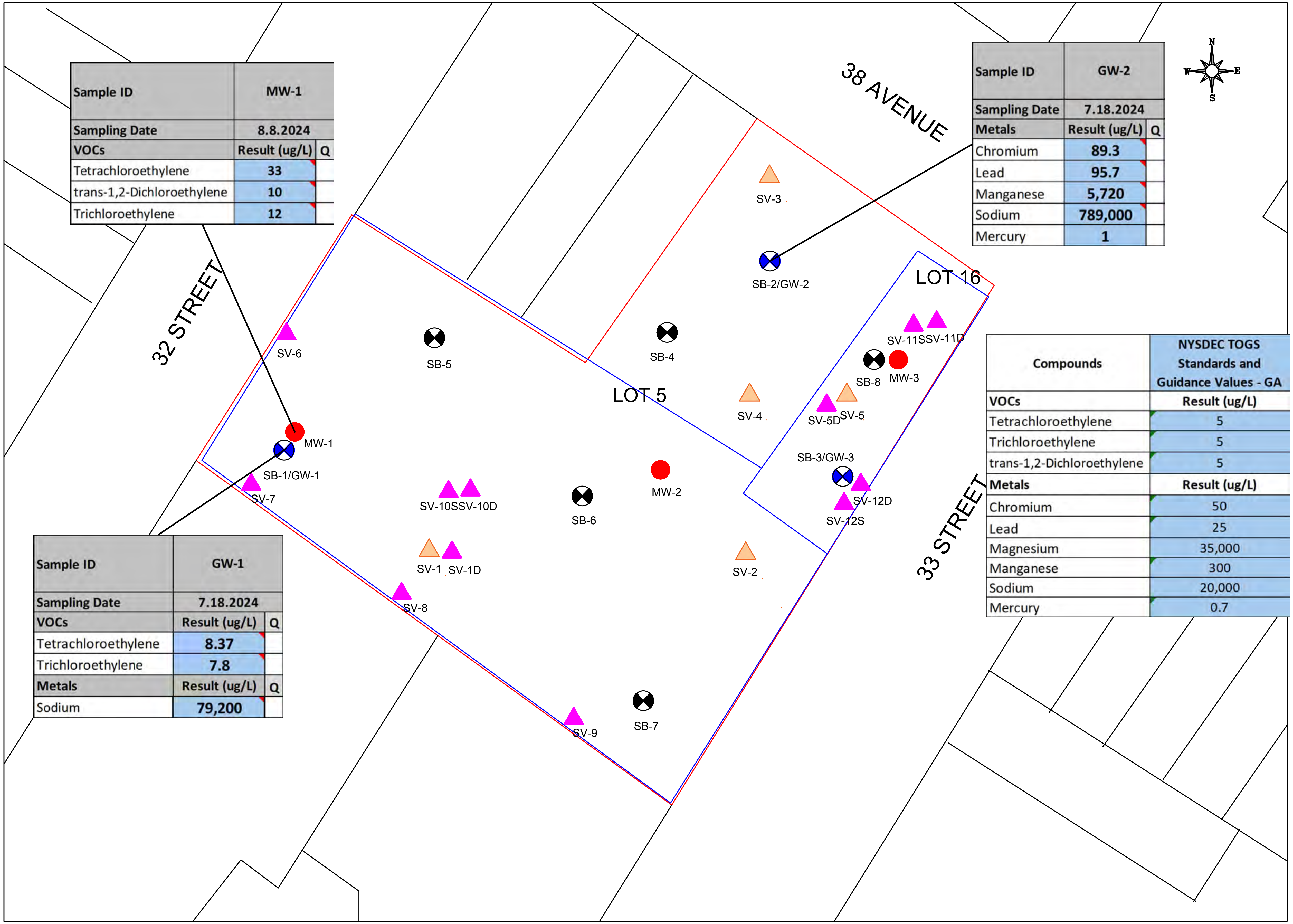
Figure Name: Soil Sample Exceedances

Report: RIWP

Date: 9/20/2024

Drawn By: KB

Site Address: 32-20 38th Avenue &
38-18 33rd Street
Queens, New York



Sample ID	MW-1	
Sampling Date	8.8.2024	
VOCs	Result (ug/L)	Q
Tetrachloroethylene	33	
trans-1,2-Dichloroethylene	10	
Trichloroethylene	12	

Sample ID	GW-2	
Sampling Date	7.18.2024	
Metals	Result (ug/L)	Q
Chromium	89.3	
Lead	95.7	
Manganese	5,720	
Sodium	789,000	
Mercury	1	

Compounds	NYSDEC TOGS Standards and Guidance Values - GA
VOCs	Result (ug/L)
Tetrachloroethylene	5
Trichloroethylene	5
trans-1,2-Dichloroethylene	5
Metals	Result (ug/L)
Chromium	50
Lead	25
Magnesium	35,000
Manganese	300
Sodium	20,000
Mercury	0.7

Sample ID	GW-1	
Sampling Date	7.18.2024	
VOCs	Result (ug/L)	Q
Tetrachloroethylene	8.37	
Trichloroethylene	7.8	
Metals	Result (ug/L)	Q
Sodium	79,200	

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Legend:

🟥	Property Boundary
🟦	Building Boundary
⊗ SB-X	Soil Boring Location and Designated ID (July 2024)
⊗ SB-X/GW-X	Soil Boring/Groundwater Sample Location and Designated ID (July 2024)
△ SV-X	Soil Vapor Point Location and Designated ID (July 2024)
● MW-X	Monitoring Well Location and Designated ID (August 2024)
▲ SV-X	Soil Vapor Point Location and Designated ID (August 2024)

Scale:

0 30

Figure No. 5

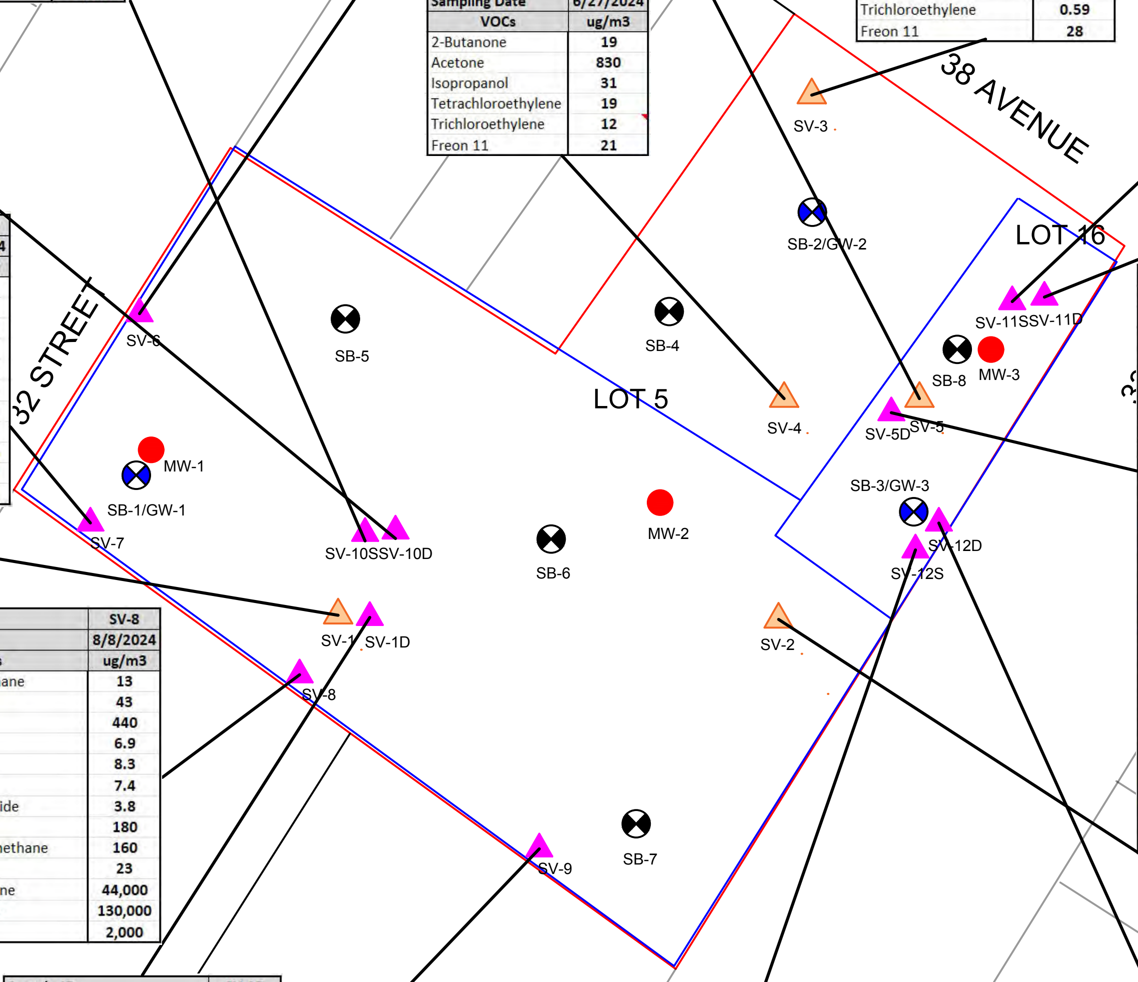
Figure Name: Groundwater Sample Exceedances

Report: RIWP

Date: 9/20/2024

Drawn By: KB

Site Address: 32-20 38th Avenue &
38-18 33rd Street
Queens, New York



Sample ID	SV-10D
Sampling Date	8/8/2024
VOCs	ug/m3
1,1,1-Trichloroethane	22
Freon 113	120
1,2-Dichlorotetrafluoroethane	22
Acetone	16
Benzene	7.6
Carbon disulfide	11
Carbon tetrachloride	11
Chloroform	130
cis-1,2-Dichloroethylene	8.7
Dichlorodifluoromethane	370
Isopropanol	11
Propylene	13
Tetrachloroethylene	12,000
Trichloroethylene	18,000
Freon 11	14,000

Sample ID	SV-10S
Sampling Date	8/8/2024
VOCs	ug/m3
1,1,1-Trichloroethane	27
Freon 113	120
1,2-Dichlorotetrafluoroethane	25
Acetone	82
Acrylonitrile	5.3
Carbon tetrachloride	15
Chloroform	150
cis-1,2-Dichloroethylene	12
Dichlorodifluoromethane	420
Isopropanol	13
Propylene	6.4
Tetrachloroethylene	13,000
trans-1,2-Dichloroethylene	7.4
Trichloroethylene	18,000
Freon 11	14,000

Sample ID	SV-6
Sampling Date	8/8/2024
VOCs	ug/m3
1,1,1-Trichloroethane	12
2-Butanone	27
Acetone	110
Benzene	5.3
Carbon disulfide	16
Carbon tetrachloride	7.3
Chloroform	69
Dichlorodifluoromethane	50
Isopropanol	13
Propylene	8
Tetrachloroethylene	5,300
Trichloroethylene	2,100
Freon 11	1,900

Sample ID	SV-5
Sampling Date	6/27/2024
VOCs	ug/m3
Freon 113	41
2-Butanone	13
4-Methyl-2-pentanone	7.4
Acetone	63
Acrylonitrile	5.9
Benzene	8.1
Carbon disulfide	44
Carbon tetrachloride	3.4
Propylene	62
Tetrachloroethylene	66
Toluene	20
Trichloroethylene	1,700
Freon 11	2,700

Sample ID	SV-3
Sampling Date	6/27/2024
VOCs	ug/m3
1,1,1-Trichloroethane	1.3
1,2,4-Trimethylbenzene	2.1
2-Butanone	5.4
Acetone	150
Benzene	0.7
Carbon disulfide	1.3
Chloroform	11
Dichlorodifluoromethane	2.8
Isopropanol	3.1
o-Xylene	1
p- & m- Xylenes	2.2
p-Ethyltoluene	2
Propylene	7.9
Tetrachloroethylene	66
Tetrahydrofuran	1.4
Toluene	1.2
Trichloroethylene	0.59
Freon 11	28

Sample ID	SV-11S
Sampling Date	8/8/2024
VOCs	ug/m3
Freon 113	62
2-Butanone	17
Acetone	67
Acrylonitrile	21
Carbon disulfide	5
Carbon tetrachloride	7.1
Chloroform	9.4
Dichlorodifluoromethane	11
Propylene	46
Tetrachloroethylene	74
Toluene	6
Trichloroethylene	1,300
Freon 11	4,400

Sample ID	SV-11D
Sampling Date	8/8/2024
VOCs	ug/m3
Freon 113	43
1,3-Butadiene	19
2-Butanone	98
2-Hexanone	33
4-Methyl-2-pentanone	18
Acetone	570
Benzene	8.2
Carbon disulfide	15
Carbon tetrachloride	10
Chloroform	8.6
Dichlorodifluoromethane	12
Isopropanol	19
n-Heptane	15
n-Hexane	18
Propylene	180
Tetrachloroethylene	34
Toluene	22
Trichloroethylene	800
Freon 11	3,900

Sample ID	SV-4
Sampling Date	6/27/2024
VOCs	ug/m3
2-Butanone	19
Acetone	830
Isopropanol	31
Tetrachloroethylene	19
Trichloroethylene	12
Freon 11	21

Sample ID	SV-7
Sampling Date	8/8/2024
VOCs	ug/m3
1,1,1-Trichloroethane	18
Acetone	22
Carbon disulfide	5.3
Chloroform	32
cis-1,2-Dichloroethylene	8.6
Dichlorodifluoromethane	26
Isopropanol	9.5
Propylene	2.7
Tetrachloroethylene	15,000
Trichloroethylene	5,200
Freon 11	780

Sample ID	SV-2
Sampling Date	7/19/2024
VOCs	ug/m3
1,1,1-Trichloroethane	1
1,1,2,2-Tetrachloroethane	1.6
Freon 113	2
1,1-Dichloroethane	0.78
1,1-Dichloroethylene	0.69
1,2,4-Trichlorobenzene	2.7
1,2,4-Trimethylbenzene	5
1,2-Dichlorobenzene	2.6
1,2-Dichloroethane	0.78
1,3,5-Trimethylbenzene	3.3
1,3-Dichlorobenzene	2
1,4-Dichlorobenzene	2.1
1,4-Dioxane	3.4
2,2,4-Trimethylpentane	0.9
2-Butanone	2.4
2-Hexanone	3.1
4-Methyl-2-pentanone	3.6
Acetone	15
Acrylonitrile	0.61
Benzene	1.2
Benzyl chloride	1.7
Bromomethane	1
Carbon disulfide	1.5
Carbon tetrachloride	1.3
Chlorobenzene	0.88
Chloroethane	0.55
Chloroform	1.5
cis-1,2-Dichloroethylene	0.69
Cyclohexane	0.66
Dichlorodifluoromethane	2.7
Ethyl Benzene	1.8
Hexachlorobutadiene	5.6
Isopropanol	4.5
Methyl Methacrylate	1.1
MTBE	0.69
Methylene chloride	1.3
Naphthalene	3.6
n-Heptane	0.79
n-Hexane	0.8
o-Xylene	2.8
p- & m- Xylenes	6.1
p-Ethyltoluene	4.2
Styrene	1.5
Tetrachloroethylene	3.4
Tetrahydrofuran	1.2
Toluene	2
trans-1,2-Dichloroethylene	0.69
Trichloroethylene	2.8
Freon 11	7.1
Vinyl bromide	0.84
Vinyl Chloride	0.4

Sample ID	SV-5D
Sampling Date	8/8/2024
VOCs	ug/m3
Freon 113	69
1,3-Butadiene	84
2,2,4-Trimethylpentane	3.8
2-Butanone	28
2-Hexanone	17
3-Chloropropene	31
4-Methyl-2-pentanone	8.6
Acetone	100
Benzene	46
Carbon disulfide	68
Carbon tetrachloride	12
Chloroform	12
Chloromethane	3.7
Dichlorodifluoromethane	8.8
Ethyl Benzene	9.8
Isopropanol	8
n-Heptane	46
n-Hexane	46
o-Xylene	9.8
p- & m- Xylenes	30
Propylene	830
Tetrachloroethylene	50
Toluene	77
Trichloroethylene	2,200
Freon 11	4,300

Sample ID	SV-1
Sampling Date	7/19/2024
VOCs	ug/m3
1,1,1-Trichloroethane	10
Freon 113	39
Acetone	32
Carbon disulfide	11
Carbon tetrachloride	3
Chloroform	130
cis-1,2-Dichloroethylene	160
Dichlorodifluoromethane	190
Isopropanol	11
Tetrachloroethylene	33,000
trans-1,2-Dichloroethylene	24
Trichloroethylene	90,000
Freon 11	4,300

Sample ID	SV-8
Sampling Date	8/8/2024
VOCs	ug/m3
1,1,1-Trichloroethane	13
Freon 113	43
Acetone	440
Acrylonitrile	6.9
Benzene	8.3
Carbon disulfide	7.4
Carbon tetrachloride	3.8
Chloroform	180
Dichlorodifluoromethane	160
Isopropanol	23
Tetrachloroethylene	44,000
Trichloroethylene	130,000
Freon 11	2,000

Sample ID	SV-1D
Sampling Date	8/8/2024
VOCs	ug/m3
1,1,1-Trichloroethane	28
Freon 113	79
1,2-Dichlorotetrafluoroethane	18
Acetone	18
Carbon disulfide	6.6
Carbon tetrachloride	11
Chloroform	280
cis-1,2-Dichloroethylene	190
Dichlorodifluoromethane	330
Isopropanol	12
Propylene	3
Tetrachloroethylene	22,000
trans-1,2-Dichloroethylene	40
Trichloroethylene	62,000
Freon 11	9,800

Sample ID	SV-9
Sampling Date	8/8/2024
VOCs	ug/m3
1,1,1-Trichloroethane	15
Freon 113	51
1,2,4-Trimethylbenzene	8.8
1,3,5-Trimethylbenzene	8.8
2-Butanone	12
Acetone	51
Benzene	6.2
Carbon disulfide	12
Carbon tetrachloride	5.1
Chloroform	32
Dichlorodifluoromethane	210
p-Ethyltoluene	8
Propylene	8.4
Tetrachloroethylene	170
Trichloroethylene	1,800
Freon 11	8,000

Sample ID	SV-12S
Sampling Date	8/8/2024
VOCs	ug/m3
Freon 113	37
2-Butanone	11
Acetone	43
Benzene	11
Carbon disulfide	40
Carbon tetrachloride	25
Chloroform	17
Dichlorodifluoromethane	8.1
Isopropanol	8.1
Propylene	26
Tetrachloroethylene	29
Toluene	29
Trichloroethylene	450
Freon 11	1,800

Sample ID	SV-12D
Sampling Date	8/8/2024
VOCs	ug/m3
Freon 113	43
1,3-Butadiene	26
2-Butanone	14
Acetone	330
Benzene	16
Carbon disulfide	38
Carbon tetrachloride	28
Chloroform	18
Cyclohexane	7.9
Isopropanol	14
n-Heptane	12
n-Hexane	26
Propylene	290
Tetrachloroethylene	19
Toluene	35
Trichloroethylene	360
Freon 11	2,200

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Legend:

🟥	Property Boundary
🟦	Building Boundary
⊗ SB-X	Prior Soil Boring Location and Designated ID (July 2024)
⊗ SB-X/GW-X	Prior Soil Boring/Groundwater Sample Location and Designated ID (July 2024)
△ SV-X	Prior Soil Vapor Point Location and Designated ID (July 2024)
● MW-X	Monitoring Welll Location and Designated ID
▲ SV-X	Soil Vapor Point Location and Designated ID (August 2024)

Notes:

1. All feature locations are approximate
2. All units are reported in micrograms per cubic meter
3. Freon 113: 1,1,2-Trichloro-1,2,2-trifluoroethane
4. Freon 11: Trichlorofluoromethane

Scale:

0 30

Figure No. 6

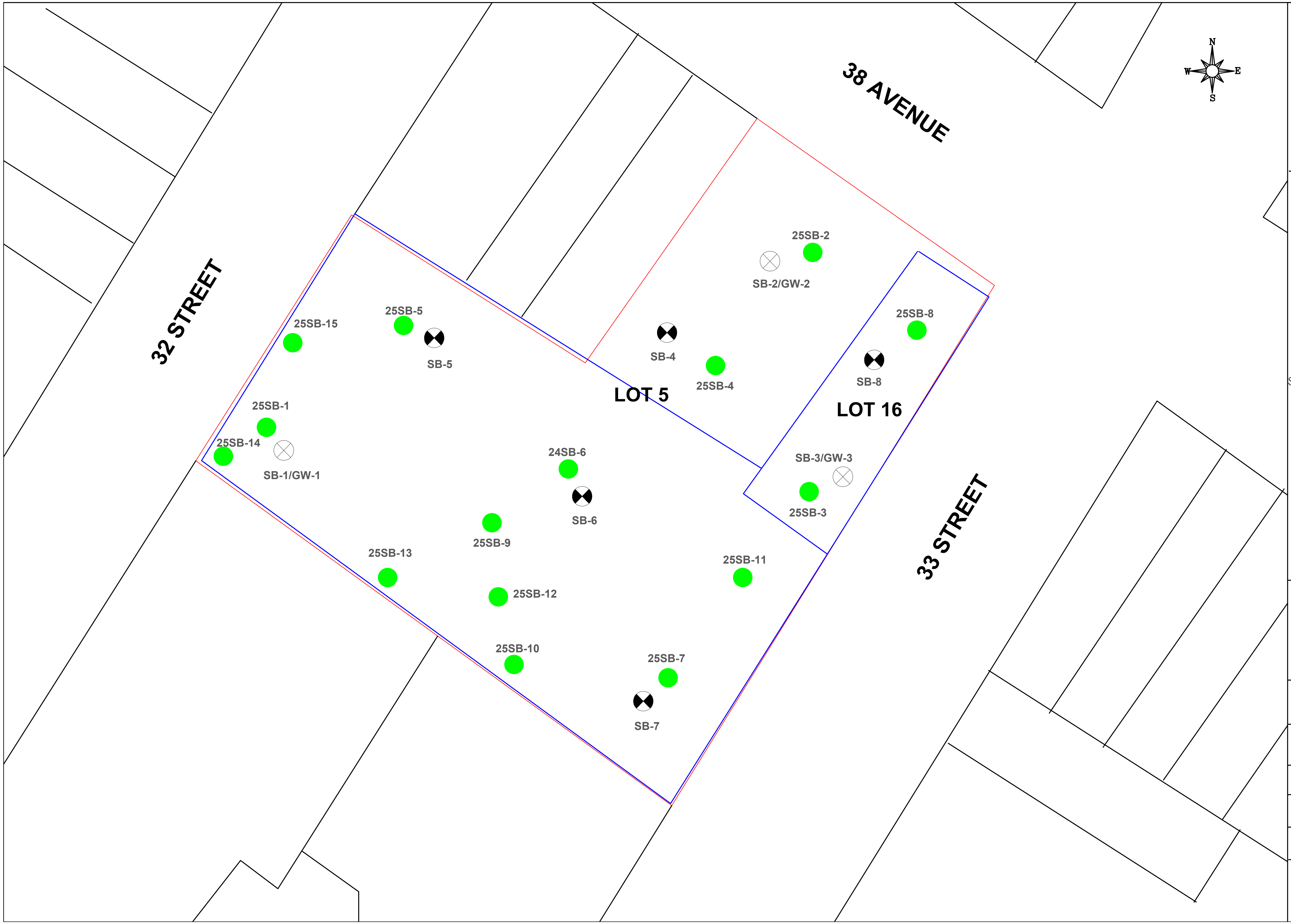
Figure Name: Soil Vapor Detections Spider Map

Report: RIWP

Date: 9/5/2024

Drawn By: KB

Site Address: 32-20 38th Avenue &
38-18 33rd Street
Queens, New York



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Legend:

- □ Property Boundary
- □ Building Boundary
- ⊗ SB-X Prior Soil Boring Location and Designated ID (July 2024)
- ⊗ SB-X/GW-X Prior Soil Boring/Groundwater Sample Location and Designated ID (July 2024)
- ● 25SB-X Proposed Soil Sample Location

Notes:

1. All feature locations are approximate

Scale:

0 30

Figure No. 7

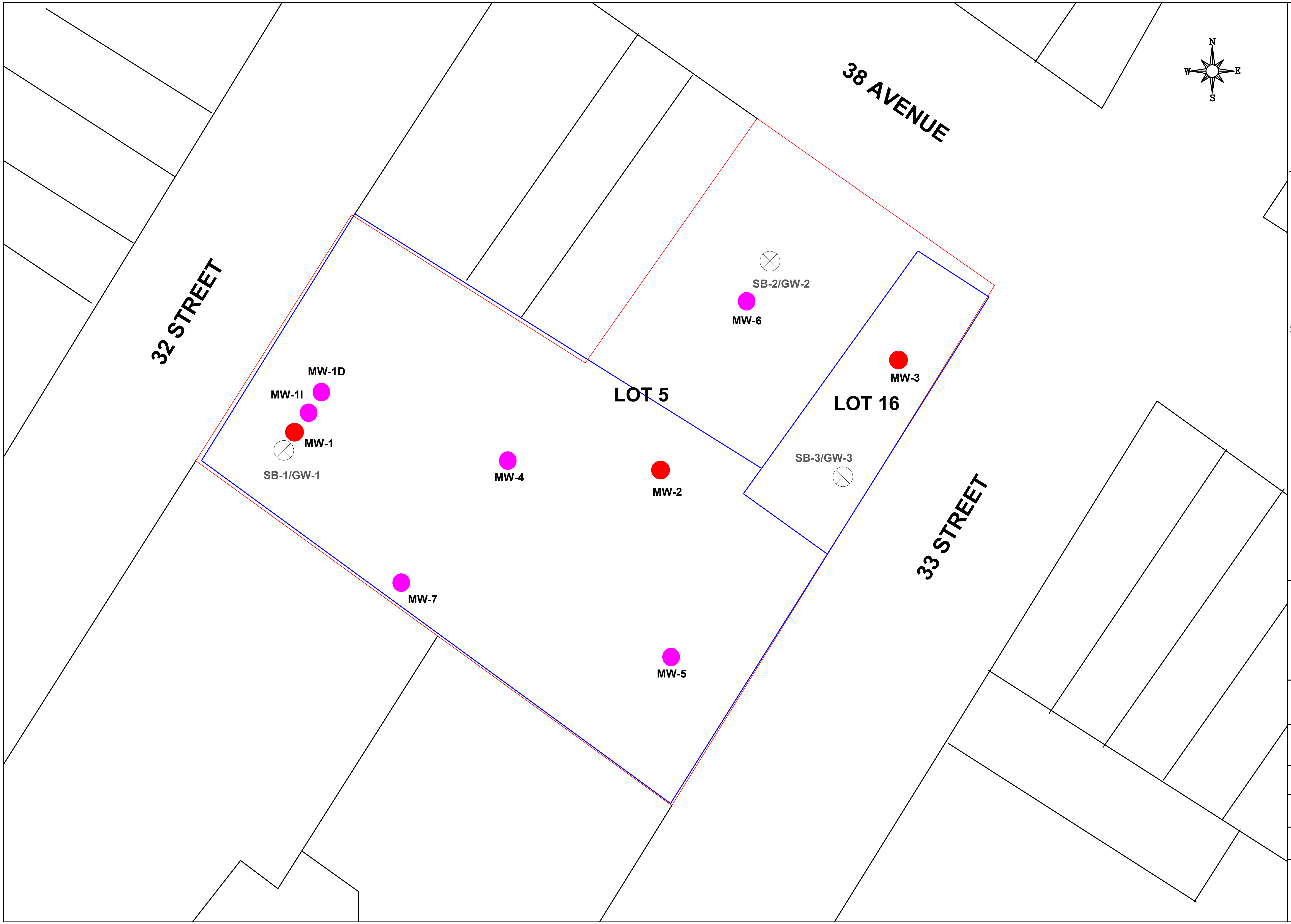
Figure Name: Proposed Soil Sampling Plan

Report: RIWP

Date: 9/20/2024

Drawn By: EK

Site Address: 32-20 38TH AVENUE &
38-18 33RD STREET
QUEENS, NEW YORK



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Legend:

🟥	Property Boundary
🟦	Building Boundary
⊗ SB-X/GW-X	Prior Soil Boring/Groundwater Sample Location and Designated ID (July 2024)
● MW-X	Monitoring Well Location and Designated ID (August 2024 and Proposed for Resample)
● MW-X	Monitoring Well Location and Designated ID

Notes:

1. All feature locations are approximate

Scale:

0 30

Figure No. 8

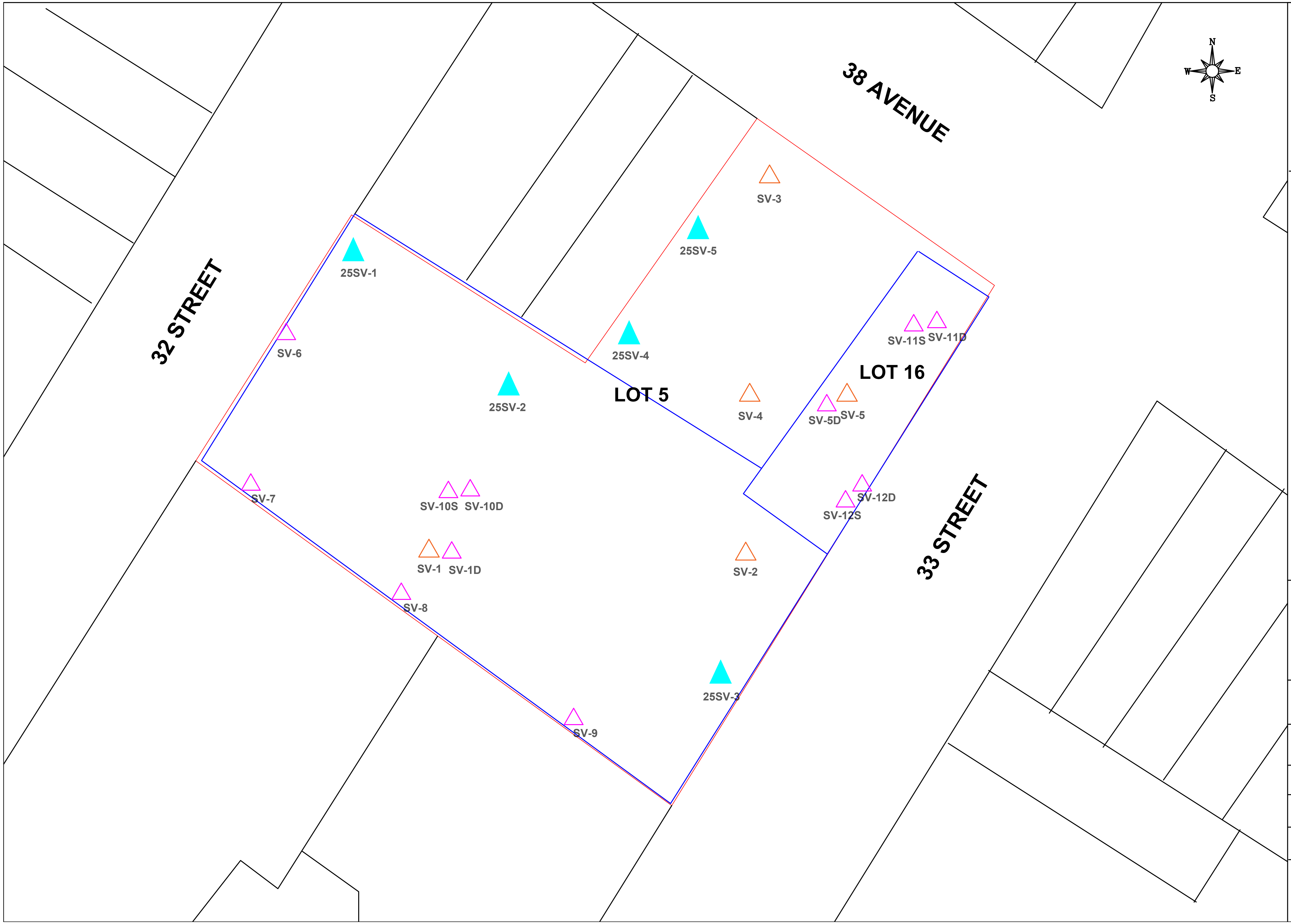
Figure Name: Proposed Groundwater Sampling Plan

Report: RIWP

Date: 9/20/2024

Drawn By: EK

Site Address: 32-20 38TH AVENUE &
38-18 33RD STREET
QUEENS, NEW YORK



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Legend:

- ▭ Property Boundary
- ▭ Building Boundary
- △ SV-X Prior Soil Vapor Point Location and Designated ID (July 2024 - To Be Validated)
- △ SV-X Prior Soil Vapor Point Location and Designated ID (August 2024 - To Be Validated)
- ▲ 25SV-X Proposed Soil Vapor Point Location and Designated ID

Notes:

1. All feature locations are approximate

Scale:

0 30

Figure No.	9
Figure Name:	Proposed Soil Vapor Sampling Plan
Report:	RIWP
Date:	9/20/2024
Drawn By:	EK
Site Address:	32-20 38TH AVENUE & 38-18 33RD STREET QUEENS, NEW YORK

APPENDICES

APPENDIX A

PREVIOUS ENVIRONMENTAL REPORTS

(Submitted separately due to size)

APPENDIX B

QUALITY ASSURANCE PROJECT PLAN (QAPP)

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QUALITY ASSURANCE PROJECT PLAN

Prepared For: 38-18 33rd Street LLC and 32-20 38th Avenue LLC c/o Cavu Property Group

Project Name: Former Refron Inc. Gas Reclamation Site

BCP Site No: C241285

Project Location: 38-18 33rd Street and 32-20 38th Avenue, Queens, New York 11101

Date: March 2025

37 West 37th Street, 6th Floor, New York, NY 10018

Table of Contents

Tables

Figures

Attachments

1.0 INTRODUCTION

This Quality Assurance Project Plan (QAPP) was prepared on behalf of 38-18 33rd Street LLC and 32-20 38th Avenue LLC (the Requestor) for the implementation of a Remedial Investigative Work Plan (RIWP) by Vektor Consultants (Vektor) and its subcontractors for the Former Refron Inc. Gas Reclamation Site located at 38-18 33rd Street and 32-20 38th Avenue in the Long Island City section of Queens County, New York (the Site). The Site is identified by the City of New York as Borough of Brooklyn, Tax Block 381, Lots 5 and 16.

The Requestor intends to enroll in the New York State Department of Environmental Conservation (NYSDEC) Brownfield Cleanup Program (BCP) as a Volunteer to investigate and remediate the Site. A BCP Application is submitted along with this RIWP.

The RI activities will be conducted in accordance with a New York State Department of Environmental Conservation (NYSDEC) approved Remedial Investigation Work Plan (RIWP).

This QAPP describes the protocols and procedures to be followed during the implementation of the NYSDEC approved RIWP. This QAPP was prepared in accordance with the NYSDEC DER-10 Technical Guidance for Site Investigation and Remediation and the NYSDEC BCP Guide.

1.1 Scope of Work

A Remedial Investigation (RI) is proposed herein will investigate the Site to characterize the nature and extent of contamination associated with historical operations at the Site. The data will be analyzed to characterize the nature and extent of contamination at the Site and to evaluate remedial action alternatives.

The proposed investigation will consist of the following scope of work:

- Geophysical survey to locate unidentified underground storage tanks (USTs) and identify utilities in the vicinity of the proposed boring locations,
- Installation of fifteen soil borings to 15 feet below sidewalk grade, or refusal across the Site and collection of forty-five (45) soil samples and additional quality assurance /quality control (QA/QC) samples,
- Installation of six monitoring wells and collection of nine groundwater samples and additional QA/QC samples from the newly installed monitoring wells and three existing groundwater monitoring wells,
- Installation of five soil vapor points and collection of five soil vapor samples, one duplicate soil vapor samples, and one ambient air sample as a QA/QC.

A licensed geophysical surveyor will conduct the survey prior to intrusive work. A direct push drill-rig operated by a licensed driller subcontractor will be utilized for the installation of soil borings, monitoring wells and soil vapor points at the Site.

2.0 PROJECT TEAM

Vektor's team of trained and experienced environmental scientists, geologists, and engineers along with Vektor's licensed subcontractors will perform the below-listed tasks in a manner consistent with DER-10 Technical Guidance for Site Investigation and Remediation (DER-10).

Position	**Name**	**Organization**	**Phone/E-mail**
Principal Engineer, P.E.	Hilmi U. Aydin	Vektor Consultants	(347) 871-0750 aydin@vektorconsultants.com
Project Director, QEP	Ezgi Karayel	Vektor Consultants	(347) 871-0750 ezgi@vektorconsultants.com
Project Manager	David Klein	Vektor Consultants	(347) 871-0750 dklein@vektorconsultants.com
QA/QC Officer	Peter Rathsack	Vektor Consultants	(347) 871-0750 prathsack@vektorconsultants.com
Field Leader	Dominick Basilone	Vektor Consultants	(347) 871-0750 dbasilone@vektorconsultants.com
Laboratory QA/QC Officer	Zachary Scott	York Analytical Laboratories, Inc.	(203) 325-1371 scott@yorklab.com
Laboratory QA/QC Officer	Dhurba Raj Pandey	York Analytical Laboratories, Inc.	(203) 325-1371 dpandey@yorklab.com
Third-party Data Validator	Don Anne	Alpha Geoscience	(518) 348-6995 danne@alphageoscience.com
Drilling Company	Marc Morgenstern	Coastal Environmental Solutions	(516) 587-9570 marc@coastalenvsolutions.com

2.1 Principal Engineer

Hilmi U. Aydin, Professional Engineer, will act as the Principal Engineer and will oversee the successful completion of this project. He will have the direct responsibility of preparation and certification of the Remedial Investigation Report (RIR).

2.2 Project Director

Ezgi Karayel, Qualified Environmental Professional, will act as the Project Director, will oversee the Project Managers, and will ensure the successful completion of the remedial investigation.

2.3 Quality Assurance / Quality Control Officer

Peter Rathsack will act as the Quality Assurance/Quality Control (QA/QC) officer and will ensure all QA/QC samples are collected as proposed in the approved RIWP and confirm laboratory's reporting limits are within the acceptable ranges. QA/QC officer will coordinate with the third-party data validator for the review of all analytical data and preparation of DURSs.

2.4 Project Manager

David Klein of Vektor will act as the Project Manager. He will oversee the field activities and coordinate for all elements of the RIWP. He will be responsible for coordinating with the field leader and other field crew as necessary.

2.5 Field Leader

Dominick Basilone of Vektor will lead the field activities and ensure implementation of Health and Safety Plan (HASP) during all field work. They have the authority to stop all work if unsafe conditions are observed. They will be responsible for coordinating with all subcontractors. They will oversee the subcontractors in the field and collect samples outlined in the RIWP and in this QAPP.

2.6 Laboratory Quality Assurance/Quality Control Officer

Laboratory analysis will be completed by York Analytical Laboratories (York) of Stratford, CT. York is a New York State Department of Health (NYSDOH) Environmental Laboratory Accreditation Program (ELAP) certified laboratory (NY Cert. Numbers 10854 and 12058). Zachary Scott is the Client Manager who will ensure that all glassware including laboratory prepared trip blanks and chain of custodies are properly packaged and shipped. QA/QC Officer is Dhurba Raj Pandey who will ensure that quality assurance procedures are followed. Quality Assurance requirements for analytical laboratory data include accuracy, precision, sensitivity, representativeness, and completeness. Data will be supplied in Analytical Services Protocol (ASP) Category B Data Packages.

2.7 Third-Party Data Validator

Don Anne of Alpha Geoscience will be the third-party validator. Data validation will be performed in accordance with the EPA validation guidelines for organic and inorganic data review. A Data Usability Summary Report (DUSR) will be prepared by Don Anne upon receipt of the analytical laboratory reports. The DUSR will present the results of the 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 of each analytical method. Don Anne's resume can be found in Attachment 5.

2.8 Other Subcontractors

- Coastal Environmental Solutions (Coastal) of Bohemia, New York will conduct a geophysical survey and perform the soil boring, monitoring well, and soil vapor points installation.

3.0 SAMPLING METHODS PROCEDURES

This section describes the field protocol and procedures to be followed during the remedial investigation activities.

Table 1 provides a copy of the sampling summary. Figures 1 through 3 provide the proposed sampling plans.

3.1 Soil Sampling

Fifteen soil borings (25SB-1 through 25SB-15) will be installed to investigate potential impacts from the former uses of the Site. A direct push drill-rig (Geoprobe®) operated by a licensed driller subcontractor will be utilized for the installation of soil borings at the Site. The soil borings will be advanced continuously to 15 feet below sidewalk grade, or refusal (the "boring termination depth"), or immediately above the groundwater interface (anticipated between 14-15 feet below grade).

Soil samples will be retrieved using 1.5-inch diameters, 5-foot-long core sampler with disposable acetate liners. A Geologist will be on Site to log the soils, visually characterize them, and field screen them with a photo ionization detector (PID) for the presence of petroleum contamination.

Soil samples representative of Site conditions will be collected at 15 locations throughout the Site. From each boring location, a minimum of three soil samples (total of 45 samples) will be collected for laboratory analysis. At these borings, one soil sample will be collected from the fill layer at 0 feet to 2 feet bgs, one sample below the historic fill layer, and one sample immediately above the groundwater table. If historic fill extends to refusal depth, a soil sample will be collected above the interval immediately above refusal. However, if evidence of contamination is observed at 15 feet below the sidewalk grade or the water table interface, the boring shall be completed until no evidence of contamination is observed.

Additional samples will be collected, as needed, from any interval within the advanced borings which are observed to exhibit evidence of contamination (i.e., staining, odors, elevated PID readings).Representative soil samples will immediately be containerized in pre-cleaned laboratory supplied glassware, stored in a chilled cooler (4^{o}C), and submitted to a New York State Department of Health certified laboratory.

The soil samples from 24SB-1 through 24SB-15 will be analyzed for:

- Target Compound List (TCL) volatile organic compounds (VOCs) via Environmental Protection Agency (EPA) Method 8260C/5035
- TCL semi-volatile organic compounds (SVOCs) via EPA Method 8270D
- Total analyte list (TAL) metals via EPA Method 6010D/7471B
- Polychlorinated biphenyls (PCBs) via EPA Method 8082A

- TLC pesticides via EPA Method 8081B
- NYSDEC list per and polyfluoroalkyl substances (PFAS) (40 compounds) via EPA Method 1633:
- 1,4-dioxane via EPA Method 8270 SIM.

Laboratory reporting limits for PFOA and PFOS via EPA Method 1633 should not exceed 0.5 ug/kg. Laboratory reporting limits for 1,4-dioxane via EPA Method 8270 SIM should not exceed 1 ug/kg. Table 1 provides a sampling matrix, and Figure 1 shows the proposed soil sample locations.

3.2 Groundwater Sampling

Four 2-inch permanent groundwater monitoring wells, MW-4 through MW-7, will be installed to evaluate the groundwater quality beneath the Site utilizing a direct push drill rig within the central portion of the Site, southern portion of the Site, and northern portion of the Site. Two additional 2-inch permanent groundwater monitoring wells, MW-1I and MW-1D, will be installed to a depth of 25 feet below grade and 35 feet below grade, respectively, to further evaluate the CVOCs identified within MW-1 during the Phase II investigation. Based on gauging during the most recent investigation, the groundwater depth beneath the Site ranges from approximately 14 feet below grade to 15 feet below grade.

In addition to the newly installed monitoring wells, the existing well network on-site, consisting of MW-1, MW-2, and MW-3, will be sampled for full TCL parameters during the RI to assess groundwater quality beneath the Site.

The proposed monitoring wells will be constructed of 2-inch diameter PVC casing and 0.020-inch slotted PVC well screen or 2-inch pre-packed wells. The 10 feet screen will be set 5 feet below the groundwater table. Morrie No. 1 or equivalent clean sand will be used to fill the annular gap around the screen and above the top of the screened interval. A bentonite seal will be installed above the sand and the remainder of the borehole will be backfilled to grade with non-petroleum impacted drill cuttings and/or clean sand. The monitoring wells will have stick-up risers above grade for visibility.

Monitoring wells will then be developed by surging a pump, bailer, or surge block inside the wells. The method will be repeated until sediment free water is produced, or water turbidity is 50 nephelometric turbidity units (NTU) or less.

All monitoring wells will be surveyed by a New York State licensed surveyor in order to determine the actual direction of groundwater beneath the Site.

Approximately one week after well development, one groundwater sample will be collected from each of the newly installed monitoring wells and existing monitoring wells (total of nine groundwater samples). Prior to sampling, each monitoring well will be gauged and purged until groundwater quality parameters such as temperature, dissolved oxygen, oxidation-reduction potential, pH and turbidity stabilize. Samples will then be collected using a peristaltic pump and dedicated tubing in accordance with low-flow sampling procedures. The pump will be decontaminated with Alconox® and water between each monitoring well.

Groundwater samples will be containerized in pre-cleaned laboratory-supplied glassware, stored in a chilled cooler (4°C), and submitted to a New York State Department of Health certified laboratory.

The groundwater samples will be analyzed for:

- Target Compound List (TCL) volatile organic compounds (VOCs) via Environmental Protection Agency (EPA) Method 8260C
- TCL semi-volatile organic compounds (SVOCs) via EPA Method 8270D
- Total analyte list (TAL) metals (filtered and unfiltered) via EPA Method 6010D/7470
- Polychlorinated biphenyls (PCBs) via EPA Method 8082A
- TLC pesticides via EPA Method 8081B
- NYSDEC list per and polyfluoroalkyl substances (PFAS) via EPA Method 1633 (40 compounds):
    - 11CL-PF3OUdS, 1H,1H,2H,2H-Perfluorodecanesulfonic acid (8:2 FTS), 1H,1H,2H,2H-Perfluorohexanesulfonic acid (4:2 FTS), 1H,1H,2H,2H-Perfluorooctanesulfonic acid (6:2 FTS), 3-Perfluoroheptyl propanoic acid (FHpPA), 3-Perfluoropentyl propanoic acid (FPePA) , 3-Perfluoropropyl propanoic acid (FPrPA), 9CL-PF3ONS, ADONA, HFPO-DA (Gen-X), N-EtFOSA, N-EtFOSAA, N-EtFOSE, N-MeFOSA, N-MeFOSAA, N-MeFOSE, Perfluoro(2-ethoxyethane)sulfonic acid (PFEESA), Perfluoro-1-decanesulfonic acid (PFDS), Perfluoro-1-heptanesulfonic acid (PFHpS), Perfluoro-1-nonanesulfonic acid (PFNS), Perfluoro-1-octanesulfonamide (FOSA), Perfluoro-1-pentanesulfonate (PFPeS), Perfluoro-3,6-dioxaheptanoic acid (NFDHA), Perfluoro-4-oxapentanoic acid (PFMPA), Perfluoro-5-oxahexanoic acid (PFMBA), Perfluorobutanesulfonic acid (PFBS), Perfluorodecanoic acid (PFDA), Perfluorododecanesulfonic acid (PFDoS), Perfluorododecanoic acid (PFDoA), Perfluoroheptanoic acid (PFHpA), Perfluorohexanesulfonic acid (PFHxS), Perfluorohexanoic acid (PFHxA), Perfluoro-n-butanoic acid (PFBA), Perfluorononanoic acid (PFNA), Perfluorooctanesulfonic acid (PFOS), Perfluorooctanoic acid (PFOA), Perfluoropentanoic acid (PFPeA), Perfluorotetradecanoic acid (PFTA), Perfluorotridecanoic acid (PFTrDA), and Perfluoroundecanoic acid (PFUnA).

- 1,4-dioxane via EPA Method 8270D SIM.

Laboratory reporting limits for PFOA and PFOS via EPA Method 1633 should not exceed 0.002 ug/L. Laboratory reporting limits for 1,4-dioxane via EPA Method 8270 SIM should not exceed 0.35 ug/L. Table 1 provides a sampling matrix, and Figure 2 shows the proposed monitoring well locations.

3.3 Soil Vapor and Ambient Air Sampling

Five (5) soil vapor points (25SV-1 through 25SV-5) will be installed using the same direct-push drill rig mentioned above. Soil vapor points will be installed and sampled in accordance with the Final Guidance for Evaluating Soil Vapor Intrusion in the State of New York (October 2006). Soil vapor points will be installed at approximately 12 feet below grade surface. If groundwater is encountered during the RI, soil vapor points will be installed 2 feet above the water table. Sample points will be constructed of a dedicated stainless-steel screen fitted with ¼-inch outer diameter inert polyethylene, teflon lined, tubing which will be extended above ground surface to allow for purging and sampling. The points will be backfilled using glass beads followed by environmental grade silica sand and topped with a bentonite layer to seal the tubing in the hole.

Prior to testing, a tracer gas will be used in accordance with NYSDOH protocols to serve as a quality assurance/quality control (QA/QC) technique to verify the integrity of the soil vapor point seal. The integrity of vapor points will be tested by placing a plastic shroud over the vapor points to isolate them from ambient air. Then, a helium tracer gas will be applied into the shroud and will be screened utilizing a helium detector for presence of helium. If no helium is detected in any of the vapor points, then sampling will occur. If helium is detected, then the points will be resealed properly prior to sampling.

After purging approximately three volumes of air from each vapor point at a flow rate less than 200 milliliters per minute, representative samples will be collected for laboratory analysis utilizing 6-liter SUMMA canisters fitted with 8-hour flow controllers set not to exceed 0.2 liters per minute, as established by the NYSDOH Guidance document. Upon completion of the vapor sampling, all canisters will be labeled properly with the sample ID numbers, and vacuum pressure readings in the canisters before and after the sample collection. The vapor samples will then be submitted to a NYSDOH ELAP-certified laboratory under proper chain of custody procedures to be analyzed for VOCs by EPA Method TO-15.

The QA/QC sample for soil vapor will include one blind duplicate sample from one of the five installed soil vapor points. The sample will be determined by Site logistics. One ambient air sample will be collected at a breathing height as a background sample. The outdoor air sample will be collected over an 8-hour sampling period concurrently with the soil vapor samples and analyzed for VOCs via EPA Method TO-15.

Table 1 provides a sampling matrix, and Figure 3 shows the proposed soil vapor locations.

3.4 PFAS Sampling Procedures

- PFAS samples will be collected first in order to prevent cross-contamination since sample containers for other methods may have PFAS present on the containers.
- Nitrile gloves will be using during sampling.
- No food or drink will be present during PFAS sampling.
- No waterproof field notebooks, plastic clipboards, sharpies, or adhesives will be used.
- PFAS samples will be kept in a separate cooler away from other sampling containers that may contain PFAS.
- Coolers will be filled with regular ice only.
- Only Alconox will be used for decontamination.
- Sampler will not wear clothing washed with fabric softener or containing Tyvek or PVC.
- Sampler will not use cosmetics, moisturizer, hand cream or other similar products on the day of the sampling.
- Sampler will not wear sunscreen or insect repellants.

Attachment 1 provides a copy of the NYSDEC Guidance document for sampling and analysis, and assessment of PFAS under NYSDEC's Part 375 Remedial Programs.

Attachment 2 provides a copy of York Analytical Laboratories' Standard Operating Procedure Summary for PFAS in Groundwater, Surface Water, and Soils.

Attachment 3 provides a copy of York Analytical Laboratories' PFOS/PFOA Certification and Reporting Limits for PFAS.

Attachment 4 provides a copy of blank chain of custody samples.

3.5 Quality Assurance (QA)/ Quality Control (QC) Sampling

The accuracy, precision and completeness of the samples will be addressed by the certified laboratory for all data generated. The QA/QC sample for soil vapor will include one blind duplicate sample from one of the five installed soil vapor points. The sample will be determined by Site logistics. One outdoor ambient air sample will be collected and submitted to the laboratory for analysis of the same parameters. It is assumed that all soil vapor samples will be collected in one day. The accuracy, precision and completeness of the samples will be addressed by the certified laboratory for all data generated. One blind duplicate sample and one matrix spike/matrix spike duplicate (MS/MSD) sample will be collected for every 20 samples of soil and for every 20 samples of groundwater and submitted to the laboratory for analysis of the same parameters. One field blank per sampling media will be collected and analyzed for the same parameters as the respective media. It is assumed that all soil and soil vapor samples will be collected in one day, and all groundwater samples will be collected on another day. Trip blanks will be included in each cooler whenever samples are collected and transported to the laboratory for analysis of VOCs.

3.5.1 Trip Blanks

A trip blank consisting of two 40-ml vials filled with distilled, deionized water, will be provided by the laboratory. Trip blanks will be included in each cooler and will be analyzed for VOCs.

3.5.2 Field Blanks

Field blanks will be collected at a rate of one per 20 per soil and groundwater samples. Field blanks will be analyzed for the same analysis as the soil and groundwater samples collected on the day of the sampling.

3.5.3 PFAS Field Blank

A PFAS field blank will be prepared on each day that PFAS sampling occurs. Laboratory will provide PFAS blank bottles as well as pre-filled PFAS field blank water container. The contents of the PFAS field blank water container will be transferred into the PFAS field blank bottle. Both bottles will be returned to the laboratory along with the PFAS samples that were collected.

3.5.4 Blind Duplicate

A blind duplicate sample will be collected at a rate of one per 20 soil and groundwater samples. Blink duplicates will be analyzed for the same analysis as the soil and groundwater samples collected on the day of the sampling.

3.5.5 Matrix Spike/Matrix Spike Duplicate (MS/MSD)

MS/MSD samples will be collected at a rate of one per 20 soil and groundwater samples. MS/MSD samples will be analyzed for the same analysis as the soil and groundwater samples collected on the day of the sampling.

Table 2 provides laboratory analytical methods, glassware, and holding times for each analysis.

3.6 Field Instrumentation

The field instruments to be used during the remedial investigation will be calibrated at the beginning of each day as per the manufacturers' specifications. Calibration records will be recorded in the field book.

4.0 DECONTAMINATION

All sampling equipment will be decontaminated between sampling locations unless they are dedicated disposable tools. Decontamination of non-dedicated sampling equipment will consist of the following procedure:

- Gently tap or scrape to remove adhered soil
- Rinse with tap water
- Wash with Alconox detergent solution and scrub
- Rinse with tap water
- Rinse with distilled or deionized water

Drilling equipment will be decontaminated between sample locations. All spoons, if not disposable, will be decontaminated between sampling locations and between different sampling depths at the same location.

4.1 PFAS Sampling

All sampling equipment used during the collection of PFAS will be decontaminated between sampling locations unless they are dedicated disposable tools. Decontamination of non-dedicated sampling equipment for PFAS sampling will consist of the following procedure:

- Gently tap or scape to remove adhere soil (for soil sampling)
- Rinse with laboratory certified “PFAS-free” water for equipment decontamination
- Use of only Alconox or Liquinox soap for decontamination
- Rinse with laboratory certified “PFAS-free” water

Sampling equipment utilized during PFAS sampling will be decontaminated before and after each sampling location.

4.2 Investigation Derived Waste

As per the DER-10, soil cuttings from a depth below the fill layer and other soil generated on-site during remedial investigation will be returned to the borehole, unless:

- Free product, NAPL, or grossly contaminated soil, are present in the cuttings,
- The boreholes will be used for installation of a monitoring well,
- The borehole has an aquitard, or other confining layer,
- Backfilling the borehole with cuttings will create a significant path for vertical movement of contaminant
- Soil cannot fit into the borehole

Those soil cuttings needing to be managed on-site will be containerized in properly labeled Department of Transportation (DOT) approved 55-gallon drums for future off-site disposal at a permitted facility. All boreholes which require soil cuttings disposal would ultimately be filled with hydrated bentonite chips and asphalt/concrete capping.

Groundwater purged from the monitoring wells during development and sampling will be placed into DOT approved 55-gallon drums for future off-site disposal.

TABLES

Table 1
Sampling Rationale and Summary
38-18 33rd Street and 32-20 38th Avenue, Queens, NY
Former Refron Inc. Gas Reclamation Site

Sample Matrix	Sample ID	Sample Interval (feet below surface grade)	Rationale	Estimated Number of Samples	Analysis
SOIL	25SB-1 (Depth)	0'-2' (historic fill)	To assess the extent of historic fill and overall soil quality beneath the Site	1	Target Compound List (TCL) volatile organic compounds (VOCs), TCL semivolatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs), Pesticides, Total Analyte List (TAL) Metals, hexavalent chromium, trivalent chromium, per- and poly-fluoroalkyl substances (PFAS), and 1,4-dioxane
	25SB-1 (Depth)	Collected from immediately below the historic fill layer		1	
	25SB-1 (Depth)	Collected from immediately above the groundwater table		1	
	25SB-2 (Depth)	0'-2' (historic fill)		1	
	25SB-2 (Depth)	Collected from immediately below the historic fill layer		1	
	25SB-2 (Depth)	Collected from immediately above the groundwater table		1	
	25SB-3 (Depth)	0'-2' (historic fill)		1	
	25SB-3 (Depth)	Collected from immediately below the historic fill layer		1	
	25SB-3 (Depth)	Collected from immediately above the groundwater table		1	
	25SB-4 (Depth)	0'-2' (historic fill)		1	
	25SB-4 (Depth)	Collected from immediately below the historic fill layer		1	
	25SB-4 (Depth)	Collected from immediately above the groundwater table		1	
	25SB-5 (Depth)	0'-2' (historic fill)		1	
	25SB-5 (Depth)	Collected from immediately below the historic fill layer		1	
	25SB-5 (Depth)	Collected from immediately above the groundwater table		1	
	25SB-6 (Depth)	0'-2' (historic fill)		1	
	25SB-6 (Depth)	Collected from immediately below the historic fill layer		1	
	25SB-6 (Depth)	Collected from immediately above the groundwater table		1	
	25SB-7 (Depth)	0'-2' (historic fill)		1	
	25SB-7 (Depth)	Collected from immediately below the historic fill layer		1	
	25SB-7 (Depth)	Collected from immediately above the groundwater table		1	
	25SB-8 (Depth)	0'-2' (historic fill)		1	
	25SB-8 (Depth)	Collected from immediately below the historic fill layer		1	
	25SB-8 (Depth)	Collected from immediately above the groundwater table		1	
	25SB-9 (Depth)	0'-2' (historic fill)		1	
	25SB-9 (Depth)	Collected from immediately below the historic fill layer		1	
	25SB-9 (Depth)	Collected from immediately above the groundwater table		1	
	25SB-10 (Depth)	0'-2' (historic fill)		1	
	25SB-10 (Depth)	Collected from immediately below the historic fill layer		1	
	25SB-10 (Depth)	Collected from immediately above the groundwater table		1	
	25SB-11 (Depth)	0'-2' (historic fill)		1	
	25SB-11 (Depth)	Collected from immediately below the historic fill layer		1	
	25SB-11 (Depth)	Collected from immediately above the groundwater table		1	
	25SB-12 (Depth)	0'-2' (historic fill)		1	
	25SB-12 (Depth)	Collected from immediately below the historic fill layer		1	
	25SB-12 (Depth)	Collected from immediately above the groundwater table		1	
	25SB-13 (Depth)	0'-2' (historic fill)		1	
	25SB-13 (Depth)	Collected from immediately below the historic fill layer		1	
	25SB-13 (Depth)	Collected from immediately above the groundwater table		1	
	25SB-14 (Depth)	0'-2' (historic fill)		1	
	25SB-14 (Depth)	Collected from immediately below the historic fill layer		1	
	25SB-14 (Depth)	Collected from immediately above the groundwater table		1	
	25SB-15 (Depth)	0'-2' (historic fill)		1	
	25SB-15 (Depth)	Collected from immediately below the historic fill layer		1	
	25SB-15 (Depth)	Collected from immediately above the groundwater table		1	
	25-SB-DUP (Depth)	Field Duplicate	QA/QC	2	
	25-SB-X-MS/MSD	Matrix Spike / Matrix Spike Duplicate	QA/QC	2	
	FB-X	Field Blank	QA/QC	3	
	TB-X	Trip Blank	QA/QC	3	TCL VOCs
			Total Quantity	55	

* Additional soil samples may be collected based on field conditions (i.e: elevated PID readings, odor, sheen, etc.)

Table 1
Sampling Rationale and Summary
38-18 33rd Street and 32-20 38th Avenue, Queens, NY
Former Refron Inc. Gas Reclamation Site

Sample Matrix	Sample ID	Sample Interval (feet below surface grade)	Rationale	Estimated Number of Samples	Analysis
GROUNDWATER	MW-1	10'-20' below grade	To assess groundwater quality beneath the Site	1	TCL VOCs, TCL SVOCs, PCBs, Pesticides, TAL Metals (filtered and unfiltered), hexavalent chromium, trivalent chromium, PFAS, and 1,4-dioxane
	MW-1I	15-25' below grade		1	
	MW-1D	25-35' below grade		1	
	MW-2	10'-20' below grade		1	
	MW-3	10'-20' below grade		1	
	MW-4	10'-20' below grade		1	
	MW-5	10'-20' below grade		1	
	MW-6	10'-20' below grade		1	
	MW-7	10'-20' below grade		1	
	MW-DUP-1	Blind Duplicate: One per 20 groundwater samples	QA/QC	1	
	MW-MS/MSD-1	One per 20 groundwater samples	QA/QC	1	
	FB-1	Field Blank	QA/QC	1	
	TB-1	Trip Blank: 1 per cooler per day (Lab-prepared)	QA/QC	1	TCL VOCs
			Total Quantity	13	

Table 1
Sampling Rationale and Summary
38-18 33rd Street and 32-20 38th Avenue, Queens, NY
Former Refron Inc. Gas Reclamation Site

Sample Matrix	Sample ID	Sample Interval (feet below surface grade)	Rationale	Estimated Number of Samples	Analysis
SOIL VAPOR	25SV-1	12 feet	To further evaluate soil vapor conditions beneath the Site	1	VOCs (TO-15)
	25SV-2	12 feet		1	
	25SV-3	12 feet		1	
	25SV-4	12 feet		1	
	25SV-5	12 feet		1	
	25OA-1	Background (Outdoor) Sample	QA/QC	1	
	25SV-DUP*	TBD	QA/QC	1	
	Total Quantity			7	

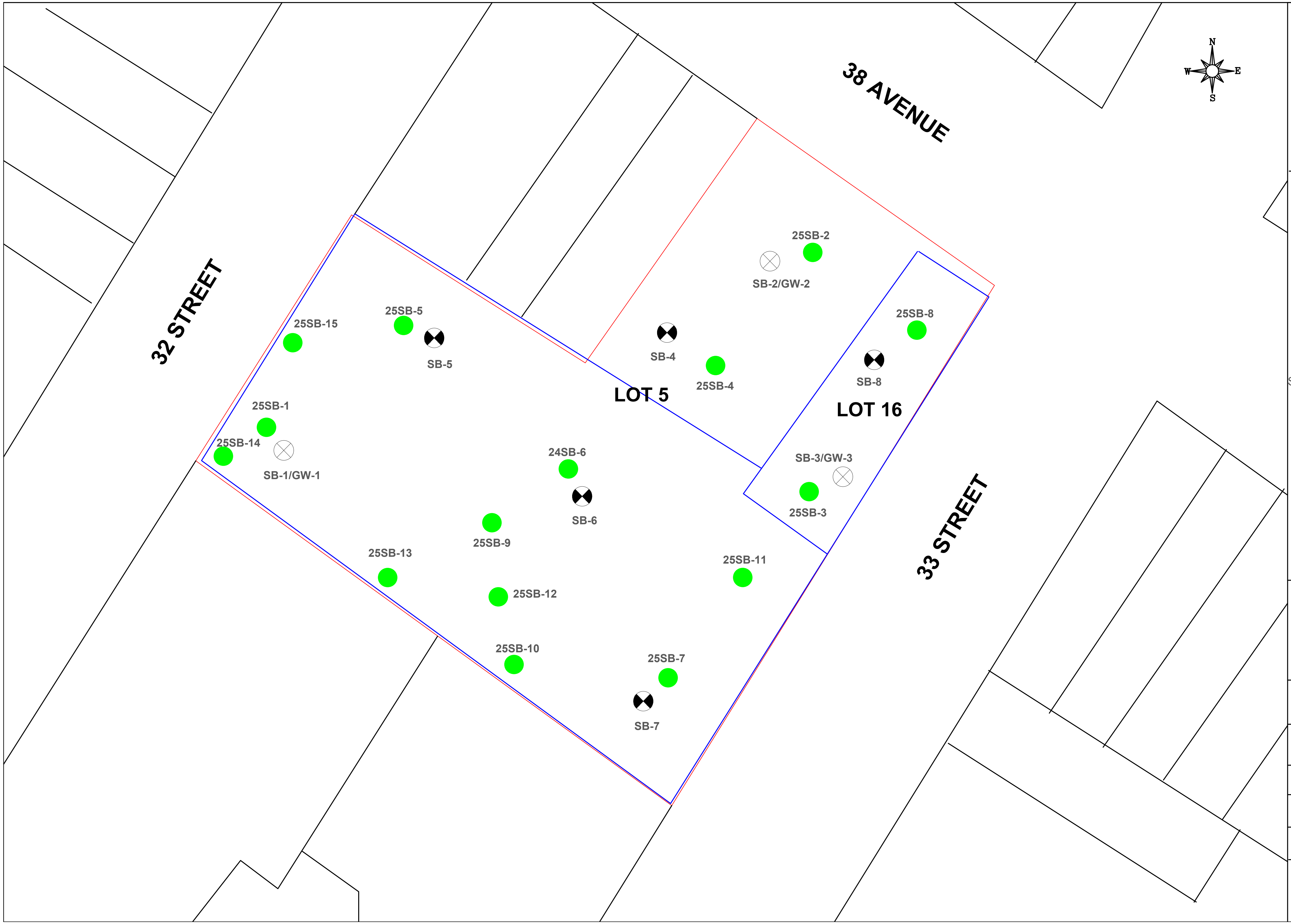
* A blind duplicate sample (24SV-X) will be collected at **one of the soil vapor locations** (determined by Site Logistics)

Table 2
Preservation and Holding Times

Sample Matrix	Analysis	Container	Preservation	Holding Time
Soil and Soil QA/QC Samples	VOCs	Glass, Four 40-ml vials with teflon-lined cap: 2 VOA vials with 5-ml H_2O, 1 VOA vial with MeOH, and 1 blank vial or 5-g Encore samplers	Cool, 4°C	14 days
	SVOCs	Glass, 8-oz teflon-line cap	Cool, 4°C	14 days to extract, 40 days after extraction to analyze
	PCBs & Pesticides	Glass, 100-g tefloned-lined cap	Cool, 4°C	14 days to extract, 40 days after extraction to analyze
	Metals	Glass, 2-oz teflon-lined cap	Cool, 4°C	6 months (except for mercury 28 days)
	Chromium Hexavalent	Glass, 2-oz teflon-lined cap	Cool, 4°C	28 days
	PFAS	8-oz HDPE bottles	Cool, 4°C	28 days
	1,4-Dioxane	Glass, Four 40-ml vials with teflon-lined cap: 2 VOA vials with 5-ml H2O, 1 VOA vial with MeOH, and 1 blank vial or 5-g Encore samplers	Cool, 4°C	14 days
Groundwater and Groundwater QA/QC Samples	VOCs	Glass, three 40-mil vials with teflon-lined septum cap	HCl pH<2, no headspace, Cool, 4°C	14 days
	SVOCs	Glass, 1 liter with teflon-lined cap	Cool, 4°C	7 days to extract, 40 days after extraction to analyze
	PCBs &Pesticides	Glass, 1 liter with teflon-lined cap	Cool, 4°C	7 days to extract, 40 days after extraction to analyze
	Metals	Plastic, 250-ml	HNO_3 to pH<2, Cool, 4°C	6 months (except for mercury 28 days)
	Chromium Hexavalent	Plastic, 250-ml	Cool, 4°C	24 hours
	PFAS	250-ml HDPE bottles	Cool, 4°C	14 days
	1,4-Dioxane	Glass, 1 liter with teflon-lined cap	Cool, 4°C	7 days
Soil Vapor and Soil Vapor QA/QC Samples	VOCs	Summa Canister	None	30 days

FIGURE 1

PROPOSED SOIL SAMPLING PLAN



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Legend:

🟥 Property Boundary

🟦 Building Boundary

⨂ SB-X Prior Soil Boring Location and Designated ID (July 2024)

⊗ SB-X/GW-X Prior Soil Boring/Groundwater Sample Location and Designated ID (July 2024)

🟢 25SB-X Proposed Soil Sample Location

Notes:

1. All feature locations are approximate

Scale:

0 30

Figure No. 1

Figure Name: Proposed Soil Sampling Plan

Report: RIWP-QAPP

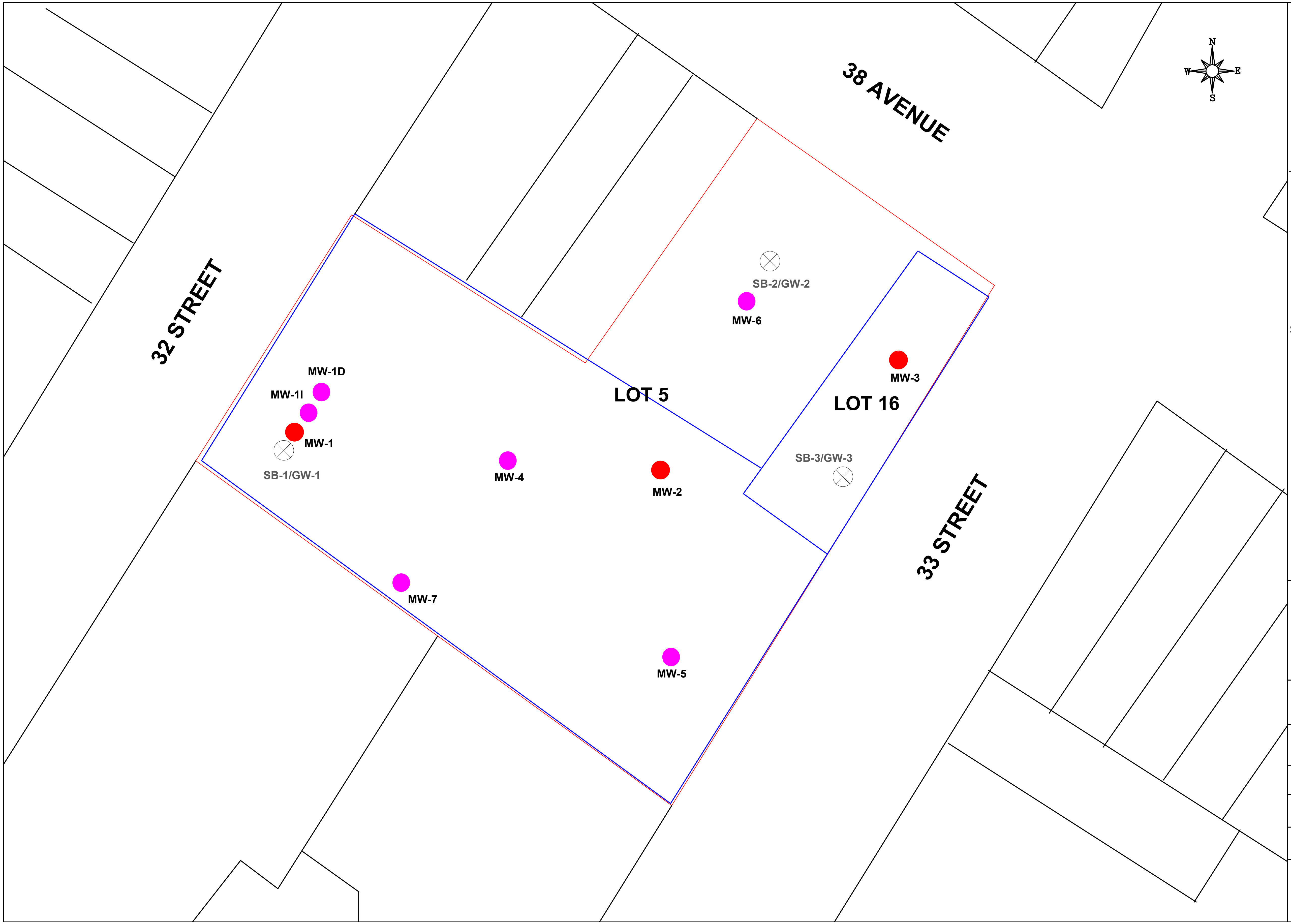
Date: 9/20/2024

Drawn By: EK

Site Address: 32-20 38TH AVENUE &
38-18 33RD STREET
QUEENS, NEW YORK

FIGURE 2

PROPOSED GROUNDWATER SAMPLING PLAN



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Legend:

□ Property Boundary

□ Building Boundary

⊗ SB-X/GW-X Prior Soil Boring/Groundwater Sample Location and Designated ID (July 2024)

● MW-X Monitoring Well Location and Designated ID (August 2024 and Proposed for Resample)

● MW-X Monitoring Well Location and Designated ID

Notes:

1. All feature locations are approximate

Scale:

0 30

Figure No. 2

Figure Name: Proposed Groundwater Sampling Plan

Report: RIWP-QAPP

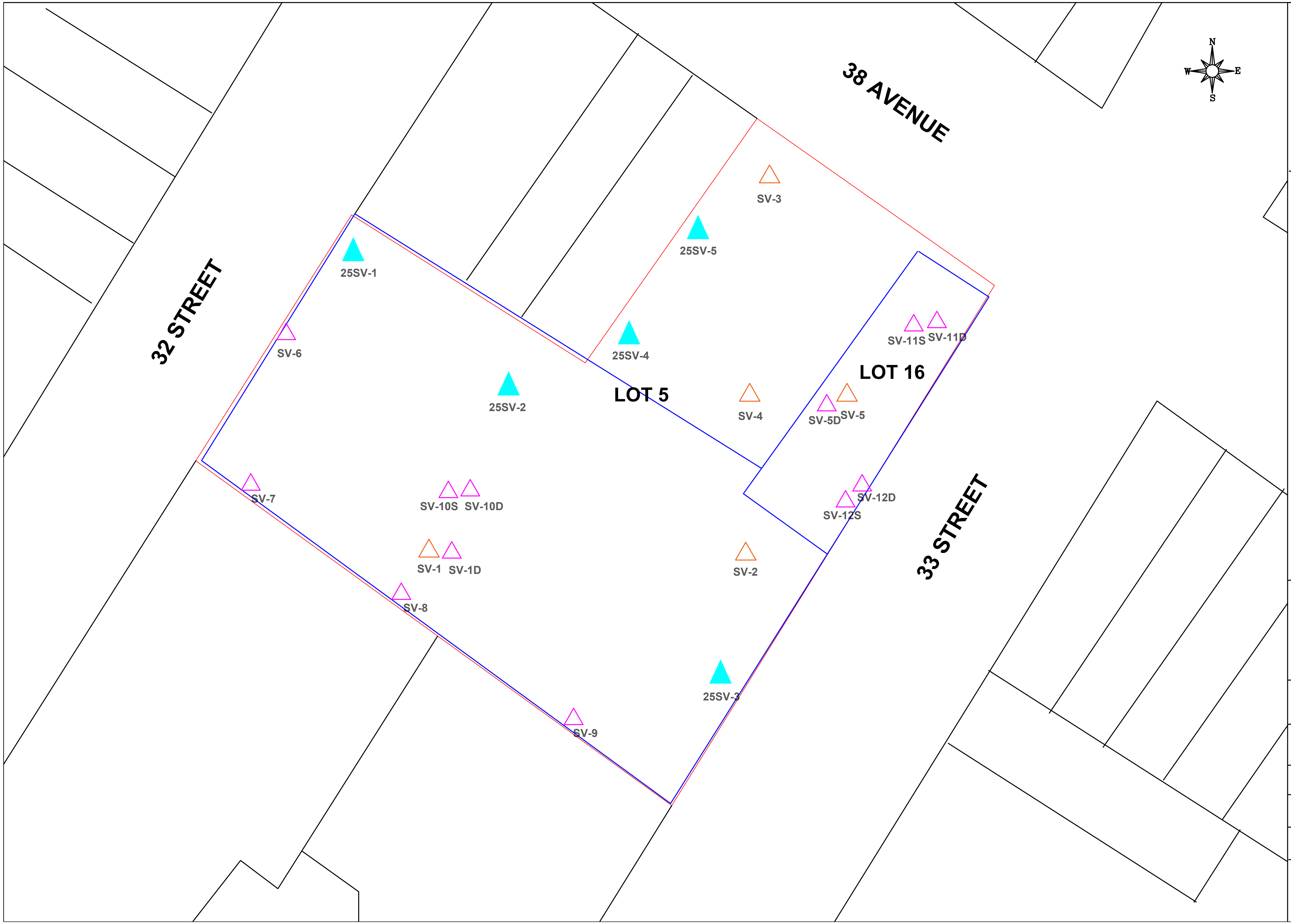
Date: 9/20/2024

Drawn By: EK

Site Address:
32-20 38TH AVENUE &
38-18 33RD STREET
QUEENS, NEW YORK

FIGURE 3

PROPOSED SOIL VAPOR SAMPLING PLAN



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Legend:

▭ Property Boundary

▭ Building Boundary

△ SV-X Prior Soil Vapor Point Location and Designated ID (July 2024 - To Be Validated)

△ SV-X Prior Soil Vapor Point Location and Designated ID (August 2024 - To Be Validated)

▲ 25SV-X Proposed Soil Vapor Point Location and Designated ID

Notes:

1. All feature locations are approximate

Scale:

0 30

Figure No.	3
Figure Name:	Proposed Soil Vapor Sampling Plan
Report:	RIWP-QAPP
Date:	9/20/2024
Drawn By:	EK
Site Address:	32-20 38TH AVENUE & 38-18 33RD STREET QUEENS, NEW YORK

ATTACHMENTS

ATTACHMENT 1

NYSDEC GUIDANCE FOR PFAS SAMPLING

NEW YORK
STATE OF
OPPORTUNITY.

Department of
Environmental
Conservation

SAMPLING, ANALYSIS, AND ASSESSMENT OF PER- AND POLYFLUOROALKYL SUBSTANCES (PFAS)

Under NYSDEC's Part 375 Remedial Programs

April 2023

www.dec.ny.gov

Table of Contents

April 2023

ERRATA SHEET for

SAMPLING, ANALYSIS, AND ASSESSMENT OF PER- AND POLYFLUOROALKYL SUBSTANCES (PFAS) Under NYSDEC's Part 375 Remedial Programs Issued January 17, 2020

Citation and Page Number	Current Text	Corrected Text	Date
Title of Appendix I, page 32	Appendix H	Appendix I	2/25/2020
Document Cover, page 1	Guidelines for Sampling and Analysis of PFAS	Sampling, Analysis, and Assessment of Per- and Polyfluoroalkyl Substances (PFAS) Under NYSDEC's Part 375 Remedial Programs	9/15/2020
Data Assessment and Application to Site Cleanup Page 3	Until such time as Ambient Water Quality Standards (AWQS) and Soil Cleanup Objectives (SCOs) for PFOA and PFOS are published	Until such time as Soil Cleanup Objectives (SCOs) for PFOA and PFOS are published	3/28/2023
Water Sample Results Page 3	PFOA and PFOS should be further assessed and considered as potential contaminants of concern in groundwater or surface water if PFOA or PFOS is detected in any water sample at or above 10 ng/L (ppt) and is determined to be attributable to the site, either by a comparison of upgradient and downgradient levels, or the presence of soil source areas, as defined below.	NYSDEC has adopted ambient water quality guidance values for PFOA and PFOS. Groundwater samples should be compared to the human health criteria of 6.7 ng/l (ppt) for PFOA and 2.7 ng/l (ppt) for PFOS. These guidance values also include criteria for surface water for PFOS applicable for aquatic life, which may be applicable at some sites. Drinking water sample results should be compared to the NYS maximum contaminant level (MCL) of 10 ng/l (ppt).Analysis to determine if PFOA and PFOS concentrations are attributable to the site should include a comparison between upgradient and downgradient levels, and the presence of soil source areas, as defined below.	3/28/2023
Soil Sample Results Page 3	Soil cleanup objectives for PFOA and PFOS have been proposed in an upcoming revision to 6 NYCRR Part 375-6. Until SCOs are in effect, the following are to be used as guidance values:	NYSDEC will delay adding soil cleanup objectives for PFOA and PFOS to 6 NYCRR Part 375-6 until the PFAS rural soil background study has been completed. Until SCOs are in effect, the following are to be used as guidance values:	3/28/2023
Protection of Groundwater Page 3	PFOA (ppb) 1.1 PFOS (ppb) 3.7	PFOA (ppb) 0.8 PFOS (ppb) 1.0	3/28/2023

Citation and Page Number	Current Text	Corrected Text	Date
Footnote 2 Page 3	The movement of PFAS in the environment is being aggressively researched at this time; that research will eventually result in more accurate models for the behaviors of these chemicals. In the meantime, DEC has calculated the guidance value for the protection of groundwater using the same procedure used for all other chemicals, as described in Section 7.7 of the Technical Support Document (http://www.dec.ny.gov/docs/remediation_hudson_pdf/techsuppdoc.pdf).	The Protection of Groundwater values are based on the above referenced ambient groundwater guidance values. Details on that calculation are available in the following document, prepared for the February 2022 proposed changes to Part 375 (https://www.dec.ny.gov/docs/remediation_hudson_pdf/part375techsupport.pdf). The movement of PFAS in the environment is being aggressively researched at this time; that research will eventually result in more accurate models for the behaviors of these chemicals. In the meantime, DEC has calculated the guidance value for the protection of groundwater using the same procedure used for all other chemicals, as described in Section 7.7 of the Technical Support Document (http://www.dec.ny.gov/docs/remediation_hudson_pdf/techsuppdoc.pdf).	3/28/2023
Testing for Imported Soil Page 4	If the concentrations of PFOA and PFOS in leachate are at or above 10 ppt (the Maximum Contaminant Levels established for drinking water by the New York State Department of Health), then the soil is not acceptable.	If the concentrations of PFOA and PFOS in leachate are at or above the ambient water quality guidance values for groundwater, then the soil is not acceptable.	3/28/2023
Routine Analysis, page 9	“However, laboratories analyzing environmental samples…PFOA and PFOS in drinking water by EPA Method 537, 537.1 or ISO 25101.”	“However, laboratories analyzing environmental samples…PFOA and PFOS in drinking water by EPA Method 537, 537.1, ISO 25101, or Method 533.”	9/15/2020
Additional Analysis, page 9, new paragraph regarding soil parameters	None	“In cases where site-specific cleanup objectives for PFOA and PFOS are to be assessed, soil parameters, such as Total Organic Carbon (EPA Method 9060), soil pH (EPA Method 9045), clay content (percent), and cation exchange capacity (EPA Method 9081), should be included in the analysis to help evaluate factors affecting the leachability of PFAS in site soils.”	9/15/2020

Citation and Page Number	Current Text	Corrected Text	Date
Data Assessment and Application to Site Cleanup Page 10	Until such time as Ambient Water Quality Standards (AWQS) and Soil Cleanup Objectives (SCOs) for PFAS are published, the extent of contaminated media potentially subject to remediation should be determined on a case-by-case basis using the procedures discussed below and the criteria in DER-10. Target levels for cleanup of PFAS in other media, including biota and sediment, have not yet been established by the DEC.	Until such time as Ambient Water Quality Standards (AWQS) and Soil Cleanup Objectives (SCOs) for PFOA and PFOS are published, the extent of contaminated media potentially subject to remediation should be determined on a case-by-case basis using the procedures discussed below and the criteria in DER-10. Preliminary target levels for cleanup of PFOA and PFOS in other media, including biota and sediment, have not yet been established by the DEC.	9/15/2020
Water Sample Results Page 10	PFAS should be further assessed and considered as a potential contaminant of concern in groundwater or surface water (…) If PFAS are identified as a contaminant of concern for a site, they should be assessed as part of the remedy selection process in accordance with Part 375 and DER-10.	PFOA and PFOS should be further assessed and considered as potential contaminants of concern in groundwater or surface water (…) If PFOA and/or PFOS are identified as contaminants of concern for a site, they should be assessed as part of the remedy selection process in accordance with Part 375 and DER-10.	9/15/2020

Citation and Page Number	Current Text	Corrected Text	Date
Soil Sample Results, page 10	"The extent of soil contamination for purposes of delineation and remedy selection should be determined by having certain soil samples tested by Synthetic Precipitation Leaching Procedure (SPLP) and the leachate analyzed for PFAS. Soil exhibiting SPLP results above 70 ppt for either PFOA or PFOS (individually or combined) are to be evaluated during the cleanup phase."	"Soil cleanup objectives for PFOA and PFOS will be proposed in an upcoming revision to 6 NYCRR Part 375-6. Until SCOs are in effect, the following are to be used as guidance values. " [Interim SCO Table] "PFOA and PFOS results for soil are to be compared against the guidance values listed above. These guidance values are to be used in determining whether PFOA and PFOS are contaminants of concern for the site and for determining remedial action objectives and cleanup requirements. Site-specific remedial objectives for protection of groundwater can also be presented for evaluation by DEC. Development of site-specific remedial objectives for protection of groundwater will require analysis of additional soil parameters relating to leachability. These additional analyses can include any or all the parameters listed above (soil pH, cation exchange capacity, etc.) and/or use of SPLP. As the understanding of PFAS transport improves, DEC welcomes proposals for site-specific remedial objectives for protection of groundwater. DEC will expect that those may be dependent on additional factors including soil pH, aqueous pH, % organic carbon, % Sand/Silt/Clay, soil cations: K, Ca, Mg, Na, Fe, Al, cation exchange capacity, and anion exchange capacity. Site-specific remedial objectives should also consider the dilution attenuation factor (DAF). The NJDEP publication on DAF can be used as a reference: https://www.nj.gov/dep/srp/guidance/rs/daf.pdf. "	9/15/2020

Citation and Page Number	Current Text	Corrected Text	Date
Testing for Imported Soil Page 11	Soil imported to a site for use in a soil cap, soil cover, or as backfill is to be tested for PFAS in general conformance with DER-10, Section 5.4(e) for the PFAS Analyte List (Appendix F) using the analytical procedures discussed below and the criteria in DER-10 associated with SVOCs. If PFOA or PFOS is detected in any sample at or above 1 µg/kg, then soil should be tested by SPLP and the leachate analyzed for PFAS. If the SPLP results exceed 10 ppt for either PFOA or PFOS (individually) then the source of backfill should be rejected, unless a site-specific exemption is provided by DER. SPLP leachate criteria is based on the Maximum Contaminant Levels proposed for drinking water by New York State's Department of Health, this value may be updated based on future Federal or State promulgated regulatory standards. Remedial parties have the option of analyzing samples concurrently for both PFAS in soil and in the SPLP leachate to minimize project delays. Category B deliverables should be submitted for backfill samples, though a DUSR is not required.	Testing for PFAS should be included any time a full TAL/TCL analyte list is required. Results for PFOA and PFOS should be compared to the applicable guidance values. If PFOA or PFOS is detected in any sample at or above the guidance values then the source of backfill should be rejected, unless a site-specific exemption is provided by DER based on SPLP testing, for example. If the concentrations of PFOA and PFOS in leachate are at or above 10 ppt (the Maximum Contaminant Levels established for drinking water by the New York State Department of Health), then the soil is not acceptable. PFOA, PFOS and 1,4-dioxane are all considered semi-volatile compounds, so composite samples are appropriate for these compounds when sampling in accordance with DER-10, Table 5.4(e)10. Category B deliverables should be submitted for backfill samples, though a DUSR is not required.	9/15/2020

Citation and Page Number	Current Text	Corrected Text	Date
Footnotes	None	[1] TOP Assay analysis of highly contaminated samples, such as those from an AFFF (aqueous film-forming foam) site, can result in incomplete oxidation of the samples and an underestimation of the total perfluoroalkyl substances. [2] The movement of PFAS in the environment is being aggressively researched at this time; that research will eventually result in more accurate models for the behaviors of these chemicals. In the meantime, DEC has calculated the soil cleanup objective for the protection of groundwater using the same procedure used for all other chemicals, as described in Section 7.7 of the Technical Support Document (http://www.dec.ny.gov/docs/remediation_hudson_pdf/techsuppdoc.pdf).	9/15/2020
Additional Analysis, page 9	In cases… soil parameters, such as Total Organic Carbon (EPA Method 9060), soil…	In cases… soil parameters, such as Total Organic Carbon (Lloyd Kahn), soil…	1/8/2021
Appendix A, General Guidelines, fourth bullet	List the ELAP-approved lab(s) to be used for analysis of samples	List the ELAP- certified lab(s) to be used for analysis of samples	1/8/2021
Appendix E, Laboratory Analysis and Containers	Drinking water samples collected using this protocol are intended to be analyzed for PFAS by ISO Method 25101.	Drinking water samples collected using this protocol are intended to be analyzed for PFAS by EPA Method 537, 537.1, 533, or ISO Method 25101	1/8/2021
Water Sample Results Page 9	"In addition, further assessment of water may be warranted if either of the following screening levels are met: a. any other individual PFAS (not PFOA or PFOS) is detected in water at or above 100 ng/L; or b. total concentration of PFAS (including PFOA and PFOS) is detected in water at or above 500 ng/L"	Deleted	6/15/2021

Citation and Page Number	Current Text	Corrected Text	Date
Routine Analysis, Page XX	Currently, New York State Department of Health's Environmental Laboratory Approval Program (ELAP)… criteria set forth in the DER's laboratory guidelines for PFAS in non-potable water and solids (Appendix H - Laboratory Guidelines for Analysis of PFAS in Non-Potable Water and Solids).	Deleted	5/31/2022
Analysis and Reporting, Page XX	As of October 2020, the United States Environmental Protection Agency (EPA) does not have a validated method for analysis of PFAS for media commonly analyzed under DER remedial programs (non-potable waters, solids). DER has developed the following guidelines to ensure consistency in analysis and reporting of PFAS.	Deleted	5/31/2022
Routine Analysis, Page XX	LC-MS/MS analysis for PFAS using methodologies based on EPA Method 537.1 is the procedure to use for environmental samples. Isotope dilution techniques should be utilized for the analysis of PFAS in all media.	EPA Method 1633 is the procedure to use for environmental samples.	
Soil Sample Results, Page XX	Soil cleanup objectives for PFOA and PFOS will be proposed in an upcoming revision to 6 NYCRR Part 375-6	Soil cleanup objectives for PFOA and PFOS have been proposed in an upcoming revision to 6 NYCRR Part 375-6	
Appendix A	"Include in the text… LC-MS/MS for PFAS using methodologies based on EPA Method 537.1"	"Include in the text ….EPA Method 1633"	
Appendix A	"Laboratory should have ELAP certification for PFOA and PFOS in drinking water by EPA Method 537, 537.1, EPA Method 533, or ISO 25101"	Deleted	
Appendix B	"Samples collected using this protocol are intended to be analyzed for PFAS using methodologies based on EPA Method 537.1"	"Samples collected using this protocol are intended to be analyzed for PFAS using EPA Method 1633"	

Citation and Page Number	Current Text	Corrected Text	Date
Appendix C	“Samples collected using this protocol are intended to be analyzed for PFAS using methodologies based on EPA Method 537.1”	“Samples collected using this protocol are intended to be analyzed for PFAS using EPA Method 1633”	
Appendix D	“Samples collected using this protocol are intended to be analyzed for PFAS using methodologies based on EPA Method 537.1”	“Samples collected using this protocol are intended to be analyzed for PFAS using EPA Method 1633”	
Appendix G		Updated to include all forty PFAS analytes in EPA Method 533	
Appendix H		Deleted	
Appendix I	Appendix I	Appendix H	
Appendix H	“These guidelines are intended to be used for the validation of PFAS analytical results for projects within the Division of Environmental Remediation (DER) as well as aid in the preparation of a data usability summary report.”	“These guidelines are intended to be used for the validation of PFAS using EPA Method 1633 for projects within the Division of Environmental Remediation (DER).”	
Appendix H	“The holding time is 14 days…”	“The holding time is 28 days…”	
Appendix H, Initial Calibration	“The initial calibration should contain a minimum of five standards for linear fit…”	“The initial calibration should contain a minimum of six standards for linear fit…”	
Appendix H, Initial Calibration	Linear fit calibration curves should have an R^2 value greater than 0.990.	Deleted	
Appendix H, Initial Calibration Verification	Initial Calibration Verification Section	Deleted	
Appendix H	secondary Ion Monitoring Section	Deleted	
Appendix H	Branched and Linear Isomers Section	Deleted	

April 2023

NEW YORK STATE OF OPPORTUNITY | Department of Environmental Conservation

Sampling, Analysis, and Assessment of Per- and Polyfluoroalkyl Substances (PFAS) Under NYSDEC's Part 375 Remedial Programs

Objective

New York State Department of Environmental Conservation's Division of Environmental Remediation (DER) performs or oversees sampling of environmental media and subsequent analysis of PFAS as part of remedial programs implemented under 6 NYCRR Part 375. To ensure consistency in sampling, analysis, reporting, and assessment of PFAS, DER has developed this document which summarizes currently accepted procedures and updates previous DER technical guidance pertaining to PFAS.

Applicability

All work plans submitted to DEC pursuant to one of the remedial programs under Part 375 shall include PFAS sampling and analysis procedures that conform to the guidelines provided herein.

As part of a site investigation or remedial action compliance program, whenever samples of potentially affected media are collected and analyzed for the standard Target Analyte List/Target Compound List (TAL/TCL), PFAS analysis should also be performed. Potentially affected media can include soil, groundwater, surface water, and sediment. Based upon the potential for biota to be affected, biota sampling and analysis for PFAS may also be warranted as determined pursuant to a Fish and Wildlife Impact Analysis. Soil vapor sampling for PFAS is not required.

Field Sampling Procedures

DER-10 specifies technical guidance applicable to DER's remedial programs. Given the prevalence and use of PFAS, DER has developed "best management practices" specific to sampling for PFAS. As specified in DER-10 Chapter 2, quality assurance procedures are to be submitted with investigation work plans. Typically, these procedures are incorporated into a work plan, or submitted as a stand-alone document (e.g., a Quality Assurance Project Plan). Quality assurance guidelines for PFAS are listed in Appendix A - Quality Assurance Project Plan (QAPP) Guidelines for PFAS.

Field sampling for PFAS performed under DER remedial programs should follow the appropriate procedures outlined for soils, sediments, or other solids (Appendix B), non-potable groundwater (Appendix C), surface water (Appendix D), public or private water supply wells (Appendix E), and fish tissue (Appendix F).

QA/QC samples (e.g. duplicates, MS/MSD) should be collected as specified in DER-10, Section 2.3(c). For sampling equipment coming in contact with aqueous samples only, rinsate or equipment blanks should be collected. Equipment blanks should be collected at a minimum frequency of one per day per site or one per twenty samples, whichever is more frequent.

Analysis and Reporting

The investigation work plan should describe analysis and reporting procedures, including laboratory analytical procedures for the methods discussed below. As specified in DER-10 Section 2.2, laboratories should provide a full Category B deliverable. In addition, a Data Usability Summary Report (DUSR) should be prepared by an independent, third-party data validator. Electronic data submissions should meet the requirements provided at: https://www.dec.ny.gov/chemical/62440.html.

DER has developed a *PFAS Analyte List* (Appendix G) for remedial programs to understand the nature of contamination at sites. It is expected that reported results for PFAS will include, at a minimum, all the compounds listed. If lab and/or matrix specific issues are encountered for any analytes, the DER project manager, in consultation with the DER chemist, will make case-by-case decisions as to whether certain analytes may be temporarily or permanently discontinued from analysis at each site. As with other contaminants that are analyzed for at a site, the *PFAS Analyte List* may be refined for future sampling events based on investigative findings.

Routine Analysis

EPA Method 1633 is the procedure to use for environmental samples. Reporting limits for PFOA and PFOS in aqueous samples should not exceed 2 ng/L. Reporting limits for PFOA and PFOS in solid samples should not exceed 0.5 µg/kg. Reporting limits for all other PFAS in aqueous and solid media should be as close to these limits as possible. If laboratories indicate that they are not able to achieve these reporting limits for the entire *PFAS Analyte List*, site-specific decisions regarding acceptance of elevated reporting limits for specific PFAS can be made by the DER project manager in consultation with the DER chemist. Data review guidelines were developed by DER to ensure data comparability and usability (Appendix H - Data Review Guidelines for Analysis of PFAS in Non-Potable Water and Solids).

Additional Analysis

Additional laboratory methods for analysis of PFAS may be warranted at a site, such as the Synthetic Precipitation Leaching Procedure (SPLP) and Total Oxidizable Precursor Assay (TOP Assay).

In cases where site-specific cleanup objectives for PFOA and PFOS are to be assessed, soil parameters, such as Total Organic Carbon (Lloyd Kahn), soil pH (EPA Method 9045), clay content (percent), and cation exchange capacity (EPA Method 9081), should be included in the analysis to help evaluate factors affecting the leachability of PFAS in site soils.

SPLP is a technique used to determine the mobility of chemicals in liquids, soils and wastes, and may be useful in determining the need for addressing PFAS-containing material as part of the remedy. SPLP by EPA Method 1312 should be used unless otherwise specified by the DER project manager in consultation with the DER chemist.

Impacted materials can be made up of PFAS that are not analyzable by routine analytical methodology. A TOP Assay can be utilized to conceptualize the amount and type of oxidizable PFAS which could be liberated in the environment, which approximates the maximum concentration of perfluoroalkyl substances that could be generated if all polyfluoroalkyl substances were oxidized. For example, some polyfluoroalkyl substances may degrade or transform to form perfluoroalkyl substances (such as PFOA or PFOS), resulting in an increase in perfluoroalkyl substance concentrations as contaminated groundwater moves away from a source. The TOP Assay converts, through oxidation, polyfluoroalkyl substances (precursors) into perfluoroalkyl substances that can be detected by routine analytical methodology.[1]

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[1] TOP Assay analysis of highly contaminated samples, such as those from an AFFF (aqueous film-forming foam) site, can result in incomplete oxidation of the samples and an underestimation of the total perfluoroalkyl substances.

Commercial laboratories have adopted methods which allow for the quantification of targeted PFAS in air and biota. The EPA's Office of Research and Development (ORD) is currently developing methods which allow for air emissions characterization of PFAS, including both targeted and non-targeted analysis of PFAS. Consult with the DER project manager and the DER chemist for assistance on analyzing biota/tissue and air samples.

Data Assessment and Application to Site Cleanup

Until such time as Soil Cleanup Objectives (SCOs) for PFOA and PFOS are published, the extent of contaminated media potentially subject to remediation should be determined on a case-by-case basis using the procedures discussed below and the criteria in DER-10. Preliminary target levels for cleanup of PFOA and PFOS in other media, including biota and sediment, have not yet been established by the DEC.

Water Sample Results

NYSDEC has adopted ambient water quality guidance values for PFOA and PFOS. Groundwater samples should be compared to the human health criteria of 6.7 ng/l (ppt) for PFOA and 2.7 ng/l (ppt) for PFOS. These human health criteria should also be applied to surface water that is used as a water supply. This guidance also includes criteria for surface water for PFOS applicable for aquatic life, which may be applicable at some sites. Drinking water sample results should be compared to the NYS maximum contaminant level (MCL) of 10 ng/l (ppt). Analysis to determine if PFOA and PFOS concentrations are attributable to the site should include a comparison between upgradient and downgradient levels, and the presence of soil source areas, as defined below.

If PFOA and/or PFOS are identified as contaminants of concern for a site, they should be assessed as part of the remedy selection process in accordance with Part 375 and DER-10.

Soil Sample Results

NYSDEC will delay adding soil cleanup objectives for PFOA and PFOS to 6 NYCRR Part 375-6 until the PFAS rural soil background study has been completed. Until SCOs are in effect, the following are to be used as guidance values:

Guidance Values for Anticipated Site Use	PFOA (ppb)	PFOS (ppb)
Unrestricted	0.66	0.88
Residential	6.6	8.8
Restricted Residential	33	44
Commercial	500	440
Industrial	600	440
Protection of Groundwater[2]	0.8	1.0

PFOA and PFOS results for soil are to be compared against the guidance values listed above. These guidance values are to be used in determining whether PFOA and PFOS are contaminants of concern for the site and for determining remedial action objectives and cleanup requirements. Site-specific remedial objectives for protection of groundwater can also be presented for evaluation by DEC. Development of site-specific remedial objectives for protection of groundwater will require analysis of additional soil parameters relating to leachability. These

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[2] The Protection of Groundwater values are based on the above referenced ambient groundwater guidance values. Details on that calculation are available in the following document, prepared for the February 2022 proposed changes to Part 375 (https://www.dec.ny.gov/docs/remediation_hudson_pdf/part375techsupport.pdf). The movement of PFAS in the environment is being aggressively researched at this time; that research will eventually result in more accurate models for the behaviors of these chemicals. In the meantime, DEC has calculated the guidance value for the protection of groundwater using the same procedure used for all other chemicals, as described in Section 7.7 of the Technical Support Document (http://www.dec.ny.gov/docs/remediation_hudson_pdf/techsuppdoc.pdf).

additional analyses can include any or all the parameters listed above (soil pH, cation exchange capacity, etc.) and/or use of SPLP.

As the understanding of PFAS transport improves, DEC welcomes proposals for site-specific remedial objectives for protection of groundwater. DEC will expect that those may be dependent on additional factors including soil pH, aqueous pH, % organic carbon, % Sand/Silt/Clay, soil cations: K, Ca, Mg, Na, Fe, Al, cation exchange capacity, and anion exchange capacity. Site-specific remedial objectives should also consider the dilution attenuation factor (DAF). The NJDEP publication on DAF can be used as a reference: https://www.nj.gov/dep/srp/guidance/rs/daf.pdf.

Testing for Imported Soil

Testing for PFAS should be included any time a full TAL/TCL analyte list is required. Results for PFOA and PFOS should be compared to the applicable guidance values. If PFOA or PFOS is detected in any sample at or above the guidance values then the source of backfill should be rejected, unless a site-specific exemption is provided by DER based on SPLP testing, for example. If the concentrations of PFOA and PFOS in leachate are at or above the ambient water quality guidance values for groundwater, then the soil is not acceptable.

PFOA, PFOS and 1,4-dioxane are all considered semi-volatile compounds, so composite samples are appropriate for these compounds when sampling in accordance with DER-10, Table 5.4(e)10. Category B deliverables should be submitted for backfill samples, though a DUSR is not required.

Appendix A - Quality Assurance Project Plan (QAPP) Guidelines for PFAS

The following guidelines (general and PFAS-specific) can be used to assist with the development of a QAPP for projects within DER involving sampling and analysis of PFAS.

General Guidelines in Accordance with DER-10

- Document/work plan section title – Quality Assurance Project Plan
- Summarize project scope, goals, and objectives
- Provide project organization including names and resumes of the project manager, Quality Assurance Officer (QAO), field staff, and Data Validator
    - The QAO should not have another position on the project, such as project or task manager, that involves project productivity or profitability as a job performance criterion
- List the ELAP certified lab(s) to be used for analysis of samples
- Include a site map showing sample locations
- Provide detailed sampling procedures for each matrix
- Include Data Quality Usability Objectives
- List equipment decontamination procedures
- Include an "Analytical Methods/Quality Assurance Summary Table" specifying:
    - Matrix type
    - Number or frequency of samples to be collected per matrix
    - Number of field and trip blanks per matrix
    - Analytical parameters to be measured per matrix
    - Analytical methods to be used per matrix with minimum reporting limits
    - Number and type of matrix spike and matrix spike duplicate samples to be collected
    - Number and type of duplicate samples to be collected
    - Sample preservation to be used per analytical method and sample matrix
    - Sample container volume and type to be used per analytical method and sample matrix
    - Sample holding time to be used per analytical method and sample matrix
- Specify Category B laboratory data deliverables and preparation of a DUSR

Specific Guidelines for PFAS

- Include in the text that sampling for PFAS will take place
- Include in the text that PFAS will be analyzed by EPA Method 1633
- Include the list of PFAS compounds to be analyzed (*PFAS Analyte List*)
- Include the laboratory SOP for PFAS analysis
- List the minimum method-achievable Reporting Limits for PFAS
    - Reporting Limits should be less than or equal to:
        - Aqueous – 2 ng/L (ppt)
        - Solids – 0.5 µg/kg (ppb)
- Include the laboratory Method Detection Limits for the PFAS compounds to be analyzed
-
- Include detailed sampling procedures
    - Precautions to be taken
    - Pump and equipment types
    - Decontamination procedures
    - Approved materials only to be used
- Specify that regular ice only will be used for sample shipment
- Specify that equipment blanks should be collected at a minimum frequency of 1 per day per site for each matrix

Appendix B - Sampling Protocols for PFAS in Soils, Sediments and Solids

General

The objective of this protocol is to give general guidelines for the collection of soil, sediment and other solid samples for PFAS analysis. The sampling procedure used should be consistent with Sampling Guidelines and Protocols – Technological Background and Quality Control/Quality Assurance for NYS DEC Spill Response Program – March 1991 (http://www.dec.ny.gov/docs/remediation_hudson_pdf/sgpsect5.pdf), with the following limitations.

Laboratory Analysis and Containers

Samples collected using this protocol are intended to be analyzed for PFAS using EPA Method 1633.

The preferred material for containers is high density polyethylene (HDPE). Pre-cleaned sample containers, coolers, sample labels, and a chain of custody form will be provided by the laboratory.

Equipment

Acceptable materials for sampling include stainless steel, HDPE, PVC, silicone, acetate, and polypropylene. Additional materials may be acceptable if pre-approved by New York State Department of Environmental Conservation’s Division of Environmental Remediation.

No sampling equipment components or sample containers should come in to contact with aluminum foil, low density polyethylene, glass, or polytetrafluoroethylene (PTFE, Teflon™) materials including sample bottle cap liners with a PTFE layer.

A list of acceptable equipment is provided below, but other equipment may be considered appropriate based on sampling conditions.

- stainless steel spoon
- stainless steel bowl
- steel hand auger or shovel without any coatings

Equipment Decontamination

Standard two step decontamination using detergent (Alconox is acceptable) and clean, PFAS-free water will be performed for sampling equipment. All sources of water used for equipment decontamination should be verified in advance to be PFAS-free through laboratory analysis or certification.

Sampling Techniques

Sampling is often conducted in areas where a vegetative turf has been established. In these cases, a pre-cleaned trowel or shovel should be used to carefully remove the turf so that it may be replaced at the conclusion of sampling. Surface soil samples (e.g. 0 to 6 inches below surface) should then be collected using a pre-cleaned, stainless steel spoon. Shallow subsurface soil samples (e.g. 6 to ~36 inches below surface) may be collected by digging a hole using a pre-cleaned hand auger or shovel. When the desired subsurface depth is reached, a pre-cleaned hand auger or spoon shall be used to obtain the sample.

When the sample is obtained, it should be deposited into a stainless steel bowl for mixing prior to filling the sample containers. The soil should be placed directly into the bowl and mixed thoroughly by rolling the material into the middle until the material is homogenized. At this point the material within the bowl can be placed into the laboratory provided container.

Sample Identification and Logging

A label shall be attached to each sample container with a unique identification. Each sample shall be included on the chain of custody (COC).

Quality Assurance/Quality Control

- Immediately place samples in a cooler maintained at 4 ± 2º Celsius using ice
- Collect one field duplicate for every sample batch, minimum 1 duplicate per 20 samples. The duplicate shall consist of an additional sample at a given location
- Collect one matrix spike / matrix spike duplicate (MS/MSD) for every sample batch, minimum 1 MS/MSD per 20 samples. The MS/MSD shall consist of an additional two samples at a given location and identified on the COC
- Request appropriate data deliverable (Category B) and an electronic data deliverable

Documentation

A soil log or sample log shall document the location of the sample/borehole, depth of the sample, sampling equipment, duplicate sample, visual description of the material, and any other observations or notes determined to be appropriate. Additionally, care should be performed to limit contact with PFAS containing materials (e.g. waterproof field books, food packaging) during the sampling process.

Personal Protection Equipment (PPE)

For most sampling Level D PPE is anticipated to be appropriate. The sampler should wear nitrile gloves while conducting field work and handling sample containers.

Field staff shall consider the clothing to be worn during sampling activities. Clothing that contains PTFE material (including GORE-TEX®) or that have been waterproofed with PFAS materials should be avoided. All clothing worn by sampling personnel should have been laundered multiple times.

Appropriate rain gear (PVC, polyurethane, or rubber rain gear are acceptable), bug spray, and sunscreen should be used that does not contain PFAS. Well washed cotton coveralls may be used as an alternative to bug spray and/or sunscreen.

PPE that contains PFAS is acceptable when site conditions warrant additional protection for the samplers and no other materials can be used to be protective. Documentation of such use should be provided in the field notes.

Appendix C - Sampling Protocols for PFAS in Monitoring Wells

General

The objective of this protocol is to give general guidelines for the collection of groundwater samples for PFAS analysis. The sampling procedure used should be consistent with Sampling Guidelines and Protocols – Technological Background and Quality Control/Quality Assurance for NYS DEC Spill Response Program – March 1991 (http://www.dec.ny.gov/docs/remediation_hudson_pdf/sgpsect5.pdf), with the following limitations.

Laboratory Analysis and Container

Samples collected using this protocol are intended to be analyzed for PFAS using EPA Method 1633.

The preferred material for containers is high density polyethylene (HDPE). Pre-cleaned sample containers, coolers, sample labels, and a chain of custody form will be provided by the laboratory.

Equipment

Acceptable materials for sampling include: stainless steel, HDPE, PVC, silicone, acetate, and polypropylene. Additional materials may be acceptable if pre-approved by New York State Department of Environmental Conservation's Division of Environmental Remediation.

No sampling equipment components or sample containers should come in contact with aluminum foil, low density polyethylene, glass, or polytetrafluoroethylene (PTFE, Teflon™) materials including plumbers tape and sample bottle cap liners with a PTFE layer.

A list of acceptable equipment is provided below, but other equipment may be considered appropriate based on sampling conditions.

- stainless steel inertia pump with HDPE tubing
- peristaltic pump equipped with HDPE tubing and silicone tubing
- stainless steel bailer with stainless steel ball
- bladder pump (identified as PFAS-free) with HDPE tubing

Equipment Decontamination

Standard two step decontamination using detergent (Alconox is acceptable) and clean, PFAS-free water will be performed for sampling equipment. All sources of water used for equipment decontamination should be verified in advance to be PFAS-free through laboratory analysis or certification.

Sampling Techniques

Monitoring wells should be purged in accordance with the sampling procedure (standard/volume purge or low flow purge) identified in the site work plan, which will determine the appropriate time to collect the sample. If sampling using standard purge techniques, additional purging may be needed to reduce turbidity levels, so samples contain a limited amount of sediment within the sample containers. Sample containers that contain sediment may cause issues at the laboratory, which may result in elevated reporting limits and other issues during the sample preparation that can compromise data usability. Sampling personnel should don new nitrile gloves prior to sample collection due to the potential to contact PFAS containing items (not related to the sampling equipment) during the purging activities.

Sample Identification and Logging

A label shall be attached to each sample container with a unique identification. Each sample shall be included on the chain of custody (COC).

Quality Assurance/Quality Control

- Immediately place samples in a cooler maintained at 4 ± 2º Celsius using ice
- Collect one field duplicate for every sample batch, minimum 1 duplicate per 20 samples. The duplicate shall consist of an additional sample at a given location
- Collect one matrix spike / matrix spike duplicate (MS/MSD) for every sample batch, minimum 1 MS/MSD per 20 samples. The MS/MSD shall consist of an additional two samples at a given location and identified on the COC
- Collect one equipment blank per day per site and minimum 1 equipment blank per 20 samples. The equipment blank shall test the new and decontaminated sampling equipment utilized to obtain a sample for residual PFAS contamination. This sample is obtained by using laboratory provided PFAS-free water and passing the water over or through the sampling device and into laboratory provided sample containers
- Additional equipment blank samples may be collected to assess other equipment that is utilized at the monitoring well
- Request appropriate data deliverable (Category B) and an electronic data deliverable

Documentation

A purge log shall document the location of the sample, sampling equipment, groundwater parameters, duplicate sample, visual description of the material, and any other observations or notes determined to be appropriate. Additionally, care should be performed to limit contact with PFAS containing materials (e.g. waterproof field books, food packaging) during the sampling process.

Personal Protection Equipment (PPE)

For most sampling Level D PPE is anticipated to be appropriate. The sampler should wear nitrile gloves while conducting field work and handling sample containers.

Field staff shall consider the clothing to be worn during sampling activities. Clothing that contains PTFE material (including GORE-TEX®) or that have been waterproofed with PFAS materials should be avoided. All clothing worn by sampling personnel should have been laundered multiple times.

Appropriate rain gear (PVC, polyurethane, or rubber rain gear are acceptable), bug spray, and sunscreen should be used that does not contain PFAS. Well washed cotton coveralls may be used as an alternative to bug spray and/or sunscreen.

PPE that contains PFAS is acceptable when site conditions warrant additional protection for the samplers and no other materials can be used to be protective. Documentation of such use should be provided in the field notes.

Appendix D - Sampling Protocols for PFAS in Surface Water

General

The objective of this protocol is to give general guidelines for the collection of surface water samples for PFAS analysis. The sampling procedure used should be consistent with Sampling Guidelines and Protocols – Technological Background and Quality Control/Quality Assurance for NYS DEC Spill Response Program – March 1991 (http://www.dec.ny.gov/docs/remediation_hudson_pdf/sgpsect5.pdf), with the following limitations.

Laboratory Analysis and Container

Samples collected using this protocol are intended to be analyzed for PFAS using EPA Method 1633.

The preferred material for containers is high density polyethylene (HDPE). Pre-cleaned sample containers, coolers, sample labels, and a chain of custody form will be provided by the laboratory.

Equipment

Acceptable materials for sampling include: stainless steel, HDPE, PVC, silicone, acetate, and polypropylene. Additional materials may be acceptable if pre-approved by New York State Department of Environmental Conservation's Division of Environmental Remediation.

No sampling equipment components or sample containers should come in contact with aluminum foil, low density polyethylene, glass, or polytetrafluoroethylene (PTFE, Teflon™) materials including sample bottle cap liners with a PTFE layer.

A list of acceptable equipment is provided below, but other equipment may be considered appropriate based on sampling conditions.

- stainless steel cup

Equipment Decontamination

Standard two step decontamination using detergent (Alconox is acceptable) and clean, PFAS-free water will be performed for sampling equipment. All sources of water used for equipment decontamination should be verified in advance to be PFAS-free through laboratory analysis or certification.

Sampling Techniques

Where conditions permit, (e.g. creek or pond) sampling devices (e.g. stainless steel cup) should be rinsed with site medium to be sampled prior to collection of the sample. At this point the sample can be collected and poured into the sample container.

If site conditions permit, samples can be collected directly into the laboratory container.

Sample Identification and Logging

A label shall be attached to each sample container with a unique identification. Each sample shall be included on the chain of custody (COC).

Quality Assurance/Quality Control

- Immediately place samples in a cooler maintained at 4 ± 2º Celsius using ice
- Collect one field duplicate for every sample batch, minimum 1 duplicate per 20 samples. The duplicate shall consist of an additional sample at a given location
- Collect one matrix spike / matrix spike duplicate (MS/MSD) for every sample batch, minimum 1 MS/MSD per 20 samples. The MS/MSD shall consist of an additional two samples at a given location and identified on the COC
- Collect one equipment blank per day per site and minimum 1 equipment blank per 20 samples. The equipment blank shall test the new and decontaminated sampling equipment utilized to obtain a sample for residual PFAS contamination. This sample is obtained by using laboratory provided PFAS-free water and passing the water over or through the sampling device and into laboratory provided sample containers
- Request appropriate data deliverable (Category B) and an electronic data deliverable

Documentation

A sample log shall document the location of the sample, sampling equipment, duplicate sample, visual description of the material, and any other observations or notes determined to be appropriate. Additionally, care should be performed to limit contact with PFAS containing materials (e.g. waterproof field books, food packaging) during the sampling process.

Personal Protection Equipment (PPE)

For most sampling Level D PPE is anticipated to be appropriate. The sampler should wear nitrile gloves while conducting field work and handling sample containers.

Field staff shall consider the clothing to be worn during sampling activities. Clothing that contains PTFE material (including GORE-TEX®) or that have been waterproofed with PFAS materials should be avoided. All clothing worn by sampling personnel should have been laundered multiple times.

Appropriate rain gear (PVC, polyurethane, or rubber rain gear are acceptable), bug spray, and sunscreen should be used that does not contain PFAS. Well washed cotton coveralls may be used as an alternative to bug spray and/or sunscreen.

PPE that contains PFAS is acceptable when site conditions warrant additional protection for the samplers and no other materials can be used to be protective. Documentation of such use should be provided in the field notes.

Appendix E - Sampling Protocols for PFAS in Private Water Supply Wells

General

The objective of this protocol is to give general guidelines for the collection of water samples from private water supply wells (with a functioning pump) for PFAS analysis. The sampling procedure used should be consistent with Sampling Guidelines and Protocols – Technological Background and Quality Control/Quality Assurance for NYS DEC Spill Response Program – March 1991 (http://www.dec.ny.gov/docs/remediation_hudson_pdf/sgpsect5.pdf), with the following limitations.

Laboratory Analysis and Container

Drinking water samples collected using this protocol are intended to be analyzed for PFAS by EPA Method 537, 537.1, 533, or ISO Method 25101. The preferred material for containers is high density polyethylene (HDPE). Pre-cleaned sample containers, coolers, sample labels, and a chain of custody form will be provided by the laboratory.

Equipment

Acceptable materials for sampling include stainless steel, HDPE, PVC, silicone, acetate, and polypropylene. Additional materials may be acceptable if pre-approved by New York State Department of Environmental Conservation's Division of Environmental Remediation.

No sampling equipment components or sample containers should come in contact with aluminum foil, low density polyethylene, glass, or polytetrafluoroethylene (PTFE, Teflon™) materials (e.g. plumbers tape), including sample bottle cap liners with a PTFE layer.

Equipment Decontamination

Standard two step decontamination using detergent (Alconox is acceptable) and clean, PFAS-free water will be performed for sampling equipment. All sources of water used for equipment decontamination should be verified in advance to be PFAS-free through laboratory analysis or certification.

Sampling Techniques

Locate and assess the pressure tank and determine if any filter units are present within the building. Establish the sample location as close to the well pump as possible, which is typically the spigot at the pressure tank. Ensure sampling equipment is kept clean during sampling as access to the pressure tank spigot, which is likely located close to the ground, may be obstructed and may hinder sample collection.

Prior to sampling, a faucet downstream of the pressure tank (e.g., washroom sink) should be run until the well pump comes on and a decrease in water temperature is noted which indicates that the water is coming from the well. If the homeowner is amenable, staff should run the water longer to purge the well (15+ minutes) to provide a sample representative of the water in the formation rather than standing water in the well and piping system including the pressure tank. At this point a new pair of nitrile gloves should be donned and the sample can be collected from the sample point at the pressure tank.

Sample Identification and Logging

A label shall be attached to each sample container with a unique identification. Each sample shall be included on the chain of custody (COC).

Quality Assurance/Quality Control

- Immediately place samples in a cooler maintained at 4 ± 2º Celsius using ice
- Collect one field duplicate for every sample batch, minimum 1 duplicate per 20 samples. The duplicate shall consist of an additional sample at a given location
- Collect one matrix spike / matrix spike duplicate (MS/MSD) for every sample batch, minimum 1 MS/MSD per 20 samples. The MS/MSD shall consist of an additional two samples at a given location and identified on the COC
- If equipment was used, collect one equipment blank per day per site and a minimum 1 equipment blank per 20 samples. The equipment blank shall test the new and decontaminated sampling equipment utilized to obtain a sample for residual PFAS contamination. This sample is obtained by using laboratory provided PFAS-free water and passing the water over or through the sampling device and into laboratory provided sample containers.
- A field reagent blank (FRB) should be collected at a rate of one per 20 samples. The lab will provide a FRB bottle containing PFAS free water and one empty FRB bottle. In the field, pour the water from the one bottle into the empty FRB bottle and label appropriately.
- Request appropriate data deliverable (Category B) and an electronic data deliverable
- For sampling events where multiple private wells (homes or sites) are to be sampled per day, it is acceptable to collect QC samples at a rate of one per 20 across multiple sites or days.

Documentation

A sample log shall document the location of the private well, sample point location, owner contact information, sampling equipment, purge duration, duplicate sample, visual description of the material, and any other observations or notes determined to be appropriate and available (e.g. well construction, pump type and location, yield, installation date). Additionally, care should be performed to limit contact with PFAS containing materials (e.g. waterproof field books, food packaging) during the sampling process.

Personal Protection Equipment (PPE)

For most sampling Level D PPE is anticipated to be appropriate. The sampler should wear nitrile gloves while conducting field work and handling sample containers.

Field staff shall consider the clothing to be worn during sampling activities. Clothing that contains PTFE material (including GORE-TEX®) or that have been waterproofed with PFAS materials should be avoided. All clothing worn by sampling personnel should have been laundered multiple times.

Appendix F - Sampling Protocols for PFAS in Fish

This appendix contains a copy of the current SOP developed by the Division of Fish and Wildlife (DFW) entitled “General Fish Handling Procedures for Contaminant Analysis” (Ver. 8). This SOP should be followed when collecting fish for contaminant analysis. Note, however, that the Bureau of Ecosystem Health will not be supplying bags or tags. All supplies are the responsibility of the collector

Procedure Name: General Fish Handling Procedures for Contaminant Analysis

Number: FW-005

Purpose: This procedure describes data collection, fish processing and delivery of fish collected for contaminant monitoring. It contains the chain of custody and collection record forms that should be used for the collections.

Organization: Environmental Monitoring Section
Bureau of Ecosystem Health
Division of Fish and Wildlife (DFW)
New York State Department of Environmental Conservation (NYSDEC)
625 Broadway
Albany, New York 12233-4756

Version: 8

Previous Version Date: 21 March 2018

Summary of Changes to this Version: Updated bureau name to Bureau of Ecosystem Health. Added direction to list the names of all field crew on the collection record. Minor formatting changes on chain of custody and collection records.

Originator or Revised by: Wayne Richter, Jesse Becker

Date: 26 April 2019

Quality Assurance Officer and Approval Date: Jesse Becker, 26 April 2019

NEW YORK STATE
DEPARTMENT OF ENVIRONMENTAL CONSERVATION

GENERAL FISH HANDLING PROCEDURES FOR CONTAMINANT ANALYSES

A. Original copies of all continuity of evidence (i.e., Chain of Custody) and collection record forms must accompany delivery of fish to the lab. A copy shall be directed to the Project Leader or as appropriate, Wayne Richter. All necessary forms will be supplied by the Bureau of Ecosystem Health. Because some samples may be used in legal cases, it is critical that each section is filled out completely. Each Chain of Custody form has three main sections:

1. The top box is to be filled out **and signed** by the person responsible for the fish collection (e.g., crew leader, field biologist, researcher). This person is responsible for delivery of the samples to DEC facilities or personnel (e.g., regional office or biologist).

2. The second section is to be filled out **and signed** by the person responsible for the collections while being stored at DEC, before delivery to the analytical lab. This may be the same person as in (1), but it is still required that they complete the section. Also important is the **range of identification numbers** (i.e., tag numbers) included in the sample batch.

3. Finally, the bottom box is to record any transfers between DEC personnel and facilities. Each subsequent transfer should be **identified, signed, and dated**, until laboratory personnel take possession of the fish.

B. The following data are required on each **Fish Collection Record** form:

1. Project and Site Name.

2. DEC Region.

3. All personnel (and affiliation) involved in the collection.

4. Method of collection (gill net, hook and line, etc.)

5. Preservation Method.

C. The following data are to be taken on each fish collected and recorded on the **Fish Collection Record** form:

1. Tag number - Each specimen is to be individually jaw tagged at time of collection with a unique number. Make sure the tag is turned out so that the number can be read without opening the bag. Use tags in sequential order. For small fish or composite samples place the tag inside the bag with the samples. The Bureau of Ecosystem Health can supply the tags.

2. Species identification (please be explicit enough to enable assigning genus and species). Group fish by species when processing.

3. Date collected.

4. Sample location (waterway and nearest prominent identifiable landmark).

5. Total length (nearest mm or smallest sub-unit on measuring instrument) and weight (nearest g or

smallest sub-unit of weight on weighing instrument). Take all measures as soon as possible with calibrated, protected instruments (e.g. from wind and upsets) and prior to freezing.

6. Sex - fish may be cut enough to allow sexing or other internal investigation, but do not eviscerate. Make any incision on the right side of the belly flap or exactly down the midline so that a left-side fillet can be removed.

D. General data collection recommendations:

1. It is helpful to use an ID or tag number that will be unique. It is best to use metal striped bass or other uniquely numbered metal tags. If uniquely numbered tags are unavailable, values based on the region, water body and year are likely to be unique: for example, R7CAY11001 for Region 7, Cayuga Lake, 2011, fish 1. If the fish are just numbered 1 through 20, we have to give them new numbers for our database, making it more difficult to trace your fish to their analytical results and creating an additional possibility for errors.

2. Process and record fish of the same species sequentially. Recording mistakes are less likely when all fish from a species are processed together. Starting with the bigger fish species helps avoid missing an individual.

3. If using Bureau of Ecosystem Health supplied tags or other numbered tags, use tags in sequence so that fish are recorded with sequential Tag Numbers. This makes data entry and login at the lab and use of the data in the future easier and reduces keypunch errors.

4. Record length and weight as soon as possible after collection and before freezing. Other data are recorded in the field upon collection. An age determination of each fish is optional, but if done, it is recorded in the appropriate “Age” column.

5. For composite samples of small fish, record the number of fish in the composite in the Remarks column. Record the length and weight of each individual in a composite. All fish in a composite sample should be of the same species and members of a composite should be visually matched for size.

6. Please submit photocopies of topographic maps or good quality navigation charts indicating sampling locations. GPS coordinates can be entered in the Location column of the collection record form in addition to or instead for providing a map. These records are of immense help to us (and hopefully you) in providing documented location records which are not dependent on memory and/or the same collection crew. In addition, they may be helpful for contaminant source trackdown and remediation/control efforts of the Department.

7. When recording data on fish measurements, it will help to ensure correct data recording for the data recorder to call back the numbers to the person making the measurements.

E. Each fish is to be placed in its own individual plastic bag. For small fish to be analyzed as a composite, put all of the fish for one composite in the same bag but use a separate bag for each composite. It is important to individually bag the fish to avoid difficulties or cross contamination when processing the fish for chemical analysis. Be sure to include the fish’s tag number inside the bag, preferably attached to the fish with the tag number turned out so it can be read. Tie or otherwise secure the bag closed. **The Bureau of Ecosystem Health will supply the bags.** If necessary, food grade bags may be procured from a suitable vendor (e.g., grocery store). It is preferable to redundantly label each bag with a manila tag tied between the knot and the body of the bag. This tag should be labeled with the project name, collection location, tag number, collection date, and fish species. If scales are collected, the scale envelope should be labeled with the same information.

F. Groups of fish, by species, are to be placed in one large plastic bag per sampling location. **The Bureau of Ecosystem Health will supply the larger bags.** Tie or otherwise secure the bag closed. Label the site bag with a manila tag tied between the knot and the body of the bag. The tag should contain: project, collection location, collection date, species and **tag number ranges**. Having this information on the manila tag enables lab staff to know what is in the bag without opening it.

G. Do not eviscerate, fillet or otherwise dissect the fish unless specifically asked to. If evisceration or dissection is specified, the fish must be cut along the exact midline or on the right side so that the left side fillet can be removed intact at the laboratory. If filleting is specified, the procedure for taking a standard fillet (SOP PREPLAB 4) must be followed, including removing scales.

H. Special procedures for PFAS: Unlike legacy contaminants such as PCBs, which are rarely found in day to day life, PFAS are widely used and frequently encountered. Practices that avoid sample contamination are therefore necessary. While no standard practices have been established for fish, procedures for water quality sampling can provide guidance. The following practices should be used for collections when fish are to be analyzed for PFAS:

No materials containing Teflon.
No Post-it notes.
No ice packs; only water ice or dry ice.
Any gloves worn must be powder free nitrile.
No Gore-Tex or similar materials (Gore-Tex is a PFC with PFOA used in its manufacture).
No stain repellent or waterproof treated clothing; these are likely to contain PFCs.
Avoid plastic materials, other than HDPE, including clipboards and waterproof notebooks.
Wash hands after handling any food containers or packages as these may contain PFCs. Keep pre-wrapped food containers and wrappers isolated from fish handling.
Wear clothing washed at least six times since purchase.
Wear clothing washed without fabric softener.
Staff should avoid cosmetics, moisturizers, hand creams and similar products on the day of sampling as many of these products contain PFCs (Fujii et al. 2013). Sunscreen or insect repellent should not contain ingredients with "fluor" in their name. Apply any sunscreen or insect repellent well downwind from all materials. Hands must be washed after touching any of these products.

I. All fish must be kept at a temperature <45° F (<8° C) immediately following data processing. As soon as possible, freeze at -20° C ± 5° C. Due to occasional freezer failures, daily freezer temperature logs are required. The freezer should be locked or otherwise secured to maintain chain of custody.

J. In most cases, samples should be delivered to the Analytical Services Unit at the Hale Creek field station. Coordinate delivery with field station staff and send copies of the collection records, continuity of evidence forms and freezer temperature logs to the field station. For samples to be analyzed elsewhere, non-routine collections or other questions, contact Wayne Richter, Bureau of Ecosystem Health, NYSDEC, 625 Broadway, Albany, New York 12233-4756, 518-402-8974, or the project leader about sample transfer. Samples will then be directed to the analytical facility and personnel noted on specific project descriptions.

K. A recommended equipment list is at the end of this document.

page ______ of ______

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
DIVISION OF FISH AND WILDLIFE
FISH COLLECTION RECORD

Project and Site Name ____ DEC Region ____________

Collections made by (include all crew) ____

Sampling Method: ☐Electrofishing ☐Gill netting ☐Trap netting ☐Trawling ☐Seining ☐Angling ☐Other ____________________

Preservation Method: ☐Freezing ☐Other ________________ Notes (SWFDB survey number): ____________________

FOR LAB USE ONLY- LAB ENTRY NO.	COLLECTION OR TAG NO.	SPECIES	DATE TAKEN	LOCATION	AGE	SEX &/OR REPROD. CONDIT	LENGTH ( )	WEIGHT ( )	REMARKS

richter: revised 2011, 5/7/15, 10/4/16, 3/20/17; becker: 3/23/17, 4/26/19

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
CHAIN OF CUSTODY

I, ______________________________, of ____ collected the
(Print Name) (Print Business Address)

following on ____________________, 20____ from ____
(Date) (Water Body)

in the vicinity of ____
(Landmark, Village, Road, etc.)

Town of _______________________________________, in __________________________________ County.

Item(s) ____

____

Said sample(s) were in my possession and handled according to standard procedures provided to me prior to collection. The sample(s) were placed in the custody of a representative of the New York State Department of Environmental Conservation on ____________________________________, 20______.

____ ____________________________
Signature Date

I, __________________________________, received the above mentioned sample(s) on the date specified and assigned identification number(s) ____ to the sample(s). I have recorded pertinent data for the sample(s) on the attached collection records. The sample(s) remained in my custody until subsequently transferred, prepared or shipped at times and on dates as attested to below.

_______________________________________ ___________________
Signature Date

SECOND RECIPIENT (Print Name)	TIME & DATE	PURPOSE OF TRANSFER
SIGNATURE	UNIT	
THIRD RECIPIENT (Print Name)	TIME & DATE	PURPOSE OF TRANSFER
SIGNATURE	UNIT	
FOURTH RECIPIENT (Print Name)	TIME & DATE	PURPOSE OF TRANSFER
SIGNATURE	UNIT	
RECEIVED IN LABORATORY BY (Print Name)	TIME & DATE	REMARKS
SIGNATURE	UNIT	
LOGGED IN BY (Print Name)	TIME & DATE	ACCESSION NUMBERS
SIGNATURE	UNIT	

richter: revised 21 April 2014; becker: 23 March 2017, 26 April, 2019

NOTICE OF WARRANTY

By signature to the chain of custody (reverse), the signatory warrants that the information provided is truthful and accurate to the best of his/her ability. The signatory affirms that he/she is willing to testify to those facts provided and the circumstances surrounding the same. Nothing in this warranty or chain of custody negates responsibility nor liability of the signatories for the truthfulness and accuracy of the statements provided.

HANDLING INSTRUCTIONS

On day of collection, collector(s) name(s), address(es), date, geographic location of capture (attach a copy of topographic map or navigation chart), species, number kept of each species, and description of capture vicinity (proper noun, if possible) along with name of Town and County must be indicated on reverse.

Retain organisms in manila tagged plastic bags to avoid mixing capture locations. Note appropriate information on each bag tag.

Keep samples as cool as possible. Put on ice if fish cannot be frozen within 12 hours. If fish are held more than 24 hours without freezing, they will not be retained or analyzed.

Initial recipient (either DEC or designated agent) of samples from collector(s) is responsible for obtaining and recording information on the collection record forms which will accompany the chain of custody. This person will seal the container using packing tape and writing his signature, the time and the date across the tape onto the container with indelible marker. Any time a seal is broken, for whatever purpose, the incident must be recorded on the Chain of Custody (reason, time, and date) in the purpose of transfer block. Container then is resealed using new tape and rewriting signature, with time and date.

EQUIPMENT LIST

Scale or balance of appropriate capacity for the fish to be collected.

Fish measuring board.

Plastic bags of an appropriate size for the fish to be collected and for site bags.

Individually numbered metal tags for fish.

Manila tags to label bags.

Small envelops, approximately 2” x 3.5”, if fish scales are to be collected.

Knife for removing scales.

Chain of custody and fish collection forms.

Clipboard.

Pens or markers.

Paper towels.

Dish soap and brush.

Bucket.

Cooler.

Ice.

Duct tape.

Appendix G – PFAS Analyte List

Group	Chemical Name	Abbreviation	CAS Number
Perfluoroalkyl sulfonic acids	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
Perfluoroalkyl carboxylic acids	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	PFTeDA	376-06-7
Per- and Polyfluoroether carboxylic acids	Hexafluoropropylene oxide dimer acid	HFPO-DA	13252-13-6
	4,8-Dioxa-3H-perfluorononanoic acid	ADONA	919005-14-4
	Perfluoro-3-methoxypropanoic acid	PFMPA	377-73-1
	Perfluoro-4-methoxybutanoic acid	PFMBA	863090-89-5
	Nonafluoro-3,6-dioxaheptanoic acid	NFDHA	151772-58-6
Fluorotelomer sulfonic acids	4:2 Fluorotelomer sulfonic acid	4:2-FTS	757124-72-4
	6:2 Fluorotelomer sulfonic acid	6:2-FTS	27619-97-2
	8:2 Fluorotelomer sulfonic acid	8:2-FTS	39108-34-4
Fluorotelomer carboxylic acids	3:3 Fluorotelomer carboxylic acid	3:3 FTCA	356-02-5
	5:3 Fluorotelomer carboxylic acid	5:3 FTCA	914637-49-3
	7:3 Fluorotelomer carboxylic acid	7:3 FTCA	812-70-4
Perfluorooctane sulfonamides	Perfluorooctane sulfonamide	PFOSA	754-91-6
	N-methylperfluorooctane sulfonamide	NMeFOSA	31506-32-8
	N-ethylperfluorooctane sulfonamide	NEtFOSA	4151-50-2
Perfluorooctane sulfonamidoacetic acids	N-methylperfluorooctane sulfonamidoacetic acid	N-MeFOSAA	2355-31-9
	N-ethylperfluorooctane sulfonamidoacetic acid	N-EtFOSAA	2991-50-6
Perfluorooctane sulfonamide ethanols	N-methylperfluorooctane sulfonamidoethanol	MeFOSE	24448-09-7
	N-ethylperfluorooctane sulfonamidoethanol	EtFOSE	1691-99-2

Group	Chemical Name	Abbreviation	CAS Number
Ether sulfonic acids	9-Chlorohexadecafluoro-3-oxanonane-1-sulfonic acid (F-53B Major)	9Cl-PF3ONS	756426-58-1
	11-Chloroeicosafluoro-3-oxaundecane-1-sulfonic acid (F-53B Minor)	11Cl-PF3OUdS	763051-92-9
	Perfluoro(2-ethoxyethane) sulfonic acid	PFEESA	113507-82-7

Appendix H - Data Review Guidelines for Analysis of PFAS in Non-Potable Water and Solids

General

These guidelines are intended to be used for the validation of PFAS using EPA Method 1633 for projects within the Division of Environmental Remediation (DER). Data reviewers should understand the methodology and techniques utilized in the analysis. Consultation with the end user of the data may be necessary to assist in determining data usability based on the data quality objectives in the Quality Assurance Project Plan. A familiarity with the laboratory's Standard Operating Procedure may also be needed to fully evaluate the data. If you have any questions, please contact DER's Quality Assurance Officer, Dana Barbarossa, at dana.barbarossa@dec.ny.gov.

Preservation and Holding Time

Samples should be preserved with ice to a temperature of less than 6°C upon arrival at the lab. The holding time is 28 days to extraction for aqueous and solid samples. The time from extraction to analysis for aqueous samples is 28 days and 40 days for solids.

Temperature greatly exceeds 6ºC upon arrival at the lab*	Use professional judgement to qualify detects and non-detects as estimated or rejected
Holding time exceeding 28 days to extraction	Use professional judgement to qualify detects and non-detects as estimated or rejected if holding time is grossly exceeded

*Samples that are delivered to the lab immediately after sampling may not meet the thermal preservation guidelines. Samples are considered acceptable if they arrive on ice or an attempt to chill the samples is observed.

Initial Calibration

The initial calibration should contain a minimum of six standards for linear fit and six standards for a quadratic fit. The relative standard deviation (RSD) for a quadratic fit calibration should be less than 20%.

The low-level calibration standard should be within 50% - 150% of the true value, and the mid-level calibration standard within 70% - 130% of the true value.

%RSD >20%	J flag detects and UJ non detects

Continuing Calibration Verification

Continuing calibration verification (CCV) checks should be analyzed at a frequency of one per ten field samples. If CCV recovery is very low, where detection of the analyte could be in question, ensure a low level CCV was analyzed and use to determine data quality.

CCV recovery <70 or >130%	J flag results

Blanks

There should be no detections in the method blanks above the reporting limits. Equipment blanks, field blanks, rinse blanks etc. should be evaluated in the same manner as method blanks. Use the most contaminated blank to evaluate the sample results.

Blank Result	Sample Result	Qualification
Any detection	<Reporting limit	Qualify as ND at reporting limit
Any detection	>Reporting Limit and >10x the blank result	No qualification
>Reporting limit	>Reporting limit and <10x blank result	J+ biased high

Field Duplicates

A blind field duplicate should be collected at rate of one per twenty samples. The relative percent difference (RPD) should be less than 30% for analyte concentrations greater than two times the reporting limit. Use the higher result for final reporting.

RPD >30%	Apply J qualifier to parent sample

Lab Control Spike

Lab control spikes should be analyzed with each extraction batch or one for every twenty samples. In the absence of lab derived criteria, use 70% - 130% recovery criteria to evaluate the data.

Recovery <70% or >130% (lab derived criteria can also be used)	Apply J qualifier to detects and UJ qualifier to non detects

Matrix Spike/Matrix Spike Duplicate

One matrix spike and matrix spike duplicate should be collected at a rate of one per twenty samples. Use professional judgement to reject results based on out of control MS/MSD recoveries.

Recovery <70% or >130% (lab derived criteria can also be used)	Apply J qualifier to detects and UJ qualifier to non detects of parent sample only
RPD >30%	Apply J qualifier to detects and UJ qualifier to non detects of parent sample only

Extracted Internal Standards (Isotope Dilution Analytes)

Problematic analytes (e.g. PFBA, PFPeA, fluorotelomer sulfonates) can have wider recoveries without qualification. Qualify corresponding native compounds with a J flag if outside of the range.

Recovery <50% or >150%	Apply J qualifier
Recovery <25% or >150% for poor responding analytes	Apply J qualifier
Isotope Dilution Analyte (IDA) Recovery <10%	Reject results

Signal to Noise Ratio

The signal to noise ratio for the quantifier ion should be at least 3:1. If the ratio is less than 3:1, the peak is discernable from the baseline noise and symmetrical, the result can be reported. If the peak appears to be baseline noise and/or the shape is irregular, qualify the result as tentatively identified.

Reporting Limits

If project-specific reporting limits were not met, please indicate that in the report along with the reason (e.g. over dilution, dilution for non-target analytes, high sediment in aqueous samples).

Peak Integrations

Target analyte peaks should be integrated properly and consistently when compared to standards. Ensure branched isomer peaks are included for PFAS where standards are available. Inconsistencies should be brought to the attention of the laboratory or identified in the data review summary report.

ATTACHMENT 2

LABORATORY STANDARD OPERATING PROCEDURE SUMMARY FOR PFAS

Standard Operating Procedure

Determination of Target Per- and Polyfluoroalkyl Substances (PFAS) in Aqueous and Solid matrices by Isotope Dilution Analysis by HPLC/MS-MS According to EPA Method 1633 Draft 2

Approvals

Laboratory Director/QA Officer ______________________
Krys Trafalski

Vice President/Chief Scientific Officer Robert G. Bradley ______________________
Robert Bradley

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Controlled Copy No. PFAS_LCMSMS1633, Rev 1.0-____

Issued to: NA

1. SCOPE AND APPLICATION

This method is used to identify and quantitate specific PFAS compounds in extracts of non-potable water and solid (soil/sediment) samples using HPLC/MS-MS (high pressure liquid chromatography/tandem mass spectrometry. Currently the compounds (40) that are measured by this methodology are listed in the Table 1.0 below.

Table 1.0-Target PFAS

Perfluoroalkyl carboxylic acids		
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	PFTeDA	376-06-7
Perfluoroalkyl sulfonic acids Acid Form		
Perfluorobutanesulfonic acid	PFBS	375-73-5
Perfluoropentansulfonic 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
Fluorotelomer sulfonic acids		
1*H*,1*H*, 2*H*, 2*H*-Perfluorohexane sulfonic acid	4:2FTS	757124-72-4
1*H*,1*H*, 2*H*, 2*H*-Perfluorooctane sulfonic acid	6:2FTS	27619-97-2
1*H*,1*H*, 2*H*, 2*H*-Perfluorodecane sulfonic acid	8:2FTS	39108-34-4
Perfluorooctane sulfonamides		
Perfluorooctanesulfonamide	PFOSA	754-91-6
N-methyl perfluorooctanesulfonamide	NMeFOSA	31506-32-8
N-ethyl perfluorooctanesulfonamide	NEtFOSA	4151-50-2
Perfluorooctane sulfonamidoacetic acids		
N-methyl perfluorooctanesulfonamidoacetic acid	NMeFOSAA	2355-31-9
N-ethyl perfluorooctanesulfonamidoacetic acid	NEtFOSAA	2991-50-6
Perfluorooctane sulfonamide ethanols		
N-methyl perfluorooctanesulfonamidoethanol	NMeFOSE	24448-09-7
N-ethyl perfluorooctanesulfonamidoethanol	NEtFOSE	1691-99-2
Per- and Polyfluoroether carboxylic acids		
Hexafluoropropylene oxide dimer acid	HFPO-DA	13252-13-6
4,8-Dioxa-3*H*-perfluorononanoic acid	ADONA	919005-14-4
Perfluoro-3-methoxypropanoic acid	PFMPA	377-73-1
Perfluoro-4-methoxybutanoic acid	PFMBA	863090-89-5
Nonafluoro-3,6-dioxaheptanoic acid	NFDHA	151772-58-6
Ether sulfonic acids		
9-Chlorohexadecafluoro-3-oxanonane-1-sulfonic acid	9Cl-PF3ONS	756426-58-1
11-Chloroeicosafluoro-3-oxaundecane-1-sulfonic acid	11Cl-PF3OUdS	763051-92-9
Perfluoro(2-ethoxyethane)sulfonic acid	PFEESA	113507-82-7
Fluorotelomer carboxylic acids		
3-Perfluoropropyl propanoic acid	3:3FTCA	356-02-5
2*H*,2*H*,3*H*,3*H*-Perfluorooctanoic acid	5:3FTCA	914637-49-3
3-Perfluoroheptyl propanoic acid	7:3FTCA	812-70-4

The estimated reporting limits (MRL) based upon the preparation/analysis parameters herein at the time of this revision are approximately 2.0-20.0 ng/L (ppt) for aqueous samples and 0.5-5.0 ug/kG for solids . The linear range for these PFAS can be extended by dilution. These MRLs are based upon a volume of 0.250L-0.500L extracted for aqueous samples and 2-5 g. for solids.

This method is "performance-based," which means that modifications may be made without additional EPA review to improve performance (e.g., overcome interferences, or improve the sensitivity, accuracy, or precision of the results) *provided that* all performance criteria in this method are met. Requirements for establishing equivalency are in Section 9.1.2 and include 9.1.2.2c. For CWA uses, additional flexibility is described at 40 CFR 136.6. Changes in performance, sensitivity, selectivity, precision, recovery, etc., that result from modifications within the scope of 40 CFR Part 136.6, and Section 9.0 of this method must be documented, as well as how these modifications compare to the specifications in this method. Changes outside the scope of 40 CFR Part 136.6 and Section 9.0 of this method may require prior review or approval.

2. SUMMARY

Environmental samples are prepared and extracted using method-specific procedures. Sample extracts are subjected to cleanup procedures designed to remove interferences. Analyses of the sample extracts are conducted by LC-MS/MS in the multiple reaction monitoring (MRM) mode. Sample concentrations are determined by isotope dilution or extracted internal standard quantification (see Section 10.3) using isotopically labeled compounds added to the samples before extraction

2.1 Extraction

2.1.1 Aqueous samples are spiked with isotopically labeled standards, extracted using solid-phase extraction (SPE) cartridges and undergo cleanup using carbon before analysis.

2.1.2 Solid samples are spiked with isotopically labeled standards, extracted into basic methanol, and cleaned up by carbon and SPE cartridges before analysis.

2.2 Analysis

2.2.1 Extracts are then analyzed by HPLC-MS/MS in the MRM mode. Extracts contain Non-extracted Internal Standards (NIS) to monitor instrument performance and used for quantitative analysis.

2.2.2 Individual PFAS analytes are identified through peak analysis of the quantification and confirmation ions (Precursor and product ions) where applicable.

2.2.3 The concentration of each analyte is calculated using the isotope dilution technique. This approach corrects the target analytes for surrogate analog recoveries and these surrogates are essentially extracted internal standards (EIS). For QC purposes, the percent recoveries of the isotope dilution analogues are calculated using the integrated peak areas of isotope performance standards, which are added to the final extract and function as traditional internal standards (non-extracted internal standards), exclusively applied to the isotope dilution analogues.

3. DEFINITIONS

3.1 ANALYSIS BATCH – A set of samples that is analyzed on the same instrument during a 24-hour period, including no more than 20 Field Samples, that begins and ends with the analysis of the appropriate Continuing Calibration Check (CCC) standards. Additional CCCs may be required depending on the length of the analysis batch and/or the number of Field Samples.

3.2 CALIBRATION STANDARD (CAL) – A solution of the method analytes, isotope dilution analogues, and isotope performance standards (Internal standards) prepared from the Primary Dilution Standards and stock standards. The calibration standards are used to calibrate the instrument response with respect to analyte concentration.

3.3 CONTINUING CALIBRATION VERIFICATION (CCV) – A calibration standard containing the method analytes, internal standard(s) and surrogate(s). The CCV is analyzed periodically to verify the accuracy of the existing calibration for those analytes.

3.4 EXTRACTION BATCH – A set of up to 20 Field Samples (not including QC Samples) extracted together by the same person(s) during a work day using the same lot of SPE devices, solvents, surrogate, internal standard and fortifying solutions. Required QC samples include Method blank, and Matrix spike/duplicate pair.

3.5 FIELD DUPLICATES – Separate samples collected at the same time and sampling location, shipped and stored under identical conditions. Method precision, including the contribution from sample collection procedures, is estimated from the analysis of Field Duplicates. Field Duplicates are used to prepare matrix spike/matrix spike duplicate QC samples.

3.6 FIELD BLANK (FBLK) – An aliquot of reagent water that is placed in a sample container in the laboratory and treated as a sample in all respects, including shipment to the sampling site, exposure to sampling site conditions, storage, preservation, and all analytical procedures. The purpose of the FBLK is to determine if method analytes or other interferences are introduced into the sample from shipping, storage, and the field environment.

3.7 ISOTOPE DILUTION ANALOGUES - Isotopically labeled analogues of the method analytes that are added to the sample prior to extraction in a known amount. Note: Not all target PFAS currently have an isotopically labeled analogue. In these cases, an alternate isotopically labeled analogue is used as detailed in our SOP and in the reference method.

3.8 ISOTOPE DILUTION TECHNIQUE - An analytical technique for measuring analyte concentration using the ratio of the peak area of the native analyte to that of an isotopically labeled analogue, added to the original sample in a known amount and carried through the entire analytical procedure.

3.9 ISOTOPE PERFORMANCE STANDARDS (Internal Standards) - Quality control compounds that are added to all standard solutions and extracts in a known amount and used to measure the relative response of the isotopically labelled analogues that are components of the same solution. For this method, the isotope performance standards are three isotopically labeled analogues of the method analytes. The isotope performance standards are indicators of instrument performance and are used to calculate the recovery of the isotope dilution analogues through the extraction procedure. In this method, the isotope performance standards are not used in the calculation of the recovery of the native analytes.

3.10 METHOD BLANK – An aliquot of reagent water to which known quantities of the method analytes and isotope dilution analogues are added. The results of the MBLK verify method performance in the absence of sample matrix.

3.11 MATRIX SPIKE/MATRIX SPIKE DUPLICATE (MS/MSD) – Aliquots of field samples that have been fortified with a known concentration of target compounds, prior to sample preparation and extraction, and analyzed to measure the effect of matrix interferences. The use of MS/MSD samples is generally not required in isotope dilution methods because the labeled compounds added to every sample provide more performance data than spiking a single sample in each preparation batch.

3.12 LIMIT OF QUANTITATION (LOQ) – The smallest concentration that produces a quantitative result with known and recorded precision and bias. The LOQ shall be set at or above the concentration of the lowest initial calibration standard (the lowest calibration standard must fall within the linear range). Determined by matrix through the entire preparation and analysis process.

3.13 METHOD DETECTION LIMIT (MDL) – The minimum measured concentration of a substance that can be reported with 99% confidence that the measured analyte concentration is distinguishable from method blank results (40 CFR 136, Appendix B).

3.14 MINIMUM LEVEL OF QUANTITATION (ML) – The lowest level at which the entire analytical system must give a recognizable signal and acceptable calibration point for the analyte. The ML represents the lowest concentration at which an analyte can be measured with a known level of confidence. It may be equivalent to the concentration of the lowest calibration standard, assuming that all method-specified sample weights, volumes, and cleanup procedures have been employed. Alternatively, the ML may be established by multiplying the MDL (pooled or unpooled, as appropriate) by 3.18 and rounding the result to the number nearest to 1, 2, or 5 x 10n, where n is zero or an integer (see 68 FR 11770).

3.15 PRECURSOR ION – For the purpose of this method, the precursor ion is the deprotonated molecule ([M-H]-) of the method analyte (with the exception of HFPO-DA, in which the precursor ion is formed by decarboxylation). In MS/MS, the precursor ion is mass selected and fragmented by collisionally activated dissociation to produce distinctive product ions of smaller *m/z*.

3.16 PRIMARY DILUTION STANDARD (PDS) SOLUTION – A solution containing the analytes prepared in the laboratory from stock standard solutions and diluted as needed to prepare calibration solutions and other needed analyte solutions.

3.17 PRODUCT ION – For the purpose of this method, a product ion is one of the fragment ions produced in MS/MS by collisionally activated dissociation of the precursor ion.

3.18 INITIAL CALIBRATION VERIFICATION (ICV) – A calibration standard prepared independently from the primary calibration solutions. For this method, the ICV is a repeat of the entire dilution scheme starting with the same stock materials (neat compounds or purchased stock solutions) used to prepare the primary calibration solutions. Independent sources and separate lots of the starting materials are not required, provided the laboratory has obtained the purest form of the starting materials commercially available. The purpose of the ICV is to verify the integrity of the primary calibration standards.

3.19 QUANTITATIVE STANDARD - A quantitative standard of assayed concentration and purity traceable to a Certificate of Analysis.

3.20 STOCK STANDARD SOLUTION - A concentrated solution containing one or more method analytes prepared in the laboratory using assayed reference materials or purchased from a reputable commercial source with a Certificate of Analysis.

3.21 TECHNICAL GRADE STANDARD – As defined for this method, a technical-grade standard includes a mixture of the branched and linear isomers of a method analyte. For the purposes of this method, technical-grade standards are used to identify retention times of branched and linear isomers of method analytes.

3.22 ANALYTE – A PFAS compound included in this method. The analytes are listed in Table 1.

3.23 CALIBRATION STANDARD (CS) – A solution prepared from a secondary standard and/or stock solutions and used to calibrate the response of the LC-MS/MS instrument.

3.24 CONTINUING CALIBRATION VERIFICATION (CCV) STANDARD – The mid-point calibration standard that is used to verify calibration.

3.25 CFR – Code of Federal Regulations

3.26 EXTRACTED INTERNAL STANDARD (EIS) QUANTIFICATION – The response of the target compound is compared to the response of the labeled analog of another compound in the same LOC.

3.27 INSTRUMENT SENSITIVITY CHECK – solution used to check the sensitivity of the instrument. The solution contains the native compounds at the concentration of the LOQ.

3.28 IPR – INITIAL PRECISION AND RECOVERY; four aliquots of a reference matrix spiked with the analytes of interest and labeled compounds and analyzed to establish the ability of the laboratory to generate acceptable precision and recovery. An IPR is performed prior to the first time this method is used and any time the method or instrumentation is modified

3.29 OPR - ONGOING PRECISION AND RECOVERY- – Ongoing precision and recovery standard (OPR); a method blank spiked with known quantities of analytes. The OPR is analyzed exactly like a sample. Its purpose is to assure that the results produced by the laboratory remain within the limits specified in this method for precision and recovery. Applies to OPR and LLOPR (low level OPR at **2x** the LOQ level).

3.30 SPE – SOLID PHASE EXTRACTION; a technique in which an analyte is extracted from an aqueous solution or a solid extract by passage over or through a material capable of reversibly adsorbing the analyte. Also termed liquid-solid extraction.

4. INTERFERENCES

LC-MS/MS data from blanks, samples, and spikes must be evaluated for interferences. If any interferences are present, take corrective action if necessary. Do not use aluminum foil because PFAAs can be potentially transferred from the aluminum foil to the glassware. Only aluminum foil rinsed with LC/MS grade methanol can be used where necessary.

4.1 PFAS have been used in a wide variety of manufacturing processes, and laboratory supplies should be considered potentially contaminated until they have been tested and shown to be otherwise. The materials and supplies used during the method validation process have been tested and shown to be clean. These items are listed in the Reagents section.

4.2 Method interferences may be caused by contaminants in solvents, reagents (including DI water), sample bottles and caps, and other sample processing hardware that lead to discrete artifacts and/or elevated baselines in the chromatograms. All items such as these must be routinely demonstrated to be free from interferences (less than 1/2 the Reporting Limit), under the conditions of the analysis by analyzing Method Blanks. Subtracting blank values from sample results is not permitted.

4.3 PTFE products can be a source of PFAS (PFOA) contamination. The use of PTFE in the procedure should be avoided. Polypropylene (PP) or polyethylene (PE, HDPE) products may be used in place of PTFE products to minimize PFOA contamination.

4.3.1 Standards and samples are injected from polypropylene autosampler vials with polypropylene or polyolefin snap caps, once. Multiple injections may be performed on Primers when conditioning the instrument for analysis.

4.3.2 Random evaporation losses have been observed with the polypropylene caps causing high Internal Std. recovery after the vial was punctured and sample re-injected. For this reason, it is best to inject standards and samples once in the analytical sequence, then recap with polyolefin caps for storage.

4.3.2 Teflon-lined screw caps have detected PFAS at low concentrations. Repeated injection from the same teflon-lined screw cap have detected PFNA at increasing concentration as each repeated injection was performed, therefore, it is best to use polypropylene snap caps.

4.3.3 Aqueous samples should not come in contact with any glass containers or pipettes as PFAS analytes can potentially adsorb to glass surfaces. Standards dissolved in organic solvent may be purchased in glass ampoules. These standards in organic solvent are acceptable and subsequent transfers may be performed using glass syringes and pipets. Following extraction, the eluate must be collected in a polypropylene tube prior to concentration to dryness. Concentration to dryness in glass tubes may cause poor recovery.

4.4 LC/MS grade methanol must be used for all steps where methanol is used in this method. HPLC grade methanol has been demonstrated to be acceptable if tested prior to use.

4.5 Matrix interferences may be caused by contaminants that are co-extracted from the sample. The extent of matrix interferences will vary considerably from source to source, depending upon the nature of the sample.

4.5.1 Co-extracted Organic Material - Under normal LC conditions matrix effects due to co-extracted organic material enhanced the ionization of 4:2 FTS appreciably. Total organic carbon (TOC) is a good indicator of humic content of the sample.

4.5.2 Solid phase extraction cartridges may 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. SPE cartridges should be sealed while in storage to prevent ambient contamination of the SPE sorbent.

4.6 Contamination by carryover can occur whenever a high-concentration and low concentration samples are sequentially analyzed. To reduce carryover, the sample syringe in automatically rinsed with solvent between injections. These operations are programmed into the LC multi-sampler system.

4.7 Volumetric glassware and syringes are difficult to clean after being used for solutions containing high levels of PFOA. These items should be labeled for use only with similarly concentrated solutions or verified clean prior to re-use. To the extent possible, disposable labware is used.

4.8 Both branched and linear PFAS isomers can potentially be found in the environment. Linear and branched isomers are known to exist for PFOS, PFOA, PFHxS, and PFBS, based upon the scientific literature. We have also seen branched isomers for PFHpA, NMeFOSAA, NEtFOSAA and PFNA. If multiple isomers are present for one of these PFAS they likely are adjacent peaks that completely resolve or not, but usually with a deflection point resolved during peak integration. The later of these peaks matches the retention time of its labeled linear analog. In general, earlier peaks are the branched isomers and are not the result of peak splitting.

Currently, all these species are available as linear isomers. Some available branched and linear reference standards of the technical mixtures for these specific PFAS are used to ensure that all appropriate peaks are included during peak integration. These species currently include PFOA, PFHxS, NMeFOSAA, and NEtFOSAA. These branched isomers elute before the linear isomer and are integrated and reported as total for those species. Others are also included at this time such as those listed in section 7.3.4.

4.9 In an attempt to reduce PFOS bias, it is required that *m/z* 499>80 transition be used as the quantitation transition.

5. SAMPLE HANDLING

5.1 **Aqueous Samples** - samples are collected by our clients in 250 or 500ml HDPE bottles with unlined HDPE or polypropylene caps and filled to the neck. Each sample submitted should be submitted in triplicate-with one used for determination of Suspended solids and possible pre-screening. Sub-sampling should be avoided whenever possible. When historical data are available indicating high levels of PFAS, sub-sampling may be an advisable option.

5.2 **Soil Samples** – samples are collected in wide mouth 125 or 250 mL HDPE bottles with PP unlined caps.

5.3 SAMPLE SHIPMENT AND STORAGE/HOLDING TIMES – Maintain all aqueous samples protected from light at 0 - 6 ºC from the time of collection until shipped to the laboratory. Samples must be shipped as soon as practical with sufficient ice to maintain the sample temperature below 6 ºC during transport. Sample are to be received by the laboratory within 48 hours of collection. The laboratory must confirm that the sample temperature is 0 - 6 ºC upon receipt. Once received by the laboratory, the samples may be stored at ≤ -20 ºC, or at 0 - 6 ºC, until sample preparation. However, the allowable holding time for samples depends on the storage temperature, as described below:

5.3.1 Aqueous samples may be held in the laboratory for up to 90 days from collection, when stored at ≤ -20 ºC and protected from the light. When stored at 0 - 6 ºC and protected from the light, aqueous samples may be held for up to **28 days**, with the caveat that issues were observed with certain perfluorooctane sulfonamide ethanols and perfluorooctane sulfonamidoacetic acids after **7 days**. These issues are more likely to elevate the observed concentrations of other PFAS compounds via the transformation of these precursors if they are present in the sample.

5.3.2 Solid samples (soils and sediments) may be held for up to 90 days, if stored in the dark at either 0 - 6 ºC or ≤ -20 ºC, with the caveat that samples may need to be extracted as soon as possible if NFDHA is an important analyte.

5.4 **SAMPLE EXTRACT HOLDING TIMES** – Store sample extracts in the dark at less than 0 - 4 ºC until analyzed. If stored in the dark at less than 0 - 4 ºC, sample extracts may be stored for up to 90 days, with the caveat that issues were observed for some ether sulfonates after 28 days. These issues may elevate the observed concentrations of the ether sulfonates in the extract over time. Samples may need to be extracted as soon as possible if NFDHA is an important analyte.

6. APPARATUS AND MATERIALS (as listed or demonstrated equivalents)

6.1 250-500 mL polypropylene bottles with polypropylene caps. VWR Scientific or equivalent: Part no. 414004-125, 12 pk. Alternate: White PP unlined lid L238WH and 16oz. clarified PP single wall jar 70-400 neck, item J066-Containers and Packaging.com or equivalent.

6.2 Transport Tube: Virgin Polypropylene, White, Plastic, 10 mL Capacity, 16 mm OD, 93 mm Overall Lg, Self-Standing, 250 PK， Item 710Z420, Gamut.com (Grainger), with PP cap or equivalent.

6.3 Graduated cylinders, 50, 100, 250, 500 and 1000mL, Polypropylene, VWR Scientific or equivalent

6.4 Analytical Balance, 0.0001g., checked for accuracy each day of use with Class S weights, certified annually by an outside service

6.5 Extract concentrators: Organomation Model N-EVAP 112, 24 position concentrator with water batch control and nitrogen supply controls or equivalent

6.6 3.1 Micron in-line filters, Promochrom only

6.7 1.0-2.0 mL polypropylene snap cap vials, Agilent part no. 5182-0567 or equivalent

6.8 Snap caps, polypropylene or olefin, 11 mm, 11/9k, Agilent Part no. 5182-0542

6.9 Solid Phase Extraction Tubes: for EPA 1633: WAX (weak anion exchange mixed mode polymeric sorbent – Phenomenex No. 8B-S038-HCH 200 mg or Waters Oasis 150 mg Cat. # 186002493. Must have a pKa > 8 to remain positively charged during the extraction. Alternate is Agilent Bond Elute WAX 200 mg-cat. No. 5610-2151

6.10 Syringes, Hamilton or equivalent 5.0 uL, 10 uL 25 uL, 100 uL, 250 uL, 500 uL, teflon free

6.11 Solid Phase Extraction System-automated-Promochrom 8 position autosampler system for 6 mL capacity SPE tubes. System retrofit to remove all PTFE components and replaced with PEEK tubing or PFAS free tubing. Automated bottle rinsing feature required with 3.1 um in line PP filters

6.12 Nitrogen Evaporation System- TurboVap nitrogen evaporation system operated at less than 55C.

6.13 LC/MS-MS system- Agilent 1260 or 1290 HPLC system interfaced to an Agilent 6470A or 6460C Triple Quadrupole system. The instrument control and qualitative/quantitative software is Mass Hunter versions B.8.0 and B.9.0 or later.

6.13.1 HPLC System-Agilent 1260 or 1290 Infinity II

6.13.1.1 The Agilent 1260 or 1290 Infinity II HPLC system is configured with temperature controlled column oven compartment. 4 column configuration, temperature controlled (refrigerated) auto sampler compartments, injection valve, proportioning valves, variable flow controls and variable injection capabilities.

6.13.1.2 The delay column (PFAS and other interference removal) is an Agilent Eclipse Plus C18, 4.6mm x 50 mm, 3.5 um-Part no. 959943-902 or equivalent.

6.13.1.3 The analytical column is a Restek Raptor C18 part no. 9304252 50mm x 2.1 mm ID, 1.8 u particle size or equivalent

6.13.2 Agilent LC/MS-MS- Agilent 6470AAR/6460C

6.14.2.1 Agilent model 6470AAR/6460C triple Quadrupole system with Agilent Jet Stream ESI source. UHP nitrogen is used as cell gas and High purity nitrogen is delivered for the sheath gas from a Peak Scientific nitrogen generator system.

6.14 Vortex Mixer- Benchmark Industries or equivalent

6.15 Variable Speed shaker table, 18” x 12”- Orbital Shaker- Jiangau Tenlin Instr. Co., Ltd., Model no. TLSK-III 20-230 RPM, 0-999 min, or equivalent
6.16 Centrifuge, 50 mL, Premiere Model XC-2450 Series Centrifuge 6 x 50 mL, 3500 RPM max., or equivalent
6.17 Mechanical Pipettors- 10-100 uL; 100-1000 uL; 1000-5000 uL-4 E’S Scientific or equivalent, calibrated quarterly.
6.18 Vortex Mixer- Benchmark Industries or equivalent

6.19 pH paper, short range 6-8 and full range with 0.5 pH readability- VWR Scientific or equivalent
6.20 15 mL PP or HDPE Centrifuge tubes, Corning Part no. 430791
6.21 3 mL Disposable Transfer pipets, PE, VWR part no. 16001-176
6.22 1.0 mL polypropylene snap cap vials, Agilent part no. 5182-0567
6.23 Snap caps, polypropylene, 11 mm, 11/9k, Agilent Part no. 5182-0542
6.24 2mL self standing PP microcentrifuge snap cap tubes, SKS Scientific part no. 0747-17

6.25 Collection tubes, 15 mL graduated PP or HDPE Centrifuge tubes, Corning Part no. 430791
6.26 Disposable 10 mg scoops, PP
6.27 Ultrasonic mixer
6.28 10 mL disposable syringes, PP or HDPE, luer fitting
6.29 13mm or 25 mm 0.2 um Nylon membrane filters, PALL Acrodisc or equivalent

7. REAGENTS AND STANDARDS-as listed or equivalents

7.1 ALL REAGENTS and STANDARDS MUST BE LOGGED INTO THE ELEMENT LIMS SYSTEM. This includes lot numbers, expiration, open and prepared dates, receipt date, Certification/traceability documents from supplier(s) if provided and preparer.

7.2 SOLVENTS and REAGENTS-all as listed or equivalents

7.2.1 Methanol, hypergrade for LC/MS. (Merck) from Sigma Aldrich Part no. 1060354000 or equivalent (HPLC Plus grade is an acceptable alternate)

7.2.2 Water, hypergrade for LC/MS. (Merck) from Sigma Aldrich Part no. 1153334000 or equivalent (HPLC plus grade is an acceptable alternate). Alternatively, York PFAS free water demonstrated ion and PFAS free can be used.

7.2.3 Acetic Acid, glacial. ACS grade or equivalent.

7.2.4 Ammonium Hydroxide, conc. Cert. ACS grade, 28-30% in water, Sigma Aldrich part no.1054231000, or equivalent

7.2.5 Methanolic Potassium Hydroxide (0.05 M) – add 3.3 g of KOH to 1L MeOH

7.2.6 Sodium Hydroxide, pellets, ACS grade- Sigma Aldrich part no. 221465-500G, or equivalent

7.2.7 Potassium Hydroxide, pellets, ACS grade

7.2.8 Ammonium Acetate – ACS grade or better, Ammonium Acetate, HPLC or cert. ACS grade. Sigma Aldrich Part no. 73594-100-G-F or equivalent.

7.2.9 Ammonium Acetate 5 mM for HPLC in aqueous solution: HPLC gradient A-- Weigh 0.3854 g (+ 0.0005) Ammonium Acetate and add to 1 liter hypergrade Water. Mix until dissolved then sonicate for 5 mins. To remove air bubbles. Stability - 2 weeks.

7.2.10 **Methanolic Ammonium Hydroxide 0.3 %** - take 2.5 mL of conc. ammonium hydroxide into 247 mL MeOH (measure the 247 mL in a PP graduated cylinder-they are under QQ1 somewhere). Use a mechanical pipet to add the 2.5 mL (not strictly quantitative FYI)-**Make 4 bottles of this**. *Used for soil extractions*.- 1 month life

7.2.11 **Methanolic Ammonium Hydroxide 1.0 %** - take 8.25 mL of conc. ammonium hydroxide into 242 mL MeOH (measure the 242 mL in a PP graduated cylinder-they are under QQ1 somewhere). Use a mechanical pipet to add the 8.25 mL (not strictly quantitative FYI)- **Make 4 bottles of this** -*used in Promochrom*-1 month life.

7.2.12 **Aqueous Ammonium Hydroxide 3%-** take 24.8 mL of ammonium hydroxide and add to 242 mL PFAS free water. 3 month life- *used for pH adjustment*

7.2.13 **Methanol with 4% water, 1% ammonium hydroxide and 0.625% acetic acid** – add ammonium hydroxide (3.3 mL, 30%), reagent water (1.7 mL) and acetic acid (0.625 mL) to methanol (92 mL), store at room temperature, replace after 1 month. **This solution is used to prepare the instrument blank, calibration stds and is used to dilute the extracts of samples that exceed the calibration range.**

7.2.14 **Formic Acid 0.1M-aqueous** – add 873 uL formic acid into 250 mL PFAS free water- **Make 2 bottles of this**-*used to prepare 7 below.* 2 year life

7.2.15 **Formic Acid, 0.3M**-aqueous- add 2.62 mL (2619 uL) into 250 mL PFAS free water- **Make 4 bottles of this** -*used in Promochrom*-2 year life

7.2.16 **Formic Acid methanolic 1:1, 0.1M formic acid**- mix equal volumes of Methanol and 0.1 M formic acid- **Make 4 bottles of this** -*used in Promochrom*-2 year life

7.2.17 **Formic Acid 5% aqueous**- add 12.5 mL Formic acid into 250 mL PFAS free water. *Used for pH adjustment.* 2 year life

7.3 Stock Standards

Stock Standards are purchased in mid to high concentration levels from Wellington Laboratories, Inc. Guelph, ONT, CA. Currently, Wellington is the preferred supplier of these materials. As a second source verification, prepare a mid-level from the stock independently from the preparation used for initial calibration. Document this preparation in Element. See Attachments 1,2, and 3 for detailed information.

7.3.1 Internal Standards (7-Non-Extracted –NIS)) used for the method are MPFOA, MPFOS, M3PFBA, MPFDA, MPFHxA, MPFHxS and MPFNA.

These are purchased at 250 - 1000 ng/mL depending upon the ISTD in a mixture. This mixture is purchased from Wellington Labs in 1.2 mL volumes with the following **part no.: MPFAC-HIF-IS**. Stored at 4C or less unopened this solution has a 5 year life. Once opened, the life is one year from open date.

7.3.2 Isotopic Surrogate Analogs (24 isotopes) are purchased for the method described from Wellington Labs at 250-5000 ng/mL levels, depending upon the isotope. The part no. is **MPFAC-HIF-ES**.

7.3.3 Stock Standard mixtures of both linear and branched isomers of the EPA 1633 - 40 list are purchased from Wellington Labs at varying concentrations in 5 different mixtures under part nos. PFAC-MXJ, PFAS-MXI, PFAC-MXH, PFAC-MXG, PFAC-MXF.

7.3.4 Qualitative branched isomers mix- individual available branched and linear mixes for the following PFAS are used daily to allow for qualitative knowledge of the PFAS branched isomers so they are integrated/included in quantitative analysis: T-PFOA, lp-PFNA, br-FOSA, br-NEtFOSA, br-NMeFOSA, br-NEtFOSE and br-NMeFOSE. These are purchased at 50,000 ng/mL levels from Wellington Labs-the names above are the Catalogue nos. These have a five year life at stock concentrations.

Make a 100 ng/mL Intermediate mix by adding 2.0 uL of the individual stocks up to 1.0 mL with MeOH.

Make a working solution by taking 200 uL of the 100 ng/mL intermediate into 750 uL of cal matrix solution (7.2.13) and add 50 uL of 1:10 EIS mix.

Transfer 300 uL to an autosampler vials, add 3 uL of ISTD working mix, cap, vortex and store until needed. Life is 1 year.

The summary below details the procurement requirements for this method - All from Wellington Laboratories, Inc.:

Description	Part nos.	Comes in
40 Compound Target 1633 list targets	PFAC-MXJ PFAS-MXI PFAC-MXH PFAC-MXG PFAC-MXF	4 Days – 1.2 mL
Isotopic Surrogates-24	MPFAC-HIF-ES	4 Days – 1.2 mL
EPA 1633 - 7 Internal Stds	MPFAC-HIF-IS	4 Days – 1.2 mL

7.4 Preparation of Standards

7.4.1 Preparation of Working Standards and Intermediates from STOCK Materials

All stock standards are prepared by the vendor in methanol containing a bit of sodium hydroxide to prevent losses of target PFAS compounds due to potential esterification in methanolic solution. The stocks come prepared with 4 molar equivalents (a 3x excess) of sodium hydroxide for stocks at the 50 ug/mL levels. This insures their stability with respect to potential loss due to esterification. The basic solution insures that any acidic sites on the glass ampules or acidic impurities in the methanol are neutralized to prevent ester formation and forms the sodium salt of the PFAS to stabilize it.

When preparing any intermediate level standards, the dilution must be prepared in alkaline methanol to prevent the above from occurring.

In order to do this, prepare a 5.0 mM NaOH in Hypergrade Methanol (or LC/MSMS grade) by dissolving 0.02 g. of sodium hydroxide into 100 mL of MeOH. This has a 2 week life.

For intermediate standards that are made to 10 mL final volume, add 100 uL of 5.0 mM NaOH/MeOH as part of the preparation. This results in a final concentration of NaOH at 0.05 mM.

For intermediate standards prepared to a final volume of 1.0 mL. add 10 uL of the 5.0 mM NaOH/MeOH.

For working calibration standards/CCV/SCV made to 500 uL final volume, using the mixture detailed in section 7.1.13 (MeOH/Water/acetic acid/ammonium hydroxide). This approximates the matrix of the final extracts for analysis.

7.4.2 Storage and Handling of Standards

All working standards should be stored at either room temperature or 4C provided the containers are sealed properly.

Stock Standards may be stored at 4-10 deg. C but before using must sit to allow equilibration to room temperature followed by either vigorous vortex mixing or sonication for 3-5 mins.

7.4.3 Detailed Standards Preparation Procedure-EPA 1633

7.4.4 Internal Standards-*See Attachment 1*

Internal Standards are purchased as a **stock mixture** at 250-1000 ng/mL

These as transferred to a snap cap vial that has been pre-rinsed with 5 mM NaOH/MeOH then allowed to dry.

7.4.4.1 Working level of Non-Extracted Internal Standard (NIS) –make a 1:1 dilution of the stock by taking 500 uL of the Stock and adding 500 uL MeOH.

Use as is by adding 3 uL to 300 uL volumes for QC, samples or calibration.

7.4.5 Isotopic Surrogates (Extracted Internal Standards)- *See Attachment 2*

7.4.5.1 Stock Surrogates are purchased as a mixture at 250-5000 ng/mL. These are transferred to a snap cap vial that has been pre-rinsed with 5 mM NaOH/MeOH then allowed to dry.

Option 1- Use Stock as received and add 25 uL to all samples/QC to be extracted

Option 2- Prepare **2** mL of Working EIS by preparing a 1:2 dilution to yield 125-2500 ng/mL for use as follows:
Take 1000 uL of the Surrogate Stock, plus 25 uL of 5 mM NaOH/MeOH and 975 uL MeOH to give 2.0 mL final volume**. 50 uL are added to ALL preparation blanks, samples and QC**. This is sufficient for approx. 40 x 50 uL additions to all blanks, QC and samples.

This corresponds to adding 5 to 100 ng of EIS compounds to the initial samples and QC. The final volume of extractions will typically be 5.0 ml so this yields 1-20 ng/mL of the isotope EISs in the final extract for analysis.

For calibration, the Stock mix at 250-5000 ng/mL is used by adding 100 uL up to 1.0 mL final volume to yield 25/500 ng/mL in each calibration level as directed in the calibration section 7.4.7.1.

7.4.6 Target Analytes- EPA 1633- *See Attachment 3*

The target analytes for this method are purchased commercially from Wellington Labs under the 5 part nos. described in Section 7.3.3 which contains the method target analytes only at varying concentrations. These mixtures are transferred from their glass ampules to snap cap vials that have been pre-rinsed with 5 mM NaOH/MeOH then allowed to dry. Again these are the nominal concentrations and the actual anion concentrations for those present as salts are listed in the documentation and are reflected in both Mass Hunter and Element.

Preparation of a 1.0 mL volume of a 10 x intermediate of each of the 5 mixes for Calibration. Some of the higher levels on the curve use aliquots of the stock as shown in Figure 2.

Scale the volume accordingly if less is desired. Note that the EPA 1633 mixes come 1.2 mL per vial so this recipe may consume one vial quickly.

7.4.6.1 OPR and LLOPR - these are a mid-level blank spike and low level blank spike (at 2x the LOQ). These are prepared as follows from the EPA 1633 Target mixtures (5 components) by taking 200 uL of each STOCK into a snap cap vial giving 1.0 mL final volume.

1. Element ID Y22B199- PFAC-MXF mix 200 uL
2. Element ID Y22B200- PFAC-MXG mix 200 uL
3. Element ID Y22B201- PFAC-MXH mix 200 uL
4. Element ID Y22B204- PFAC-MXI mix 200 uL
5. Element ID Y22B205- PFAC-MXJ mix 200 uL

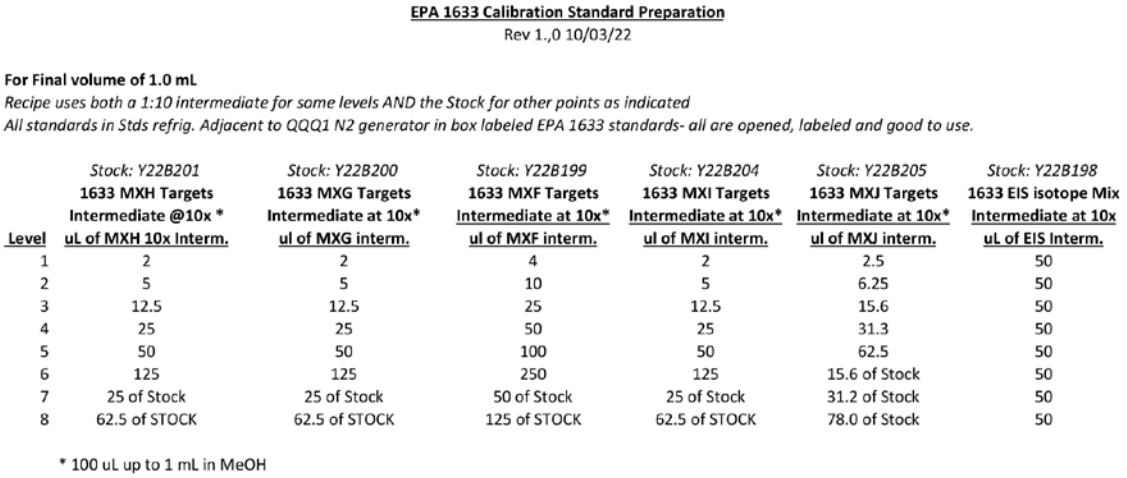
For OPR (BS) at mid-level add 100 uL to each matrix for the batch OPR and for the **LLOPR add 20 uL** of the spike mix and process through all steps of the specific matrix preparation.

7.4.7 Calibration

Calibration of the LC-MSMS systems is done by an eight level calibration covering the range 0.2 to 1650 ng/mL, nominal. Various PFAS species are present as salts and at differing concentrations and these are reflected in Mass Hunter and Element as their actual concentrations. Six to eight levels are prepared depending upon the analyte. These levels are prepared as directed below using the internal standards, surrogates and target analytes from above.
This is made to a final volume of 1000 uL in the matrix described in section 7.1.13 (MeOH/Water/acetic acid/ammonium hydroxide)

This preparation excludes the ISTD in the initial preparation. After preparation as directed, withdraw 300 uL of each level into a 500 uL PP vial and add 3 uL of ISTD before analysis, cap and vortex to mix.
These are stored at <10C and are stable for 6 months when prepared as directed.

7.4.7.1 Calibration Curve Preparation - Based upon a final volume of 1.0 mL in CAL Matrix Solution*
See Attachment 4 for details.



EPA 1633 Calibration Standard Preparation

Rev 1.,0 10/03/22

For Final volume of 1.0 mL

Recipe uses both a 1:10 intermediate for some levels AND the Stock for other points as indicated

All standards in Stds refrig. Adjacent to QQQ1 N2 generator in box labeled EPA 1633 standards- all are opened, labeled and good to use.

Level	*Stock: Y22B201* **1633 MXH Targets Intermediate @10x * uL of MXH 10x Interm.**	*Stock: Y22B200* **1633 MXG Targets Intermediate at 10x* ul of MXG interm.**	*Stock: Y22B199* **1633 MXF Targets Intermediate at 10x* ul of MXF interm.**	*Stock: Y22B204* **1633 MXI Targets Intermediate at 10x* ul of MXI interm.**	*Stock: Y22B205* **1633 MXJ Targets Intermediate at 10x* ul of MXJ interm.**	*Stock: Y22B198* **1633 EIS isotope Mix Intermediate at 10x uL of EIS Interm.**
1	2	2	4	2	2.5	50
2	5	5	10	5	6.25	50
3	12.5	12.5	25	12.5	15.6	50
4	25	25	50	25	31.3	50
5	50	50	100	50	62.5	50
6	125	125	250	125	15.6 of Stock	50
7	25 of Stock	25 of Stock	50 of Stock	25 of Stock	31.2 of Stock	50
8	62.5 of STOCK	62.5 of STOCK	125 of STOCK	62.5 of STOCK	78.0 of Stock	50

* 100 uL up to 1 mL in MeOH

*CAL MATRIX: Methanol with 4% water, 1% ammonium hydroxide and 0.625% acetic acid – Prepared by adding ammonium hydroxide (3.3 mL, 30%), reagent water (1.7 mL) and acetic acid (0.625 mL) to methanol (92 mL), store at room temperature, replace after 1 month. This solution is used to prepare the instrument blank and is used to dilute the extracts of samples that exceed the calibration range.

Amount of CAL Matrix to make up to 1.0 mL Final volumes:

CAL LEVEL	uL of CAL Matrix
1	937.5
2	918.8
3	871.9
4 *	793.7
5	637.5
6	309.0
7	843.8
8	609.5

INTERNAL STANDARD MIX (non-extracted IS-NIS). Mix 500 uL of STOCK ISTD at 250-1000 ng/mL with 500 uL of Methanol. This results in 125-500 ng/mL Intermediate ISTD. See 7.4.4.1.

Add 3.0 uL to 300 uL of each level 1-8 in a 500 uL PP autosampler vials and cap with polyolefin cap, vortex to mix and run. Add 3 uL to 300 uL of all sample/QC extracts before analysis.

*Level 4 is also used as the CCV for each analysis sequence run initially, then after every 10 samples and at the end of the sequence. Multiple vials should be prepared for this level.

7.4.8 Checking the Efficacy of the Surrogate/Spike Mixes

On a monthly basis the surrogate (EIS) and spike mixes from the vials used for spiking are assayed to ensure stability. These are prepared for the analysis by taking 3.0 uL of the surrogate (EIS) mix and 3 uL of the Spike mix into 294 uL MeOH/Water/Acetic Acid/Ammonium hydroxide from 7.1.13, then add 3 uL of NIS (ISTD). This yields a 1:100 dilution of the EIS and Spike mixes. Use 100 as the dilution factor in the Mass Hunter worklist.

7.4.9 Second Source - Initial Calibration Verification (ICV)

Currently, the EPA method 1633 does not require a second source ICV. Rather, the initial calibration is verified by preparing a Level 5 -5.0 ng/mL (nominal) calibration standard independently from calibration standard preparation. This serves as the ICV.

8. PROCEDURE

8.1 Preventative and Routine Maintenance

HPLC/MS/MS Preventative Maintenance	
As Needed: Change pump seals. Change in-line filters in autosampler (HPLC). Check/replace in-line frit if excessive pressure or poor performance. Replace column if no change following in-line frit change. Clean needle. Replace or clean Capillary Replace fused silica tube in ESI interface. Clean lenses. Clean skimmer. Ballast rough pump 30 minutes. Check Nozzle flow pattern	**Daily (When in use)** Check solvent reservoirs for sufficient level of solvent. Verify that pump is primed, operating pulse free. (ripple < 1%) Check needle wash reservoir for sufficient solvent. Verify capillary heater temperature functioning. Verify vaporizer heater temperature. Verify rough pump oil levels. Verify turbo-pump functioning. Verify nitrogen pressure for auxiliary and sheath gasses. Possible Checktune
Semi-Annually Replace oil mist and odor elements. Replace activated alumina filter if applicable	**Annually** Vacuum system components including fans and fan covers. Clean/replace fan filters, if applicable.

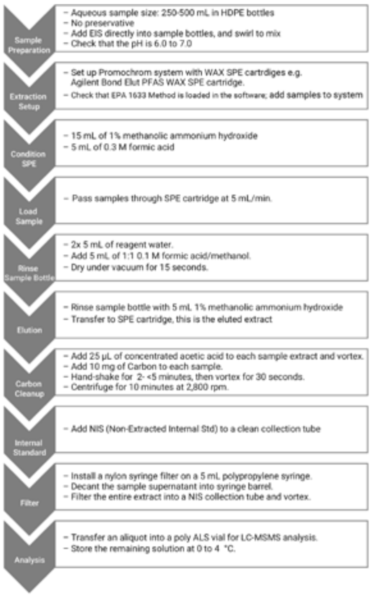
8.2 Sample Preparation (Extraction, Clean-up and Concentration)-Aqueous Matrices

A summary of the steps for the steps related to aqueous samples are shown in Figure 1.0 and in the summary below.

1. Determine % Suspended Solids – 10.0 mLs ± 0.02 mL through a tared 0.2 um PP filter. Dry filter ≥ 12 hours @ 105C, cool in dessicator. Calc % TSS
2. Check pH with short range pH paper to insure pH = 6.5 ± 0.5. Adjust if necessary with either 5% aqueous formic acid to lower pH or with 3% aqueous ammonium hydroxide to raise pH.
3. Weigh sample bottle as is to ± 0.1 g.-remove cap first since that will not be weighed later since autosampler caps are used
4. Homogenize sample by inversion 3-4 x-place full volume on Promochrom System using WAX SPE cartridges.

5. Set up MBLK, OPR at 2x LOQ (low LCS) and mid-level OPR (mid-level LCS)- spike with 10 uL of Spike mix for LLOPR and 100 uL of spike mix for mid-OPR.
6. Spike all with 25 uL EIS solution (isotopic surrogates)
7. Follow Promochrom method for EPA 1633
8. Initiate SPE program EPA1633AQ on the Promochrom system
9. Once the program is finished there will be 5 ml in the collection tube. If less, make up to exactly 5.0 mL with MeOH.
10. Remove the sample bottle from the Promochrom system and weigh the empty bottle. That will determine the weight (volume for water) assume 1g. = 1.0 mL. Enter this value into the element bench sheet and the initial volume.
11. Add 25 uL of concentrated acetic acid to each collection tube and vortex to mix.
12. Add 10 mg of activated carbon to all samples and QC. Hand mix and vortex mix for no more than 2 minutes
13. Centrifuge at 2800 rpm for approx. 10 minutes.
14. Filter the final volume through 0.2 um nylon filter using a syringe.
15. If the client provides only 250 mL of sample, in order to meet reporting limits, it may be required to concentrate the unfiltered extract by a factor of at least 2 on a TurboVap at 1.2 Liters/min with nitrogen at <55°C.. For example if final volume is 5.0 mL, concentrate to 2.0 mL final volume (2.5 x concentration). If 500 ml provided, skip this step.
16. Enter the final volume achieved into the bench sheet in Element.
17. Transfer a portion of the final extract to a 2 mL snap cap, labeled.
18. Take a 300 uL portion of the extract into a 500 uL PP autosampler vial, add 3 uL of NIS (non-extracted internal std.). Cap, vortex, store at <6°C.
19. Sample is ready for analysis.

Figure 1.0 Aqueous Sample Preparation Steps



– Aqueous sample size: 250-500 mL in HDPE bottles
– No preservative
– Add EIS directly into sample bottles, and swirl to mix
– Check that the pH is 6.0 to 7.0

– Set up Promochrom system with WAX SPE cartrdiges e.g. Agilent Bond Elut PFAS WAX SPE cartridge.
– Check that EPA 1633 Method is loaded in the software; add samples to system

– 15 mL of 1% methanolic ammonium hydroxide
– 5 mL of 0.3 M formic acid

– Pass samples through SPE cartridge at 5 mL/min.

– 2x 5 mL of reagent water.
– Add 5 mL of 1:1 0.1 M formic acid/methanol.
– Dry under vacuum for 15 seconds.

– Rinse sample bottle with 5 mL 1% methanolic ammonium hydroxide
– Transfer to SPE cartridge, this is the eluted extract

– Add 25 µL of concentrated acetic acid to each sample extract and vortex.
– Add 10 mg of Carbon to each sample.
– Hand-shake for 2- <5 minutes, then vortex for 30 seconds.
– Centrifuge for 10 minutes at 2,800 rpm.

– Add NIS (Non-Extracted Internal Std) to a clean collection tube

– Install a nylon syringe filter on a 5 mL polypropylene syringe.
– Decant the sample supernatant into syringe barrel.
– Filter the entire extract into a NIS collection tube and vortex.

– Transfer an aliquot into a poly ALS vial for LC-MSMS analysis.
– Store the remaining solution at 0 to 4 °C.

8.2.1 To measure sample initial volume for aqueous samples, remove the cap and weight the bottle and record the weight in the sample weight. For MBLK, LLOPR and OPR use 250-500 mL volumes). After SPE processing, be sure the empty bottle is dry and weight to determine the amount of sample in grams (essentially equal to volume in mL). Use that number for the initial volume in Element LIMS.

8.2.2 For every 20 field samples (Field blanks are considered field samples in as they are treated as such), a blank (MBLK), blank spikes, (2 levels- LLOPR and OPR as BS1 and BS2 respectively. A matrix spike is not necessary since isotope dilution is used. If an MS/MSD is required by a specific project, spike 100 uL of the mid-level BS mix (OPR).

8.2.3 All polypropylene equipment including graduated cylinders and sample transfer lines/reservoirs should be washed prior to using with extraction solvent (Methanol).

8.2.4 Add 25 uL of EIS (isotopic surrogates) (250/5000 ng/mL) to each sample and QC sample, recap and invert to mix well.

8.2.5 Add, 5ul (low level spike), 50 uL (mid-level spike)

8.2.6 Using the Promochrom automated system, run a cleaning run. Be sure the reservoirs of LC/MS grade methanol and HPLC plus grade water or equivalent are full. Prime all lines and align all components.

8.2.7. Load in the EPA1633 method and adjust the sample volume to 10 ml more than the highest volume container measured by visual comparison to a calibrated bottle of the same size.

8.2.8 The SPE method solvents for extractions are as follows:

- Solvent 1 = MeOH
- Solvent 2 = H_2O
- Solvent 3 = 0.3 M Formic acid,
- Solvent 4 = 1:1 0.1M Formic Acid/MeOH,
- Solvent 5 = MeOH with 1% ammonium hydroxide (“Basic MeOH”)

  W1 = Aqueous waste, W2 = Organic waste

8.2.9 Place labeled 15 mL graduated collection vessels in the sample collection tray and use Element labels to identify the vials at this point. Print 2 sets of labels for each since they will be used after the concentration step as well. These are graduated.

8.2.10 Connect the bottles to the automated system.

8.2.12 Initiate the EPA1633Aq SPE Extraction Program. Each run is approximately 1 hour 45 minutes.

8.2.13 **Evaporation Options**-Aqueous Samples

N-EVAP systems

8.2.13.1 The resulting 5 mL extracts are not further concentrated unless Work Plan reporting limits need to be lower than standard RLs. When this is required by the Work Plan, the extracts and QC are transferred to the N-EVAP concentrator systems operated at 50-55 degrees C (never more than 55C) in their original collection vials. The nitrogen flow is initiated at 1.2 ml/min and adjusted on each individual sample to provide a gentle stream causing a slight disturbance at the surface of the methanol extracts.

8.2.13.2 As this evaporation proceeds the walls of each vessel are rinsed with methanol when the volume is approximately 2.5 mls and then again when the volume is reduced to just below 2.0 mL. Then Bring up the final volume to 2.5 mL. This is a 2x concentration when needed.

8.2.14 Swirl final extract, make up to 2.0 mL with methanol. Using a disposable polypropylene pipet, carefully transfer to a 2 mL PP snap cap vial.

8.2.15 Withdraw an aliquot of 300 uL into a 500 uL autosampler vial (PP) and add 3.0 uL of ISTD (NIS) mix. .

8.2.16 Cap with polyolefin flexible caps and vortex to mix.

8.2.17 Store Extracts at <6°C until analysis.

8.3 Sample Preparation (Extraction, Clean-up and Concentration)-Soil Matrices

1. Determine % solids: use 5 grams; dry at 110C ≥ 12 hours.
2. Mix sample with a stainless steel spatula to homogenize-exclude Sticks, vegetation, rocks and the like.
3. Remove 5.0 g. from the homogenized sample container. Add to a tared 50 mL centrifuge tube. Determine the weight ± 0.01 g.
4. Prepare QC using clean matrix (Ottawa Sand) wetted with 1 mL PFAS free water in 50 mL centrifuge tubes
5. For all samples, QC blanks and LCSs (LLOPR and ML OPR) and a 25 uL aliquot of EIS onto the soil. The current Element standard ID is Y22J305. For the OPRs add appropriate amount of spike solution (10 uL for LLOPR and 100 uL for OPR. The current Element Std ID is Y22J304.
6. Swirl the samples to mix then let sit for 30 minutes.
7. Add 10 mL of 0.3% methanolic ammonium hydroxide to each centrifuge tube.
8. Vortex to mix then shake on the shaker table for 30 minutes.
9. Next, centrifuge at 3500 rpm for 5 minutes or 2800 rpm for 10 minutes.
10. Transfer the supernatant liquid to a clean 50 mL centrifuge tube
11. Add 15 mL of 0.3% methanolic ammonium hydroxide to each of the original centrifuge tubes.
12. Vortex to mix then shake on the shaker table for 30 minutes
13. Next, centrifuge at 3500 rpm for 5 minutes or 2800 rpm for 10 minutes.
14. Transfer the supernatant liquid to the centrifuge tubes from 10.0 above
15. Add another 5 mL of 0.3% methanolic ammonium hydroxide to each of the original centrifuge tubes.
16. Vortex to mix then shake on shaker table for 30 minutes
17. Next, centrifuge at 3500 rpm for 5 minutes or 2800 rpm for 10 minutes.
18. Transfer the supernatant liquid to the centrifuge tubes from 10.0 above
19. Add 10 mg of activated carbon to the combined extract using a 10 mg scoop and hand swirl for 2 minutes (never more than 5 minutes of losses of Target PFAS will occur)
20. Centrifuge at 3500 rpm for 5 minutes or 2800 rpm for 10 minutes
21. Immediately Decant into a 50 mL centrifuge tube.
22. Place in Turbovap or on the N-EVAP system and concentrate at 55 deg. C to a final volume of approx..7 mL at a nitrogen flow of 1.2 ml/min.
23. Add 35-40 mL of PFAS free water to the tube and vortex to mix.
24. Check the pH= 6.5 ± 0.5 if not adjust accordingly using 5% formic acid to lower pH or 3% aqueous ammonium hydroxide to raise pH rto within this range.

25. Set up the soil EPA 1633 method on the Promochrom be sure volume is set to 50 ml for sample size.
26. Place samples and QC centrifuge tubes on the autosampler
27. Once the program is finished, note the final volume and use that in the Element benchsheet as final volume. Should be 5.0 mL. If less make up to 5.0 mL with MeOH.
28. Add 25 uL of concentrated acetic acid to each collection tube and vortex to mix.
29. Add 10 mg of carbon to all samples and QC and mix for 2 minutes (no more than 5 minutes).
30. Immediately centrifuge at 2800 rpm for 10 minutes.
31. Filter the extract through a 0.2 um nylon membrane using a syringe and filter into a 2 mL snap cap vial.
32. When ready for analysis, remove 300 uL of extract and transfer to a 500 uL autosampler vial. Add 3 uL of NIS (internal standard), vortex to mix. Cap with polyolefin flexible caps and vortex to mix.
33. Store Extracts at <6°C until analysis
34. Samples/QC are now ready for analysis.

8.4 Sample Analysis--Running Samples/QC - Acquisition Method

The acquisition method is detailed in Attachment 4 (HPLC) and Attachment 5 (MS/MS) of this SOP. The method is a HPLC with dynamic MRM method with precursor and product ions with specific acquisition parameters to maximize sensitivity and specificity. This list may be modified to add other PFAS target analytes as necessary.

8.3.1 The triple Quadrupole (QQQ) system must be optimized for each target analyte (including surrogates and internal standards) using the Mass Hunter Optimizer program. This program determines the most abundant precursor and product ions for each compound and their abundances. These data are then used to build an MRM (multiple reaction monitor) method for acquisition. This is done initially or after any major maintenance procedures are performed to the triple quadrupole system. A high level standard is used for this in the $[M\text{-}H]^-$ mode or M-COOH for HFPO-DA.

8.3.2 The QQQ is checked for tuning on a weekly basis (if necessary) before analysis using the Tune context by selecting the CHECKTUNE radio button. This is done only in negative ion mode since that what we are operating under. If the Checktune fails, run the Autotune program-note: this takes approx. 45 mins. in negative mode. After autotune or any tuning adjustment, a re-calibration of the instrument is required.

8.3.3 Before any QC or samples can be run, the HPLC must be allowed to purge for at least thirty minutes. This purge must be done using the initial mobile phase conditions used in the method must be allowed to run for 15 minutes or until pressure has stabilized (ripple must be < 1%)

8.3.4 An instrument sequence (Worklist) is then made. It should begin with a blank, a primer (5 ng/mL) followed by a blank with ISTD to establish system cleanliness.

8.3.5 After a successful initial calibration has been completed, the analytical sequence for a batch of samples analyzed during the same time period is as follows. Standards and sample extracts must be brought to room temperature and vortexed prior to aliquoting into an instrument vial in order to ensure homogeneity of the extract.

8.3.6 **Analysis Sequence**

1. Instrument Blank *
2. Instrument Sensitivity Check –**LOQ Standard Level (SEQ-CAL 1) S/N > 3:1**
3. Calibration Verification Standard (CCV)
4. Qualitative Identification Standards –Branched PFAS
   PFOA, PFNA, PFOSA, NMeFOSA, NEtFOSA, NEtFOSE, and NMeFOSE.
5. Instrument Blank (SEQ-CCB)*
6. Method Blank (Batchxxxx-BLK1)
7. Low-level OPR (LLOPR) (Batchxxxx-BS1)
8. OPR (Batchxxxx-BS2)
9. Field Samples (10 or fewer)
10. Calibration Verification Standard (SEQ-CCVn)
11. Instrument Blank (SEQ-CCBn)*
12. Field Samples (10 or fewer)
13. Calibration Verification Standard (SEQ-CCVn)
14. Instrument Blank (SEQ-CCBn)*

* Contains solvent system for calibration, NIS and EIS

8.3.7 The run can end with a script to put the instrument into standby mode.

8.4 Daily Sample Preparation/Analysis Sequence

- Prepare extracts for analysis by placing a 300 ul aliquot of sample extract containing 3 uL of internal standards into a PP auto-sampler vial. Apply Polyolefin cap.
- Confirm that the samples loaded on the auto-sampler were entered correctly in the injection log. Make any necessary corrections.
- Run instrument CCV checks at the RL (0.25-0.5 ng/mL), then at a mid level and high level rotating every ten samples (5, 25 ng/mL) and ending with a mid level CCV.
- Enter the Worklist (<u>injection sequence</u>) into the instrument software and load samples onto the auto-sampler in the order shown above in Section 8.3.6

8.5 Data Review

The Agilent Mass Hunter Quantitation program is used to review all data. All identifications are based upon acceptable ion ratios for the abundance of both precursor and product ions along with retention time information. All positive detections of target PFAS must be less that the high point conc. of the Cal. Curve.

8.5.1 Since certain PFAS species are manufactured by different processes the presence of branched as well as linear isomers may be found. In order to properly quantitate these species, the analyst must sum the related branched and linear isomers. This affects the following species: PFOS, PFHxS, PFOA, PFNA, PFOSA, NMeFOSA, NEtFOSA, NEtFOSE, and NMeFOSE.

8.5.2 Any detection greater than the upper limit of the calibration curve requires dilution into the upper half of the curve, where possible.

9. CALIBRATION

9.1 Initial Calibration

The initial calibration covers the range 0.20 ng/mL to 1560 ng/mL nominal conc. or higher depending upon the linearity of the PFAS species. After acquisition, the data are quantitated in Mass Hunter and the default calibration model for target compounds is generated using Quadratic regression, FORCED through the origin where applicable. All same level species (EIS) used average response factor model. Depending upon the response and accuracy at each level as shown in the Mass Hunter program, use Linear, Forced, weighted (1/x) or quadratic, Forced, with or without weighting to achieve the best fit which is based upon the best accuracy on a compound by compound basis. In any case, the correlation coefficient must be greater than 0.990. Average response factor RSD should be $\leq$ 20% where used.

9.1.1 The calibration levels as shown in Section 7.6.3 use 8 levels. All points are included in the calibration with exception of some species that saturate at levels 7 and 8.

9.2 ICV/SCV

An independently prepared Initial Calibration Verification must be run immediately following initial calibration. The concentration of this standard should be in the middle of the calibration range (e.g. 5.0 ng/mL) and prepared from a separate preparation as that of the calibration. Unless project-specific data quality objectives are required, the values from the second-source check should be $\pm$ 30% of the expected concentration.

Corrective Action: Quantitative sample analyses should not proceed for a failing ICV. Recalibrate and re-run the ICV if necessary.

9.3 Continuing Calibration Verification

The first CCV is at a mid-level and run every 10 client samples including a closing CCV.

The mid-Level CCV must be ± 30% of the true value.

Corrective Action: If any of the required calibration check criteria fail, the system must be evaluated and any appropriate instrument repair or maintenance must be performed. Sample data are unacceptable and must be rerun. Reinjection the standard may be done. If the calibration check standard still fails, the system must be recalibrated.

10. Quality Control

10.1 Initial Demonstration of Capability (IDOC)

10.1.1 The initial demonstration requirement of EPA 1633 must be acceptable before analysis of samples may begin. To establish the ability to generate acceptable precision and recovery, the laboratory must perform the following operations for each sample matrix type to which the method will be applied by that laboratory.

The IDOC includes the following key elements:

- Initial Demonstration of Precision and Recovery (IPR)
- MDL determination

10.1.2 Initial Demonstration of Precision and Recovery-IPR

- Extract, concentrate, and analyze four aliquots of aqueous and soil matrices spiked with 100 uL of the native spike solution OPR Mix Y22J304, 50 µL of the EIS solution no. Y22J305. At least one method blank, matching the matrix being analyzed, must be prepared with the IPR batches by matrix. All sample processing steps that are used for processing samples, including preparation and extractions, cleanup and concentration, must be included in this test.

- Using results of the set of four analyses, compute the average percent recovery (R) of the extracts and the relative standard deviation (RSD) of the concentration for each target and EIS compound.
- For each native and isotopically labeled compound, compare RSD and % recovery with the corresponding limits for initial precision and recovery in Table 5. If RSD and R for all compounds meet the acceptance criteria, system performance is acceptable, and analysis of blanks and samples may begin. *Note these acceptance criteria are not finalized and are based upon a single lab validation. Data for this table are derived from the single-laboratory validation study, and are only provided as examples for this draft method. The data will be updated to reflect the inter-laboratory study results in a subsequent revision. Therefore, these criteria will change after inter-laboratory validation. Several sections of this method state that Table 5 criteria are required, this is standard language that will be applicable when the method is finalized.*

10.1.3 MDL Determination

MDL Determination –In order to perform the MDL study, 7 total extractions are performed on 3 different days (Extraction day 1= 3 LRBs and 3 LFBs); Extraction day 2 is 2 of each, and Extraction day 3 is also 2 of each).

The levels extracted represent approx. 3-5 x the expected LOQ.

Once extracted, the analyses are conducted on 3 separate days (we use only QQQ2 for EPA 1633 so all runs are on that system). The MDL is determined according to the EPA MDL protocol defined in Definition and Procedure of the Determination of the Method Detection Limit, Revision 2 Dec. 2016 as detailed below:

Make all computations as specified in the analytical method and express the final results in the method-specified reporting units.

Calculate the sample standard deviation (SD) of the replicate spiked sample measurements and the sample standard deviation of the replicate method blank measurements from all instruments to which the MDL will be applied.

Compute the MDLs (the MDL based on spiked samples) as follows:

MDL_s = 3.143 x SD (for seven replicates; SD = Standard Deviation)

Compute the MDLb (MDL based on method blanks-LRBs) as follows:

- If none of the blanks give numerical results then the MDLb does not apply
- If only some of the blanks (but not all) give a result, set the MDLb to the highest result found

- If ALL method blanks show a detections then use the following calculation to determine MDLb:

MDLb = Average of Blank Detections + (3.143 x Std. Dev.)

Calculate the final MDL by selecting the greater of MDLs or MDLb.

10.2 On-going QC Requirements

Preparation Batches are defined at the sample preparation step. Batches should be kept together through the whole analytical process as far as possible, but it is not mandatory to analyze prepared extracts on the same instrument or in the same sequence.

The quality control batch is a set of up to 20 samples of the same matrix processed using the same procedure and reagents within the same time period. The quality control batch may contain a matrix spike/matrix spike duplicate (MS/MSD), two laboratory control sample (LCS-LLOPR and OPR) and a method blank. Laboratory generated QC samples (Blank, LLOPR, OPR, MS/MSD) do not count toward the maximum 20 samples in a batch. Field QC samples are included in the batch count. In some cases, at client request, the MS/MSD may be replaced with a matrix spike and sample duplicate.

10.2.1 METHOD BLANK - One method blank must be extracted with every prep batch of similar matrix, not to exceed twenty (20) samples. For aqueous samples the matrix is Lab reagent water. For Soils the method blank matrix is Ottawa sand. Criteria:

- The method blank must not contain any analyte at or above 1/2 the LOQ (Reporting Limit).
- Re-extraction and reanalysis of samples associated with an unacceptable method blank is required when reportable concentrations are determined in the samples.

10.2.2 LABORATORY CONTROL SAMPLES (LCS- also called OPR and LLOPR) must be extracted with every process batch of similar matrix, not to exceed twenty (20) samples. The LCS is an aliquot of laboratory matrix (e.g. water for aqueous spiked with analytes of known identity and concentration and isotopic surrogate analogs. The OPRs must be processed in the same manner and at the same time as the associated samples. Recovery for Aqueous low level OPR target analytes is 40-150% until more data are derived. For all other Aqueous OPR levels recovery targets are 50-150%. These data are based upon EPA 1633 draft ranges that will change and are not used for acceptance/rejection but are reported until such time that fully validated acceptance ranges are provided in the final version of the method.

10.2.3 Matrix spike/Matrix spike duplicate (MS/MSD or MS/MSD). These are not typically required since each sample contains isotopic PFAS analogues that correct for any matrix effects. If the client requests them, then they are processed accordingly but are not a requirement of this method. If done they are by matrix, not to exceed twenty (20) samples. An MS/MSD pair is aliquots of a selected field sample spiked with analytes of known identity and concentration. The MS/MSD pair must be processed in the same manner and at the same time as the associated samples. Spiked analytes with recoveries or precision outside of the Laboratory control limits are flagged accordingly. Until enough statistical data per matrix is available, no criteria are offered. If a specific QA Project Plan has required limits, this is preempted. Any outliers must be qualified accordingly.

10.2.4 Initial calibration verification (ICV) –A second source standard is not required for this method. A second independently prepared mid-level standard is prepared and used for this purpose and analyzed after the ICAL. The concentration should be at the mid range of the curve and must recover within 70-130 % of expected value.

Corrective actions for the ICV include:

- Rerun the ICV
- Remake or acquire a new ICV.
- Evaluate the instrument conditions.
- Evaluate the initial calibration standards.
- Rerun the initial calibration.

10.2.5 Internal Standard- The Non-extracted Internal Standard (NIS) is added to each field and QC sample prior to analysis. The IS response (peak area) must not deviate by more than 50-200% from the mean response (peak area) of the initial calibration. If the areas are low for all the field samples and QC samples in the batch, it suggests a loss of instrument sensitivity, while low areas in only some field or QC samples suggests a possible bad injection.

Corrective action includes:

- Reinject the questionable samples
- Verifying the CCV NIS areas are compliant with the range, if so, this suggests either matrix effects and may require a small dilution to mitigate interference if only some of the NIS compounds are affected
- Qualify affected data

10.3 Initial Demonstration of Capability (IDC)

Initial Demonstration of Capability involves the following processes listed ion Table 1.0 as follows.

Table 1.0 - Initial Demonstration of Capability (IDC)

Requirement	Specification and Frequency	Acceptance Criteria
Initial Demonstration of Precision and Recovery (IPR)	Extract, concentrate, and analyze four aliquots of the matrix (aqueous and soil) spiked with target native standard solution, EIS solution and finally the NIS (ISTD). Extract a method blank of each matrix with each matrix IPR batch. All steps that are used for processing samples, including preparation and extraction must be included.	Using results of the set of four analyses, compute the average percent recovery (R) of the extracts and the relative standard deviation (RSD) of the concentration for each target and EIS compound.
		For each native and isotopically labeled compound, compare RSD and % recovery with the corresponding limits for initial precision and recovery in Table 5. If RSD and R for all compounds meet the acceptance criteria, system performance is acceptable, and analysis of blanks and samples may begin.
Method Detection Limit (MDL)	Method detection limit (MDL) - Each laboratory must also establish MDLs for all the analytes using the MDL procedure at 40 CFR Part 136, Appendix B. An MDL determination must be performed for all target compounds.	The minimum level of quantification (ML) can be calculated by multiplying the MDL by 3.18 and rounding to the nearest integer
Calibration Verification (ICV or SCV) *Section 9.1.5*	Analyze a mid-level ICV, each time a new calibration is performed or at a minimum, quarterly. The ICV must be an independent dilution beginning with the common starting materials used for ICAL. No 2nd source is required due to availability.	Results must be 70-130% of true value.

10.4 QC Requirements

Ongoing QC requirements are detailed in Table 3.0 as follows.

Table 3.0 QC Requirements

Summary of Quality Control		
Method Reference	**Requirement**	**Specification and Frequency**
Section 10.1	Mass Calibration	Annually and on as-needed basis
Section 10.1.7	Mass Calibration Verification	After mass calibration
Section 10.3	Initial Calibration (ICAL)	Minimum 6 calibration standards for linear model and 7 calibration standards for non-linear models.
Sections 10.2.2, 14.4	Retention Time (RT) window	After ICAL and at the beginning of analytical sequence
Sections 7.3.1, 9.4	Extracted Internal Standard (EIS) Analytes	All CAL standards, batch QC and field samples

Sections 7.3.2	Non-extracted Internal Standards (NIS)	All CAL standards, batch QC and field samples
Sections 7.3.4, 10.3.1, 13.3	Instrument Sensitivity Check (ISC)	Daily, prior to analysis
Section 14.2	Calibration Verification (CV) (CCV)	At the beginning and every 10 samples and at the end
Section 14.6	Instrument Blank	Daily prior to analysis and after high standards
Sections 9.1.3, 9.5, 14.7	Method Blank (MB)	One per preparation batch
Section 14.5	Ongoing Precision Recovery (OPR)	One per preparation batch
Section 11.0	Limit of Quantitation Verification (LLOPR)	Prior to analyzing samples
Section 11.0	Matrix Spike (MS/MSD)	One per preparation batch (if required) Normally not needed, since Isotope dilution is employed

11.0 DATA REVIEW, CALCULATIONS AND REPORTING

Samples concentrations are determined using either or linear regression or quadratic regression FORCED through the origin. Weighted ($1/x$ or $1/x^2$) may assist with low level accuracy and is recommended where necessary. All calibration curves have greater than 6 points. Any target analyte exceeding the calibration range will require dilution.

11.1 Data interpretation

All sample data calculations are performed by the Agilent Mass Hunter software in ng/mL and then final data are calculated taking into account final extract volumes and the initial sample volumes extracted which are entered into the Element bench sheet.

11.2 Linear and Branched Isomers are addressed in Section 8.5 and are reported for the noted species as Total which is a sum of the linear and branched isomers for affected species.

11.3 All Data are uploaded into Element LIMS and all final concentration calculations and associated recoveries are detailed. All pdfs of Mass Hunter Quant reports are uploaded to the Element Raw_Data drive for association with ICALs and all batch and analysis sequence runs. Data are set to Analyzed status once uploaded and initially reviewed, then locked.

11.4 The Data are then evaluated using the York Qualinator ™ data review tool which evaluates all data CCVs, QC, ISTDS, Recoveries, etc. and automatically assigns outlier qualifiers for review and acceptance by the reviewer. The accepted data are then uploaded to Element and final reviewed in Laboratory Data Entry/Review module. Once reviewed, the status is set to Reviewed indicating the data are ready to be Reported by the Reporting Group.

12. HEALTH AND SAFETY

12.1 General safety considerations and requirements are detailed in the York Laboratory Safety and Health Standard Operating Procedure No. Safety011600.

Specific safety rules applying to the conduct of this analysis requiring the following:

- When handling standards and samples, latex gloves are required.
- Also, when handling neat materials, a fume hood and safety glasses are required.
- When handling samples, gloves and glasses are required.
- Highly odorous samples must be handled in a fume hood.
- Refer to SDSs for specific safety/health information.

12.2 The analysts must exercise normal care and be supervised and trained to work in an analytical chemistry laboratory. The analysts will be handling fragile glassware, needles, syringes, volatile and flammable chemicals, toxic chemicals and corrosive chemicals.

- No smoking or open flames are allowed.
- No food or food products may be brought into the laboratory.

Solvents should not be left uncovered on the laboratory benches.
All solvent transfers should be done in the hoods.

Hood doors must be kept in the position which yields approx. 100 fpm face velocity.
Solvent evaporation must be done in the hood with exhaust elevated and in the rear.

Waste containers that had solvents must be vented to a hood until all solvents have evaporated.

Safety glasses are provided and must be worn at all times in the laboratory.
Gloves are provided and must be worn when working with chemicals.
Laboratory coats are provided and should be worn to protect the analysts' clothes.
Syringes and needles must be kept in their original cases when not in use.
Care must be exercised in using and handling syringes to avoid injury.
Report any sticking with a needle immediately to your supervisor.

12.3 Specific Safety Concerns

12.3.1 Preliminary toxicity studies indicate that PFAS could have significant toxic effects. In the interest of keeping exposure levels as low as reasonably achievable, PFAS must be handled in the laboratory as hazardous and toxic chemicals.

12.3.2 Exercise caution when using syringes with attached filter disc assemblies. Application of excessive force has, upon occasion, caused a filter disc to burst during the process.

12.3.3 Laboratory procedures such as repetitive use of pipets, repetitive transferring of extracts and manipulation of filled separatory funnels and other glassware represent a significant potential for repetitive motion or other ergonomic injuries. Laboratory associates performing these procedures are in the best position to realize when they are at risk for these types of injuries.

12.3.4 Eye protection, laboratory coat, and nitrile gloves must be worn while handling samples, standards, solvents, and reagents. Disposable gloves that have been contaminated will be removed and discarded; other gloves will be cleaned immediately.

12.3.5 Perfluorocarboxylic acids are acids and are not compatible with strong bases.

12.3.6 Primary Materials Used- The following is a list of the materials used in this method, which have a serious or significant hazard rating. NOTE: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the SDS for each of the materials listed in the table. A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the SDS for each material before using it for the first time or when there are major changes to the SDS.

Methanol	-Flammable Poison -Irritant	200 ppm (TWA)	A slight irritant to the mucous membranes. Toxic effects exerted upon nervous system, particularly the optic nerve. Symptoms of overexposure may include headache, drowsiness and dizziness. Methyl alcohol is a defatting agent and may cause skin to become dry and cracked. Skin absorption can occur; symptoms may parallel inhalation exposure. Irritant to the eyes.

Acetic Acid, Glacial	-Flammable liquid and vapor. -Irritation	10 ppm TWA; 25 mg/m3 TWA	**Eye:** Causes severe eye irritation. Contact with liquid or vapor causes severe burns and possible irreversible eye damage. **Skin:** Causes skin burns. May be harmful if absorbed through the skin. Contact with the skin may cause blackening and hyperkeratosis of the skin of the hands. **Ingestion:** May cause severe and permanent damage to the digestive tract. Causes severe pain, nausea, vomiting, diarrhea, and shock. May cause polyuria, oliguria (excretion of a diminished amount of urine in relation to the fluid intake) and anuria (complete suppression of urination). Rapidly absorbed from the gastrointestinal tract. **Inhalation:** Effects may be delayed. Causes chemical burns to the respiratory tract. Exposure may lead to bronchitis, pharyngitis, and dental erosion. May be absorbed through the lungs. **Chronic:** Chronic exposure to acetic acid may cause erosion of dental enamel, bronchitis, eye irritation, darkening of the skin, and chronic inflammation of the respiratory tract. Acetic acid can cause occupational asthma. One case of a delayed asthmatic response to glacial acetic acid has been reported in a person with bronchial asthma. Skin sensitization to acetic acid is rare, but has occurred.
Ammonium Hydroxide, conc. 28-30%	- Inhalation hazard - Skin Corrosion -Eye Damage and Irritation	OSHA PEL: 35 mg/m3 ; 50 ppm OSHA TWA: 18 mg/m3; 25 ppm	Ammonia is an irritant and corrosive to the skin, eyes, respiratory tract and mucous membranes. May cause severe chemical burns to the eyes, lungs and skin. Skin and respiratory related diseases could be aggravated by exposure. The extent of injury produced by exposure to ammonia depends on the duration of the exposure, the concentration of the liquid or vapor and the depth of inhalation. Exposure Routes: Inhalation (vapors), skin and/or eye contact (vapors, liquid), ingestion (liquid).
Formic Acid, conc.	-Flammable liquid and vapor -Harmful if swallowed -Causes severe skin burns and eye damage -Toxic if inhaled -May cause respiratory irritation	OSHA TWA: 5 ppm or 9 mg/m3 OSHA PEL: 10 ppm	Formic acid is an irritant and corrosive to the skin, eyes, respiratory tract and mucous membranes. May cause severe chemical burns to the eyes, lungs and skin. Skin and respiratory related diseases could be aggravated by exposure. The extent of injury produced by exposure to ammonia depends on the duration of the exposure, the concentration of the liquid or vapor and the depth of inhalation. Exposure Routes: Inhalation (vapors), skin and/or eye contact (vapors, liquid), ingestion (liquid).

13. WASTE MANAGEMENT/POLLUTION PREVENTION

Neat Materials

Waste management procedures require the prudent use of neat materials. The ordering of neat standards and materials must be done to minimize unused material which would result in storage or handling of excess material. Quantities ordered should be sufficient to provide for necessary standards with consideration to shelf life. When ordering a unique material for a standard, be sure to order the smallest practical quantity.

Solvents
The solvents used at York for this procedure include isopropanol and Methanol. These solvents are used for sample extraction or LC cleanup, all amounts are either consumed during concentration or placed in one liter amber jars in the hood areas for evaporation. Any remaining solvent/water is transferred to a drum designated for solvent waste.

Acids and Bases
The acids and bases used for this procedure include: Acetic Acid and Formic Acid. The bases used are Ammonium hydroxide, sodium hydroxide and potassium hydroxide. Store concentrated base and acids separately whether waste or neat material.

Samples
Unused or remaining water samples are returned to the sample control room for continued storage for proper disposal by the sample control group.

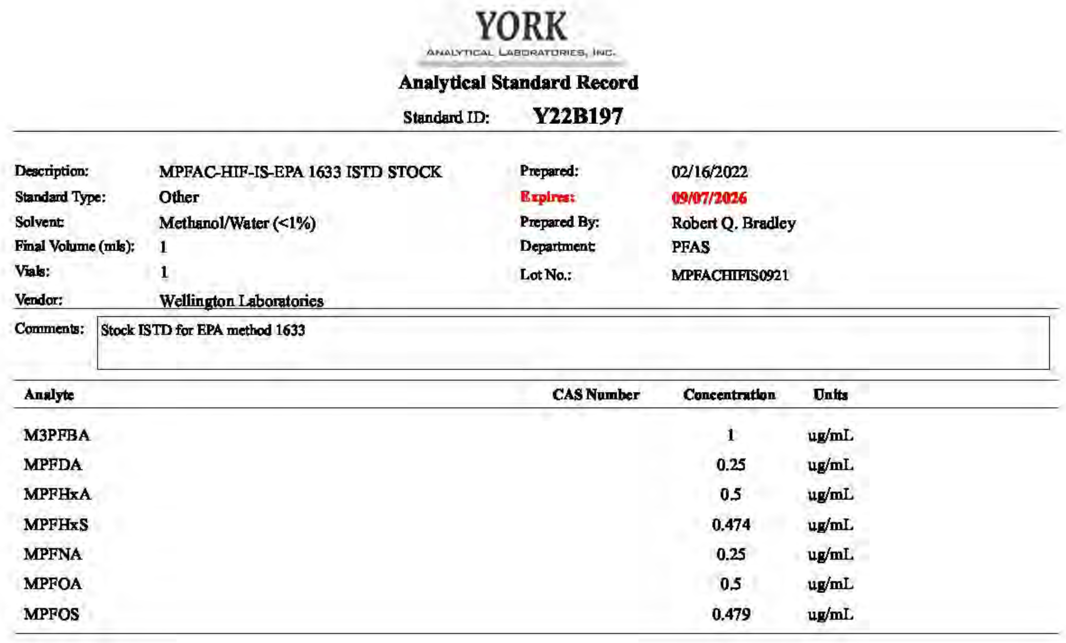
14. REFERENCES

1. EPA METHOD 1633 Draft 2 June, 2022- Analysis of Per- and Polyfluoroalkyl Substances (PFAS) in Aqueous, Solid, Biosolids, and Tissue Samples by LC-MS/MS; EPA 821-D-22-001

15. REVISION HISTORY

Revision 1.0	10/24/2022	First issue.
Revision 1.1	02/10/2023	Modified LLOPR in Section 7.4.6.1 to reflect 2x the MRL

Attachment 1 – Non-Extracted Internal Standards (NIS)



YORK
ANALYTICAL LABORATORIES, INC.

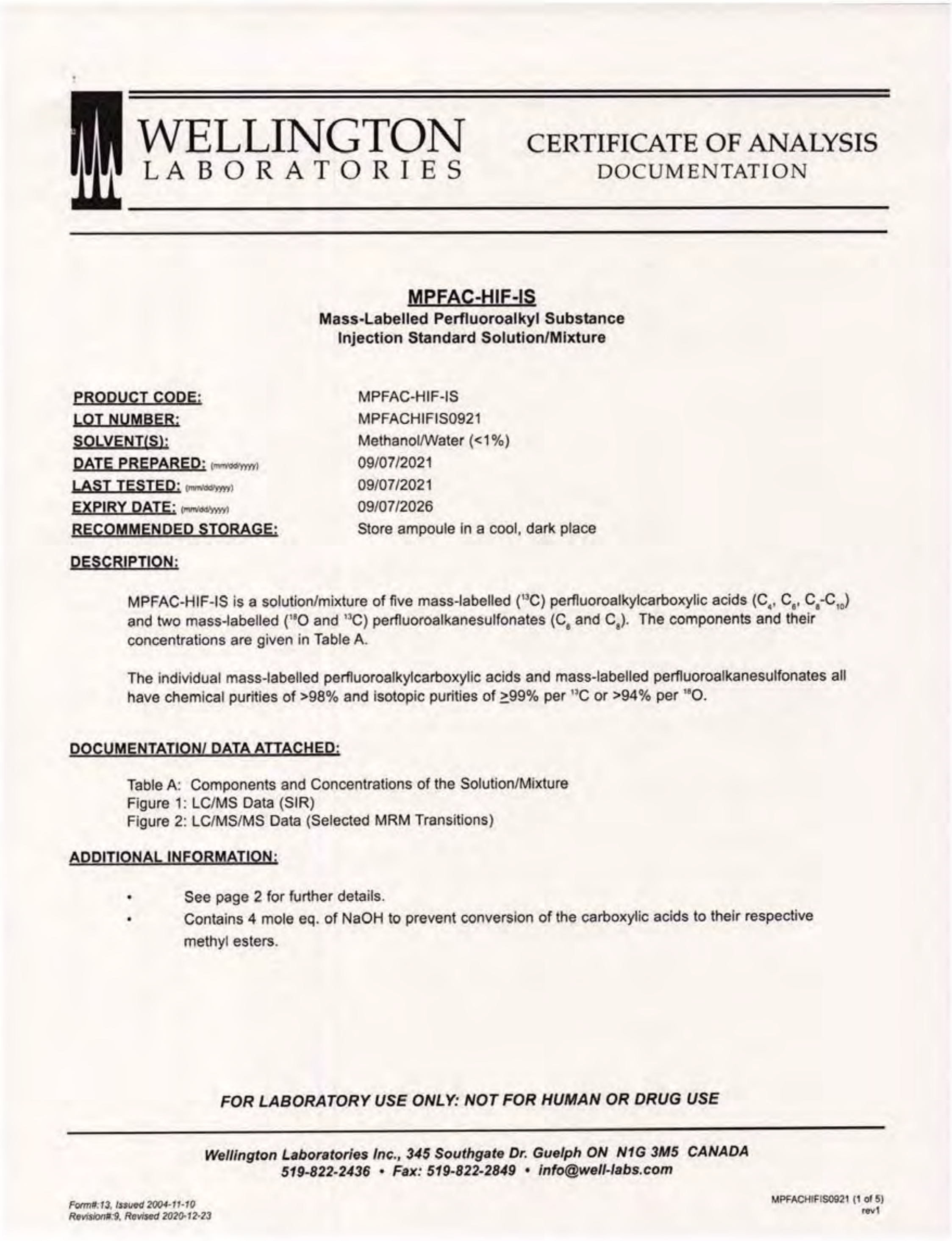
Analytical Standard Record

Standard ID: **Y22B197**

Description:	MPFAC-HIF-IS-EPA 1633 ISTD STOCK	**Prepared:**	02/16/2022
Standard Type:	Other	**Expires:**	09/07/2026
Solvent:	Methanol/Water (<1%)	**Prepared By:**	Robert Q. Bradley
Final Volume (mls):	1	**Department:**	PFAS
Vials:	1	**Lot No.:**	MPFACHIFIS0921
Vendor:	Wellington Laboratories		

Comments: Stock ISTD for EPA method 1633

Analyte	**CAS Number**	**Concentration**	**Units**
M3PFBA		1	ug/mL
MPFDA		0.25	ug/mL
MPFHxA		0.5	ug/mL
MPFHxS		0.474	ug/mL
MPFNA		0.25	ug/mL
MPFOA		0.5	ug/mL
MPFOS		0.479	ug/mL



WELLINGTON LABORATORIES

CERTIFICATE OF ANALYSIS DOCUMENTATION

MPFAC-HIF-IS

Mass-Labelled Perfluoroalkyl Substance Injection Standard Solution/Mixture

PRODUCT CODE:	MPFAC-HIF-IS
LOT NUMBER:	MPFACHIFIS0921
SOLVENT(S):	Methanol/Water (<1%)
DATE PREPARED: (mm/dd/yyyy)	09/07/2021
LAST TESTED: (mm/dd/yyyy)	09/07/2021
EXPIRY DATE: (mm/dd/yyyy)	09/07/2026
RECOMMENDED STORAGE:	Store ampoule in a cool, dark place

DESCRIPTION:

MPFAC-HIF-IS is a solution/mixture of five mass-labelled (^{13}C) perfluoroalkylcarboxylic acids (C_4, C_6, C_8-C_{10}) and two mass-labelled (^{18}O and ^{13}C) perfluoroalkanesulfonates (C_6 and C_8). The components and their concentrations are given in Table A.

The individual mass-labelled perfluoroalkylcarboxylic acids and mass-labelled perfluoroalkanesulfonates all have chemical purities of >98% and isotopic purities of $\geq$99% per ^{13}C or >94% per ^{18}O.

DOCUMENTATION/ DATA ATTACHED:

Table A: Components and Concentrations of the Solution/Mixture
Figure 1: LC/MS Data (SIR)
Figure 2: LC/MS/MS Data (Selected MRM Transitions)

ADDITIONAL INFORMATION:

- See page 2 for further details.
- Contains 4 mole eq. of NaOH to prevent conversion of the carboxylic acids to their respective methyl esters.

FOR LABORATORY USE ONLY: NOT FOR HUMAN OR DRUG USE

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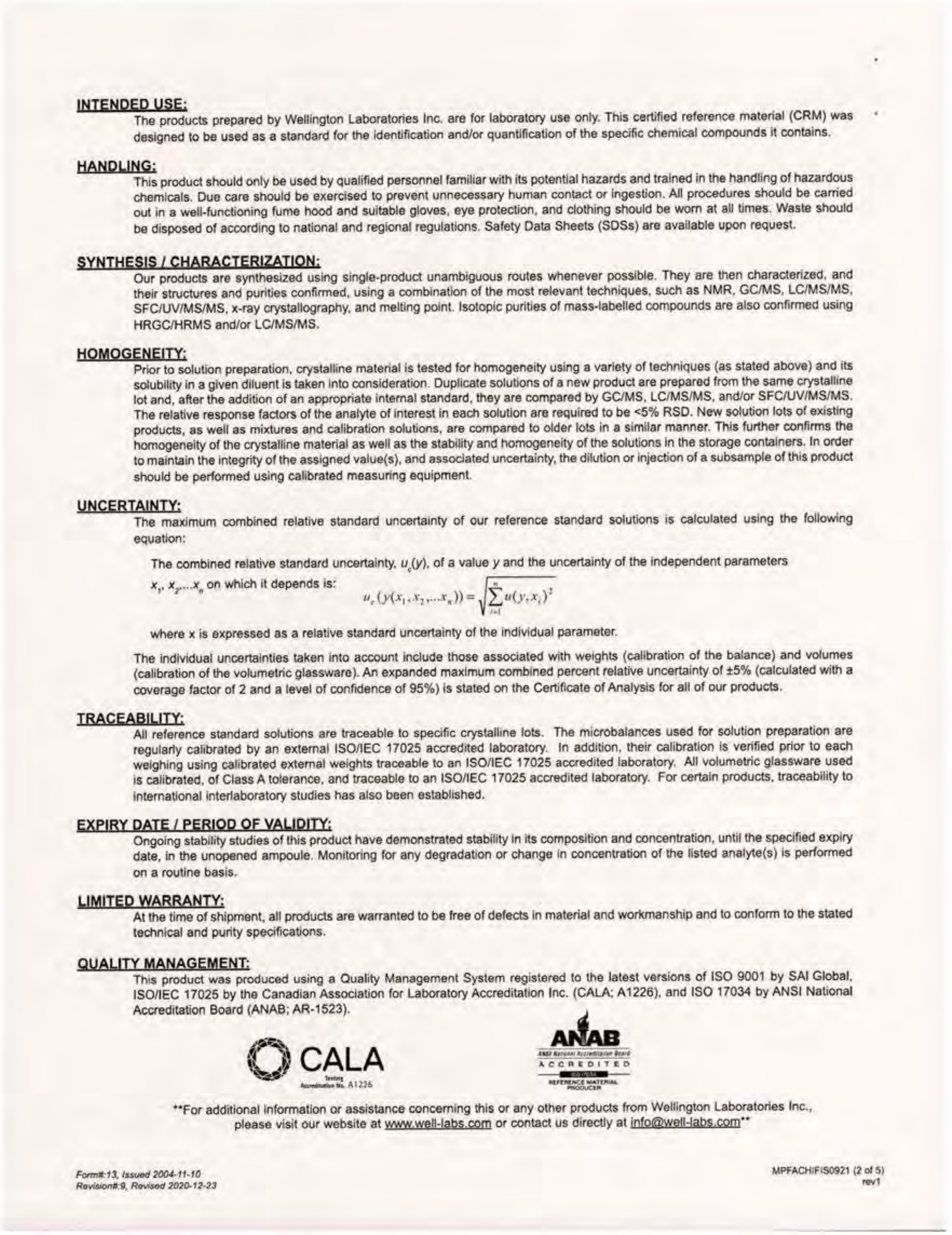
Form#:13, Issued 2004-11-10
Revision#:9, Revised 2020-12-23

MPFACHIFIS0921 (1 of 5)
rev1



INTENDED USE:

The products prepared by Wellington Laboratories Inc. are for laboratory use only. This certified reference material (CRM) was designed to be used as a standard for the identification and/or quantification of the specific chemical compounds it contains.

HANDLING:

This product should only be used by qualified personnel familiar with its potential hazards and trained in the handling of hazardous chemicals. Due care should be exercised to prevent unnecessary human contact or ingestion. All procedures should be carried out in a well-functioning fume hood and suitable gloves, eye protection, and clothing should be worn at all times. Waste should be disposed of according to national and regional regulations. Safety Data Sheets (SDSs) are available upon request.

SYNTHESIS / CHARACTERIZATION:

Our products are synthesized using single-product unambiguous routes whenever possible. They are then characterized, and their structures and purities confirmed, using a combination of the most relevant techniques, such as NMR, GC/MS, LC/MS/MS, SFC/UV/MS/MS, x-ray crystallography, and melting point. Isotopic purities of mass-labelled compounds are also confirmed using HRGC/HRMS and/or LC/MS/MS.

HOMOGENEITY:

Prior to solution preparation, crystalline material is tested for homogeneity using a variety of techniques (as stated above) and its solubility in a given diluent is taken into consideration. Duplicate solutions of a new product are prepared from the same crystalline lot and, after the addition of an appropriate internal standard, they are compared by GC/MS, LC/MS/MS, and/or SFC/UV/MS/MS. The relative response factors of the analyte of interest in each solution are required to be <5% RSD. New solution lots of existing products, as well as mixtures and calibration solutions, are compared to older lots in a similar manner. This further confirms the homogeneity of the crystalline material as well as the stability and homogeneity of the solutions in the storage containers. In order to maintain the integrity of the assigned value(s), and associated uncertainty, the dilution or injection of a subsample of this product should be performed using calibrated measuring equipment.

UNCERTAINTY:

The maximum combined relative standard uncertainty of our reference standard solutions is calculated using the following equation:

The combined relative standard uncertainty, $u_c(y)$, of a value y and the uncertainty of the independent parameters $x_1, x_2, \dots x_n$ on which it depends is:

$$u_c(y(x_1, x_2, \dots x_n)) = \sqrt{\sum_{i=1}^{n} u(y, x_i)^2}$$

where x is expressed as a relative standard uncertainty of the individual parameter.

The individual uncertainties taken into account include those associated with weights (calibration of the balance) and volumes (calibration of the volumetric glassware). An expanded maximum combined percent relative uncertainty of ±5% (calculated with a coverage factor of 2 and a level of confidence of 95%) is stated on the Certificate of Analysis for all of our products.

TRACEABILITY:

All reference standard solutions are traceable to specific crystalline lots. The microbalances used for solution preparation are regularly calibrated by an external ISO/IEC 17025 accredited laboratory. In addition, their calibration is verified prior to each weighing using calibrated external weights traceable to an ISO/IEC 17025 accredited laboratory. All volumetric glassware used is calibrated, of Class A tolerance, and traceable to an ISO/IEC 17025 accredited laboratory. For certain products, traceability to international interlaboratory studies has also been established.

EXPIRY DATE / PERIOD OF VALIDITY:

Ongoing stability studies of this product have demonstrated stability in its composition and concentration, until the specified expiry date, in the unopened ampoule. Monitoring for any degradation or change in concentration of the listed analyte(s) is performed on a routine basis.

LIMITED WARRANTY:

At the time of shipment, all products are warranted to be free of defects in material and workmanship and to conform to the stated technical and purity specifications.

QUALITY MANAGEMENT:

This product was produced using a Quality Management System registered to the latest versions of ISO 9001 by SAI Global, ISO/IEC 17025 by the Canadian Association for Laboratory Accreditation Inc. (CALA; A1226), and ISO 17034 by ANSI National Accreditation Board (ANAB; AR-1523).

CALA
Testing
Accreditation No. A1226

ANAB
ANSI National Accreditation Board
ACCREDITED
REFERENCE MATERIAL PRODUCER

For additional information or assistance concerning this or any other products from Wellington Laboratories Inc., please visit our website at www.well-labs.com or contact us directly at info@well-labs.com

Form#:13, Issued 2004-11-10
Revision#:9, Revised 2020-12-23

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rev1

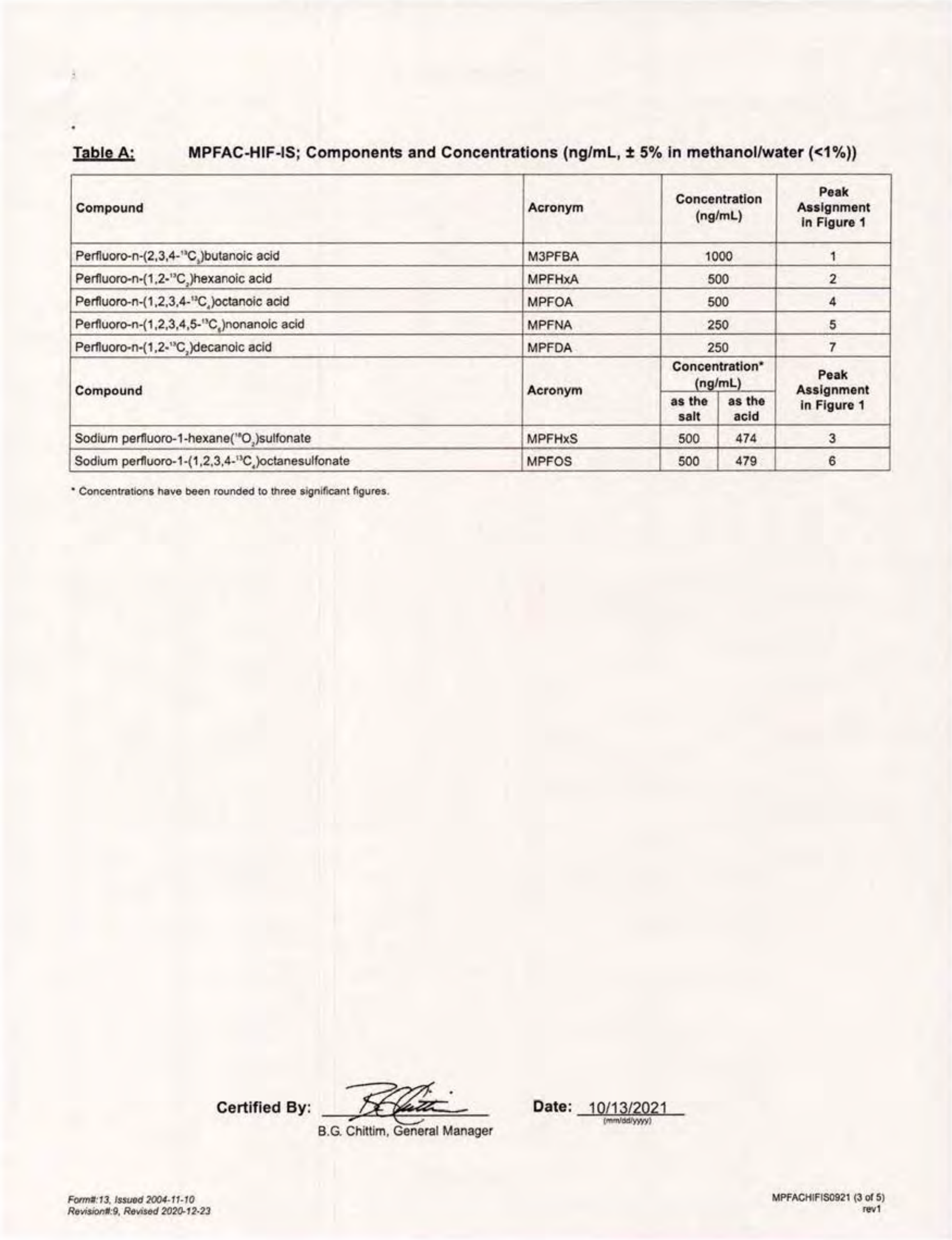


Table A: **MPFAC-HIF-IS; Components and Concentrations (ng/mL, ± 5% in methanol/water (<1%))**

Compound	Acronym	Concentration (ng/mL)		Peak Assignment in Figure 1
Perfluoro-n-(2,3,4-$^{13}C_3$)butanoic acid	M3PFBA	1000		1
Perfluoro-n-(1,2-$^{13}C_2$)hexanoic acid	MPFHxA	500		2
Perfluoro-n-(1,2,3,4-$^{13}C_4$)octanoic acid	MPFOA	500		4
Perfluoro-n-(1,2,3,4,5-$^{13}C_5$)nonanoic acid	MPFNA	250		5
Perfluoro-n-(1,2-$^{13}C_2$)decanoic acid	MPFDA	250		7
Compound	**Acronym**	**Concentration* (ng/mL)**		**Peak Assignment in Figure 1**
		as the salt	**as the acid**	
Sodium perfluoro-1-hexane($^{18}O_2$)sulfonate	MPFHxS	500	474	3
Sodium perfluoro-1-(1,2,3,4-$^{13}C_4$)octanesulfonate	MPFOS	500	479	6

* Concentrations have been rounded to three significant figures.

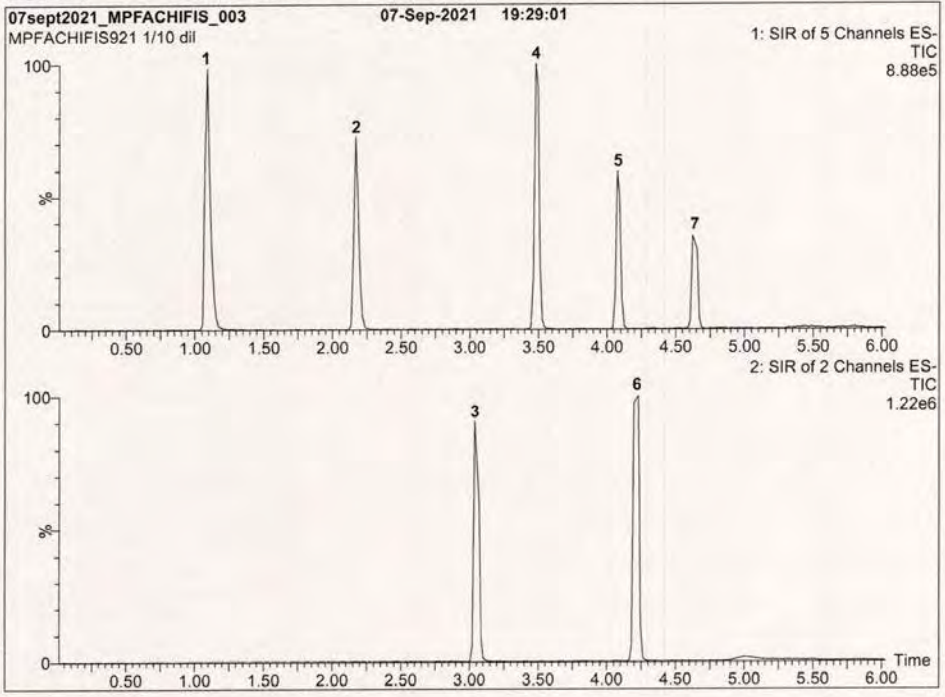
Certified By: B.G. Chittim, General Manager

Date: 10/13/2021
(mm/dd/yyyy)

Form#:13, Issued 2004-11-10
Revision#:9, Revised 2020-12-23

MPFACHIFIS0921 (3 of 5)
rev1

Figure 1: **MPFAC-HIF-IS; LC/MS Data (SIR)**



Conditions for Figure 1:

Waters Acquity Ultra Performance LC
Waters Xevo TQ-S micro MS

Chromatographic Conditions:

Column: Acquity UPLC BEH Shield RP_{18}
1.7 µm, 2.1 x 100 mm

Mobile phase: Gradient
Start: 50% H_2O / 50% (80:20 MeOH:ACN)
(both with 10 mM NH_4OAc buffer)
Ramp to 90% organic over 9 min and hold for
2 min before returning to initial conditions in 1 min.
Time: 15 min

Flow: 300 µL/min

MS Parameters:

Experiment: SIR

Source: Electrospray (negative)
Capillary Voltage (kV) = 2.00
Cone Voltage (V) = variable (2-6)
Desolvation Temperature (°C) = 350
Desolvation Gas Flow (L/hr) = 1000

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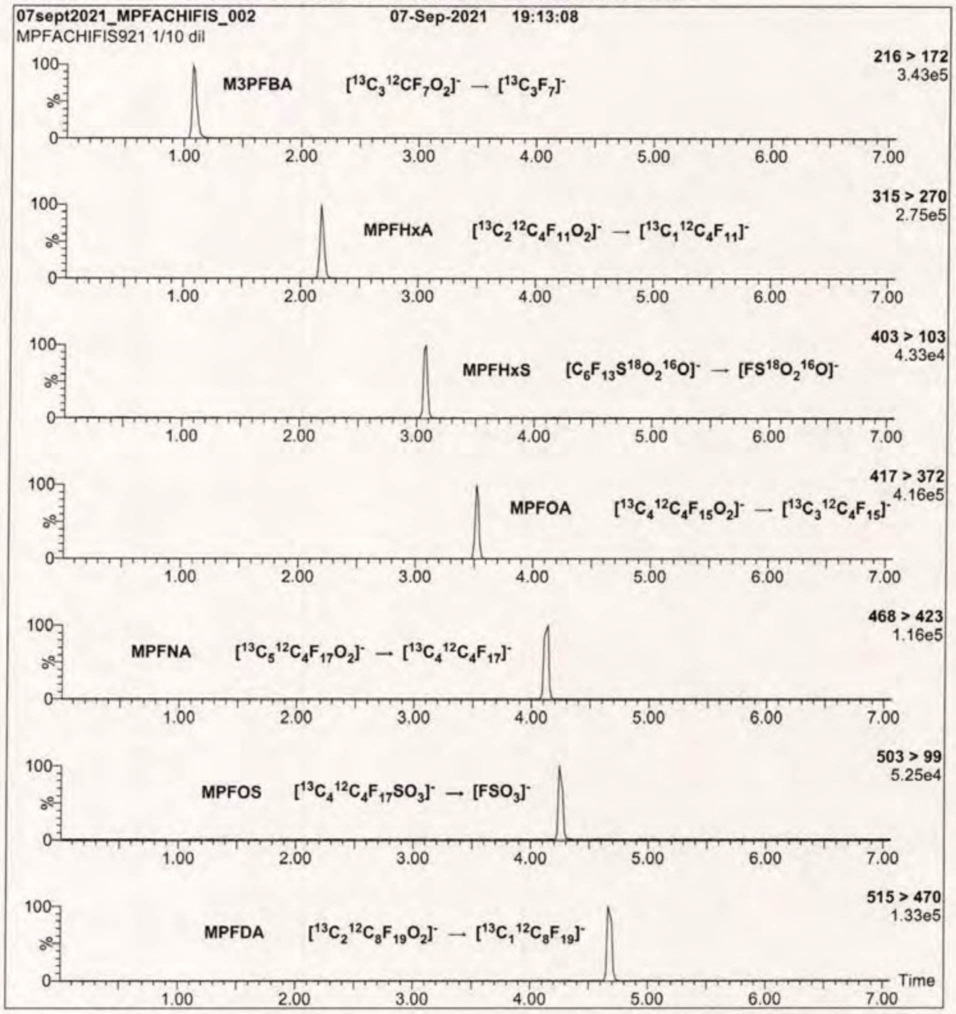
Figure 2: **MPFAC-HIF-IS; LC/MS/MS Data (Selected MRM Transitions)**



Conditions for Figure 2:

Injection: On-column (MPFAC-HIF-IS)

Mobile phase: Same as Figure 1

Flow: 300 µL/min

MS Parameters:

Collision Gas (mbar) = 3.18e-3
Collision Energy (eV) = 4-64 (variable)

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Revision#:9, Revised 2020-12-23

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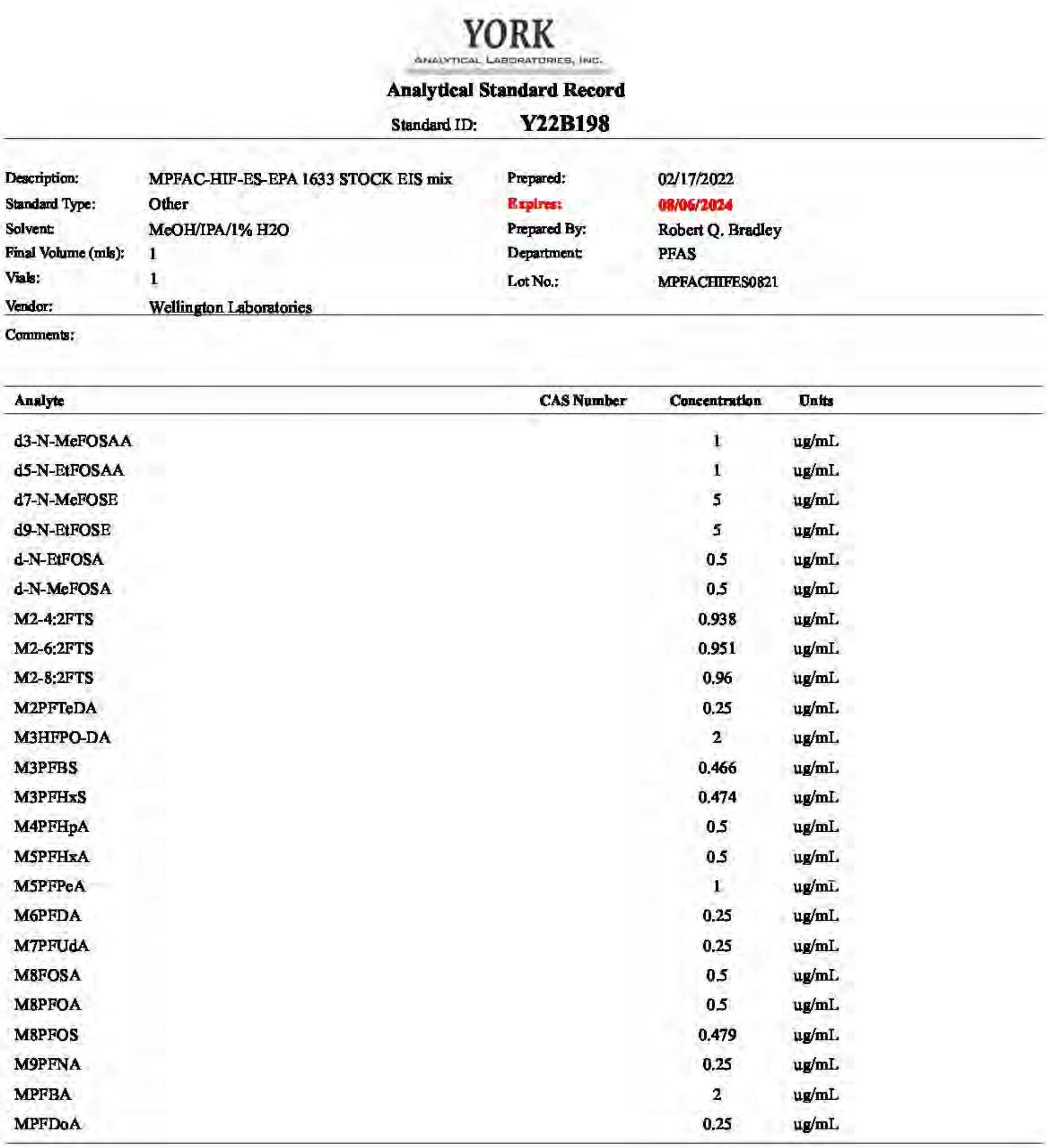
rev1

Attachment 2 – Extracted Internal Standards (EIS)



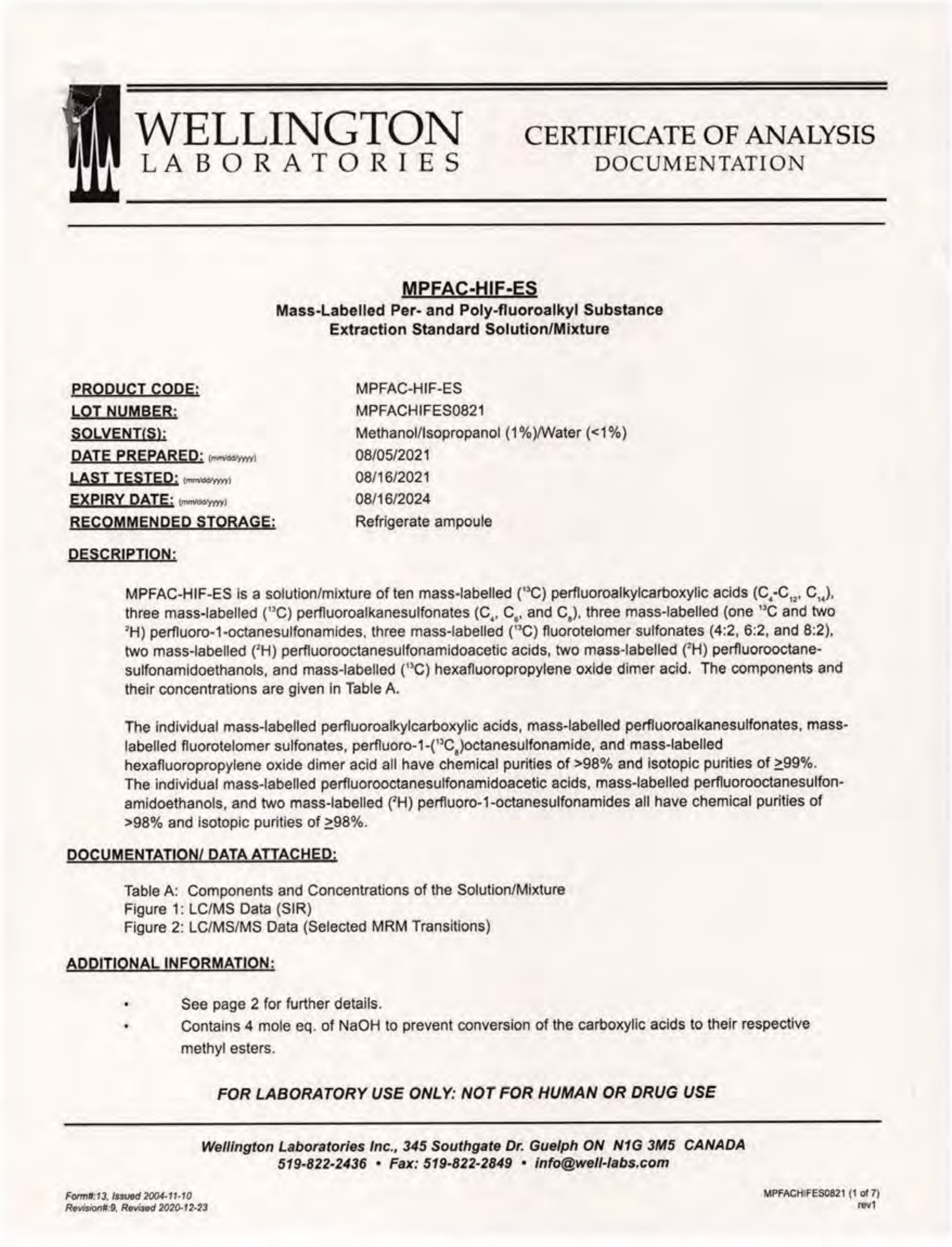
YORK
ANALYTICAL LABORATORIES, INC.

Analytical Standard Record

Standard ID: Y22B198

Description:	MPFAC-HIF-ES-EPA 1633 STOCK EIS mix	**Prepared:**	02/17/2022
Standard Type:	Other	**Expires:**	08/06/2024
Solvent:	MeOH/IPA/1% H2O	**Prepared By:**	Robert Q. Bradley
Final Volume (mls):	1	**Department:**	PFAS
Vials:	1	**Lot No.:**	MPFACHIFES0821
Vendor:	Wellington Laboratories		
Comments:			

Analyte	CAS Number	Concentration	Units
d3-N-MeFOSAA		1	ug/mL
d5-N-EtFOSAA		1	ug/mL
d7-N-MeFOSE		5	ug/mL
d9-N-EtFOSE		5	ug/mL
d-N-EtFOSA		0.5	ug/mL
d-N-MeFOSA		0.5	ug/mL
M2-4:2FTS		0.938	ug/mL
M2-6:2FTS		0.951	ug/mL
M2-8:2FTS		0.96	ug/mL
M2PFTeDA		0.25	ug/mL
M3HFPO-DA		2	ug/mL
M3PFBS		0.466	ug/mL
M3PFHxS		0.474	ug/mL
M4PFHpA		0.5	ug/mL
M5PFHxA		0.5	ug/mL
M5PFPeA		1	ug/mL
M6PFDA		0.25	ug/mL
M7PFUdA		0.25	ug/mL
M8FOSA		0.5	ug/mL
M8PFOA		0.5	ug/mL
M8PFOS		0.479	ug/mL
M9PFNA		0.25	ug/mL
MPFBA		2	ug/mL
MPFDoA		0.25	ug/mL



WELLINGTON
LABORATORIES

CERTIFICATE OF ANALYSIS
DOCUMENTATION

MPFAC-HIF-ES

Mass-Labelled Per- and Poly-fluoroalkyl Substance
Extraction Standard Solution/Mixture

PRODUCT CODE:	MPFAC-HIF-ES
LOT NUMBER:	MPFACHIFES0821
SOLVENT(S):	Methanol/Isopropanol (1%)/Water (<1%)
DATE PREPARED: (mm/dd/yyyy)	08/05/2021
LAST TESTED: (mm/dd/yyyy)	08/16/2021
EXPIRY DATE: (mm/dd/yyyy)	08/16/2024
RECOMMENDED STORAGE:	Refrigerate ampoule

DESCRIPTION:

MPFAC-HIF-ES is a solution/mixture of ten mass-labelled (^{13}C) perfluoroalkylcarboxylic acids (C_4-C_{12}, C_{14}), three mass-labelled (^{13}C) perfluoroalkanesulfonates (C_4, C_6, and C_8), three mass-labelled (one ^{13}C and two ^{2}H) perfluoro-1-octanesulfonamides, three mass-labelled (^{13}C) fluorotelomer sulfonates (4:2, 6:2, and 8:2), two mass-labelled (^{2}H) perfluorooctanesulfonamidoacetic acids, two mass-labelled (^{2}H) perfluorooctanesulfonamidoethanols, and mass-labelled (^{13}C) hexafluoropropylene oxide dimer acid. The components and their concentrations are given in Table A.

The individual mass-labelled perfluoroalkylcarboxylic acids, mass-labelled perfluoroalkanesulfonates, mass-labelled fluorotelomer sulfonates, perfluoro-1-($^{13}C_8$)octanesulfonamide, and mass-labelled hexafluoropropylene oxide dimer acid all have chemical purities of >98% and isotopic purities of ≥99%. The individual mass-labelled perfluorooctanesulfonamidoacetic acids, mass-labelled perfluorooctanesulfonamidoethanols, and two mass-labelled (^{2}H) perfluoro-1-octanesulfonamides all have chemical purities of >98% and isotopic purities of ≥98%.

DOCUMENTATION/ DATA ATTACHED:

Table A: Components and Concentrations of the Solution/Mixture
Figure 1: LC/MS Data (SIR)
Figure 2: LC/MS/MS Data (Selected MRM Transitions)

ADDITIONAL INFORMATION:

- See page 2 for further details.
- Contains 4 mole eq. of NaOH to prevent conversion of the carboxylic acids to their respective methyl esters.

FOR LABORATORY USE ONLY: NOT FOR HUMAN OR DRUG USE

Wellington Laboratories Inc., 345 Southgate Dr. Guelph ON N1G 3M5 CANADA
519-822-2436 • Fax: 519-822-2849 • info@well-labs.com

Form#:13, Issued 2004-11-10
Revision#:9, Revised 2020-12-23

MPFACHIFES0821 (1 of 7)
rev1

INTENDED USE:

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HANDLING:

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HOMOGENEITY:

Prior to solution preparation, crystalline material is tested for homogeneity using a variety of techniques (as stated above) and its solubility in a given diluent is taken into consideration. Duplicate solutions of a new product are prepared from the same crystalline lot and, after the addition of an appropriate internal standard, they are compared by GC/MS, LC/MS/MS, and/or SFC/UV/MS/MS. The relative response factors of the analyte of interest in each solution are required to be <5% RSD. New solution lots of existing products, as well as mixtures and calibration solutions, are compared to older lots in a similar manner. This further confirms the homogeneity of the crystalline material as well as the stability and homogeneity of the solutions in the storage containers. In order to maintain the integrity of the assigned value(s), and associated uncertainty, the dilution or injection of a subsample of this product should be performed using calibrated measuring equipment.

UNCERTAINTY:

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The combined relative standard uncertainty, $u_c(y)$, of a value y and the uncertainty of the independent parameters $x_1, x_2, \ldots x_n$ on which it depends is:

$$u_c(y(x_1, x_2, \ldots x_n)) = \sqrt{\sum_{i=1}^{n} u(y, x_i)^2}$$

where x is expressed as a relative standard uncertainty of the individual parameter.

The individual uncertainties taken into account include those associated with weights (calibration of the balance) and volumes (calibration of the volumetric glassware). An expanded maximum combined percent relative uncertainty of ±5% (calculated with a coverage factor of 2 and a level of confidence of 95%) is stated on the Certificate of Analysis for all of our products.

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EXPIRY DATE / PERIOD OF VALIDITY:

Ongoing stability studies of this product have demonstrated stability in its composition and concentration, until the specified expiry date, in the unopened ampoule. Monitoring for any degradation or change in concentration of the listed analyte(s) is performed on a routine basis.

LIMITED WARRANTY:

At the time of shipment, all products are warranted to be free of defects in material and workmanship and to conform to the stated technical and purity specifications.

QUALITY MANAGEMENT:

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CALA
Testing
Accreditation No. A1226

ANAB
ANSI National Accreditation Board
ACCREDITED
REFERENCE MATERIAL PRODUCER

For additional information or assistance concerning this or any other products from Wellington Laboratories Inc., please visit our website at www.well-labs.com or contact us directly at info@well-labs.com

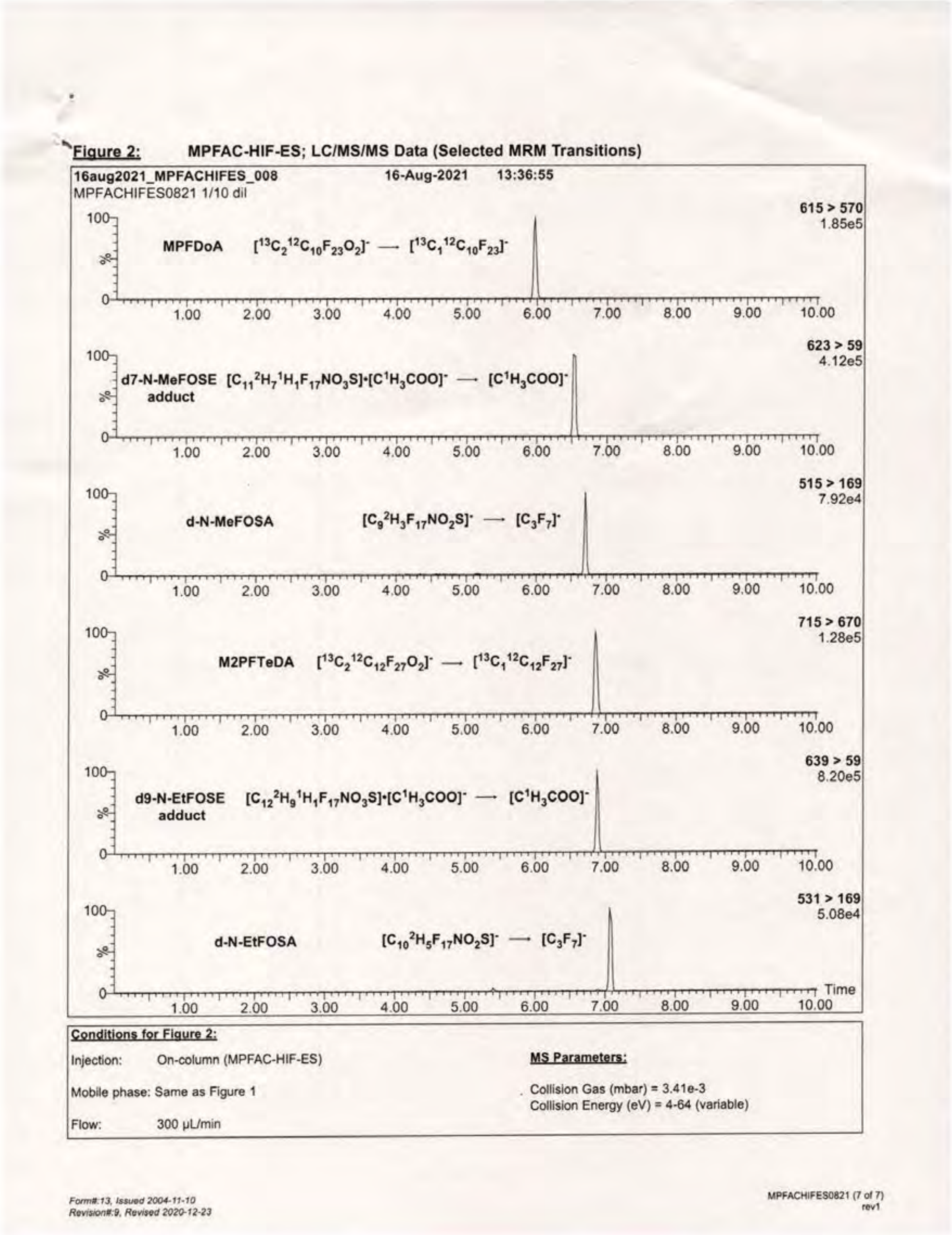

Figure 2: **MPFAC-HIF-ES; LC/MS/MS Data (Selected MRM Transitions)**

16aug2021_MPFACHIFES_008 **16-Aug-2021** **13:36:55**
MPFACHIFES0821 1/10 dil

Conditions for Figure 2:

Injection: On-column (MPFAC-HIF-ES)

Mobile phase: Same as Figure 1

Flow: 300 µL/min

MS Parameters:

Collision Gas (mbar) = 3.41e-3
Collision Energy (eV) = 4-64 (variable)

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rev1

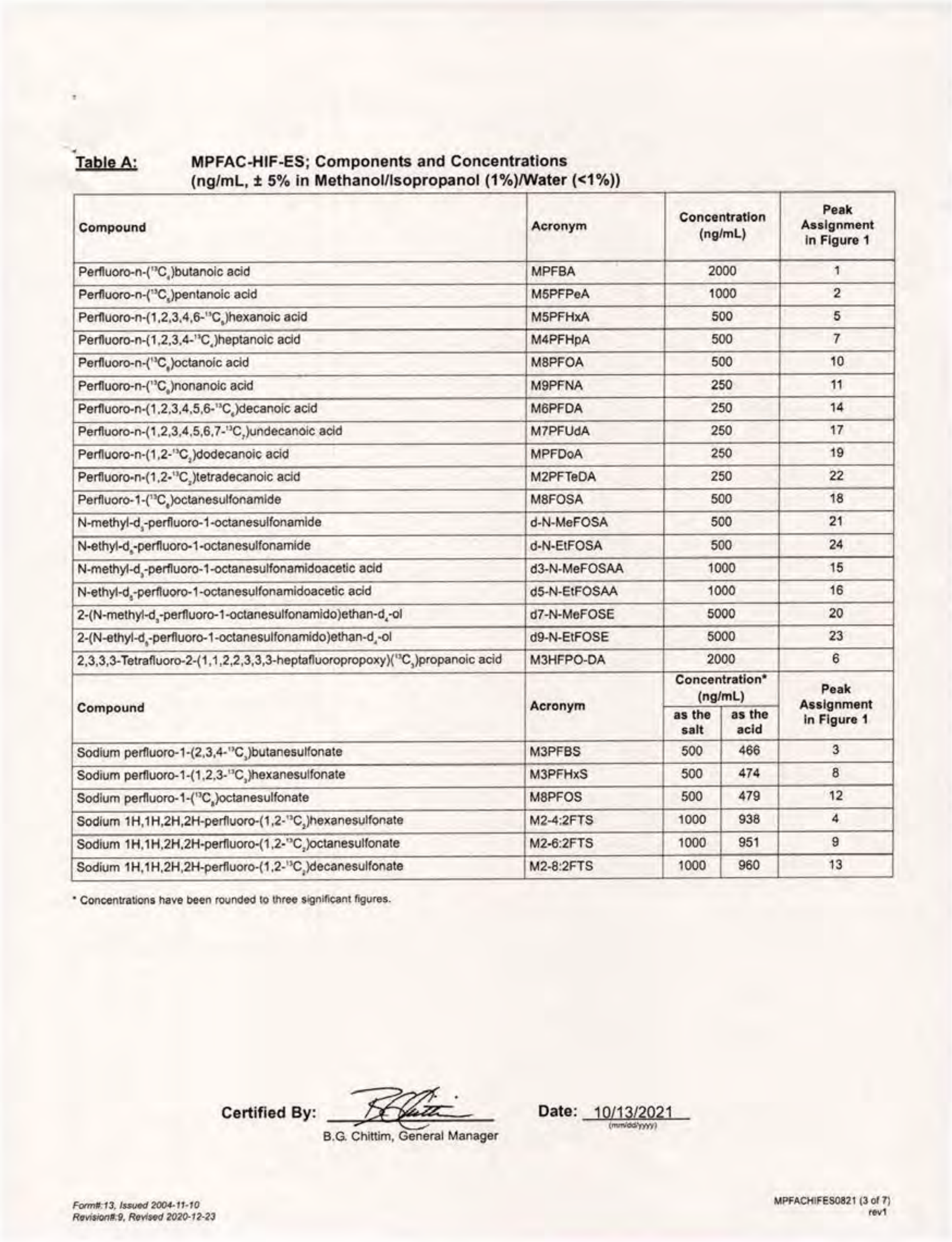

Table A: **MPFAC-HIF-ES; Components and Concentrations (ng/mL, ± 5% in Methanol/Isopropanol (1%)/Water (<1%))**

Compound	Acronym	Concentration (ng/mL)	Peak Assignment in Figure 1
Perfluoro-n-($^{13}C_4$)butanoic acid	MPFBA	2000	1
Perfluoro-n-($^{13}C_5$)pentanoic acid	M5PFPeA	1000	2
Perfluoro-n-(1,2,3,4,6-$^{13}C_5$)hexanoic acid	M5PFHxA	500	5
Perfluoro-n-(1,2,3,4-$^{13}C_4$)heptanoic acid	M4PFHpA	500	7
Perfluoro-n-($^{13}C_8$)octanoic acid	M8PFOA	500	10
Perfluoro-n-($^{13}C_9$)nonanoic acid	M9PFNA	250	11
Perfluoro-n-(1,2,3,4,5,6-$^{13}C_6$)decanoic acid	M6PFDA	250	14
Perfluoro-n-(1,2,3,4,5,6,7-$^{13}C_7$)undecanoic acid	M7PFUdA	250	17
Perfluoro-n-(1,2-$^{13}C_2$)dodecanoic acid	MPFDoA	250	19
Perfluoro-n-(1,2-$^{13}C_2$)tetradecanoic acid	M2PFTeDA	250	22
Perfluoro-1-($^{13}C_8$)octanesulfonamide	M8FOSA	500	18
N-methyl-d_3-perfluoro-1-octanesulfonamide	d-N-MeFOSA	500	21
N-ethyl-d_5-perfluoro-1-octanesulfonamide	d-N-EtFOSA	500	24
N-methyl-d_3-perfluoro-1-octanesulfonamidoacetic acid	d3-N-MeFOSAA	1000	15
N-ethyl-d_5-perfluoro-1-octanesulfonamidoacetic acid	d5-N-EtFOSAA	1000	16
2-(N-methyl-d_3-perfluoro-1-octanesulfonamido)ethan-d_4-ol	d7-N-MeFOSE	5000	20
2-(N-ethyl-d_5-perfluoro-1-octanesulfonamido)ethan-d_4-ol	d9-N-EtFOSE	5000	23
2,3,3,3-Tetrafluoro-2-(1,1,2,2,3,3,3-heptafluoropropoxy)($^{13}C_3$)propanoic acid	M3HFPO-DA	2000	6

Compound	Acronym	Concentration* (ng/mL)		Peak Assignment in Figure 1
		as the salt	as the acid	
Sodium perfluoro-1-(2,3,4-$^{13}C_3$)butanesulfonate	M3PFBS	500	466	3
Sodium perfluoro-1-(1,2,3-$^{13}C_3$)hexanesulfonate	M3PFHxS	500	474	8
Sodium perfluoro-1-($^{13}C_8$)octanesulfonate	M8PFOS	500	479	12
Sodium 1H,1H,2H,2H-perfluoro-(1,2-$^{13}C_2$)hexanesulfonate	M2-4:2FTS	1000	938	4
Sodium 1H,1H,2H,2H-perfluoro-(1,2-$^{13}C_2$)octanesulfonate	M2-6:2FTS	1000	951	9
Sodium 1H,1H,2H,2H-perfluoro-(1,2-$^{13}C_2$)decanesulfonate	M2-8:2FTS	1000	960	13

* Concentrations have been rounded to three significant figures.

Certified By: B.G. Chittim, General Manager **Date:** 10/13/2021 (mm/dd/yyyy)

Form#:13, Issued 2004-11-10
Revision#:9, Revised 2020-12-23

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rev1

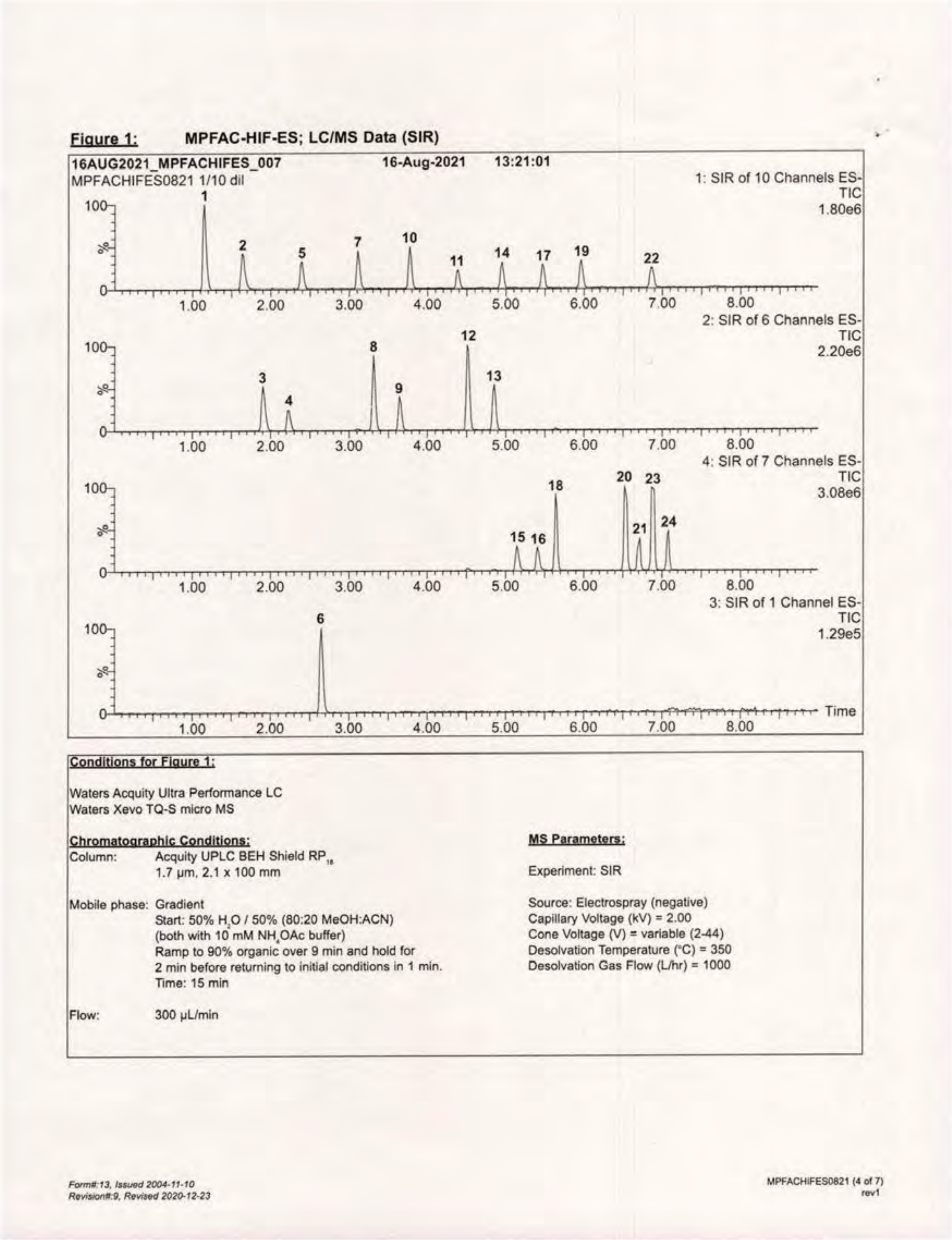

Figure 1: **MPFAC-HIF-ES; LC/MS Data (SIR)**

16AUG2021_MPFACHIFES_007 **16-Aug-2021** **13:21:01**
MPFACHIFES0821 1/10 dil

Conditions for Figure 1:

Waters Acquity Ultra Performance LC
Waters Xevo TQ-S micro MS

Chromatographic Conditions:

Column:	Acquity UPLC BEH Shield RP$_{18}$ 1.7 µm, 2.1 x 100 mm
Mobile phase:	Gradient Start: 50% H$_2$O / 50% (80:20 MeOH:ACN) (both with 10 mM NH$_4$OAc buffer) Ramp to 90% organic over 9 min and hold for 2 min before returning to initial conditions in 1 min. Time: 15 min
Flow:	300 µL/min

MS Parameters:

Experiment: SIR

Source: Electrospray (negative)
Capillary Voltage (kV) = 2.00
Cone Voltage (V) = variable (2-44)
Desolvation Temperature (°C) = 350
Desolvation Gas Flow (L/hr) = 1000

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Revision#:9, Revised 2020-12-23

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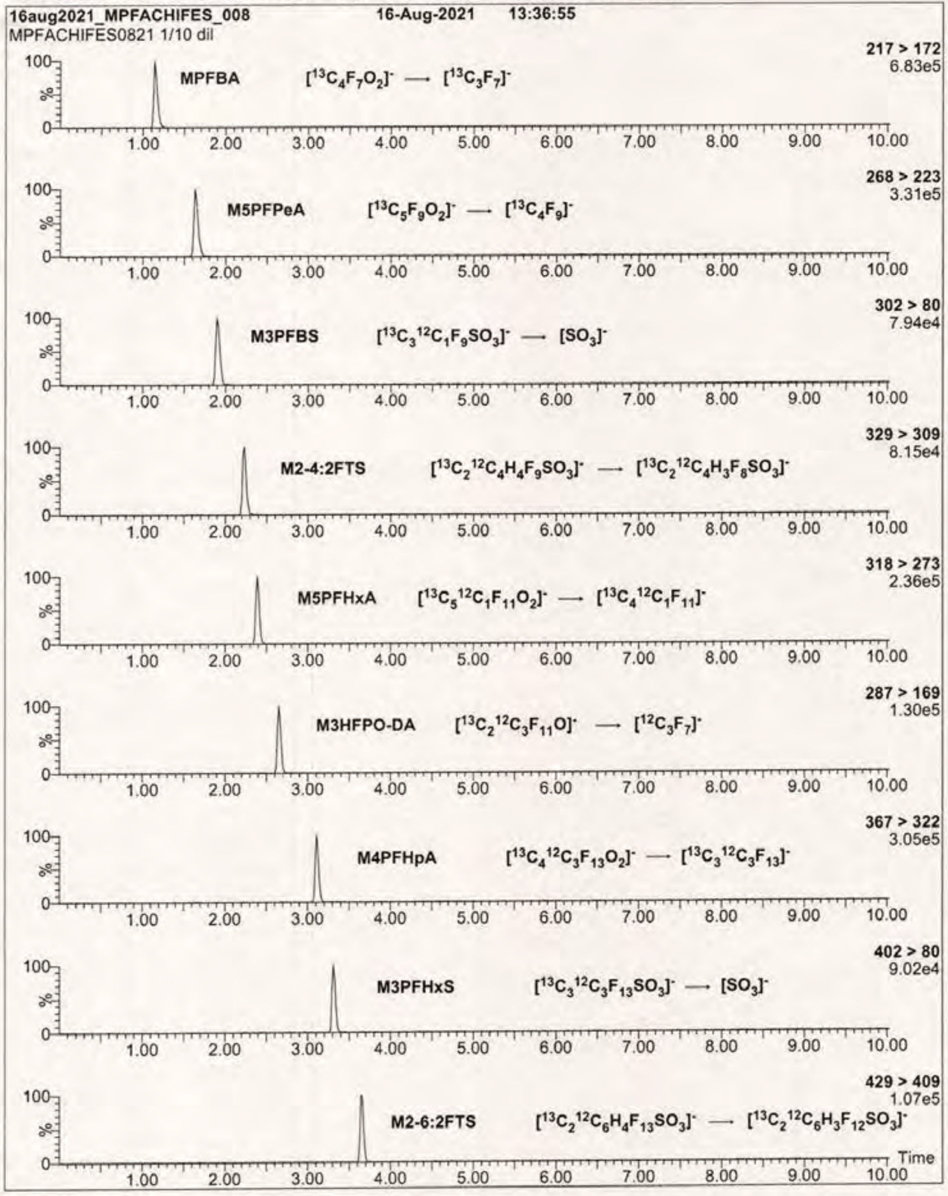
rev1

Figure 2: MPFAC-HIF-ES; LC/MS/MS Data (Selected MRM Transitions)



Form#:13, Issued 2004-11-10
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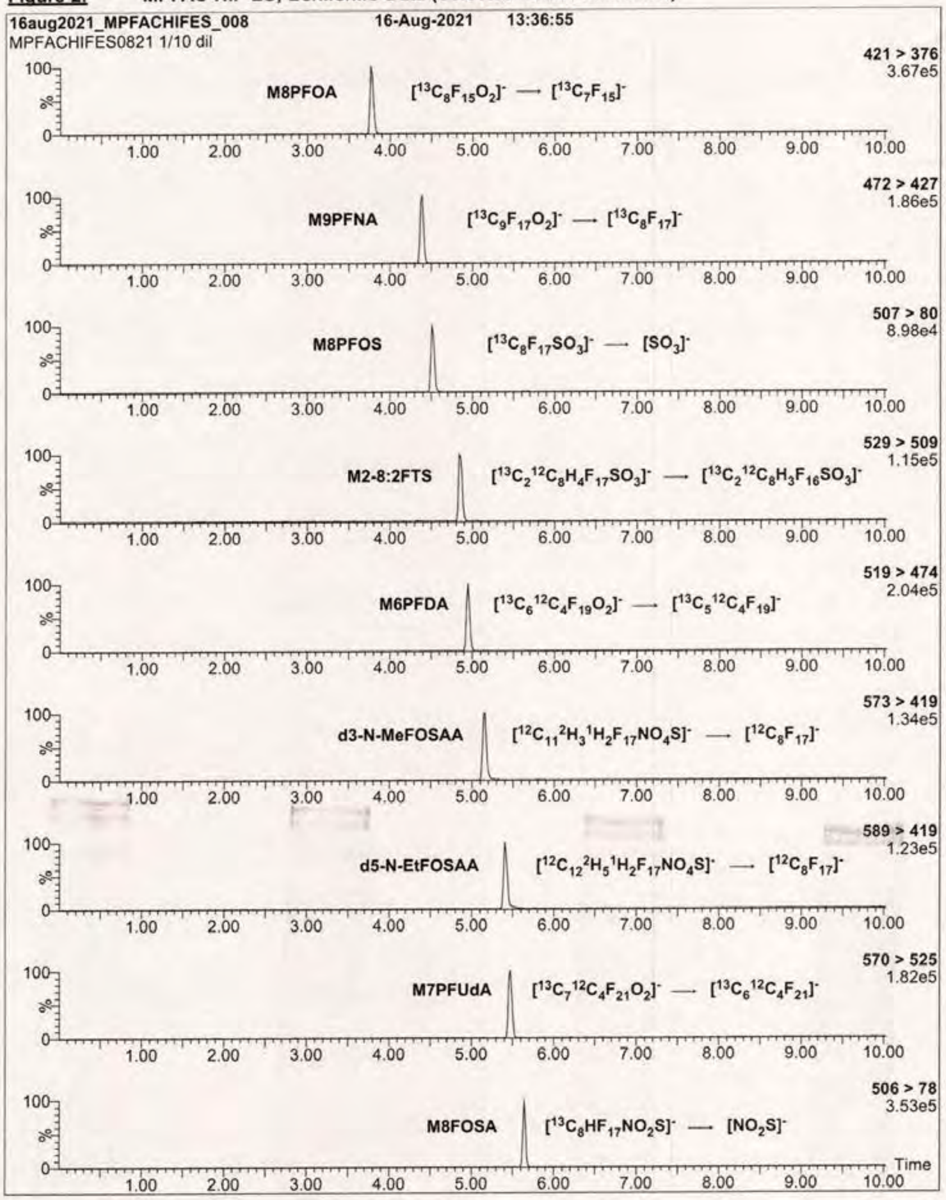
MPFACHIFES0821 (5 of 7)
rev1

Figure 2: **MPFAC-HIF-ES; LC/MS/MS Data (Selected MRM Transitions)**



Form#:13, Issued 2004-11-10
Revision#:9, Revised 2020-12-23

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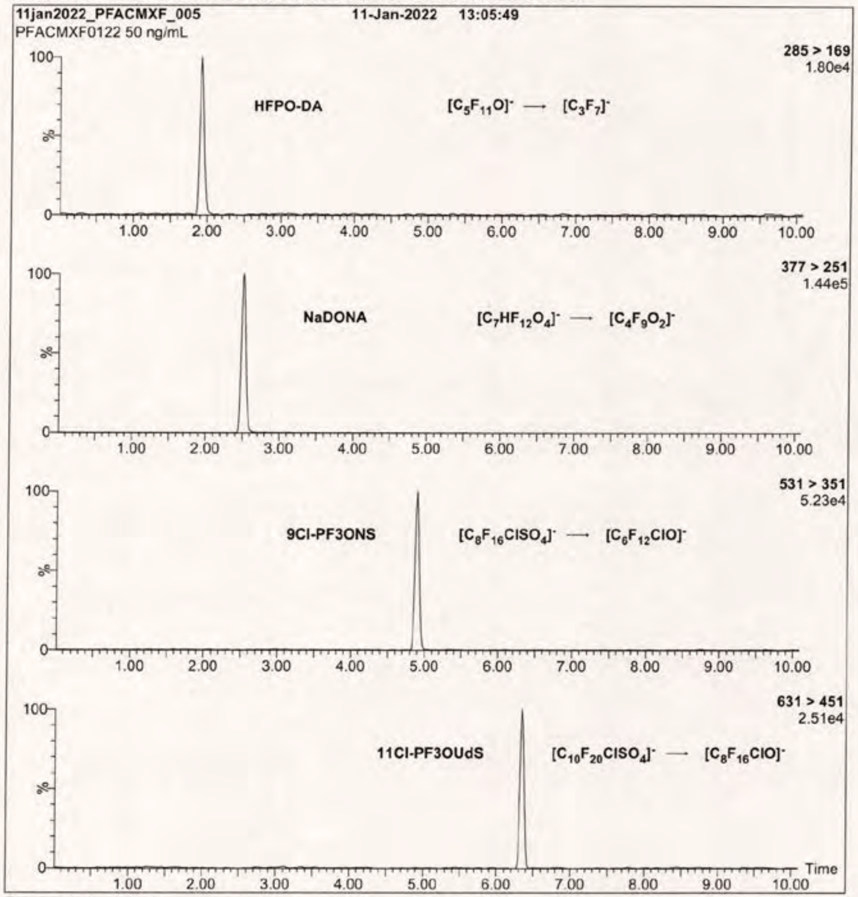
rev1

Attachment 3 – Target Analyte Mixtures

Figure 2: **PFAC-MXF; LC/MS/MS Data (Selected MRM Transitions)**



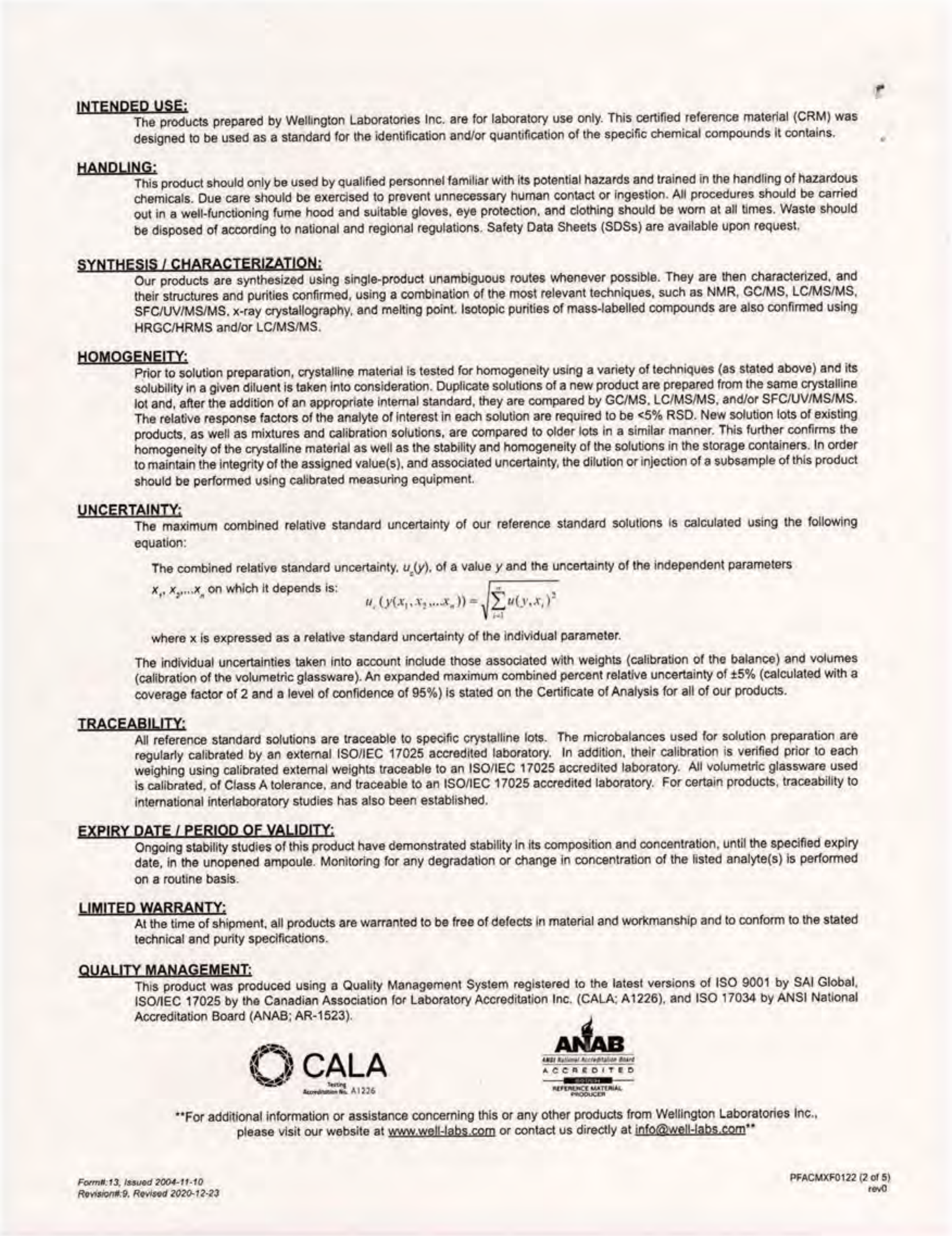
Conditions for Figure 2:

Injection: On-column (PFAC-MXF)

Mobile phase: Same as Figure 1

Flow: 300 µL/min

MS Parameters:
Collision Gas (mbar) = 3.43e-3
Collision Energy (eV) = 6-60 (variable)



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HANDLING:

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HOMOGENEITY:

Prior to solution preparation, crystalline material is tested for homogeneity using a variety of techniques (as stated above) and its solubility in a given diluent is taken into consideration. Duplicate solutions of a new product are prepared from the same crystalline lot and, after the addition of an appropriate internal standard, they are compared by GC/MS, LC/MS/MS, and/or SFC/UV/MS/MS. The relative response factors of the analyte of interest in each solution are required to be <5% RSD. New solution lots of existing products, as well as mixtures and calibration solutions, are compared to older lots in a similar manner. This further confirms the homogeneity of the crystalline material as well as the stability and homogeneity of the solutions in the storage containers. In order to maintain the integrity of the assigned value(s), and associated uncertainty, the dilution or injection of a subsample of this product should be performed using calibrated measuring equipment.

UNCERTAINTY:

The maximum combined relative standard uncertainty of our reference standard solutions is calculated using the following equation:

The combined relative standard uncertainty, $u_c(y)$, of a value y and the uncertainty of the independent parameters $x_1, x_2, \ldots x_n$ on which it depends is:

$$u_c(y(x_1, x_2, \ldots x_n)) = \sqrt{\sum_{i=1}^{n} u(y, x_i)^2}$$

where x is expressed as a relative standard uncertainty of the individual parameter.

The individual uncertainties taken into account include those associated with weights (calibration of the balance) and volumes (calibration of the volumetric glassware). An expanded maximum combined percent relative uncertainty of ±5% (calculated with a coverage factor of 2 and a level of confidence of 95%) is stated on the Certificate of Analysis for all of our products.

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LIMITED WARRANTY:

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CALA Testing Accreditation No. A1226

ANAB ANSI National Accreditation Board ACCREDITED REFERENCE MATERIAL PRODUCER

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Form#:13, Issued 2004-11-10
Revision#:9, Revised 2020-12-23

PFACMXF0122 (2 of 5)
rev0

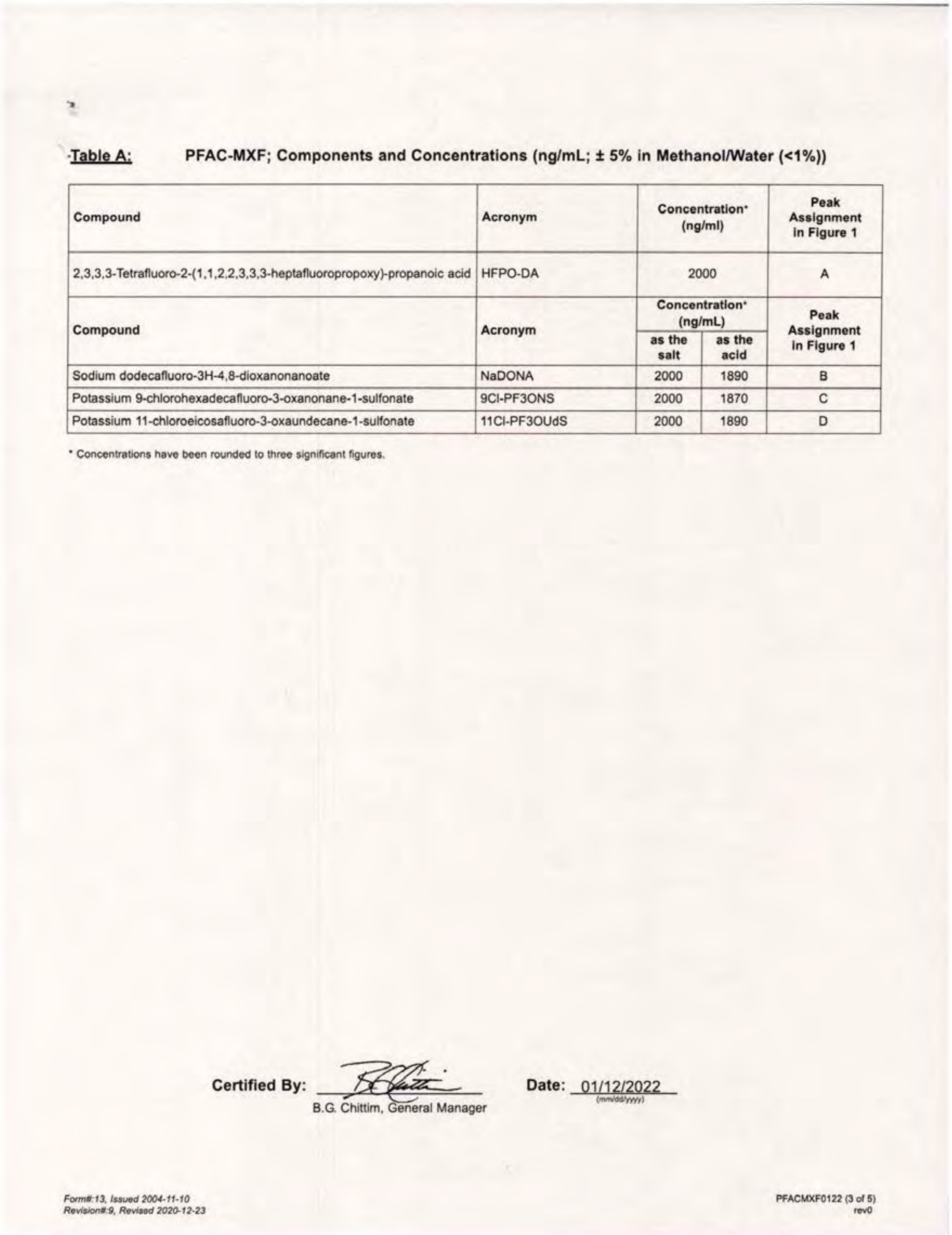

Table A: **PFAC-MXF; Components and Concentrations (ng/mL; ± 5% in Methanol/Water (<1%))**

Compound	Acronym	Concentration* (ng/ml)	Peak Assignment in Figure 1
2,3,3,3-Tetrafluoro-2-(1,1,2,2,3,3,3-heptafluoropropoxy)-propanoic acid	HFPO-DA	2000	A

Compound	Acronym	Concentration* (ng/mL) as the salt	Concentration* (ng/mL) as the acid	Peak Assignment in Figure 1
Sodium dodecafluoro-3H-4,8-dioxanonanoate	NaDONA	2000	1890	B
Potassium 9-chlorohexadecafluoro-3-oxanonane-1-sulfonate	9Cl-PF3ONS	2000	1870	C
Potassium 11-chloroeicosafluoro-3-oxaundecane-1-sulfonate	11Cl-PF3OUdS	2000	1890	D

* Concentrations have been rounded to three significant figures.

Certified By: B.G. Chittim, General Manager **Date:** 01/12/2022
(mm/dd/yyyy)

Form#:13, Issued 2004-11-10
Revision#:9, Revised 2020-12-23

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rev0

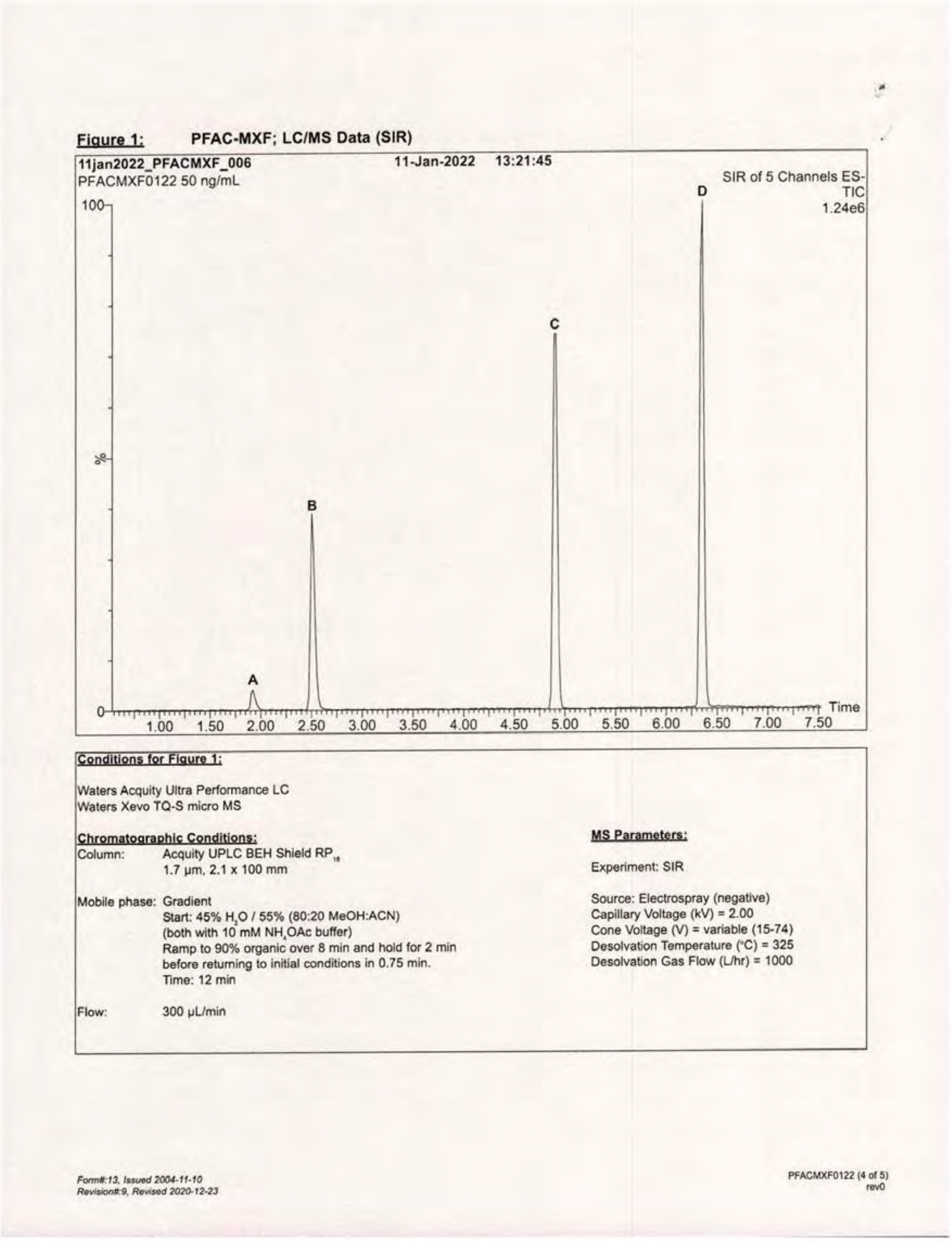


Figure 1: **PFAC-MXF; LC/MS Data (SIR)**

Conditions for Figure 1:

Waters Acquity Ultra Performance LC
Waters Xevo TQ-S micro MS

Chromatographic Conditions:

Column: Acquity UPLC BEH Shield RP$_{18}$
1.7 µm, 2.1 x 100 mm

Mobile phase: Gradient
Start: 45% H_2O / 55% (80:20 MeOH:ACN)
(both with 10 mM NH_4OAc buffer)
Ramp to 90% organic over 8 min and hold for 2 min before returning to initial conditions in 0.75 min.
Time: 12 min

Flow: 300 µL/min

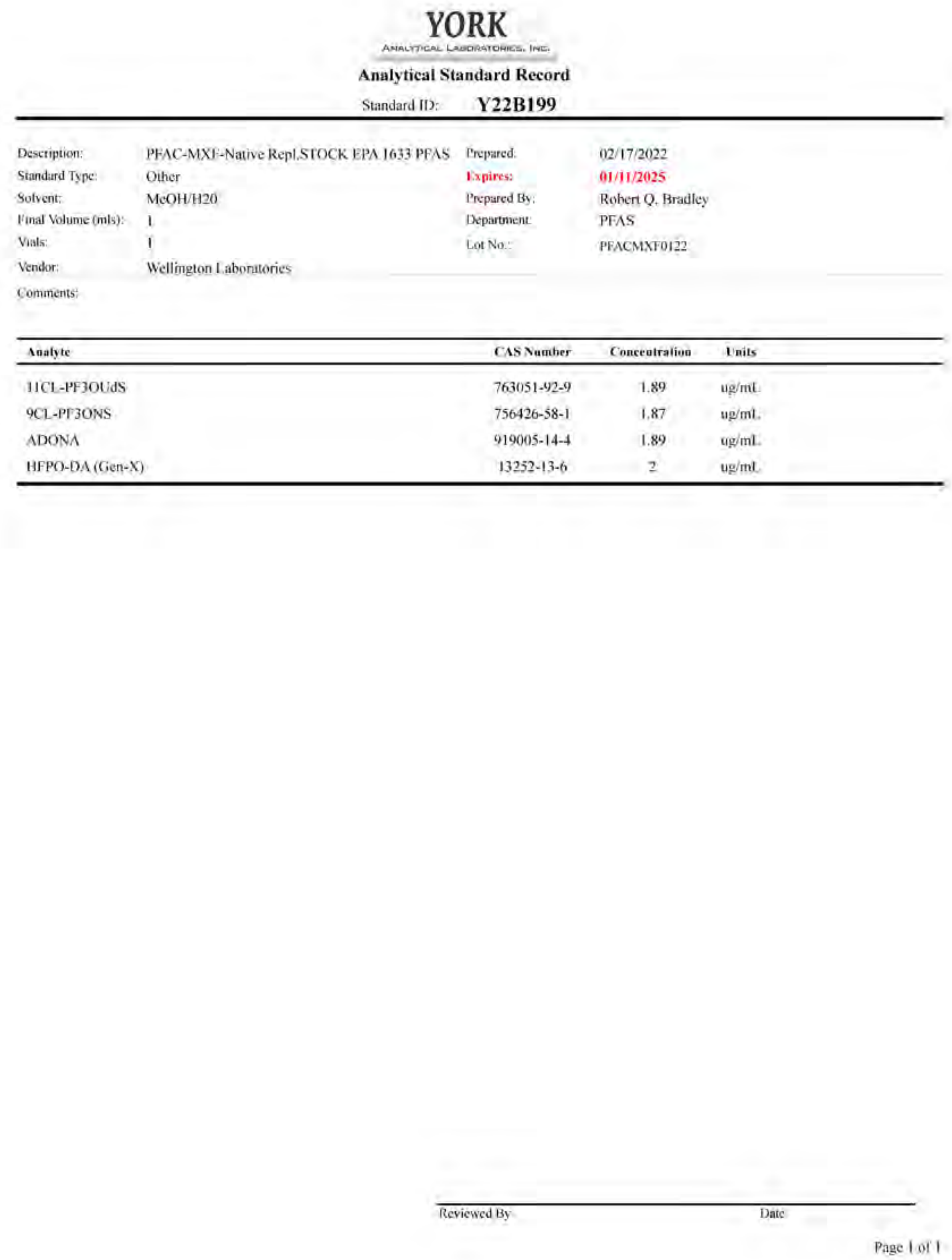
MS Parameters:

Experiment: SIR

Source: Electrospray (negative)
Capillary Voltage (kV) = 2.00
Cone Voltage (V) = variable (15-74)
Desolvation Temperature (°C) = 325
Desolvation Gas Flow (L/hr) = 1000

Form#:13, Issued 2004-11-10
Revision#:9, Revised 2020-12-23

PFACMXF0122 (4 of 5)
rev0



YORK
ANALYTICAL LABORATORIES, INC.

Analytical Standard Record

Standard ID: **Y22B199**

Description:	PFAC-MXF-Native Repl.STOCK EPA 1633 PFAS	Prepared:	02/17/2022
Standard Type:	Other	**Expires:**	**01/11/2025**
Solvent:	MeOH/H20	Prepared By:	Robert Q. Bradley
Final Volume (mls):	1	Department:	PFAS
Vials:	1	Lot No.:	PFACMXF0122
Vendor:	Wellington Laboratories		
Comments:			

Analyte	CAS Number	Concentration	Units
11CL-PF3OUdS	763051-92-9	1.89	ug/mL
9CL-PF3ONS	756426-58-1	1.87	ug/mL
ADONA	919005-14-4	1.89	ug/mL
HFPO-DA (Gen-X)	13252-13-6	2	ug/mL

Reviewed By: Date:

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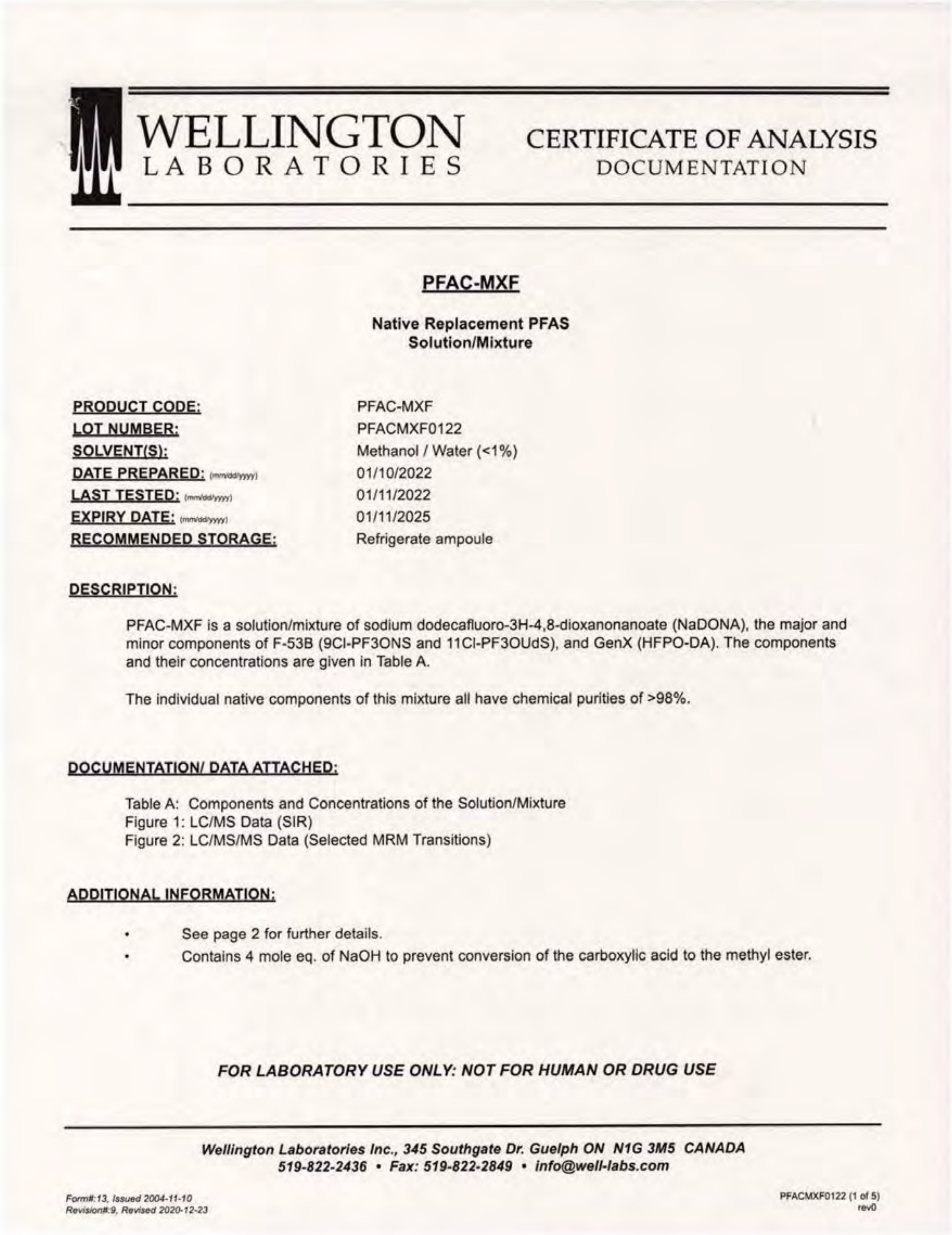

WELLINGTON
LABORATORIES

CERTIFICATE OF ANALYSIS
DOCUMENTATION

PFAC-MXF

Native Replacement PFAS
Solution/Mixture

PRODUCT CODE:	PFAC-MXF
LOT NUMBER:	PFACMXF0122
SOLVENT(S):	Methanol / Water (<1%)
DATE PREPARED: (mm/dd/yyyy)	01/10/2022
LAST TESTED: (mm/dd/yyyy)	01/11/2022
EXPIRY DATE: (mm/dd/yyyy)	01/11/2025
RECOMMENDED STORAGE:	Refrigerate ampoule

DESCRIPTION:

PFAC-MXF is a solution/mixture of sodium dodecafluoro-3H-4,8-dioxanonanoate (NaDONA), the major and minor components of F-53B (9Cl-PF3ONS and 11Cl-PF3OUdS), and GenX (HFPO-DA). The components and their concentrations are given in Table A.

The individual native components of this mixture all have chemical purities of >98%.

DOCUMENTATION/ DATA ATTACHED:

Table A: Components and Concentrations of the Solution/Mixture
Figure 1: LC/MS Data (SIR)
Figure 2: LC/MS/MS Data (Selected MRM Transitions)

ADDITIONAL INFORMATION:

- See page 2 for further details.
- Contains 4 mole eq. of NaOH to prevent conversion of the carboxylic acid to the methyl ester.

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PFACMXF0122 (1 of 5)
rev0

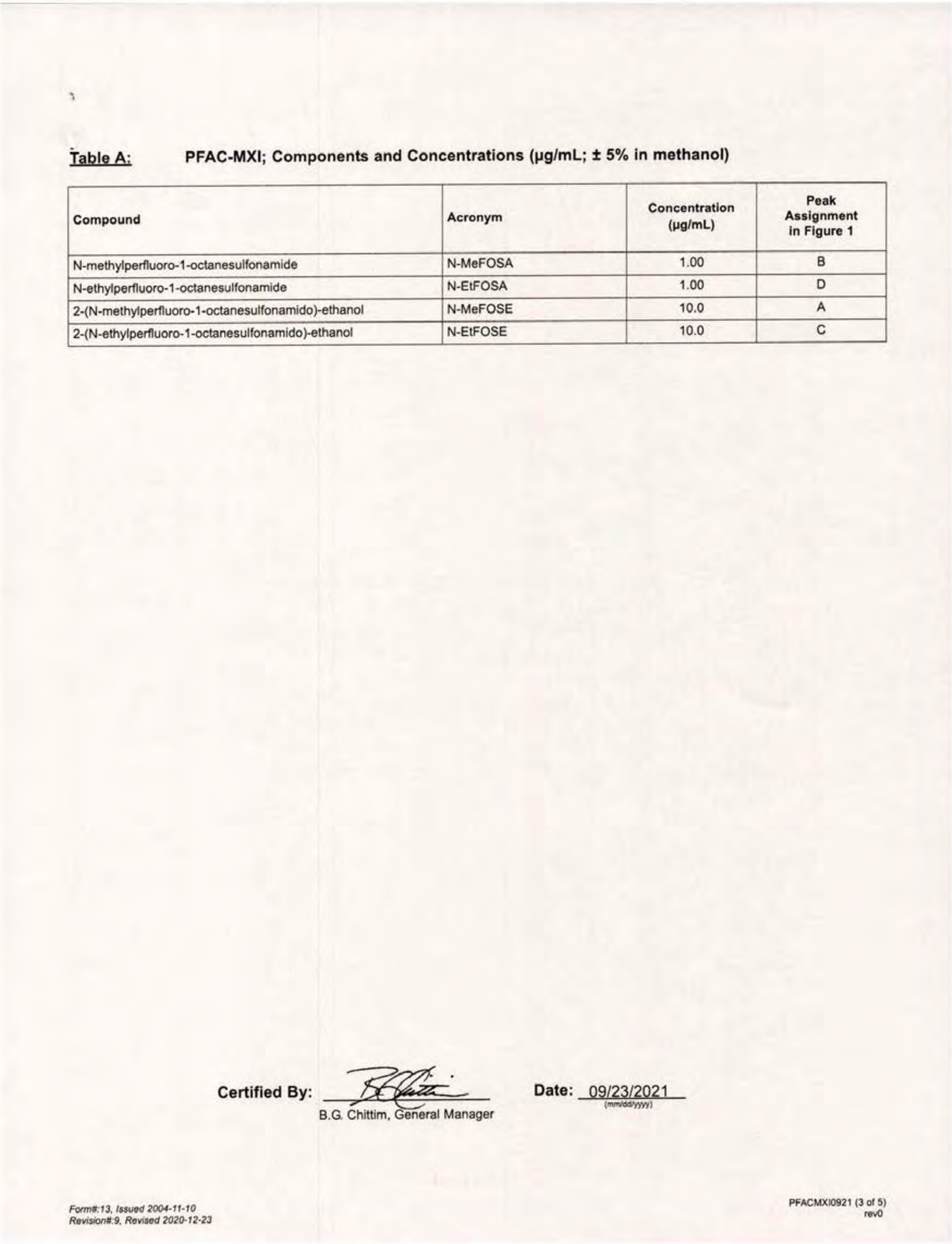


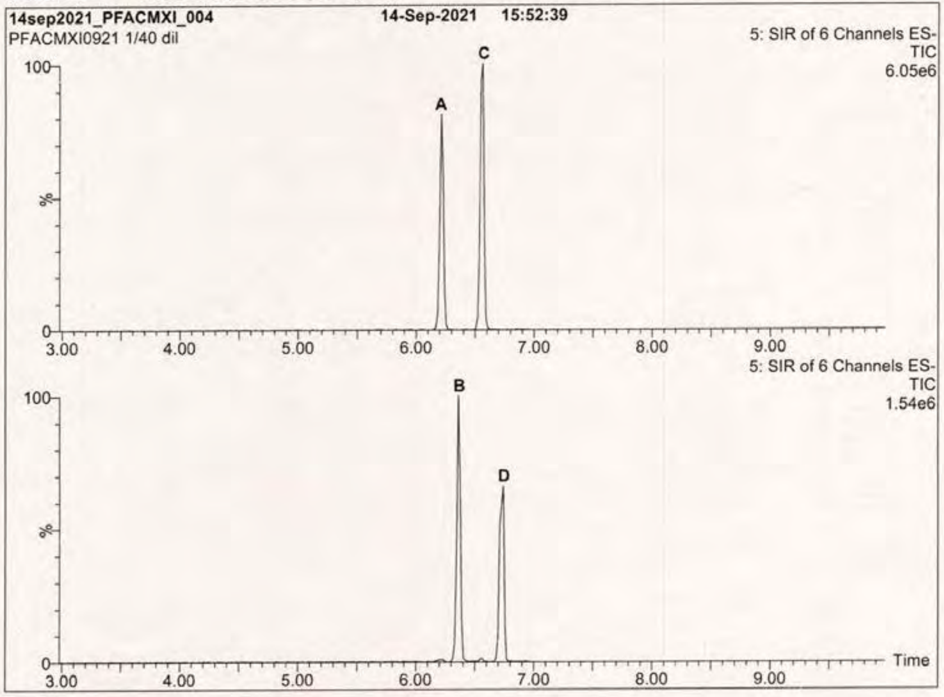
Table A: **PFAC-MXI; Components and Concentrations (µg/mL; ± 5% in methanol)**

Compound	Acronym	Concentration (µg/mL)	Peak Assignment in Figure 1
N-methylperfluoro-1-octanesulfonamide	N-MeFOSA	1.00	B
N-ethylperfluoro-1-octanesulfonamide	N-EtFOSA	1.00	D
2-(N-methylperfluoro-1-octanesulfonamido)-ethanol	N-MeFOSE	10.0	A
2-(N-ethylperfluoro-1-octanesulfonamido)-ethanol	N-EtFOSE	10.0	C

Certified By: B.G. Chittim, General Manager

Date: 09/23/2021
(mm/dd/yyyy)

Figure 1: **PFAC-MXI; LC/MS Data (SIR)**



Conditions for Figure 1:

Waters Acquity Ultra Performance LC
Waters Xevo TQ-S micro MS

Chromatographic Conditions:

Column: Acquity UPLC BEH Shield RP$_{18}$
1.7 µm, 2.1 x 100 mm

Mobile phase: Gradient
Start: 50% H$_2$O / 50% (80:20 MeOH:ACN)
(both with 10 mM NH$_4$OAc buffer)
Ramp to 90% organic over 9 min and hold for
2 min before returning to initial conditions in 1 min.
Time: 15 min

Flow: 300 µL/min

MS Parameters:

Experiment: SIR

Source: Electrospray (negative)
Capillary Voltage (kV) = 2.50
Cone Voltage (V) = variable (2-74)
Desolvation Temperature (°C) = 350
Desolvation Gas Flow (L/hr) = 1000

Form#:13, Issued 2004-11-10
Revision#:9, Revised 2020-12-23

PFACMXI0921 (4 of 5)
rev0

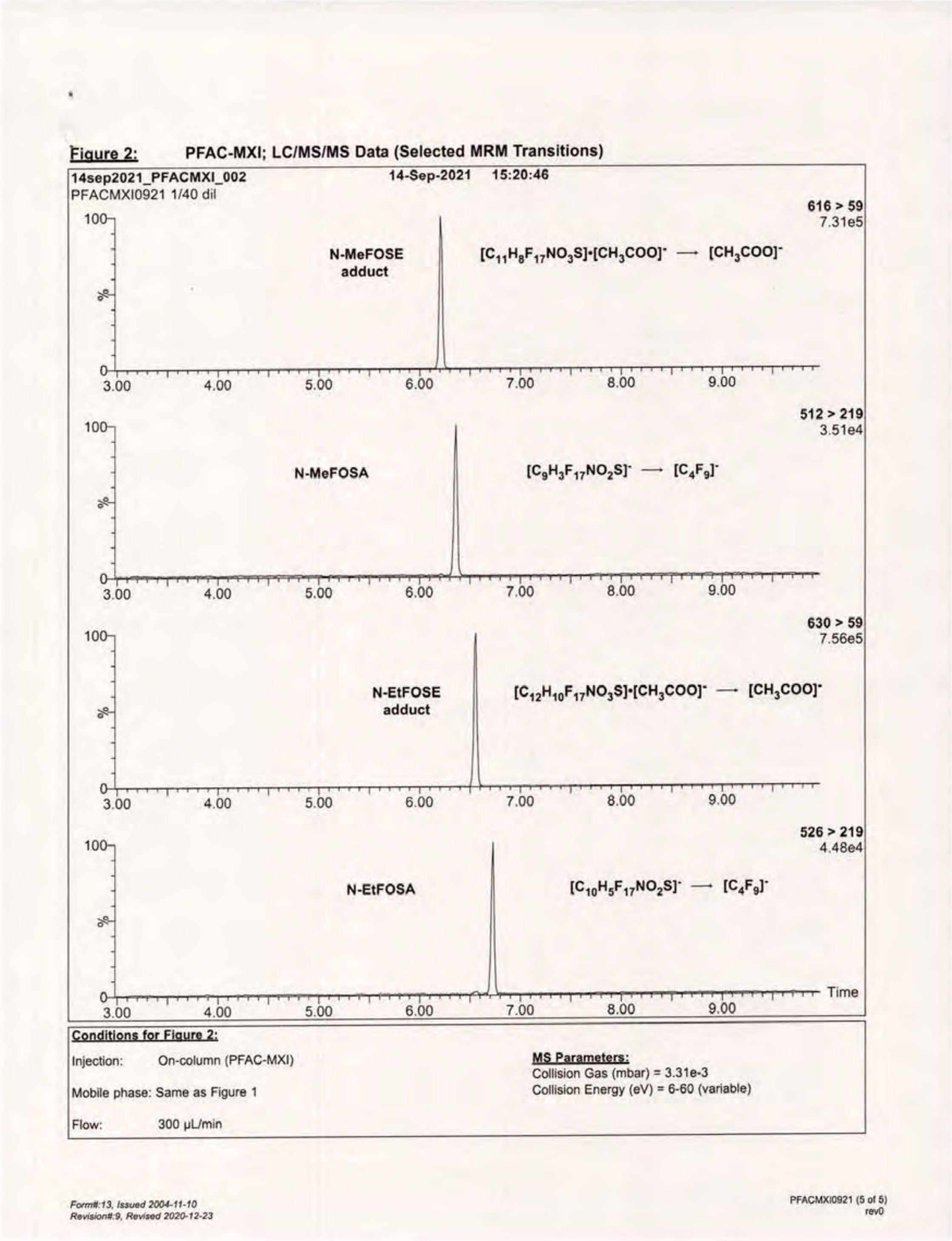


Figure 2: **PFAC-MXI; LC/MS/MS Data (Selected MRM Transitions)**

14sep2021_PFACMXI_002 **14-Sep-2021 15:20:46**
PFACMXI0921 1/40 dil

Conditions for Figure 2:

Injection: On-column (PFAC-MXI)

Mobile phase: Same as Figure 1

Flow: 300 µL/min

MS Parameters:
Collision Gas (mbar) = 3.31e-3
Collision Energy (eV) = 6-60 (variable)

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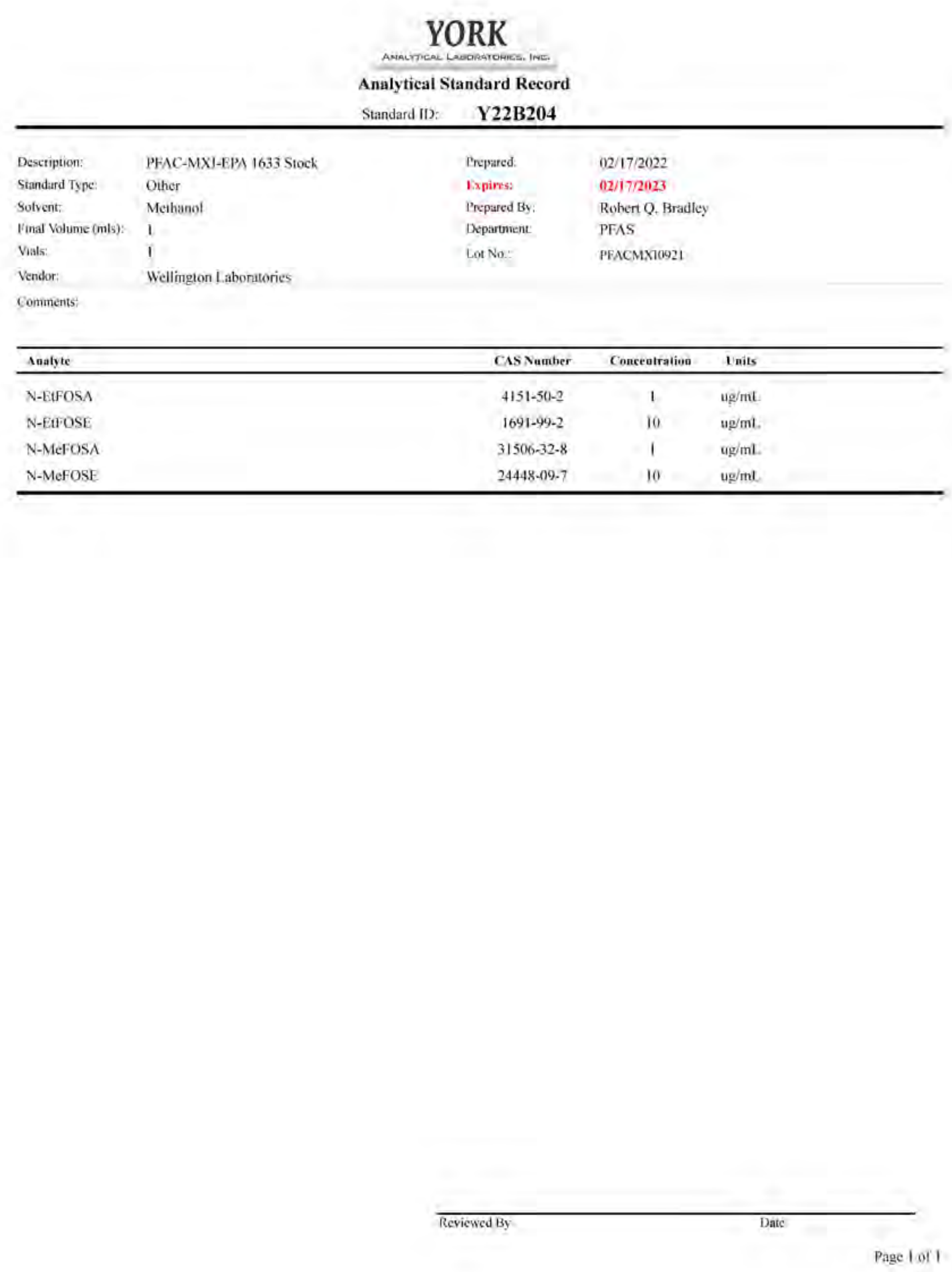
PFACMXI0921 (5 of 5)
rev0



YORK
ANALYTICAL LABORATORIES, INC.

Analytical Standard Record

Standard ID: **Y22B204**

Description:	PFAC-MXI-EPA 1633 Stock	Prepared:	02/17/2022
Standard Type:	Other	**Expires:**	**02/17/2023**
Solvent:	Methanol	Prepared By:	Robert Q. Bradley
Final Volume (mls):	1	Department:	PFAS
Vials:	1	Lot No.:	PFACMXI0921
Vendor:	Wellington Laboratories		
Comments:			

Analyte	CAS Number	Concentration	Units
N-EtFOSA	4151-50-2	1	ug/mL
N-EtFOSE	1691-99-2	10	ug/mL
N-MeFOSA	31506-32-8	1	ug/mL
N-MeFOSE	24448-09-7	10	ug/mL

Reviewed By: Date:

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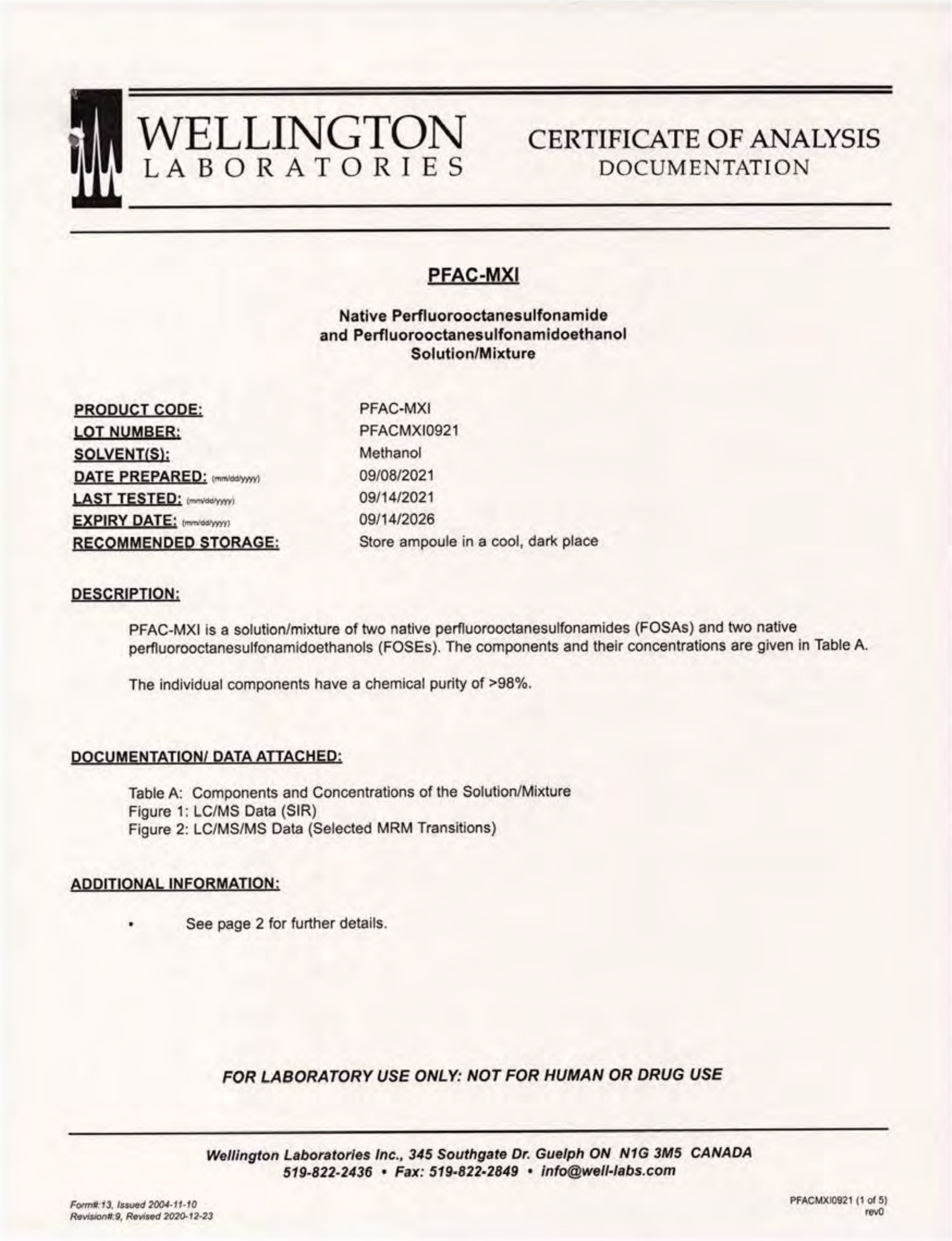

WELLINGTON LABORATORIES

CERTIFICATE OF ANALYSIS
DOCUMENTATION

PFAC-MXI

Native Perfluorooctanesulfonamide
and Perfluorooctanesulfonamidoethanol
Solution/Mixture

PRODUCT CODE:	PFAC-MXI
LOT NUMBER:	PFACMXI0921
SOLVENT(S):	Methanol
DATE PREPARED: (mm/dd/yyyy)	09/08/2021
LAST TESTED: (mm/dd/yyyy)	09/14/2021
EXPIRY DATE: (mm/dd/yyyy)	09/14/2026
RECOMMENDED STORAGE:	Store ampoule in a cool, dark place

DESCRIPTION:

PFAC-MXI is a solution/mixture of two native perfluorooctanesulfonamides (FOSAs) and two native perfluorooctanesulfonamidoethanols (FOSEs). The components and their concentrations are given in Table A.

The individual components have a chemical purity of >98%.

DOCUMENTATION/ DATA ATTACHED:

Table A: Components and Concentrations of the Solution/Mixture
Figure 1: LC/MS Data (SIR)
Figure 2: LC/MS/MS Data (Selected MRM Transitions)

ADDITIONAL INFORMATION:

- See page 2 for further details.

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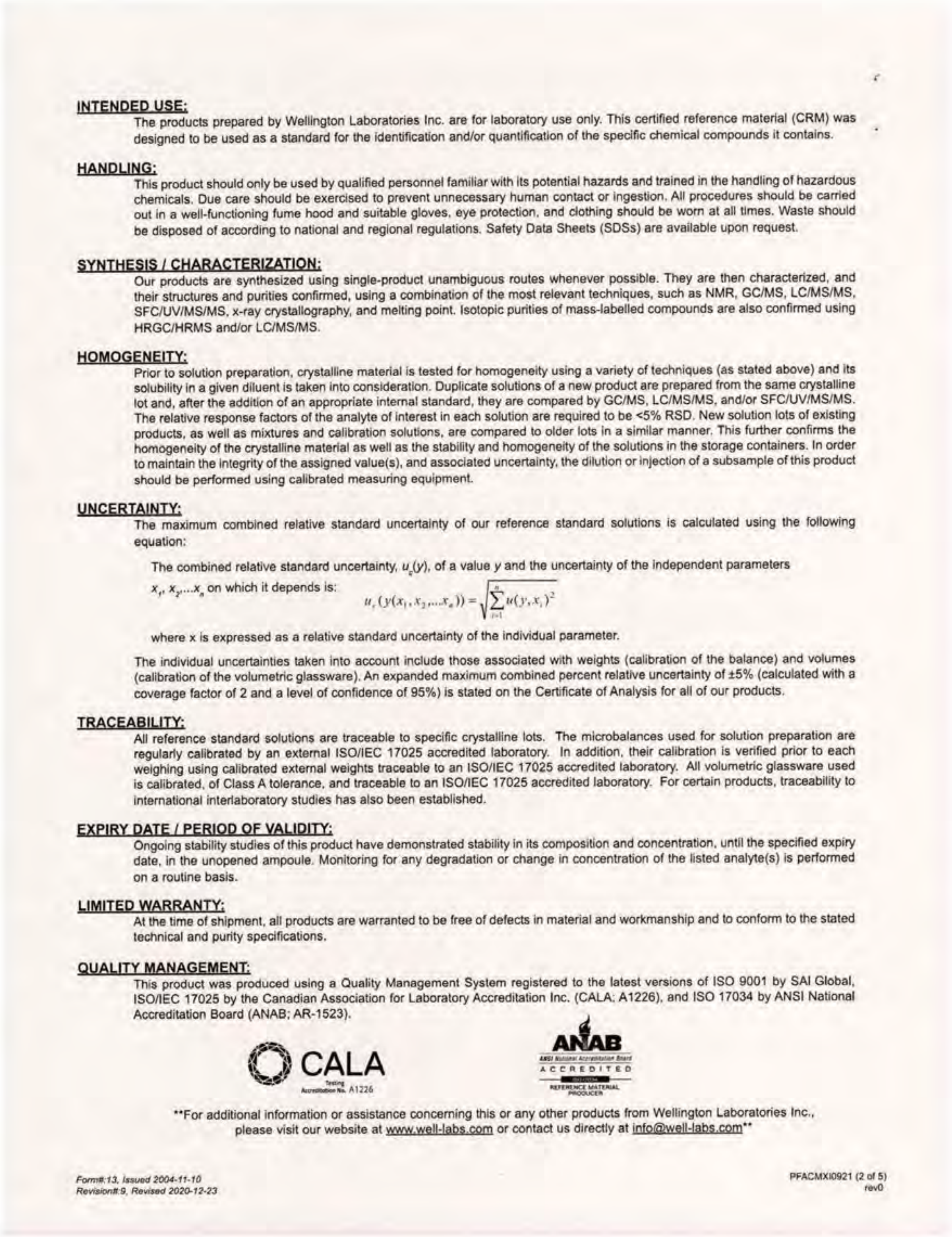
PFACMXI0921 (1 of 5)
rev0



INTENDED USE:

The products prepared by Wellington Laboratories Inc. are for laboratory use only. This certified reference material (CRM) was designed to be used as a standard for the identification and/or quantification of the specific chemical compounds it contains.

HANDLING:

This product should only be used by qualified personnel familiar with its potential hazards and trained in the handling of hazardous chemicals. Due care should be exercised to prevent unnecessary human contact or ingestion. All procedures should be carried out in a well-functioning fume hood and suitable gloves, eye protection, and clothing should be worn at all times. Waste should be disposed of according to national and regional regulations. Safety Data Sheets (SDSs) are available upon request.

SYNTHESIS / CHARACTERIZATION:

Our products are synthesized using single-product unambiguous routes whenever possible. They are then characterized, and their structures and purities confirmed, using a combination of the most relevant techniques, such as NMR, GC/MS, LC/MS/MS, SFC/UV/MS/MS, x-ray crystallography, and melting point. Isotopic purities of mass-labelled compounds are also confirmed using HRGC/HRMS and/or LC/MS/MS.

HOMOGENEITY:

Prior to solution preparation, crystalline material is tested for homogeneity using a variety of techniques (as stated above) and its solubility in a given diluent is taken into consideration. Duplicate solutions of a new product are prepared from the same crystalline lot and, after the addition of an appropriate internal standard, they are compared by GC/MS, LC/MS/MS, and/or SFC/UV/MS/MS. The relative response factors of the analyte of interest in each solution are required to be <5% RSD. New solution lots of existing products, as well as mixtures and calibration solutions, are compared to older lots in a similar manner. This further confirms the homogeneity of the crystalline material as well as the stability and homogeneity of the solutions in the storage containers. In order to maintain the integrity of the assigned value(s), and associated uncertainty, the dilution or injection of a subsample of this product should be performed using calibrated measuring equipment.

UNCERTAINTY:

The maximum combined relative standard uncertainty of our reference standard solutions is calculated using the following equation:

The combined relative standard uncertainty, $u_c(y)$, of a value y and the uncertainty of the independent parameters $x_1, x_2, \ldots x_n$ on which it depends is:

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where x is expressed as a relative standard uncertainty of the individual parameter.

The individual uncertainties taken into account include those associated with weights (calibration of the balance) and volumes (calibration of the volumetric glassware). An expanded maximum combined percent relative uncertainty of ±5% (calculated with a coverage factor of 2 and a level of confidence of 95%) is stated on the Certificate of Analysis for all of our products.

TRACEABILITY:

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LIMITED WARRANTY:

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QUALITY MANAGEMENT:

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CALA
Testing
Accreditation No. A1226

ANAB
ANSI National Accreditation Board
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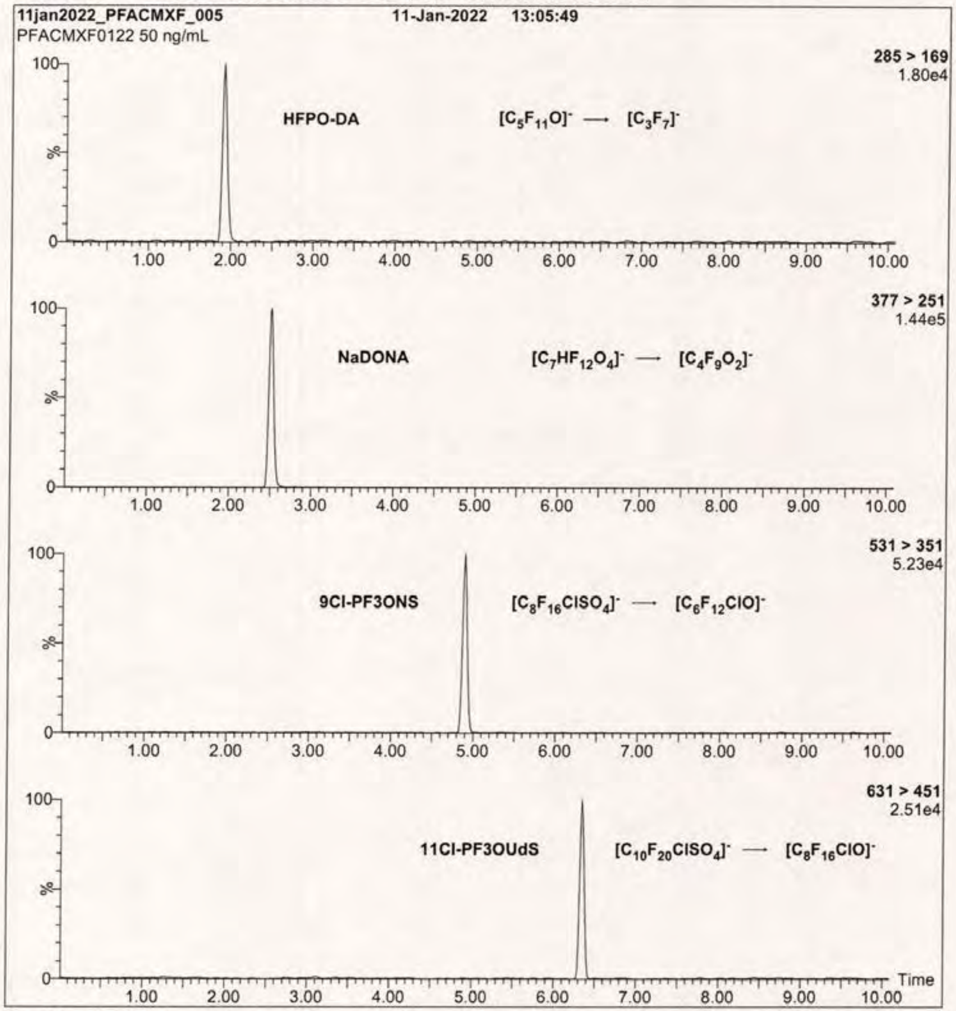
Figure 2: **PFAC-MXF; LC/MS/MS Data (Selected MRM Transitions)**



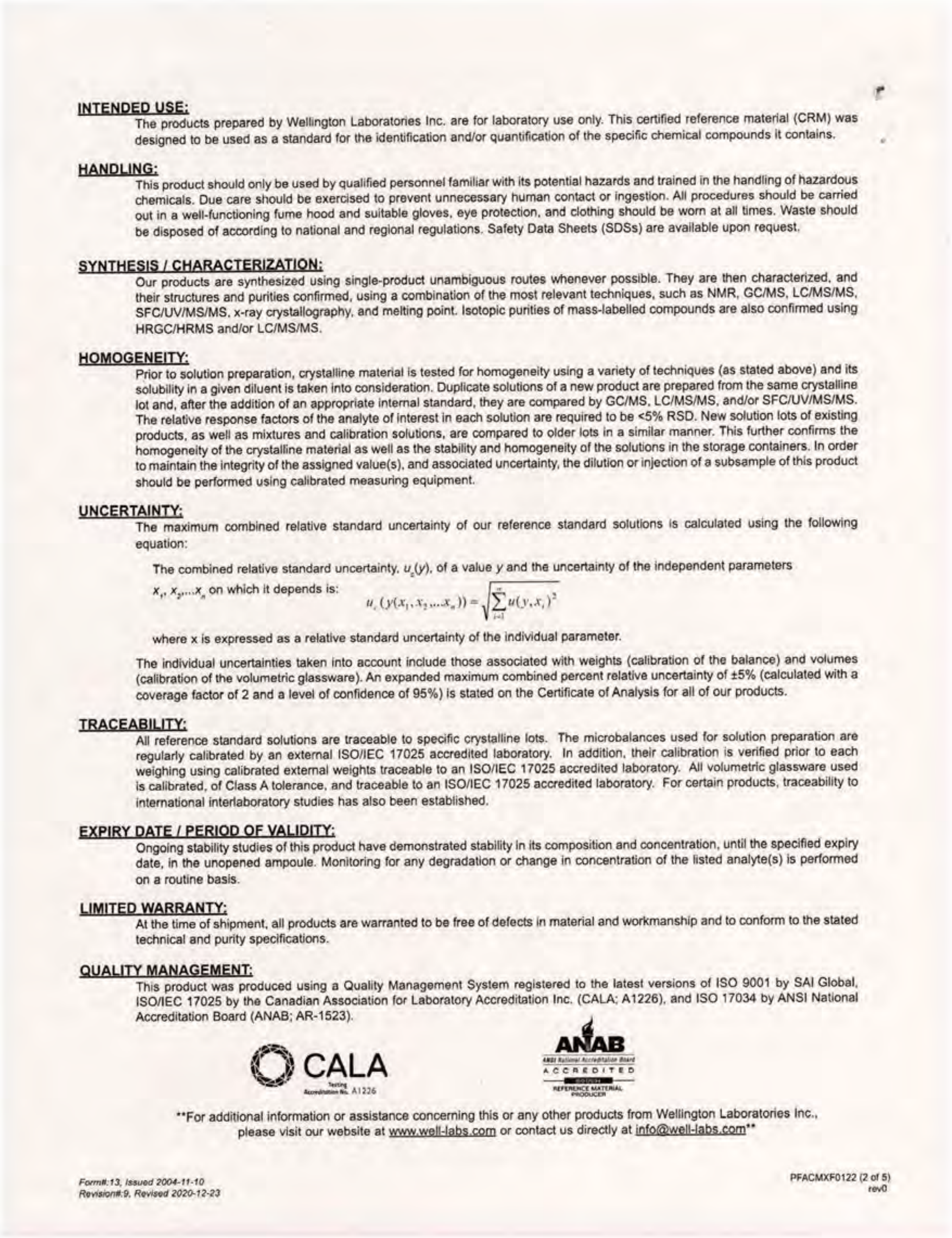
Conditions for Figure 2:

Injection: On-column (PFAC-MXF)

Mobile phase: Same as Figure 1

Flow: 300 µL/min

MS Parameters:
Collision Gas (mbar) = 3.43e-3
Collision Energy (eV) = 6-60 (variable)



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where x is expressed as a relative standard uncertainty of the individual parameter.

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CALA
Testing Accreditation No. A1226

ANAB
ANSI National Accreditation Board
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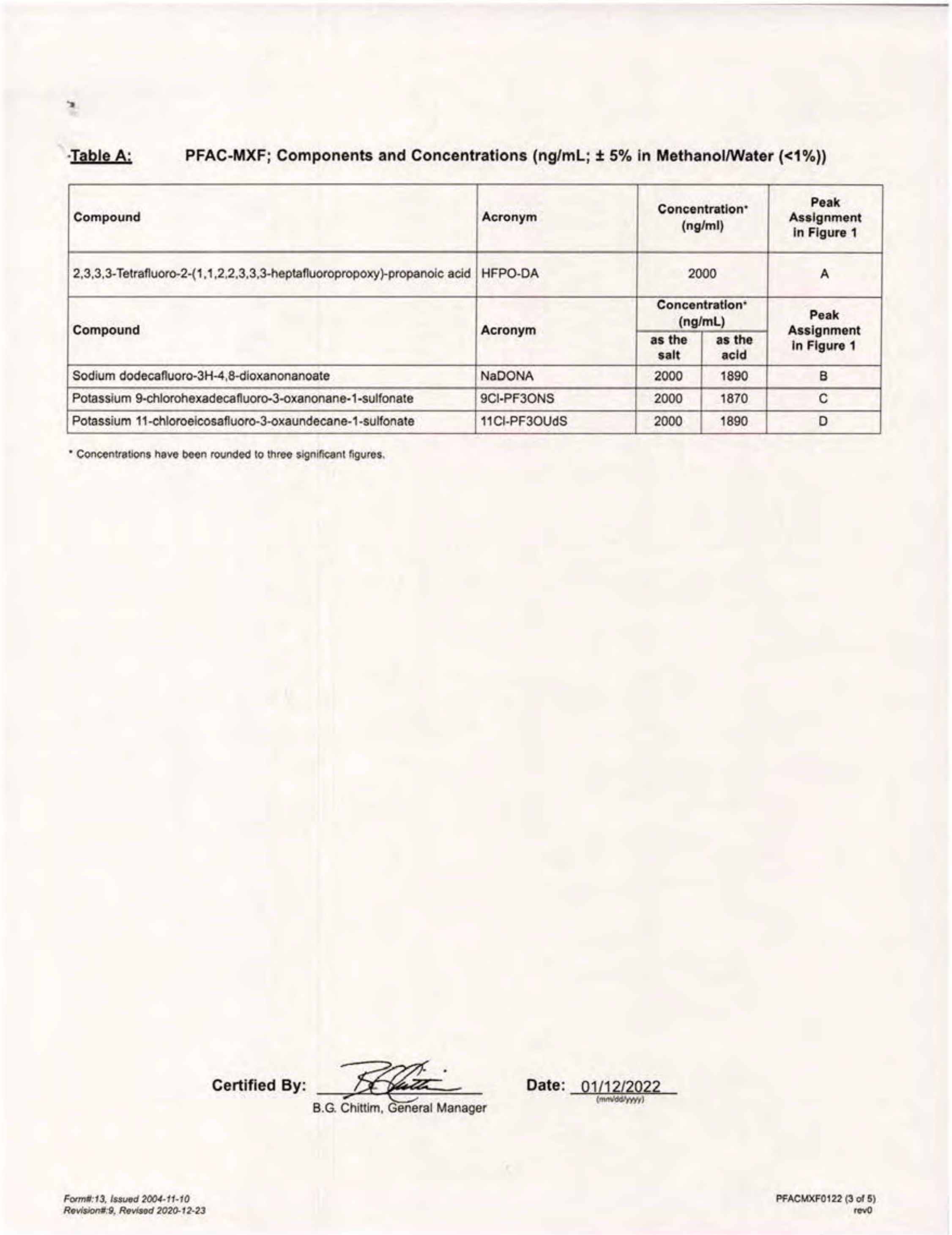

Table A: **PFAC-MXF; Components and Concentrations (ng/mL; ± 5% in Methanol/Water (<1%))**

Compound	Acronym	Concentration* (ng/ml)	Peak Assignment in Figure 1
2,3,3,3-Tetrafluoro-2-(1,1,2,2,3,3,3-heptafluoropropoxy)-propanoic acid	HFPO-DA	2000	A

Compound	Acronym	Concentration* (ng/mL)		Peak Assignment in Figure 1
		as the salt	as the acid	
Sodium dodecafluoro-3H-4,8-dioxanonanoate	NaDONA	2000	1890	B
Potassium 9-chlorohexadecafluoro-3-oxanonane-1-sulfonate	9Cl-PF3ONS	2000	1870	C
Potassium 11-chloroeicosafluoro-3-oxaundecane-1-sulfonate	11Cl-PF3OUdS	2000	1890	D

* Concentrations have been rounded to three significant figures.

Certified By: ______________ **Date:** 01/12/2022
B.G. Chittim, General Manager (mm/dd/yyyy)

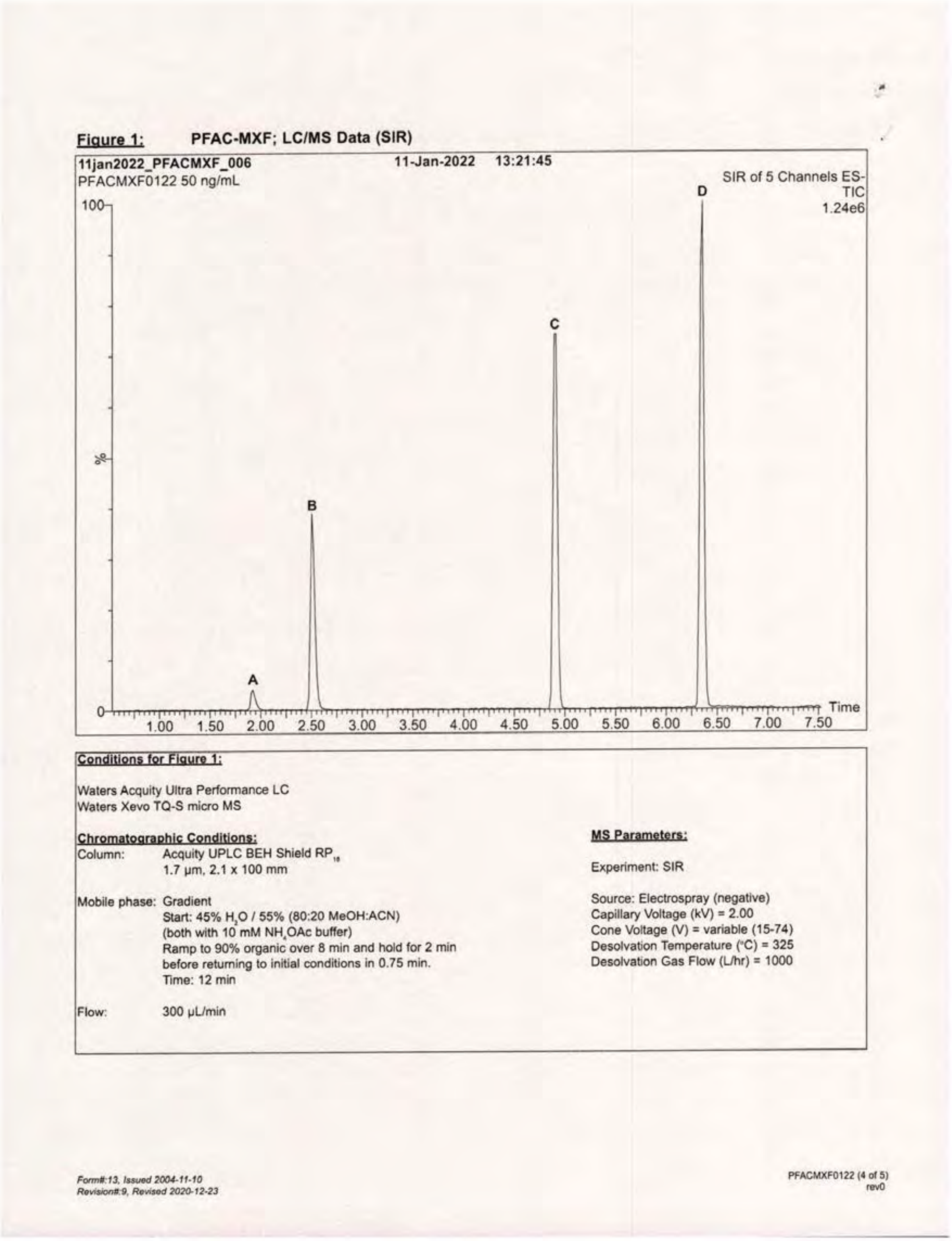

Figure 1: **PFAC-MXF; LC/MS Data (SIR)**

Conditions for Figure 1:

Waters Acquity Ultra Performance LC
Waters Xevo TQ-S micro MS

Chromatographic Conditions:

Column: Acquity UPLC BEH Shield RP_{18}
1.7 µm, 2.1 x 100 mm

Mobile phase: Gradient
Start: 45% H_2O / 55% (80:20 MeOH:ACN)
(both with 10 mM NH_4OAc buffer)
Ramp to 90% organic over 8 min and hold for 2 min
before returning to initial conditions in 0.75 min.
Time: 12 min

Flow: 300 µL/min

MS Parameters:

Experiment: SIR

Source: Electrospray (negative)
Capillary Voltage (kV) = 2.00
Cone Voltage (V) = variable (15-74)
Desolvation Temperature (°C) = 325
Desolvation Gas Flow (L/hr) = 1000

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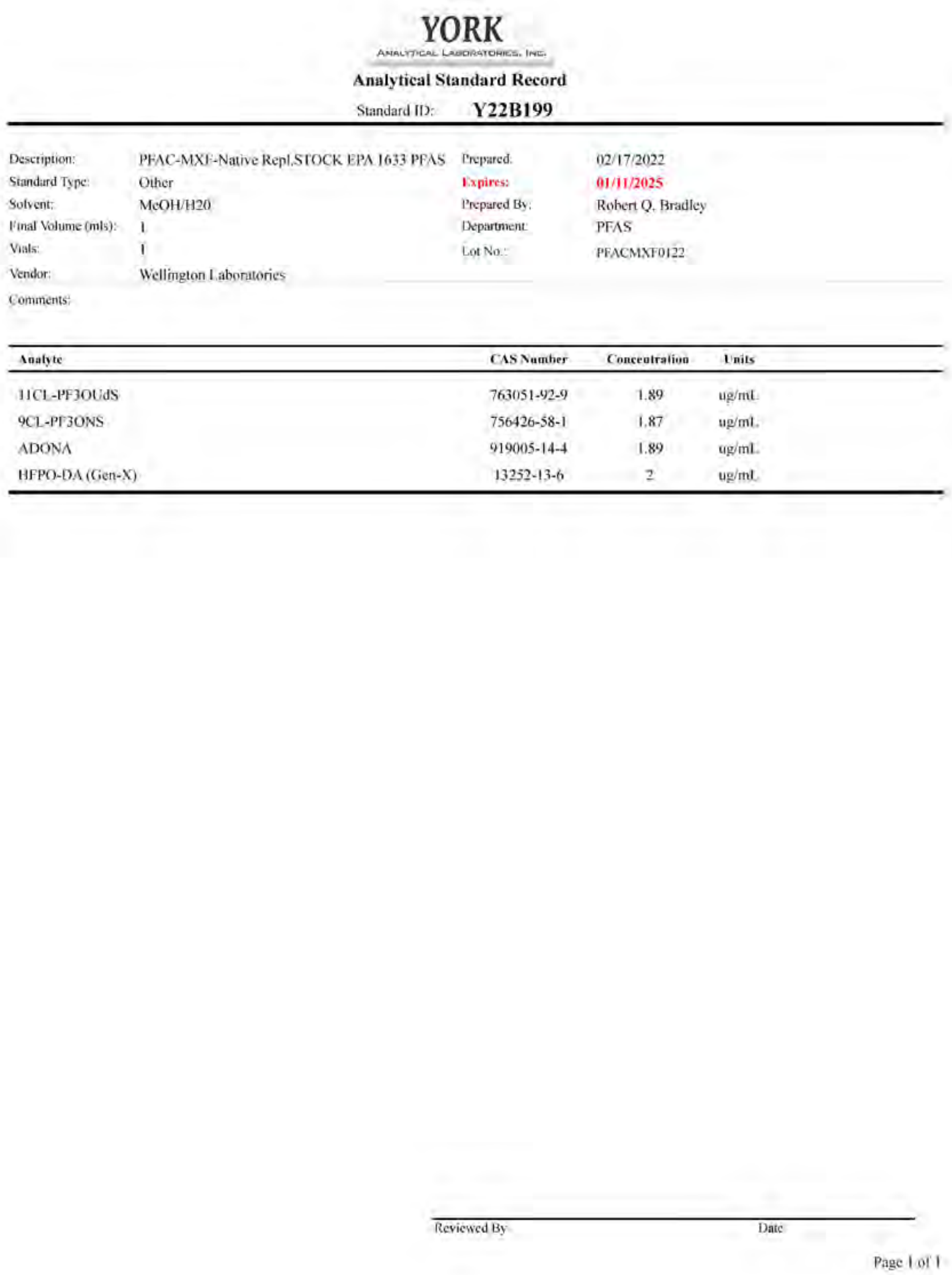
Revision#:9, Revised 2020-12-23

PFACMXF0122 (4 of 5)
rev0



YORK
ANALYTICAL LABORATORIES, INC.

Analytical Standard Record

Standard ID: **Y22B199**

Description:	PFAC-MXF-Native Repl.STOCK EPA 1633 PFAS	Prepared:	02/17/2022
Standard Type:	Other	**Expires:**	**01/11/2025**
Solvent:	MeOH/H20	Prepared By:	Robert Q. Bradley
Final Volume (mls):	1	Department:	PFAS
Vials:	1	Lot No.:	PFACMXF0122
Vendor:	Wellington Laboratories		
Comments:			

Analyte	**CAS Number**	**Concentration**	**Units**
11CL-PF3OUdS	763051-92-9	1.89	ug/mL
9CL-PF3ONS	756426-58-1	1.87	ug/mL
ADONA	919005-14-4	1.89	ug/mL
HFPO-DA (Gen-X)	13252-13-6	2	ug/mL

Reviewed By: Date:

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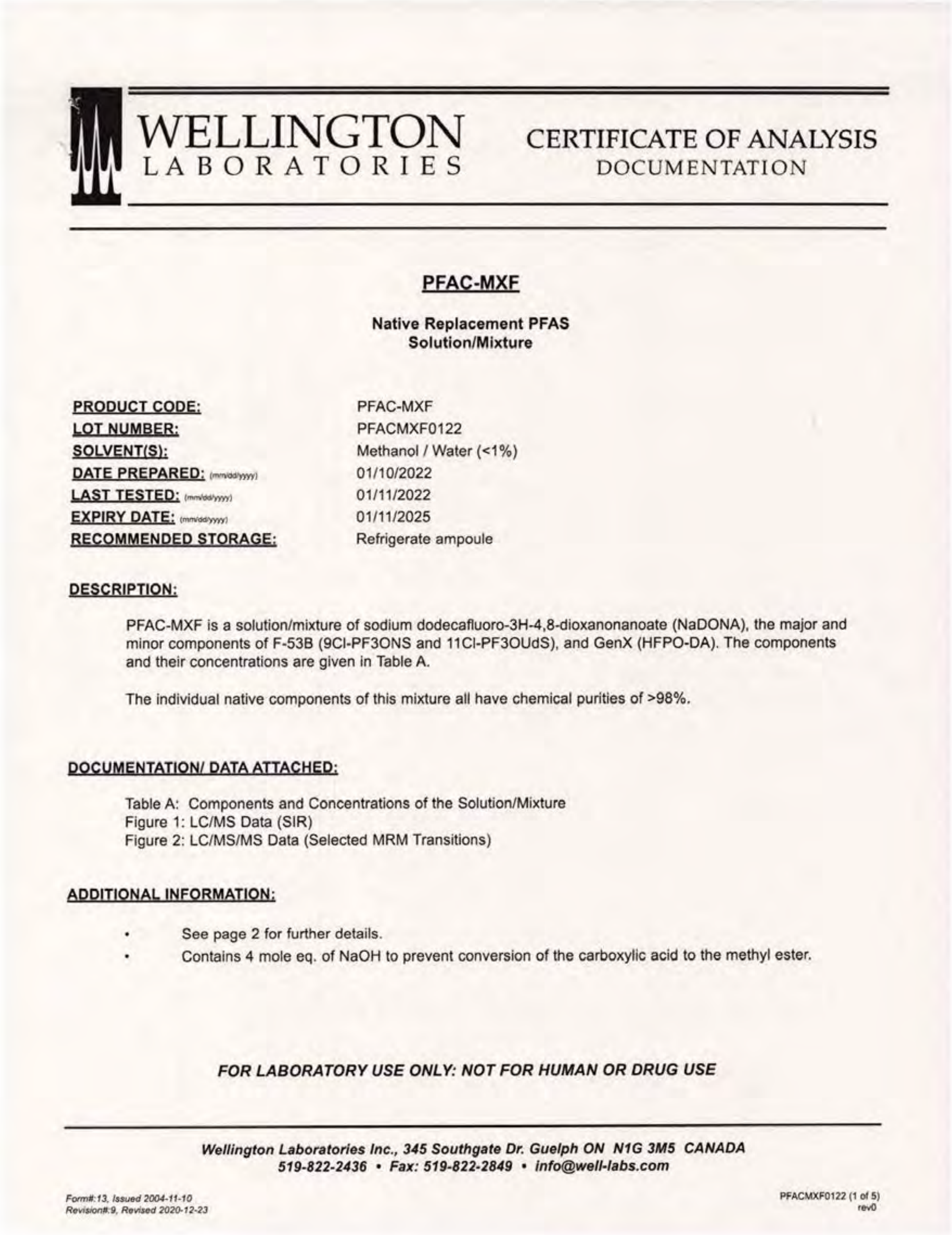

WELLINGTON
LABORATORIES

CERTIFICATE OF ANALYSIS
DOCUMENTATION

PFAC-MXF

Native Replacement PFAS
Solution/Mixture

PRODUCT CODE:	PFAC-MXF
LOT NUMBER:	PFACMXF0122
SOLVENT(S):	Methanol / Water (<1%)
DATE PREPARED: (mm/dd/yyyy)	01/10/2022
LAST TESTED: (mm/dd/yyyy)	01/11/2022
EXPIRY DATE: (mm/dd/yyyy)	01/11/2025
RECOMMENDED STORAGE:	Refrigerate ampoule

DESCRIPTION:

PFAC-MXF is a solution/mixture of sodium dodecafluoro-3H-4,8-dioxanonanoate (NaDONA), the major and minor components of F-53B (9Cl-PF3ONS and 11Cl-PF3OUdS), and GenX (HFPO-DA). The components and their concentrations are given in Table A.

The individual native components of this mixture all have chemical purities of >98%.

DOCUMENTATION/ DATA ATTACHED:

Table A: Components and Concentrations of the Solution/Mixture
Figure 1: LC/MS Data (SIR)
Figure 2: LC/MS/MS Data (Selected MRM Transitions)

ADDITIONAL INFORMATION:

- See page 2 for further details.
- Contains 4 mole eq. of NaOH to prevent conversion of the carboxylic acid to the methyl ester.

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Revision#:9, Revised 2020-12-23

PFACMXF0122 (1 of 5)
rev0

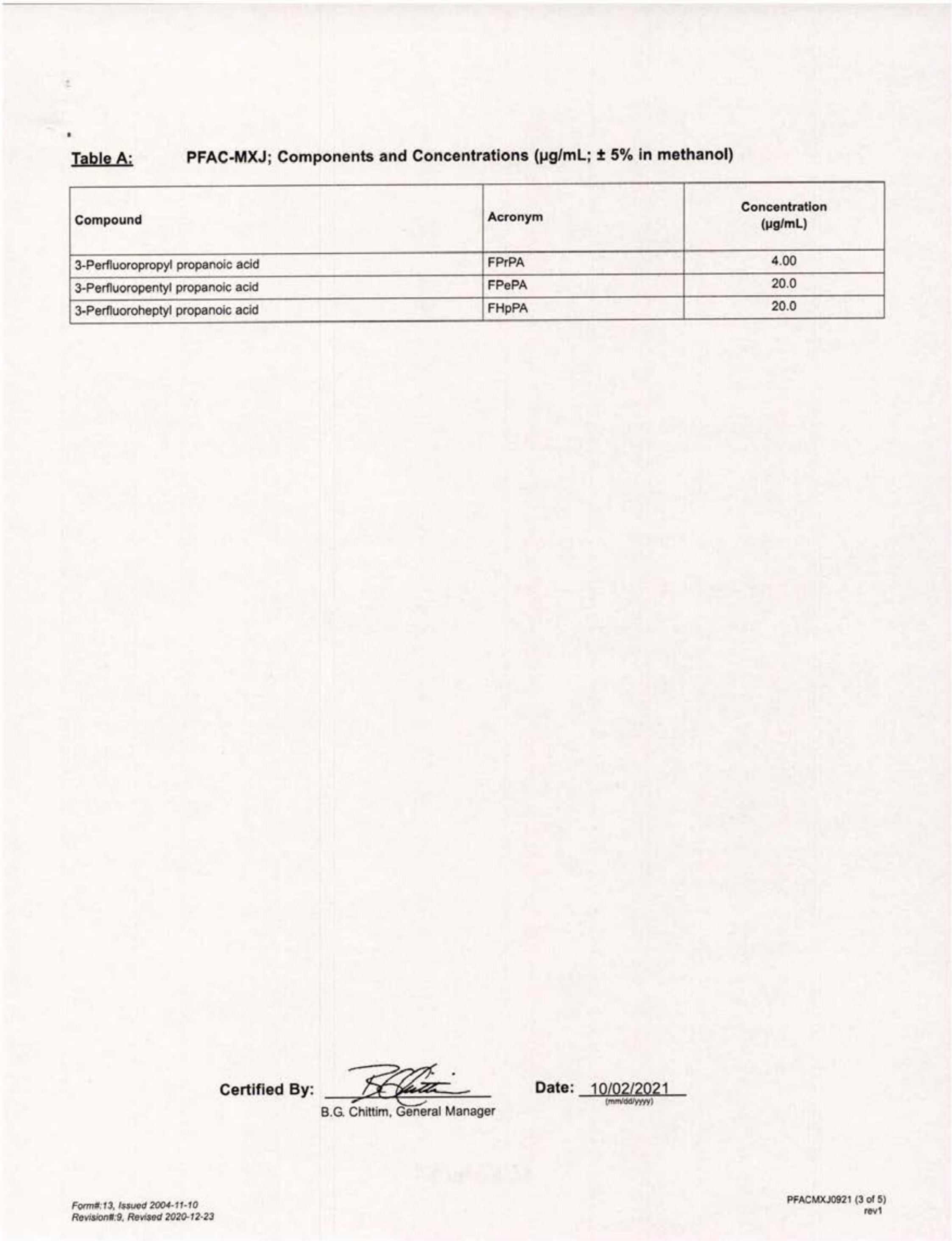

Table A: **PFAC-MXJ; Components and Concentrations (µg/mL; ± 5% in methanol)**

Compound	Acronym	Concentration (µg/mL)
3-Perfluoropropyl propanoic acid	FPrPA	4.00
3-Perfluoropentyl propanoic acid	FPePA	20.0
3-Perfluoroheptyl propanoic acid	FHpPA	20.0

Certified By: ____________________ **Date:** 10/02/2021
B.G. Chittim, General Manager (mm/dd/yyyy)

Form#:13, Issued 2004-11-10
Revision#:9, Revised 2020-12-23

PFACMXJ0921 (3 of 5)
rev1

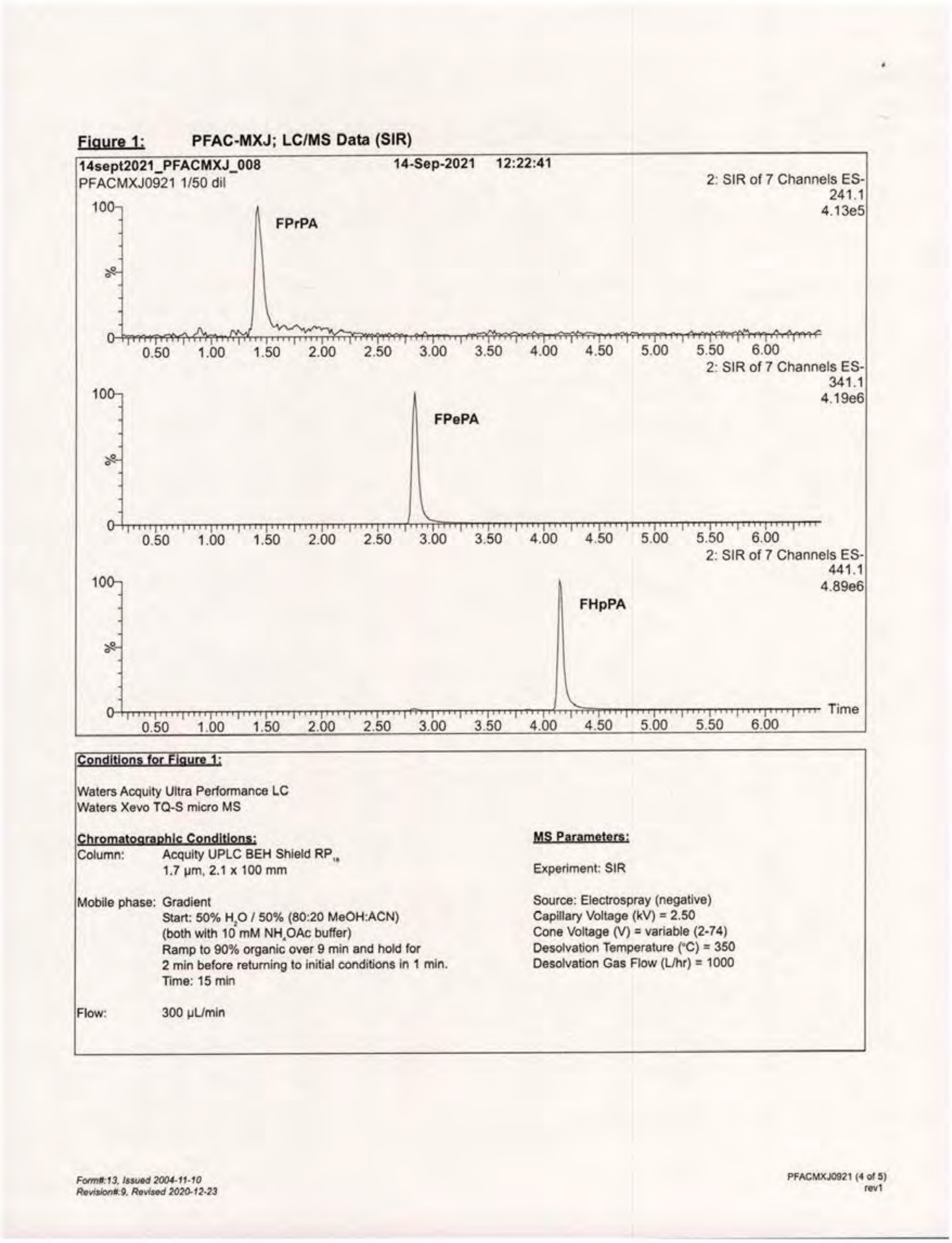

Figure 1: **PFAC-MXJ; LC/MS Data (SIR)**

Conditions for Figure 1:

Waters Acquity Ultra Performance LC
Waters Xevo TQ-S micro MS

Chromatographic Conditions:

Column: Acquity UPLC BEH Shield RP_{18}
1.7 µm, 2.1 x 100 mm

Mobile phase: Gradient
Start: 50% H_2O / 50% (80:20 MeOH:ACN)
(both with 10 mM NH_4OAc buffer)
Ramp to 90% organic over 9 min and hold for
2 min before returning to initial conditions in 1 min.
Time: 15 min

Flow: 300 µL/min

MS Parameters:

Experiment: SIR

Source: Electrospray (negative)
Capillary Voltage (kV) = 2.50
Cone Voltage (V) = variable (2-74)
Desolvation Temperature (°C) = 350
Desolvation Gas Flow (L/hr) = 1000

Form#:13, Issued 2004-11-10
Revision#:9, Revised 2020-12-23

PFACMXJ0921 (4 of 5)
rev1

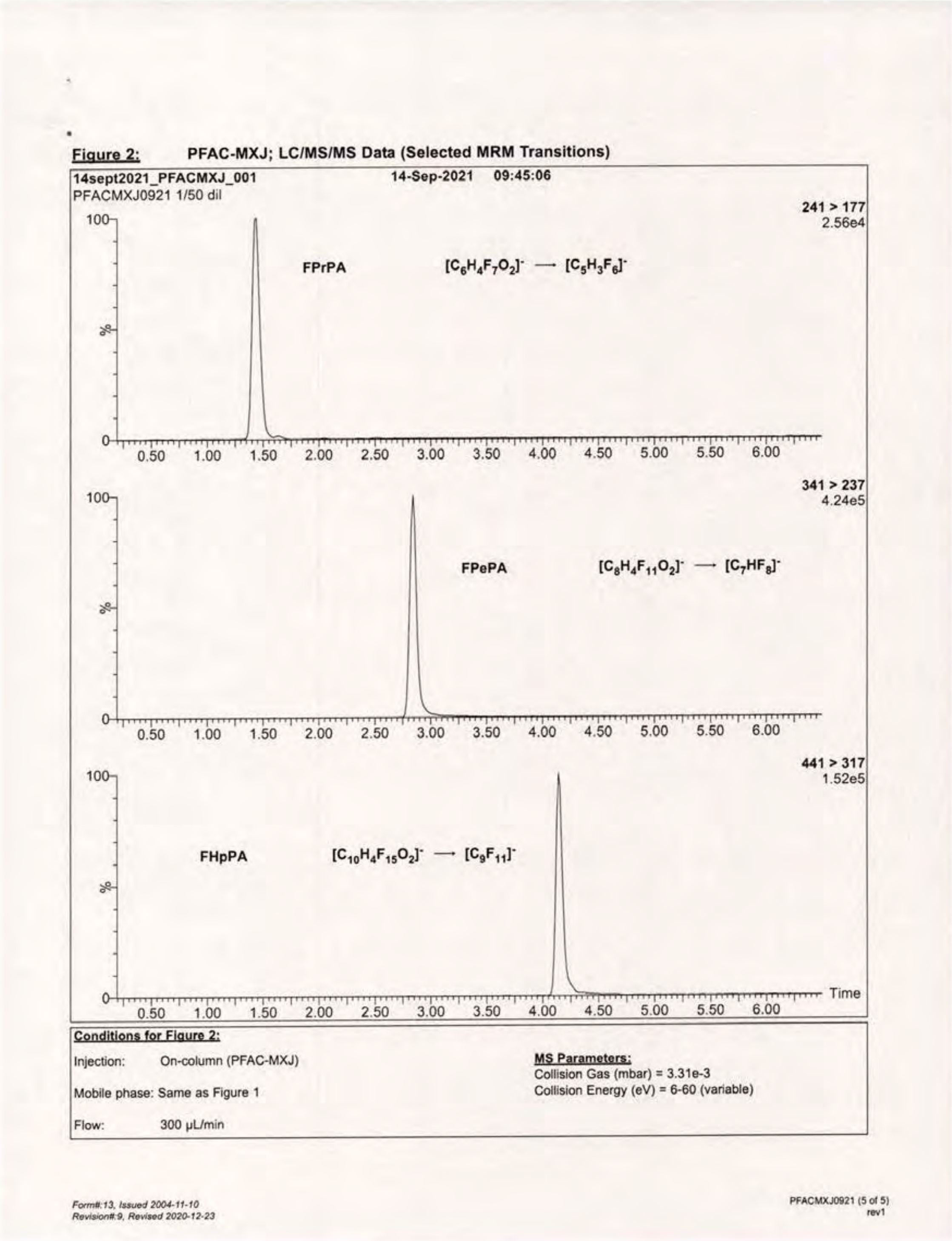

Figure 2: **PFAC-MXJ; LC/MS/MS Data (Selected MRM Transitions)**

14sept2021_PFACMXJ_001 **14-Sep-2021 09:45:06**
PFACMXJ0921 1/50 dil

Conditions for Figure 2:

Injection: On-column (PFAC-MXJ)

Mobile phase: Same as Figure 1

Flow: 300 µL/min

MS Parameters:
Collision Gas (mbar) = 3.31e-3
Collision Energy (eV) = 6-60 (variable)

Form#:13, Issued 2004-11-10
Revision#:9, Revised 2020-12-23

PFACMXJ0921 (5 of 5)
rev1

YORK
ANALYTICAL LABORATORIES, INC.

Analytical Standard Record

Standard ID: **Y22B205**

Description:	PFAC-MXJ-EPA 1633 Stock mix	**Prepared:**	02/17/2022
Standard Type:	Other	**Expires:**	09/14/2026
Solvent:	Methanol	**Prepared By:**	Robert Q. Bradley
Final Volume (mls):	1	**Department:**	PFAS
Vials:	1	**Lot No.:**	PFACMXJ0921
Vendor:	Wellington Laboratories		

Comments:

Analyte	CAS Number	Concentration	Units
3-Perfluoroheptyl propanoic acid (FHpPA	812-70-4	20	ug/mL
3-Perfluoropentyl propanoic acid (FPePA)	914637-49-3	20	ug/mL
3-Perfluoropropyl propanoic acid (FPrPA)	356-02-2	4	ug/mL

Reviewed By **Date**

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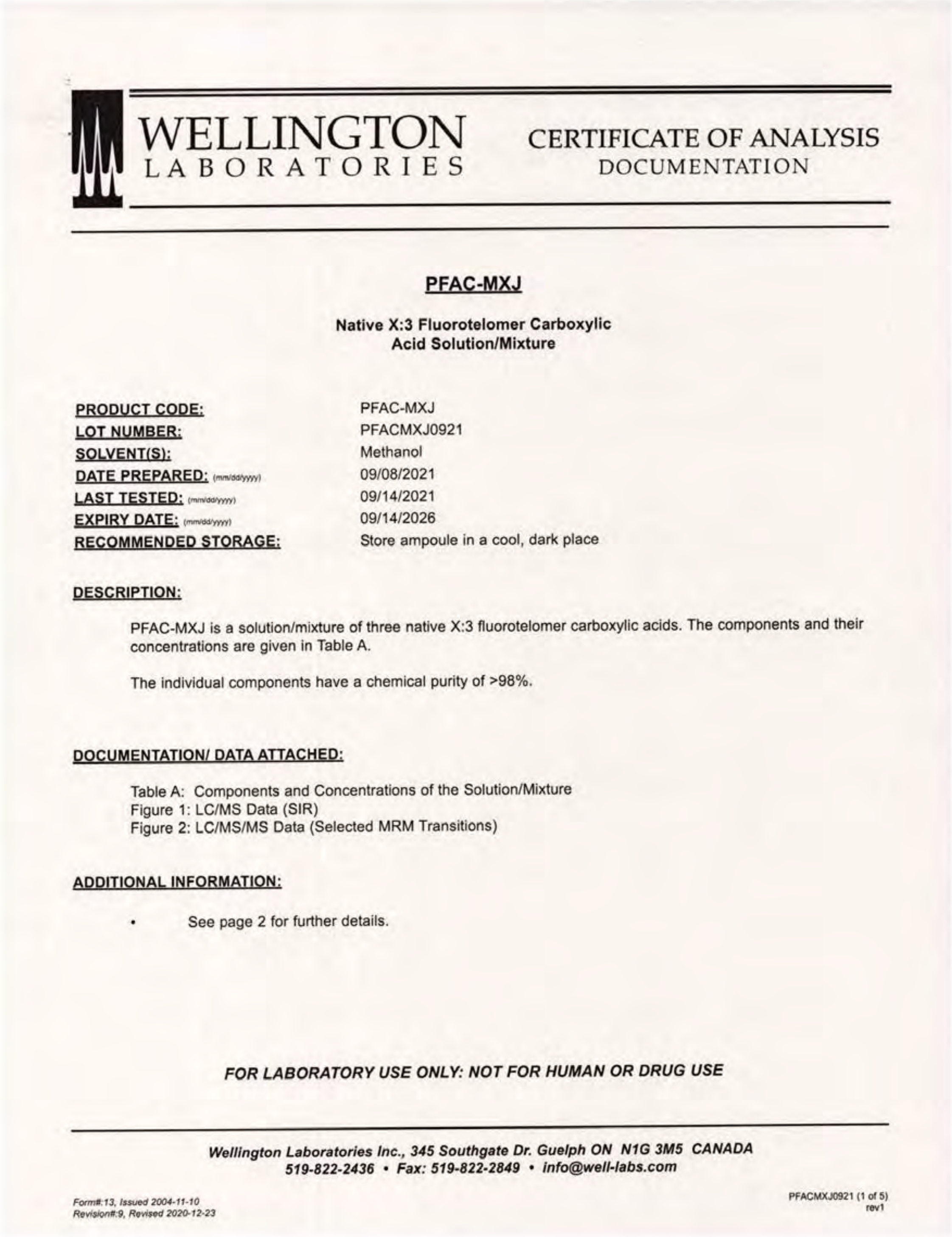

WELLINGTON
LABORATORIES

CERTIFICATE OF ANALYSIS
DOCUMENTATION

PFAC-MXJ

Native X:3 Fluorotelomer Carboxylic Acid Solution/Mixture

PRODUCT CODE:	PFAC-MXJ
LOT NUMBER:	PFACMXJ0921
SOLVENT(S):	Methanol
DATE PREPARED: (mm/dd/yyyy)	09/08/2021
LAST TESTED: (mm/dd/yyyy)	09/14/2021
EXPIRY DATE: (mm/dd/yyyy)	09/14/2026
RECOMMENDED STORAGE:	Store ampoule in a cool, dark place

DESCRIPTION:

PFAC-MXJ is a solution/mixture of three native X:3 fluorotelomer carboxylic acids. The components and their concentrations are given in Table A.

The individual components have a chemical purity of >98%.

DOCUMENTATION/ DATA ATTACHED:

Table A: Components and Concentrations of the Solution/Mixture
Figure 1: LC/MS Data (SIR)
Figure 2: LC/MS/MS Data (Selected MRM Transitions)

ADDITIONAL INFORMATION:

- See page 2 for further details.

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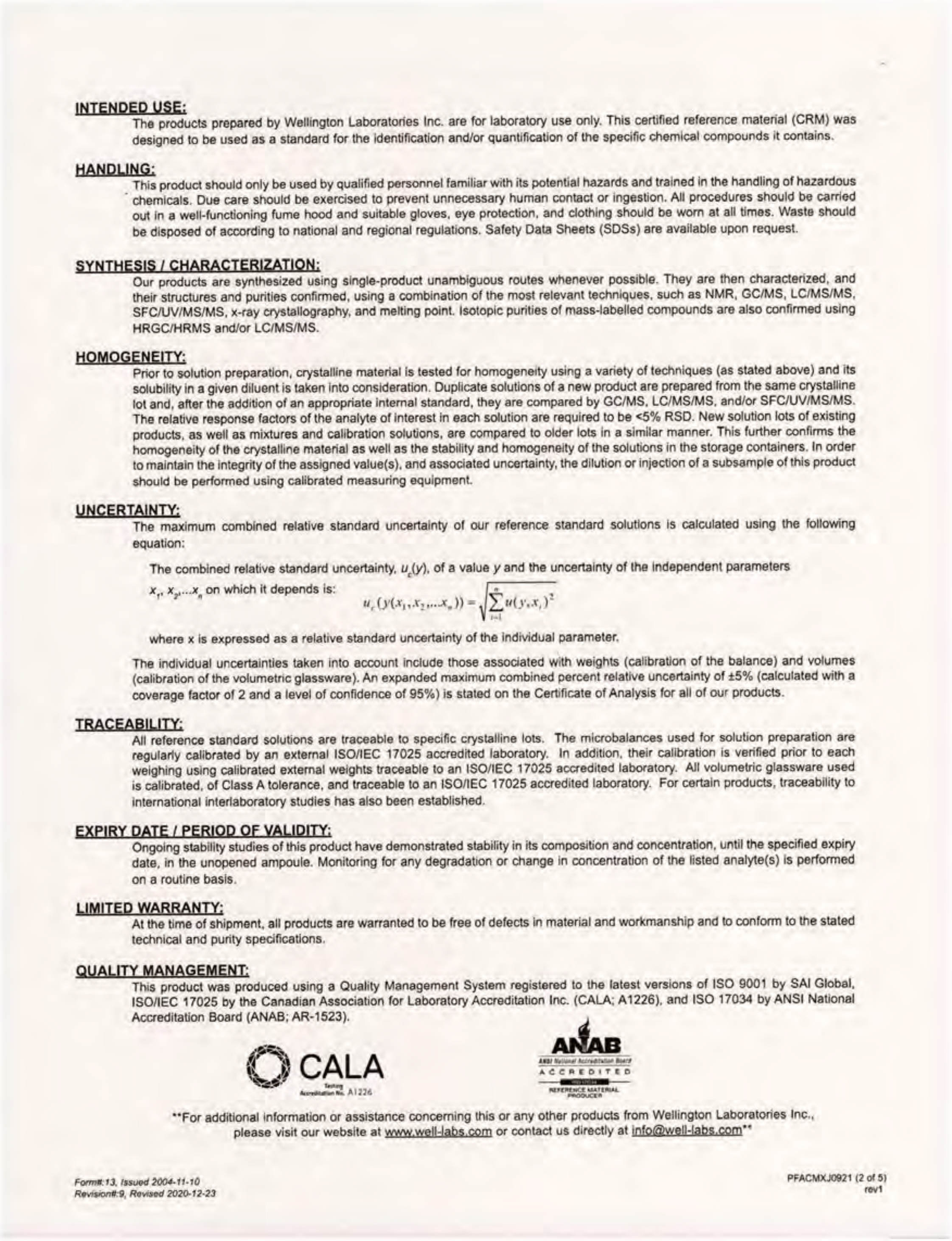
rev1



INTENDED USE:

The products prepared by Wellington Laboratories Inc. are for laboratory use only. This certified reference material (CRM) was designed to be used as a standard for the identification and/or quantification of the specific chemical compounds it contains.

HANDLING:

This product should only be used by qualified personnel familiar with its potential hazards and trained in the handling of hazardous chemicals. Due care should be exercised to prevent unnecessary human contact or ingestion. All procedures should be carried out in a well-functioning fume hood and suitable gloves, eye protection, and clothing should be worn at all times. Waste should be disposed of according to national and regional regulations. Safety Data Sheets (SDSs) are available upon request.

SYNTHESIS / CHARACTERIZATION:

Our products are synthesized using single-product unambiguous routes whenever possible. They are then characterized, and their structures and purities confirmed, using a combination of the most relevant techniques, such as NMR, GC/MS, LC/MS/MS, SFC/UV/MS/MS, x-ray crystallography, and melting point. Isotopic purities of mass-labelled compounds are also confirmed using HRGC/HRMS and/or LC/MS/MS.

HOMOGENEITY:

Prior to solution preparation, crystalline material is tested for homogeneity using a variety of techniques (as stated above) and its solubility in a given diluent is taken into consideration. Duplicate solutions of a new product are prepared from the same crystalline lot and, after the addition of an appropriate internal standard, they are compared by GC/MS, LC/MS/MS, and/or SFC/UV/MS/MS. The relative response factors of the analyte of interest in each solution are required to be <5% RSD. New solution lots of existing products, as well as mixtures and calibration solutions, are compared to older lots in a similar manner. This further confirms the homogeneity of the crystalline material as well as the stability and homogeneity of the solutions in the storage containers. In order to maintain the integrity of the assigned value(s), and associated uncertainty, the dilution or injection of a subsample of this product should be performed using calibrated measuring equipment.

UNCERTAINTY:

The maximum combined relative standard uncertainty of our reference standard solutions is calculated using the following equation:

The combined relative standard uncertainty, $u_c(y)$, of a value y and the uncertainty of the independent parameters $x_1, x_2, \ldots x_n$ on which it depends is:

$$u_c(y(x_1, x_2, \ldots x_n)) = \sqrt{\sum_{i=1}^{n} u(y, x_i)^2}$$

where x is expressed as a relative standard uncertainty of the individual parameter.

The individual uncertainties taken into account include those associated with weights (calibration of the balance) and volumes (calibration of the volumetric glassware). An expanded maximum combined percent relative uncertainty of ±5% (calculated with a coverage factor of 2 and a level of confidence of 95%) is stated on the Certificate of Analysis for all of our products.

TRACEABILITY:

All reference standard solutions are traceable to specific crystalline lots. The microbalances used for solution preparation are regularly calibrated by an external ISO/IEC 17025 accredited laboratory. In addition, their calibration is verified prior to each weighing using calibrated external weights traceable to an ISO/IEC 17025 accredited laboratory. All volumetric glassware used is calibrated, of Class A tolerance, and traceable to an ISO/IEC 17025 accredited laboratory. For certain products, traceability to international interlaboratory studies has also been established.

EXPIRY DATE / PERIOD OF VALIDITY:

Ongoing stability studies of this product have demonstrated stability in its composition and concentration, until the specified expiry date, in the unopened ampoule. Monitoring for any degradation or change in concentration of the listed analyte(s) is performed on a routine basis.

LIMITED WARRANTY:

At the time of shipment, all products are warranted to be free of defects in material and workmanship and to conform to the stated technical and purity specifications.

QUALITY MANAGEMENT:

This product was produced using a Quality Management System registered to the latest versions of ISO 9001 by SAI Global, ISO/IEC 17025 by the Canadian Association for Laboratory Accreditation Inc. (CALA; A1226), and ISO 17034 by ANSI National Accreditation Board (ANAB; AR-1523).

CALA
Testing Accreditation No. A1226

ANAB
ANSI National Accreditation Board
ACCREDITED
REFERENCE MATERIAL PRODUCER

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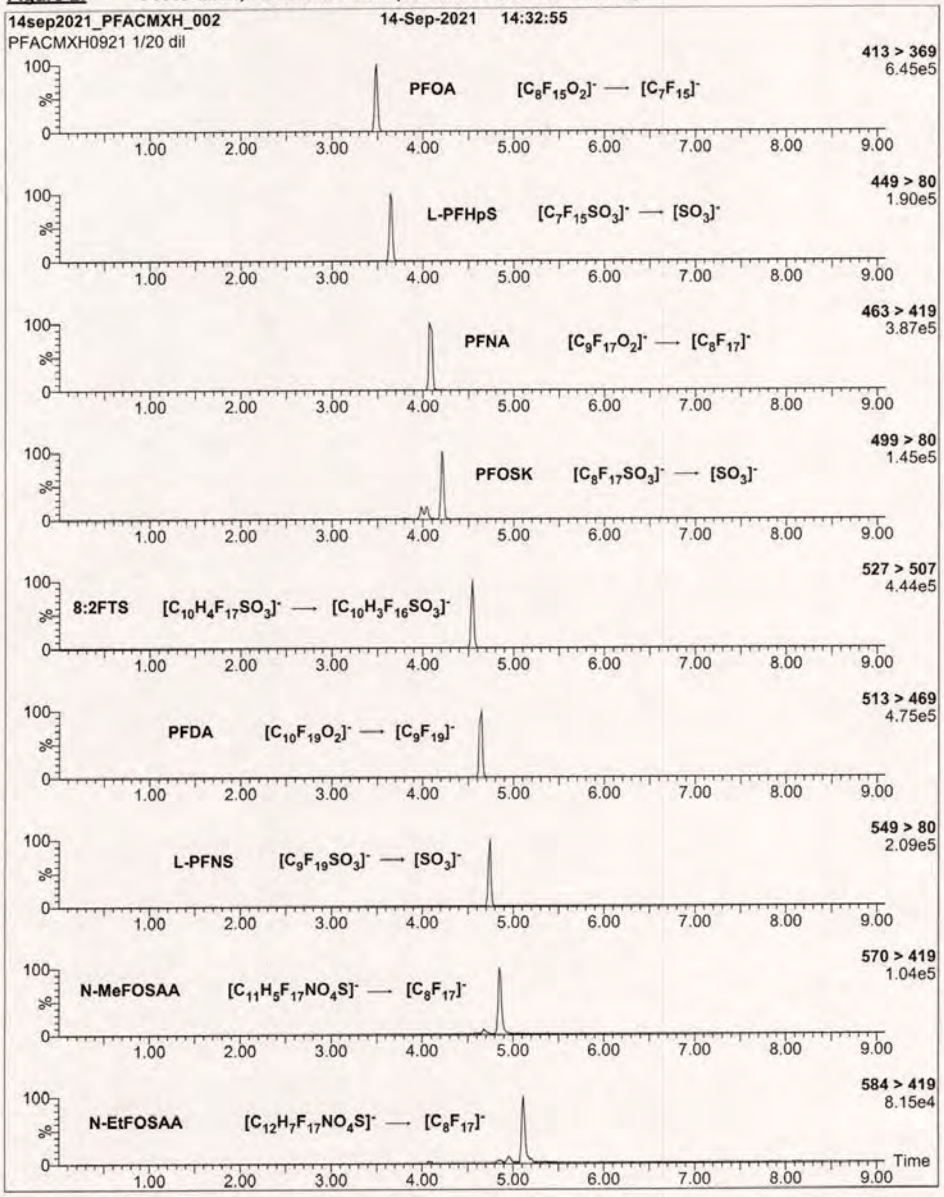
Figure 2: **PFAC-MXH; LC/MS/MS Data (Selected MRM Transitions)**



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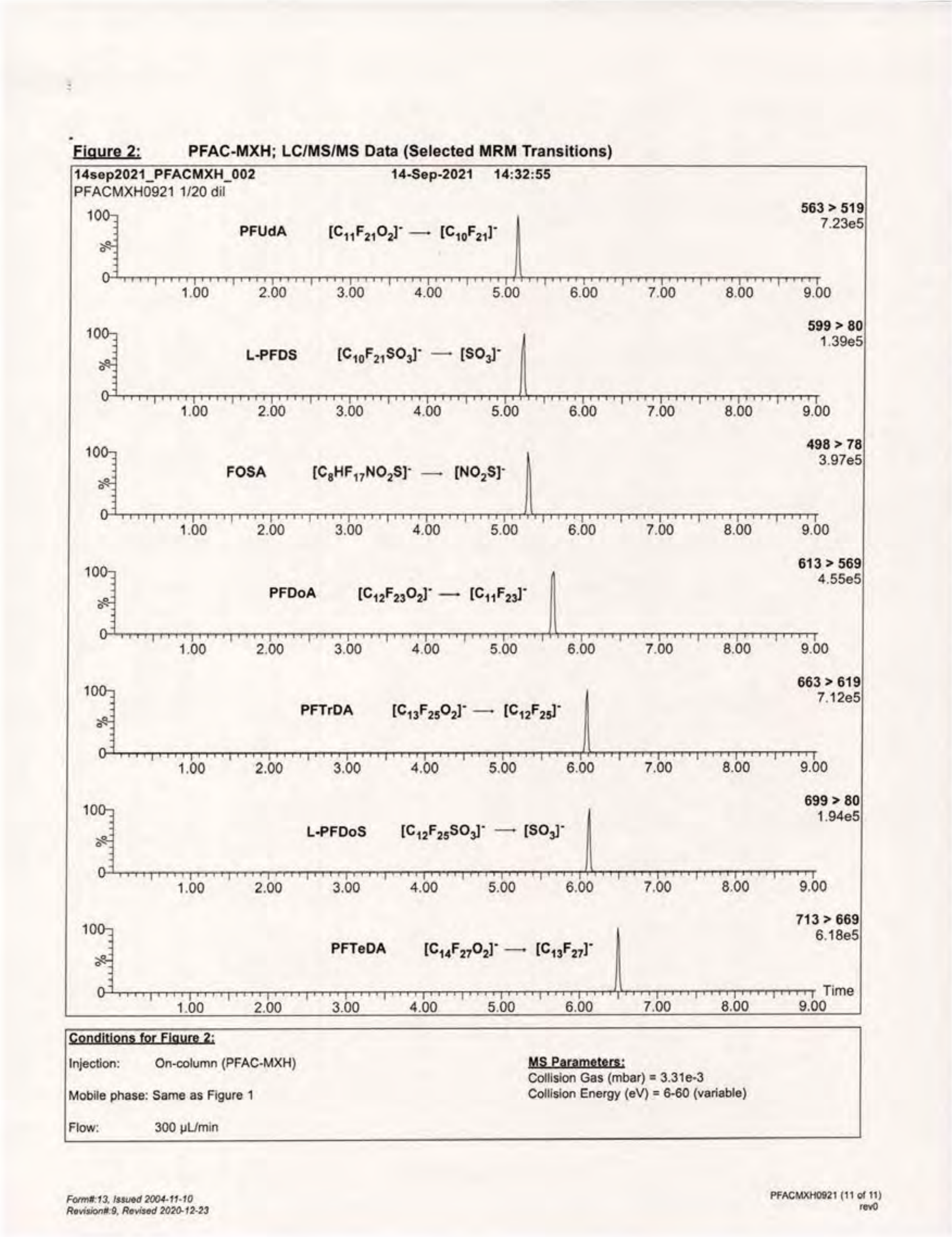

Figure 2: **PFAC-MXH; LC/MS/MS Data (Selected MRM Transitions)**

Conditions for Figure 2:

Injection: On-column (PFAC-MXH)

Mobile phase: Same as Figure 1

Flow: 300 µL/min

MS Parameters:
Collision Gas (mbar) = 3.31e-3
Collision Energy (eV) = 6-60 (variable)

Form#:13, Issued 2004-11-10
Revision#:9, Revised 2020-12-23

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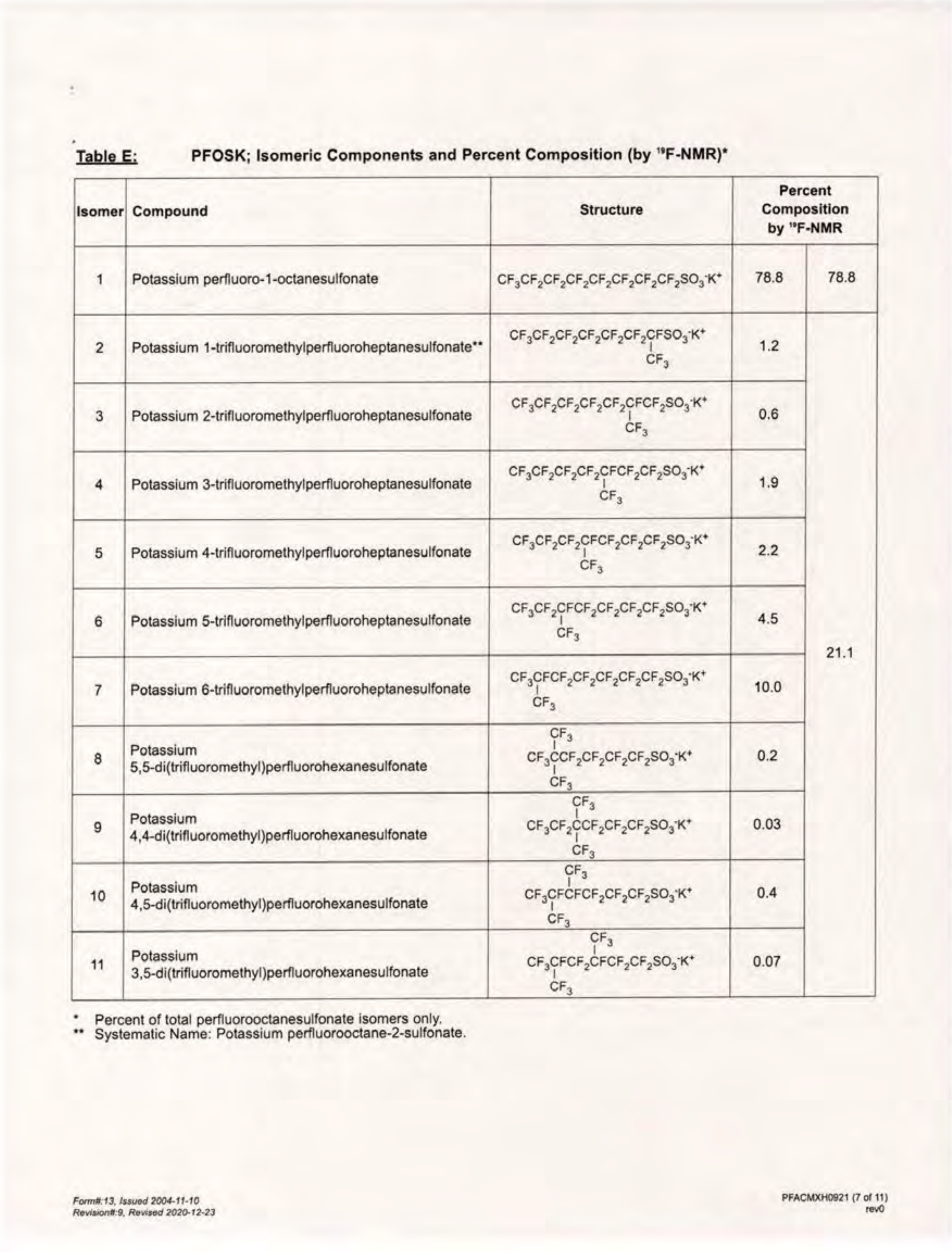

Table E: **PFOSK; Isomeric Components and Percent Composition (by ^{19}F-NMR)***

Isomer	Compound	Structure	Percent Composition by ^{19}F-NMR	
1	Potassium perfluoro-1-octanesulfonate	$CF_3CF_2CF_2CF_2CF_2CF_2CF_2CF_2SO_3^-K^+$	78.8	78.8
2	Potassium 1-trifluoromethylperfluoroheptanesulfonate**	$CF_3CF_2CF_2CF_2CF_2CF_2\underset{CF_3}{\underset{\mid}{C}}FSO_3^-K^+$	1.2	21.1
3	Potassium 2-trifluoromethylperfluoroheptanesulfonate	$CF_3CF_2CF_2CF_2CF_2\underset{CF_3}{\underset{\mid}{C}}FCF_2SO_3^-K^+$	0.6	
4	Potassium 3-trifluoromethylperfluoroheptanesulfonate	$CF_3CF_2CF_2CF_2\underset{CF_3}{\underset{\mid}{C}}FCF_2CF_2SO_3^-K^+$	1.9	
5	Potassium 4-trifluoromethylperfluoroheptanesulfonate	$CF_3CF_2CF_2\underset{CF_3}{\underset{\mid}{C}}FCF_2CF_2CF_2SO_3^-K^+$	2.2	
6	Potassium 5-trifluoromethylperfluoroheptanesulfonate	$CF_3CF_2\underset{CF_3}{\underset{\mid}{C}}FCF_2CF_2CF_2CF_2SO_3^-K^+$	4.5	
7	Potassium 6-trifluoromethylperfluoroheptanesulfonate	$CF_3\underset{CF_3}{\underset{\mid}{C}}FCF_2CF_2CF_2CF_2CF_2SO_3^-K^+$	10.0	
8	Potassium 5,5-di(trifluoromethyl)perfluorohexanesulfonate	$CF_3\overset{CF_3}{\overset{\mid}{\underset{CF_3}{\underset{\mid}{C}}}}CF_2CF_2CF_2CF_2SO_3^-K^+$	0.2	
9	Potassium 4,4-di(trifluoromethyl)perfluorohexanesulfonate	$CF_3CF_2\overset{CF_3}{\overset{\mid}{\underset{CF_3}{\underset{\mid}{C}}}}CF_2CF_2CF_2SO_3^-K^+$	0.03	
10	Potassium 4,5-di(trifluoromethyl)perfluorohexanesulfonate	$CF_3\underset{CF_3}{\underset{\mid}{C}}F\overset{CF_3}{\overset{\mid}{C}}FCF_2CF_2CF_2SO_3^-K^+$	0.4	
11	Potassium 3,5-di(trifluoromethyl)perfluorohexanesulfonate	$CF_3\underset{CF_3}{\underset{\mid}{C}}FCF_2\overset{CF_3}{\overset{\mid}{C}}FCF_2CF_2SO_3^-K^+$	0.07	

* Percent of total perfluorooctanesulfonate isomers only.
** Systematic Name: Potassium perfluorooctane-2-sulfonate.

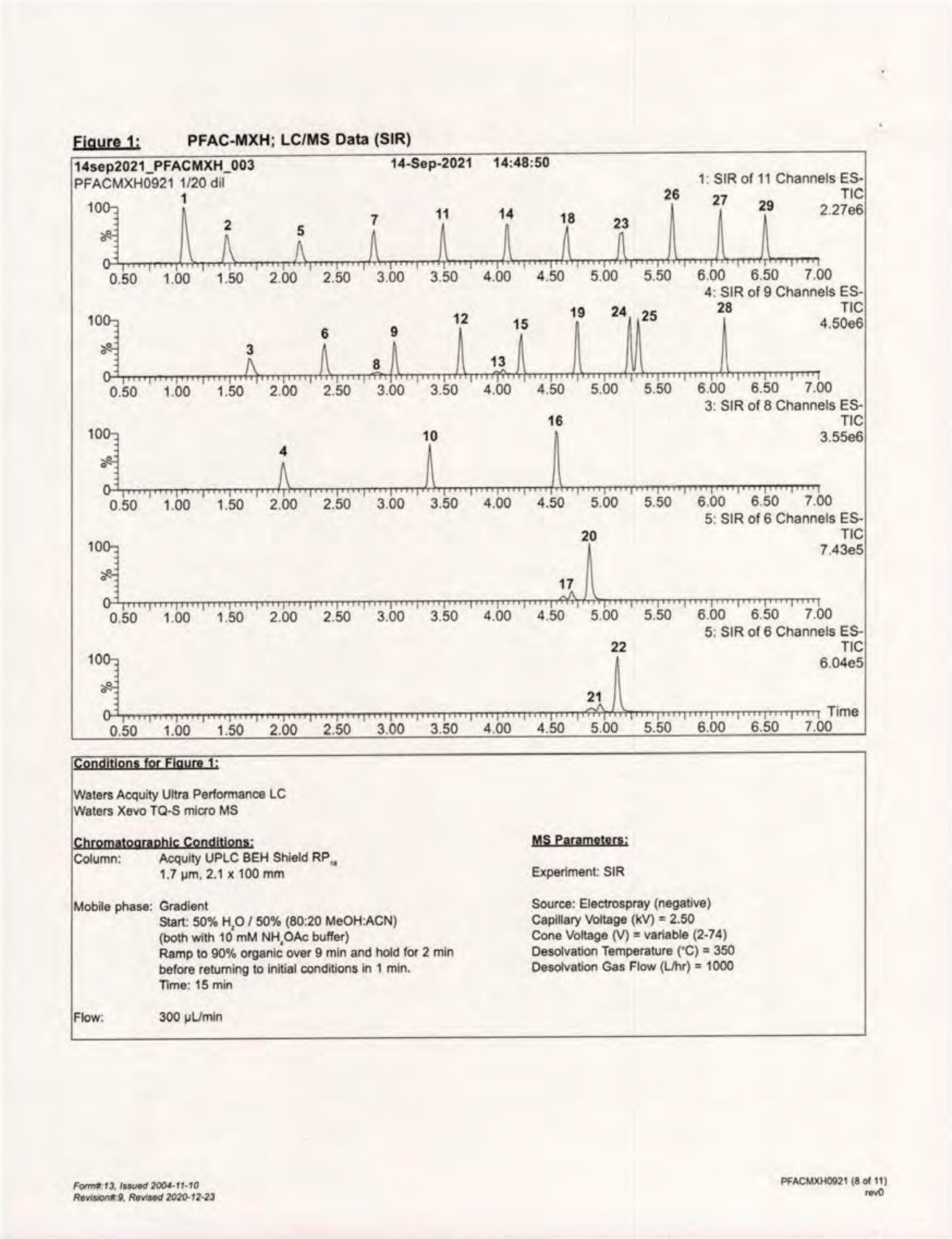

Figure 1: **PFAC-MXH; LC/MS Data (SIR)**

Conditions for Figure 1:

Waters Acquity Ultra Performance LC
Waters Xevo TQ-S micro MS

Chromatographic Conditions:

Column: Acquity UPLC BEH Shield RP_{18}
1.7 µm, 2.1 x 100 mm

Mobile phase: Gradient
Start: 50% H_2O / 50% (80:20 MeOH:ACN)
(both with 10 mM NH_4OAc buffer)
Ramp to 90% organic over 9 min and hold for 2 min
before returning to initial conditions in 1 min.
Time: 15 min

Flow: 300 µL/min

MS Parameters:

Experiment: SIR

Source: Electrospray (negative)
Capillary Voltage (kV) = 2.50
Cone Voltage (V) = variable (2-74)
Desolvation Temperature (°C) = 350
Desolvation Gas Flow (L/hr) = 1000

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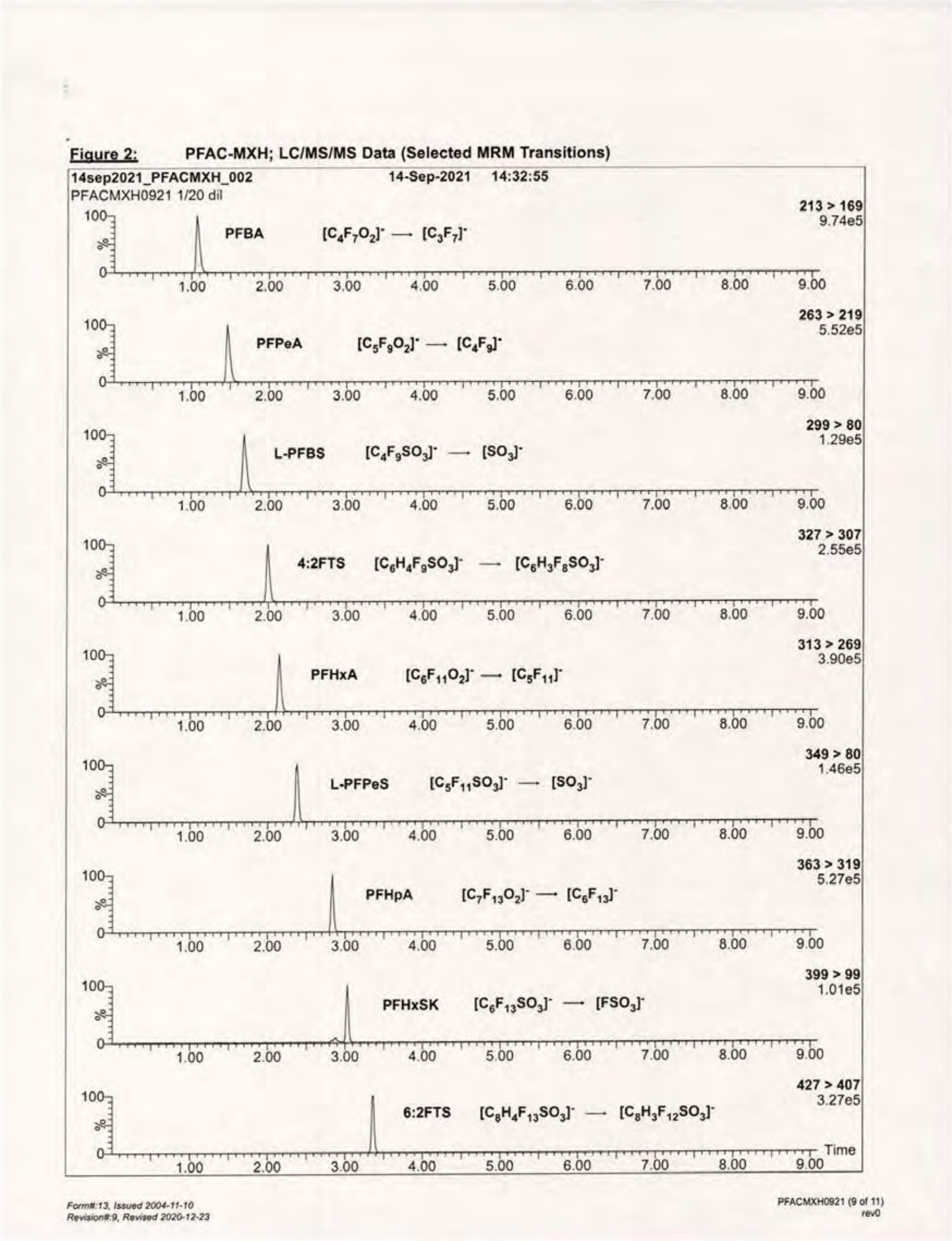

Figure 2: **PFAC-MXH; LC/MS/MS Data (Selected MRM Transitions)**

14sep2021_PFACMXH_002 14-Sep-2021 14:32:55
PFACMXH0921 1/20 dil

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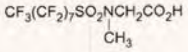
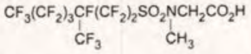
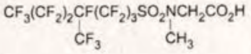
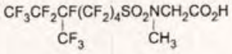
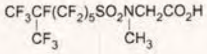
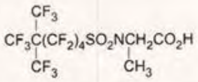
rev0

Table B: **br-NMeFOSAA; Isomeric Components and Percent Composition (by ^{19}F-NMR)***

Isomer	Compound	Structure	Percent Composition by ^{19}F-NMR	
1	N-methylperfluoro-1-octanesulfonamidoacetic acid	 $CF_3(CF_2)_7SO_2\underset{CH_3}{N}CH_2CO_2H$	76.0	76.0
2	N-methylperfluoro-3-methylheptanesulfonamidoacetic acid	 $CF_3(CF_2)_3\underset{CF_3}{C}F(CF_2)_2SO_2\underset{CH_3}{N}CH_2CO_2H$	0.7	24.0
3	N-methylperfluoro-4-methylheptanesulfonamidoacetic acid	 $CF_3(CF_2)_2\underset{CF_3}{C}F(CF_2)_3SO_2\underset{CH_3}{N}CH_2CO_2H$	2.0	
4	N-methylperfluoro-5-methylheptanesulfonamidoacetic acid	 $CF_3CF_2\underset{CF_3}{C}F(CF_2)_4SO_2\underset{CH_3}{N}CH_2CO_2H$	6.0	
5	N-methylperfluoro-6-methylheptanesulfonamidoacetic acid	 $CF_3\underset{CF_3}{C}F(CF_2)_5SO_2\underset{CH_3}{N}CH_2CO_2H$	14.0	
6	N-methylperfluoro-5,5-dimethylhexanesulfonamidoacetic acid	 $CF_3\overset{CF_3}{\underset{CF_3}{C}}(CF_2)_4SO_2\underset{CH_3}{N}CH_2CO_2H$	0.2	
7	Other Unidentified Isomers		1.1	

* Percent of total N-methylperfluorooctanesulfonamidoacetic acid isomers only.

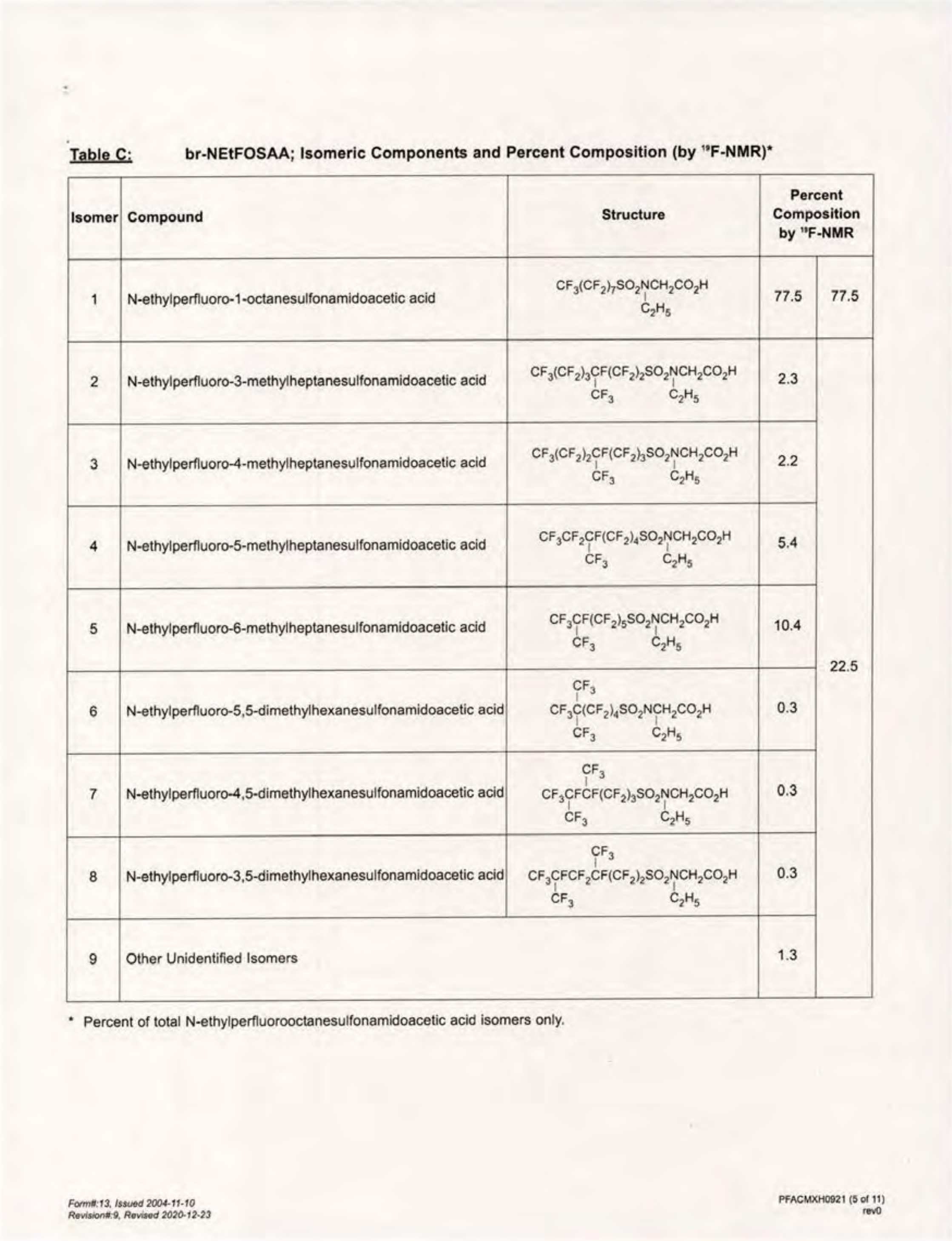


Table C: **br-NEtFOSAA; Isomeric Components and Percent Composition (by ^{19}F-NMR)***

Isomer	Compound	Structure	Percent Composition by ^{19}F-NMR	
1	N-ethylperfluoro-1-octanesulfonamidoacetic acid	$\mathrm{CF_3(CF_2)_7SO_2\underset{C_2H_5}{N}CH_2CO_2H}$	77.5	77.5
2	N-ethylperfluoro-3-methylheptanesulfonamidoacetic acid	$\mathrm{CF_3(CF_2)_3\underset{CF_3}{C}F(CF_2)_2SO_2\underset{C_2H_5}{N}CH_2CO_2H}$	2.3	22.5
3	N-ethylperfluoro-4-methylheptanesulfonamidoacetic acid	$\mathrm{CF_3(CF_2)_2\underset{CF_3}{C}F(CF_2)_3SO_2\underset{C_2H_5}{N}CH_2CO_2H}$	2.2	
4	N-ethylperfluoro-5-methylheptanesulfonamidoacetic acid	$\mathrm{CF_3CF_2\underset{CF_3}{C}F(CF_2)_4SO_2\underset{C_2H_5}{N}CH_2CO_2H}$	5.4	
5	N-ethylperfluoro-6-methylheptanesulfonamidoacetic acid	$\mathrm{CF_3\underset{CF_3}{C}F(CF_2)_5SO_2\underset{C_2H_5}{N}CH_2CO_2H}$	10.4	
6	N-ethylperfluoro-5,5-dimethylhexanesulfonamidoacetic acid	$\mathrm{CF_3\overset{CF_3}{\underset{CF_3}{C}}(CF_2)_4SO_2\underset{C_2H_5}{N}CH_2CO_2H}$	0.3	
7	N-ethylperfluoro-4,5-dimethylhexanesulfonamidoacetic acid	$\mathrm{CF_3\underset{CF_3}{C}F\overset{CF_3}{C}F(CF_2)_3SO_2\underset{C_2H_5}{N}CH_2CO_2H}$	0.3	
8	N-ethylperfluoro-3,5-dimethylhexanesulfonamidoacetic acid	$\mathrm{CF_3\underset{CF_3}{C}FCF_2\overset{CF_3}{C}F(CF_2)_2SO_2\underset{C_2H_5}{N}CH_2CO_2H}$	0.3	
9	Other Unidentified Isomers		1.3	

* Percent of total N-ethylperfluorooctanesulfonamidoacetic acid isomers only.

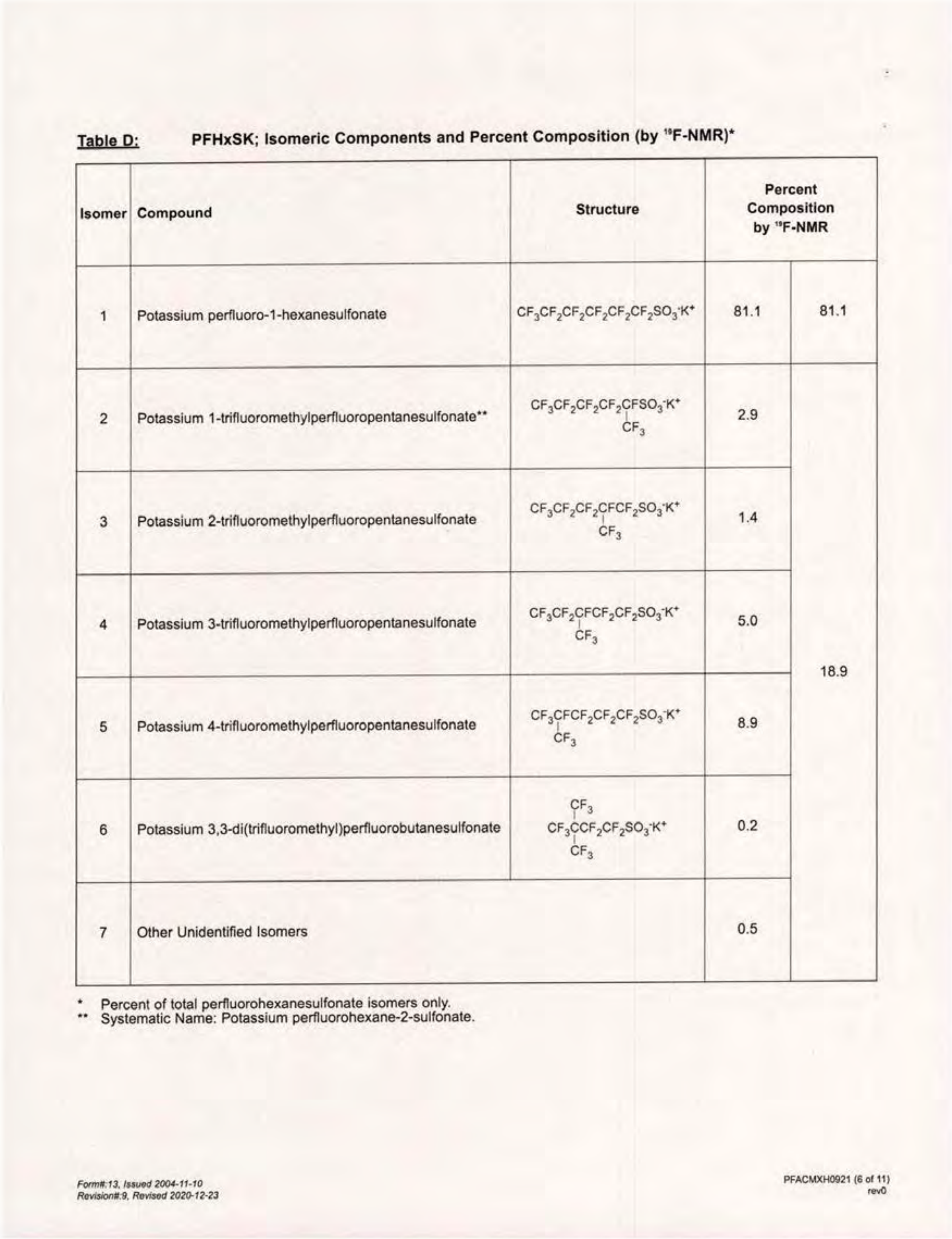
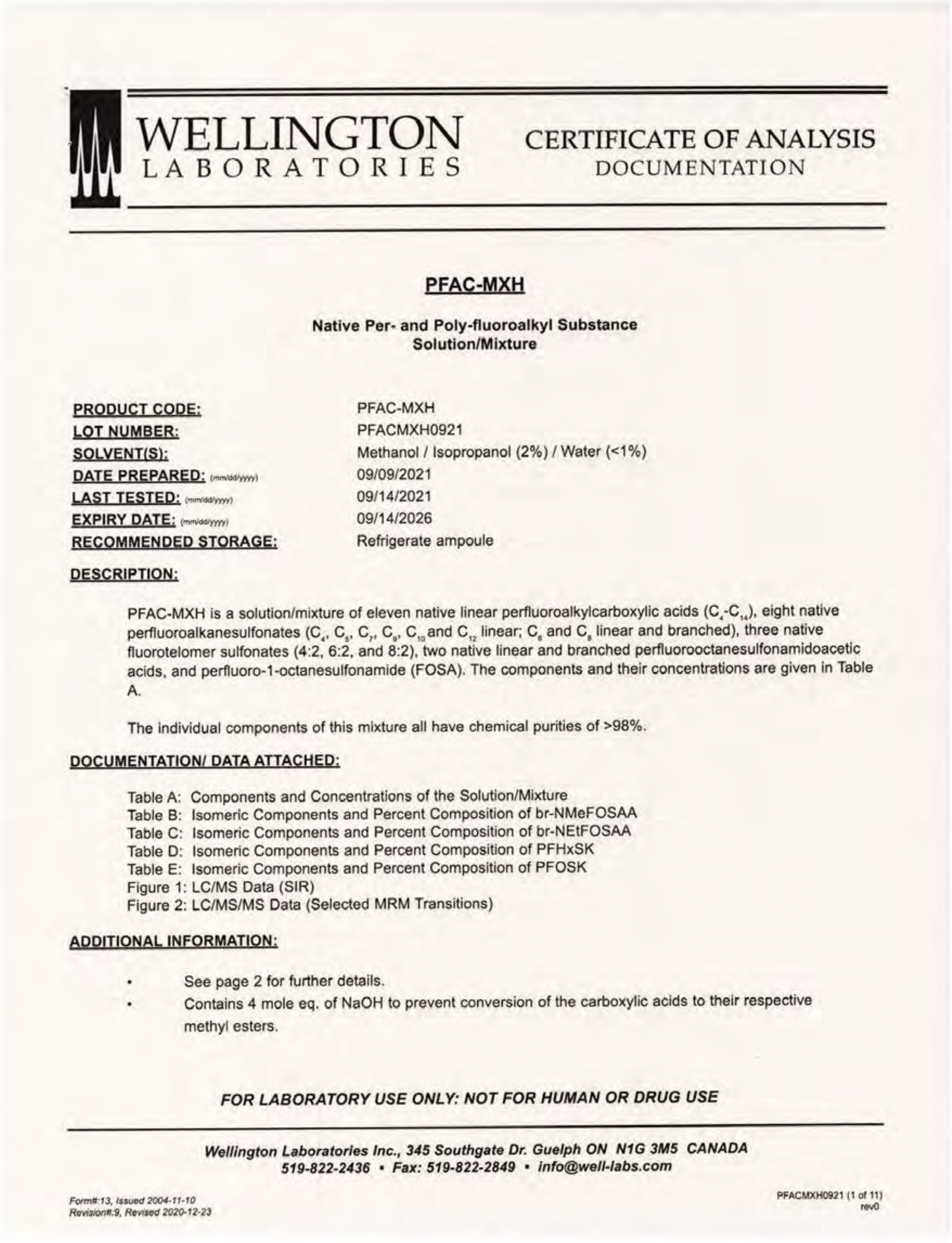


Table D: **PFHxSK; Isomeric Components and Percent Composition (by ^{19}F-NMR)***

Isomer	Compound	Structure	Percent Composition by ^{19}F-NMR	
1	Potassium perfluoro-1-hexanesulfonate	$CF_3CF_2CF_2CF_2CF_2CF_2SO_3^-K^+$	81.1	81.1
2	Potassium 1-trifluoromethylperfluoropentanesulfonate**	$CF_3CF_2CF_2CF_2\underset{CF_3}{C}FSO_3^-K^+$	2.9	18.9
3	Potassium 2-trifluoromethylperfluoropentanesulfonate	$CF_3CF_2CF_2\underset{CF_3}{C}FCF_2SO_3^-K^+$	1.4	
4	Potassium 3-trifluoromethylperfluoropentanesulfonate	$CF_3CF_2\underset{CF_3}{C}FCF_2CF_2SO_3^-K^+$	5.0	
5	Potassium 4-trifluoromethylperfluoropentanesulfonate	$CF_3\underset{CF_3}{C}FCF_2CF_2CF_2SO_3^-K^+$	8.9	
6	Potassium 3,3-di(trifluoromethyl)perfluorobutanesulfonate	$CF_3\overset{CF_3}{\underset{CF_3}{C}}CF_2CF_2SO_3^-K^+$	0.2	
7	Other Unidentified Isomers		0.5	

* Percent of total perfluorohexanesulfonate isomers only.
** Systematic Name: Potassium perfluorohexane-2-sulfonate.



WELLINGTON LABORATORIES CERTIFICATE OF ANALYSIS DOCUMENTATION

PFAC-MXH

Native Per- and Poly-fluoroalkyl Substance Solution/Mixture

PRODUCT CODE:	PFAC-MXH
LOT NUMBER:	PFACMXH0921
SOLVENT(S):	Methanol / Isopropanol (2%) / Water (<1%)
DATE PREPARED: (mm/dd/yyyy)	09/09/2021
LAST TESTED: (mm/dd/yyyy)	09/14/2021
EXPIRY DATE: (mm/dd/yyyy)	09/14/2026
RECOMMENDED STORAGE:	Refrigerate ampoule

DESCRIPTION:

PFAC-MXH is a solution/mixture of eleven native linear perfluoroalkylcarboxylic acids (C_4-C_{14}), eight native perfluoroalkanesulfonates (C_4, C_5, C_7, C_9, C_{10} and C_{12} linear; C_6 and C_8 linear and branched), three native fluorotelomer sulfonates (4:2, 6:2, and 8:2), two native linear and branched perfluorooctanesulfonamidoacetic acids, and perfluoro-1-octanesulfonamide (FOSA). The components and their concentrations are given in Table A.

The individual components of this mixture all have chemical purities of >98%.

DOCUMENTATION/ DATA ATTACHED:

Table A: Components and Concentrations of the Solution/Mixture
Table B: Isomeric Components and Percent Composition of br-NMeFOSAA
Table C: Isomeric Components and Percent Composition of br-NEtFOSAA
Table D: Isomeric Components and Percent Composition of PFHxSK
Table E: Isomeric Components and Percent Composition of PFOSK
Figure 1: LC/MS Data (SIR)
Figure 2: LC/MS/MS Data (Selected MRM Transitions)

ADDITIONAL INFORMATION:

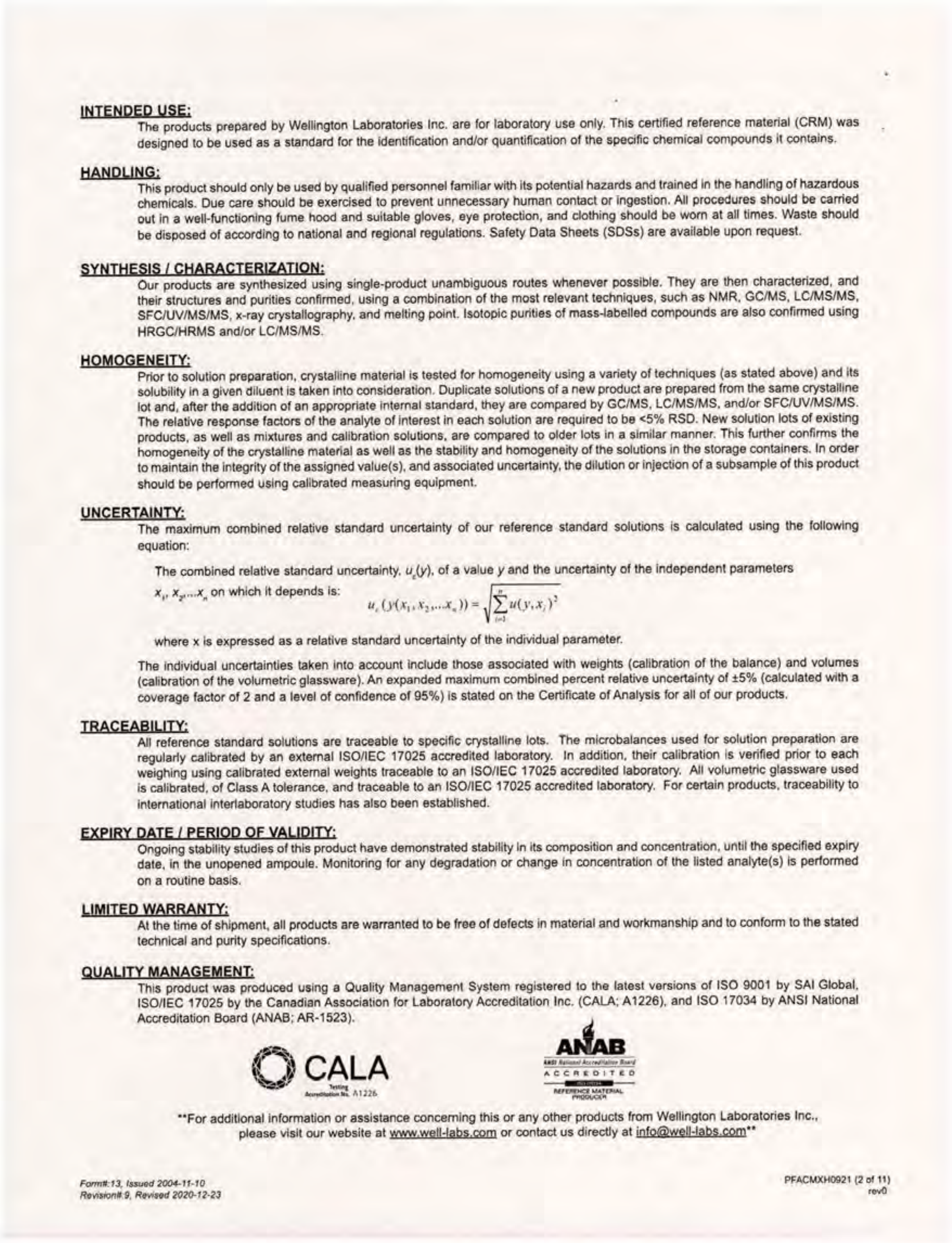
- See page 2 for further details.
- Contains 4 mole eq. of NaOH to prevent conversion of the carboxylic acids to their respective methyl esters.

FOR LABORATORY USE ONLY: NOT FOR HUMAN OR DRUG USE

Wellington Laboratories Inc., 345 Southgate Dr. Guelph ON N1G 3M5 CANADA
519-822-2436 • Fax: 519-822-2849 • info@well-labs.com

Form#:13, Issued 2004-11-10
Revision#:9, Revised 2020-12-23

PFACMXH0921 (1 of 11)
rev0



INTENDED USE:

The products prepared by Wellington Laboratories Inc. are for laboratory use only. This certified reference material (CRM) was designed to be used as a standard for the identification and/or quantification of the specific chemical compounds it contains.

HANDLING:

This product should only be used by qualified personnel familiar with its potential hazards and trained in the handling of hazardous chemicals. Due care should be exercised to prevent unnecessary human contact or ingestion. All procedures should be carried out in a well-functioning fume hood and suitable gloves, eye protection, and clothing should be worn at all times. Waste should be disposed of according to national and regional regulations. Safety Data Sheets (SDSs) are available upon request.

SYNTHESIS / CHARACTERIZATION:

Our products are synthesized using single-product unambiguous routes whenever possible. They are then characterized, and their structures and purities confirmed, using a combination of the most relevant techniques, such as NMR, GC/MS, LC/MS/MS, SFC/UV/MS/MS, x-ray crystallography, and melting point. Isotopic purities of mass-labelled compounds are also confirmed using HRGC/HRMS and/or LC/MS/MS.

HOMOGENEITY:

Prior to solution preparation, crystalline material is tested for homogeneity using a variety of techniques (as stated above) and its solubility in a given diluent is taken into consideration. Duplicate solutions of a new product are prepared from the same crystalline lot and, after the addition of an appropriate internal standard, they are compared by GC/MS, LC/MS/MS, and/or SFC/UV/MS/MS. The relative response factors of the analyte of interest in each solution are required to be <5% RSD. New solution lots of existing products, as well as mixtures and calibration solutions, are compared to older lots in a similar manner. This further confirms the homogeneity of the crystalline material as well as the stability and homogeneity of the solutions in the storage containers. In order to maintain the integrity of the assigned value(s), and associated uncertainty, the dilution or injection of a subsample of this product should be performed using calibrated measuring equipment.

UNCERTAINTY:

The maximum combined relative standard uncertainty of our reference standard solutions is calculated using the following equation:

The combined relative standard uncertainty, $u_c(y)$, of a value y and the uncertainty of the independent parameters $x_1, x_2, \ldots x_n$ on which it depends is:

$$u_c(y(x_1, x_2, \ldots x_n)) = \sqrt{\sum_{i=1}^{n} u(y, x_i)^2}$$

where x is expressed as a relative standard uncertainty of the individual parameter.

The individual uncertainties taken into account include those associated with weights (calibration of the balance) and volumes (calibration of the volumetric glassware). An expanded maximum combined percent relative uncertainty of ±5% (calculated with a coverage factor of 2 and a level of confidence of 95%) is stated on the Certificate of Analysis for all of our products.

TRACEABILITY:

All reference standard solutions are traceable to specific crystalline lots. The microbalances used for solution preparation are regularly calibrated by an external ISO/IEC 17025 accredited laboratory. In addition, their calibration is verified prior to each weighing using calibrated external weights traceable to an ISO/IEC 17025 accredited laboratory. All volumetric glassware used is calibrated, of Class A tolerance, and traceable to an ISO/IEC 17025 accredited laboratory. For certain products, traceability to international interlaboratory studies has also been established.

EXPIRY DATE / PERIOD OF VALIDITY:

Ongoing stability studies of this product have demonstrated stability in its composition and concentration, until the specified expiry date, in the unopened ampoule. Monitoring for any degradation or change in concentration of the listed analyte(s) is performed on a routine basis.

LIMITED WARRANTY:

At the time of shipment, all products are warranted to be free of defects in material and workmanship and to conform to the stated technical and purity specifications.

QUALITY MANAGEMENT:

This product was produced using a Quality Management System registered to the latest versions of ISO 9001 by SAI Global, ISO/IEC 17025 by the Canadian Association for Laboratory Accreditation Inc. (CALA; A1226), and ISO 17034 by ANSI National Accreditation Board (ANAB; AR-1523).

CALA
Testing Accreditation No. A1226

ANAB
ANSI National Accreditation Board
ACCREDITED
REFERENCE MATERIAL PRODUCER

**For additional information or assistance concerning this or any other products from Wellington Laboratories Inc.,
please visit our website at www.well-labs.com or contact us directly at info@well-labs.com**

Form#:13, Issued 2004-11-10
Revision#:9, Revised 2020-12-23

PFACMXH0921 (2 of 11)
rev0

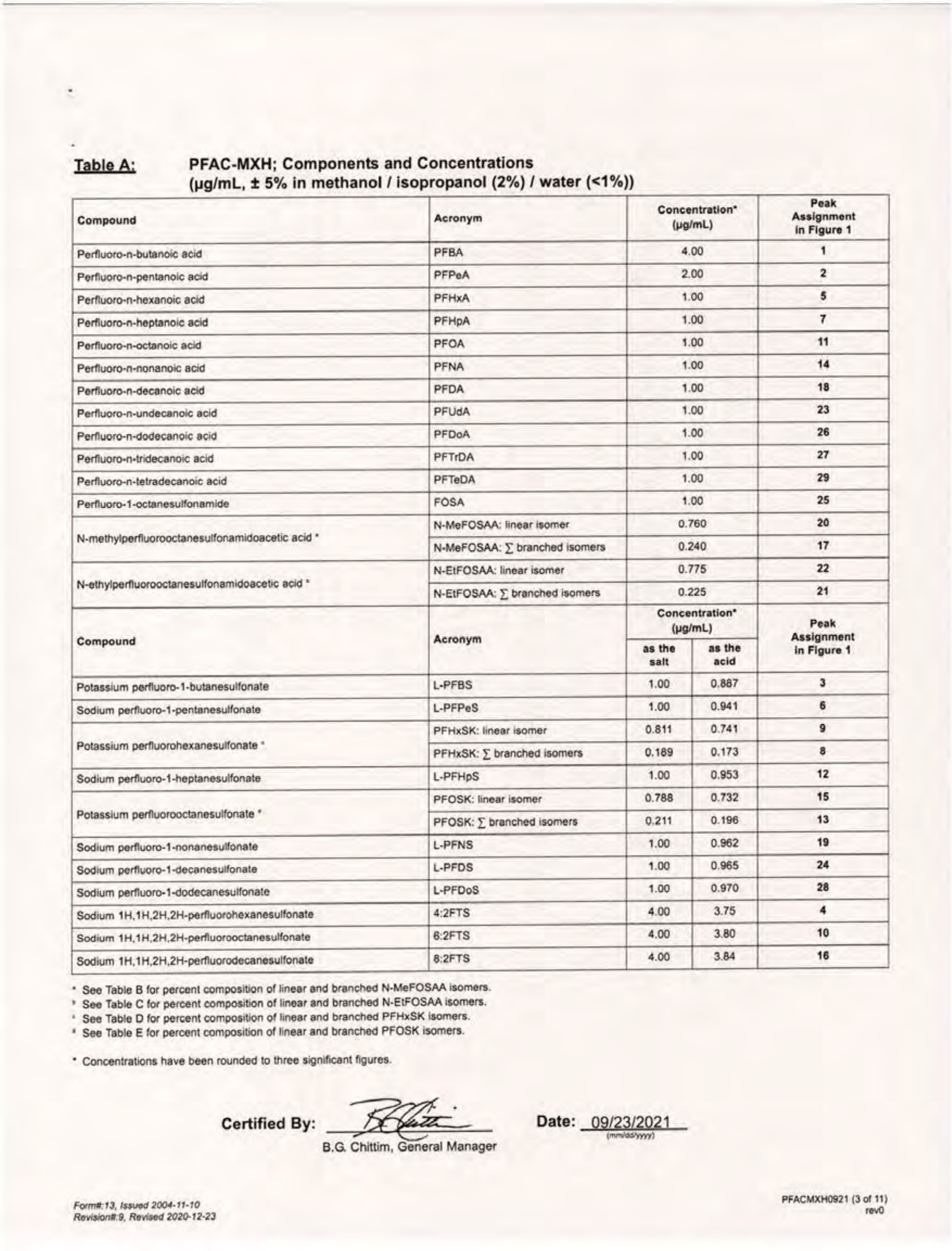


Table A: **PFAC-MXH; Components and Concentrations (µg/mL, ± 5% in methanol / isopropanol (2%) / water (<1%))**

Compound	Acronym	Concentration* (µg/mL)	Peak Assignment in Figure 1
Perfluoro-n-butanoic acid	PFBA	4.00	1
Perfluoro-n-pentanoic acid	PFPeA	2.00	2
Perfluoro-n-hexanoic acid	PFHxA	1.00	5
Perfluoro-n-heptanoic acid	PFHpA	1.00	7
Perfluoro-n-octanoic acid	PFOA	1.00	11
Perfluoro-n-nonanoic acid	PFNA	1.00	14
Perfluoro-n-decanoic acid	PFDA	1.00	18
Perfluoro-n-undecanoic acid	PFUdA	1.00	23
Perfluoro-n-dodecanoic acid	PFDoA	1.00	26
Perfluoro-n-tridecanoic acid	PFTrDA	1.00	27
Perfluoro-n-tetradecanoic acid	PFTeDA	1.00	29
Perfluoro-1-octanesulfonamide	FOSA	1.00	25
N-methylperfluorooctanesulfonamidoacetic acid [a]	N-MeFOSAA: linear isomer	0.760	20
	N-MeFOSAA: ∑ branched isomers	0.240	17
N-ethylperfluorooctanesulfonamidoacetic acid [b]	N-EtFOSAA: linear isomer	0.775	22
	N-EtFOSAA: ∑ branched isomers	0.225	21

Compound	Acronym	Concentration* (µg/mL)		Peak Assignment in Figure 1
		as the salt	as the acid	
Potassium perfluoro-1-butanesulfonate	L-PFBS	1.00	0.887	3
Sodium perfluoro-1-pentanesulfonate	L-PFPeS	1.00	0.941	6
Potassium perfluorohexanesulfonate [c]	PFHxSK: linear isomer	0.811	0.741	9
	PFHxSK: ∑ branched isomers	0.189	0.173	8
Sodium perfluoro-1-heptanesulfonate	L-PFHpS	1.00	0.953	12
Potassium perfluorooctanesulfonate [d]	PFOSK: linear isomer	0.788	0.732	15
	PFOSK: ∑ branched isomers	0.211	0.196	13
Sodium perfluoro-1-nonanesulfonate	L-PFNS	1.00	0.962	19
Sodium perfluoro-1-decanesulfonate	L-PFDS	1.00	0.965	24
Sodium perfluoro-1-dodecanesulfonate	L-PFDoS	1.00	0.970	28
Sodium 1H,1H,2H,2H-perfluorohexanesulfonate	4:2FTS	4.00	3.75	4
Sodium 1H,1H,2H,2H-perfluorooctanesulfonate	6:2FTS	4.00	3.80	10
Sodium 1H,1H,2H,2H-perfluorodecanesulfonate	8:2FTS	4.00	3.84	16

[a] See Table B for percent composition of linear and branched N-MeFOSAA isomers.
[b] See Table C for percent composition of linear and branched N-EtFOSAA isomers.
[c] See Table D for percent composition of linear and branched PFHxSK isomers.
[d] See Table E for percent composition of linear and branched PFOSK isomers.

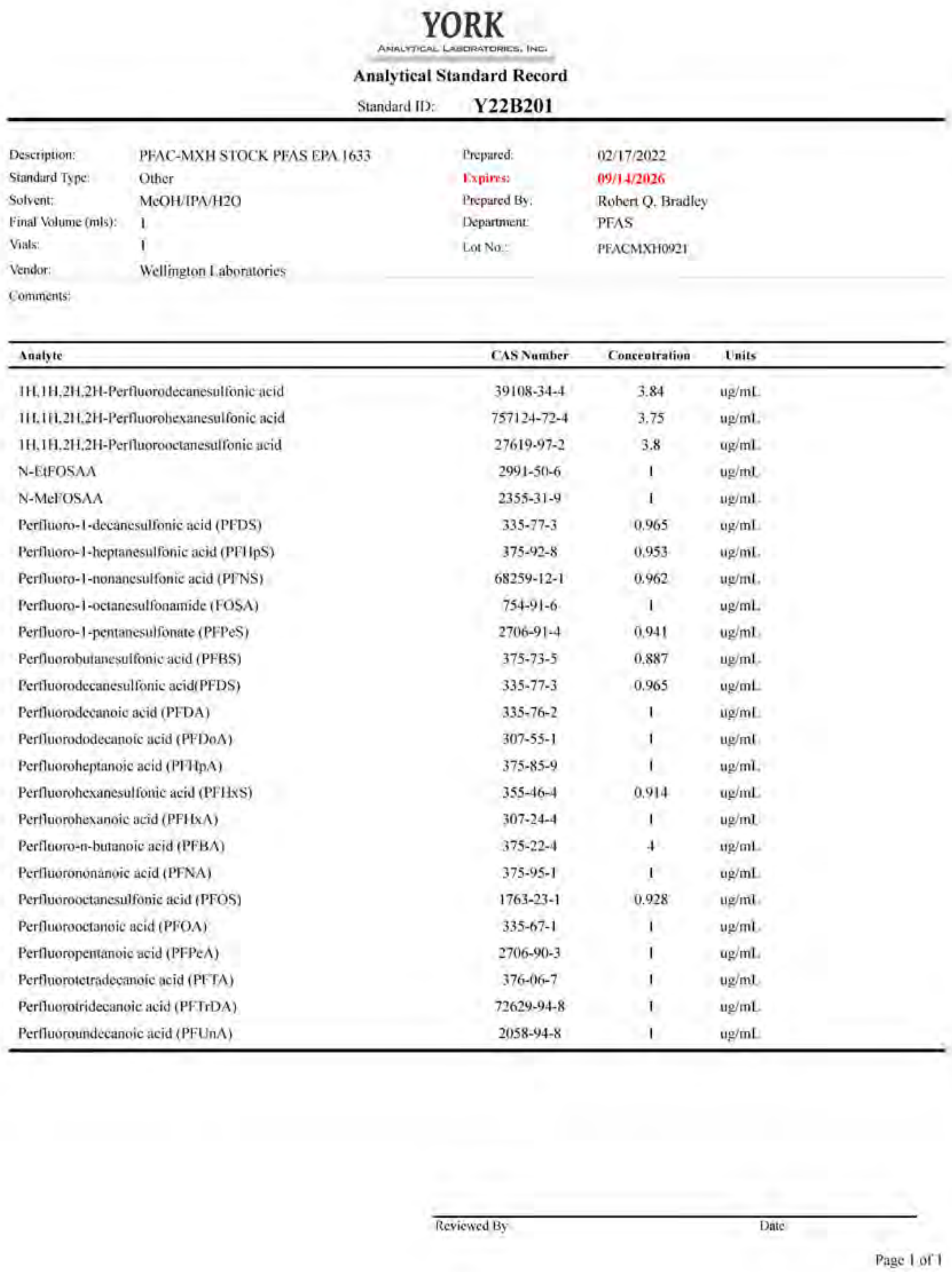
* Concentrations have been rounded to three significant figures.

Certified By: ______________
B.G. Chittim, General Manager

Date: 09/23/2021
(mm/dd/yyyy)

Form#:13, Issued 2004-11-10
Revision#:9, Revised 2020-12-23

PFACMXH0921 (3 of 11)
rev0



YORK
ANALYTICAL LABORATORIES, INC.

Analytical Standard Record

Standard ID: **Y22B201**

Description:	PFAC-MXH STOCK PFAS EPA 1633	Prepared:	02/17/2022
Standard Type:	Other	**Expires:**	**09/14/2026**
Solvent:	MeOH/IPA/H2O	Prepared By:	Robert Q. Bradley
Final Volume (mls):	1	Department:	PFAS
Vials:	1	Lot No.:	PFACMXH0921
Vendor:	Wellington Laboratories		
Comments:			

Analyte	**CAS Number**	**Concentration**	**Units**
1H,1H,2H,2H-Perfluorodecanesulfonic acid	39108-34-4	3.84	ug/mL
1H,1H,2H,2H-Perfluorohexanesulfonic acid	757124-72-4	3.75	ug/mL
1H,1H,2H,2H-Perfluorooctanesulfonic acid	27619-97-2	3.8	ug/mL
N-EtFOSAA	2991-50-6	1	ug/mL
N-MeFOSAA	2355-31-9	1	ug/mL
Perfluoro-1-decanesulfonic acid (PFDS)	335-77-3	0.965	ug/mL
Perfluoro-1-heptanesulfonic acid (PFHpS)	375-92-8	0.953	ug/mL
Perfluoro-1-nonanesulfonic acid (PFNS)	68259-12-1	0.962	ug/mL
Perfluoro-1-octanesulfonamide (FOSA)	754-91-6	1	ug/mL
Perfluoro-1-pentanesulfonate (PFPeS)	2706-91-4	0.941	ug/mL
Perfluorobutanesulfonic acid (PFBS)	375-73-5	0.887	ug/mL
Perfluorodecanesulfonic acid(PFDS)	335-77-3	0.965	ug/mL
Perfluorodecanoic acid (PFDA)	335-76-2	1	ug/mL
Perfluorododecanoic acid (PFDoA)	307-55-1	1	ug/mL
Perfluoroheptanoic acid (PFHpA)	375-85-9	1	ug/mL
Perfluorohexanesulfonic acid (PFHxS)	355-46-4	0.914	ug/mL
Perfluorohexanoic acid (PFHxA)	307-24-4	1	ug/mL
Perfluoro-n-butanoic acid (PFBA)	375-22-4	4	ug/mL
Perfluorononanoic acid (PFNA)	375-95-1	1	ug/mL
Perfluorooctanesulfonic acid (PFOS)	1763-23-1	0.928	ug/mL
Perfluorooctanoic acid (PFOA)	335-67-1	1	ug/mL
Perfluoropentanoic acid (PFPeA)	2706-90-3	1	ug/mL
Perfluorotetradecanoic acid (PFTA)	376-06-7	1	ug/mL
Perfluorotridecanoic acid (PFTrDA)	72629-94-8	1	ug/mL
Perfluoroundecanoic acid (PFUnA)	2058-94-8	1	ug/mL

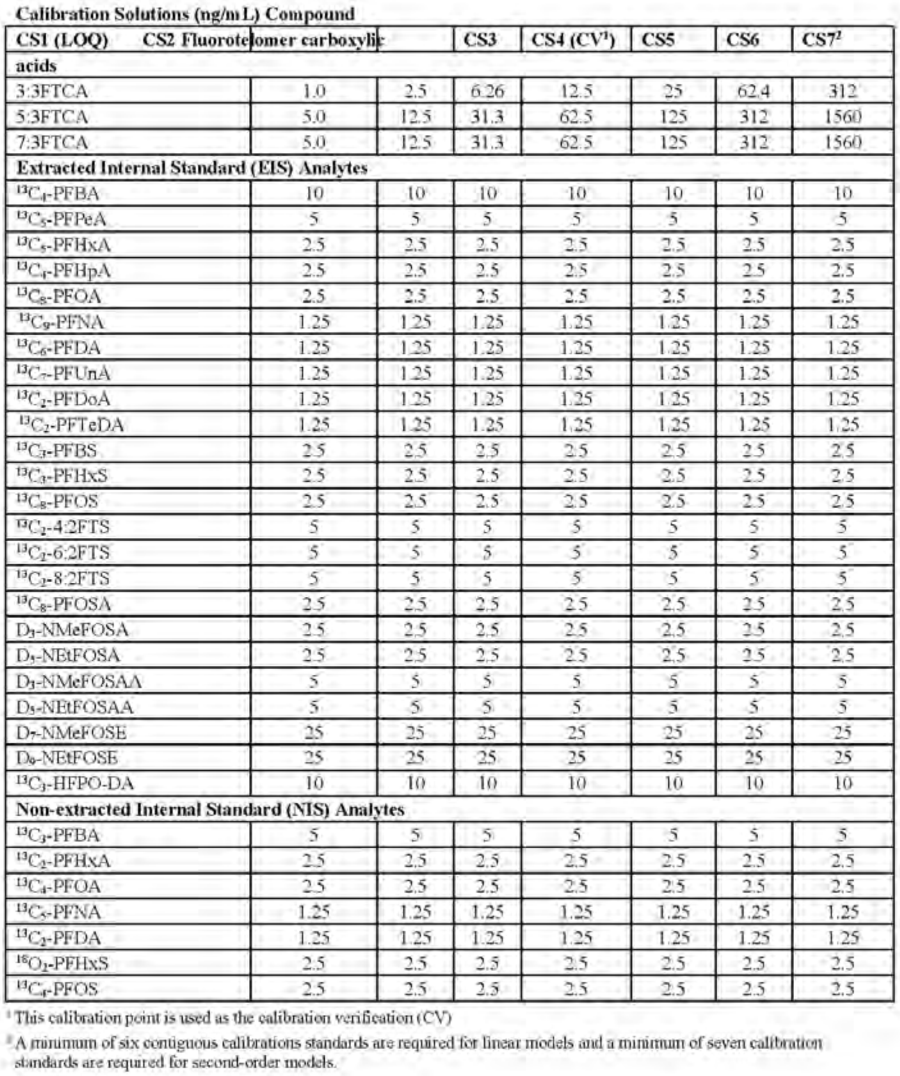
Reviewed By　　　　　　　　Date

Page 1 of 1

Attachment 4 – Calibration Concentrations, nominal

Calibration Solutions (ng/mL) Compound

CS1 (LOQ) CS2 Perfluoroalkyl carboxylic			**CS3**	**CS4 (CV^1)**	**CS5**	**CS6**	**CS7^2**
acids							
PFBA	0.8	2	5	10	20	50	250
PFPeA	0.4	1	2.5	5	10	25	125
PFHxA	0.2	0.5	1.25	2.5	5	12.5	62.5
PFHpA	0.2	0.5	1.25	2.5	5	12.5	62.5
PFOA	0.2	0.5	1.25	2.5	5	12.5	62.5
PFNA	0.2	0.5	1.25	2.5	5	12.5	62.5
PFDA	0.2	0.5	1.25	2.5	5	12.5	62.5
PFUnA	0.2	0.5	1.25	2.5	5	12.5	62.5
PFDoA	0.2	0.5	1.25	2.5	5	12.5	62.5
PFTrDA	0.2	0.5	1.25	2.5	5	12.5	62.5
PFTeDA	0.2	0.5	1.25	2.5	5	12.5	62.5
Perfluoroalkyl sulfonic acids							
PFBS	0.2	0.5	1.25	2.5	5	12.5	62.5
PFPeS	0.2	0.5	1.25	2.5	5	12.5	62.5
PFHxS	0.2	0.5	1.25	2.5	5	12.5	62.5
PFHpS	0.2	0.5	1.25	2.5	5	12.5	62.5
PFOS	0.2	0.5	1.25	2.5	5	12.5	62.5
PFNS	0.2	0.5	1.25	2.5	5	12.5	62.5
PFDS	0.2	0.5	1.25	2.5	5	12.5	62.5
PFDoS	0.2	0.5	1.25	2.5	5	12.5	62.5
Fluorotelomer sulfonic acids							
4:2FTS	0.8	2	5	10	20	50	NA
6:2FTS	0.8	2	5	10	20	50	NA
8:2FTS	0.8	2	5	10	20	50	NA
Perfluorooctane sulfonamides							
PFOSA	0.2	0.5	1.25	2.5	5	12.5	62.5
NMeFOSA	0.2	0.5	1.25	2.5	5	12.5	62.5
NEtFOSA	0.2	0.5	1.25	2.5	5	12.5	62.5
Perfluorooctane sulfonamidoacetic acids							
NMeFOSAA	0.2	0.5	1.25	2.5	5	12.5	62.5
NEtFOSAA	0.2	0.5	1.25	2.5	5	12.5	62.5
Perfluorooctane sulfonamide ethanols							
NMeFOSE	2	5	12.5	25	50	125	625
NEtFOSE	2	5	12.5	25	50	125	625
Per- and polyfluoroether carboxylic acids							
HFPO-DA	0.8	2	5	10	20	50	250
ADONA	0.8	2	5	10	20	50	250
PFMPA	0.4	1	2.5	5	10	25	125
PFMBA	0.4	1	2.5	5	10	25	125
NFDHA	0.4	1	2.5	5	10	25	125
Ether sulfonic acids							
9Cl-PF3ONS	0.8	2	5	10	20	50	250
11Cl-PF3OUdS	0.8	2	5	10	20	50	250
PFEESA	0.4	1	2.5	5	10	25	125



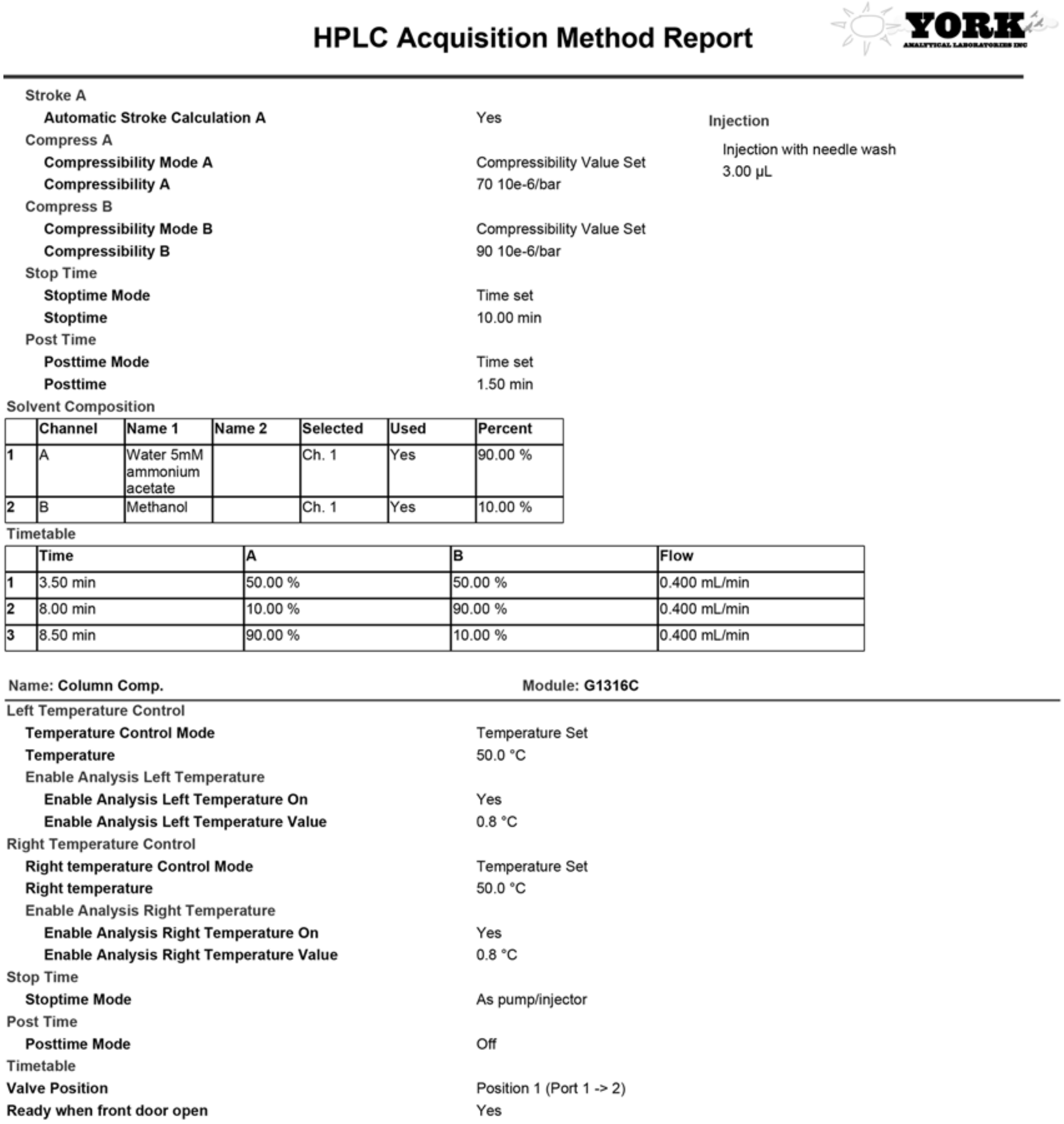
Calibration Solutions (ng/mL) Compound

CS1 (LOQ) CS2 Fluorotelomer carboxylic			**CS3**	**CS4 (CV¹)**	**CS5**	**CS6**	**CS7²**
acids							
3:3FTCA	1.0	2.5	6.26	12.5	25	62.4	312
5:3FTCA	5.0	12.5	31.3	62.5	125	312	1560
7:3FTCA	5.0	12.5	31.3	62.5	125	312	1560
Extracted Internal Standard (EIS) Analytes							
$^{13}C_4$-PFBA	10	10	10	10	10	10	10
$^{13}C_5$-PFPeA	5	5	5	5	5	5	5
$^{13}C_5$-PFHxA	2.5	2.5	2.5	2.5	2.5	2.5	2.5
$^{13}C_4$-PFHpA	2.5	2.5	2.5	2.5	2.5	2.5	2.5
$^{13}C_8$-PFOA	2.5	2.5	2.5	2.5	2.5	2.5	2.5
$^{13}C_9$-PFNA	1.25	1.25	1.25	1.25	1.25	1.25	1.25
$^{13}C_6$-PFDA	1.25	1.25	1.25	1.25	1.25	1.25	1.25
$^{13}C_7$-PFUnA	1.25	1.25	1.25	1.25	1.25	1.25	1.25
$^{13}C_2$-PFDoA	1.25	1.25	1.25	1.25	1.25	1.25	1.25
$^{13}C_2$-PFTeDA	1.25	1.25	1.25	1.25	1.25	1.25	1.25
$^{13}C_3$-PFBS	2.5	2.5	2.5	2.5	2.5	2.5	2.5
$^{13}C_3$-PFHxS	2.5	2.5	2.5	2.5	2.5	2.5	2.5
$^{13}C_8$-PFOS	2.5	2.5	2.5	2.5	2.5	2.5	2.5
$^{13}C_2$-4:2FTS	5	5	5	5	5	5	5
$^{13}C_2$-6:2FTS	5	5	5	5	5	5	5
$^{13}C_2$-8:2FTS	5	5	5	5	5	5	5
$^{13}C_8$-PFOSA	2.5	2.5	2.5	2.5	2.5	2.5	2.5
D_3-NMeFOSA	2.5	2.5	2.5	2.5	2.5	2.5	2.5
D_5-NEtFOSA	2.5	2.5	2.5	2.5	2.5	2.5	2.5
D_3-NMeFOSAA	5	5	5	5	5	5	5
D_5-NEtFOSAA	5	5	5	5	5	5	5
D_7-NMeFOSE	25	25	25	25	25	25	25
D_9-NEtFOSE	25	25	25	25	25	25	25
$^{13}C_3$-HFPO-DA	10	10	10	10	10	10	10
Non-extracted Internal Standard (NIS) Analytes							
$^{13}C_3$-PFBA	5	5	5	5	5	5	5
$^{13}C_2$-PFHxA	2.5	2.5	2.5	2.5	2.5	2.5	2.5
$^{13}C_4$-PFOA	2.5	2.5	2.5	2.5	2.5	2.5	2.5
$^{13}C_5$-PFNA	1.25	1.25	1.25	1.25	1.25	1.25	1.25
$^{13}C_2$-PFDA	1.25	1.25	1.25	1.25	1.25	1.25	1.25
$^{18}O_2$-PFHxS	2.5	2.5	2.5	2.5	2.5	2.5	2.5
$^{13}C_4$-PFOS	2.5	2.5	2.5	2.5	2.5	2.5	2.5

[1] This calibration point is used as the calibration verification (CV)

[2] A minimum of six contiguous calibrations standards are required for linear models and a minimum of seven calibration standards are required for second-order models.

Attachment 5 -HPLC Method Parameters



HPLC Acquisition Method Report

Stroke A
Automatic Stroke Calculation A Yes
Compress A
Compressibility Mode A Compressibility Value Set
Compressibility A 70 10e-6/bar
Compress B
Compressibility Mode B Compressibility Value Set
Compressibility B 90 10e-6/bar
Stop Time
Stoptime Mode Time set
Stoptime 10.00 min
Post Time
Posttime Mode Time set
Posttime 1.50 min

Injection
Injection with needle wash
3.00 µL

Solvent Composition

	Channel	Name 1	Name 2	Selected	Used	Percent
1	A	Water 5mM ammonium acetate		Ch. 1	Yes	90.00 %
2	B	Methanol		Ch. 1	Yes	10.00 %

Timetable

	Time	A	B	Flow
1	3.50 min	50.00 %	50.00 %	0.400 mL/min
2	8.00 min	10.00 %	90.00 %	0.400 mL/min
3	8.50 min	90.00 %	10.00 %	0.400 mL/min

Name: **Column Comp.** Module: **G1316C**

Left Temperature Control
Temperature Control Mode Temperature Set
Temperature 50.0 °C
Enable Analysis Left Temperature
Enable Analysis Left Temperature On Yes
Enable Analysis Left Temperature Value 0.8 °C
Right Temperature Control
Right temperature Control Mode Temperature Set
Right temperature 50.0 °C
Enable Analysis Right Temperature
Enable Analysis Right Temperature On Yes
Enable Analysis Right Temperature Value 0.8 °C
Stop Time
Stoptime Mode As pump/injector
Post Time
Posttime Mode Off
Timetable
Valve Position Position 1 (Port 1 -> 2)
Ready when front door open Yes

Attachment 6 - Triple Quadrupole Acquisition Method

Acquisition Method Report

Agilent Technologies

Acquisition Method Info

Method Name	PFAS1633_ACQ_092922.m
Method Path	D:\MassHunter\methods\PFAS1633_ACQ_092922.m
Method Description	EPA 1633_Target PFAS Isotope Dilution_Acquisition

Device List

- HiP Sampler
- Binary Pump
- Column Comp.
- QQQ

MS QQQ Mass Spectrometer

Ion Source	AJS ESI	**Tune File**	D:\MassHunter\Tune\QQQ\G6460C \atunes.TUNE.XML
Stop Mode	No Limit/As Pump	**Stop Time (min)**	1
Time Filter	On	**Time Filter Width (min)**	0.07
LC->Waste Pre Row	N/A	**LC->Waste Post Row**	N/A

Time Segments

Index	Start Time (min)	Scan Type	Ion Mode	Div Valve	Delta EMV	Store	Cycle Time (ms)	Triggered?	MRM Repeats
1	0	DynamicMRM	ESI+Agilent Jet Stream	To MS	350	Yes	550	Yes	3

Time Segment 1

Scan Segments

Cpd Name	ISTD?	Prec Ion	MS1 Res	Prod Ion	MS2 Res	Primary	Trigger	Frag (V)	CE (V)	Cell Acc (V)	Ret Time (min)	Ret Window	Polarity
11-Cl-PF3OUdS	No	631	Unit/Enh (6490)	451	Unit/Enh (6490)	Yes	No	170	33	4	7.62	3	Negative
1H,1H,2H,2H-perfluoro-1-decanesulfonate (8 2F TS)	No	527	Unit/Enh (6490)	507	Unit/Enh (6490)	Yes	No	170	28	4	7.14	3	Negative
1H,1H,2H,2H-perfluoro-1-decanesulfonate (8 2F TS)	No	527	Unit/Enh (6490)	80.9	Unit/Enh (6490)	Yes	No	170	40	4	7.14	3	Negative
1H,1H,2H,2H-perfluoro-1-hexanesulfonate (4 2F TS)	No	327	Unit/Enh (6490)	307	Unit/Enh (6490)	Yes	No	162	20	4	4.788	3	Negative
1H,1H,2H,2H-perfluoro-1-hexanesulfonate (4 2F TS)	No	327	Unit/Enh (6490)	80.9	Unit/Enh (6490)	Yes	No	162	36	4	4.788	3	Negative
1H,1H,2H,2H-perfluoro-1-octanesulfonate (6 2F TS)	No	427	Unit/Enh (6490)	407	Unit/Enh (6490)	Yes	No	162	24	4	6.168	3	Negative
1H,1H,2H,2H-perfluoro-1-octanesulfonate (6 2F TS)	No	427	Unit/Enh (6490)	79.7	Unit/Enh (6490)	Yes	No	162	48	4	6.168	3	Negative
3:3FTCA	No	241	Unit/Enh (6490)	177	Unit/Enh (6490)	Yes	No	74	4	4	3.4	3	Negative
3-3FTCA	No	241	Unit/Enh (6490)	117	Unit/Enh (6490)	Yes	No	74	44	4	3.4	3	Negative

Acquisition Method Report

Agilent Technologies

Cpd Name	ISTD?	Prec Ion	MS1 Res	Prod Ion	MS2 Res	Primary	Trigger	Frag (V)	CE(V)	Cell Acc (V)	Ret Time (min)	Ret Window	Polarity
5-3FTCA	No	341	Unit/Enh (6490)	237	Unit/Enh (6490)	Yes	No	84	12	4	5.73	3	Negative
5-3FTCA	No	341	Unit/Enh (6490)	217	Unit/Enh (6490)	Yes	No	84	24	4	5.73	3	Negative
7-3FTCA	No	441	Unit/Enh (6490)	337	Unit/Enh (6490)	Yes	No	76	12	4	6.7	3	Negative
7-3FTCA	No	441	Unit/Enh (6490)	317	Unit/Enh (6490)	Yes	No	76	24	4	6.7	3	Negative
9-Cl-PF3ONS	No	531	Unit/Enh (6490)	351	Unit/Enh (6490)	Yes	No	175	29	4	6.89	3	Negative
ADONA	No	377	Unit/Enh (6490)	251	Unit/Enh (6490)	Yes	No	103	9	4	5.62	3	Negative
ADONA	No	377	Unit/Enh (6490)	85	Unit/Enh (6490)	Yes	No	103	37	4	5.62	3	Negative
d3-NMeFOSA	No	515	Unit/Enh (6490)	219	Unit/Enh (6490)	Yes	No	134	20	4	7.17	3	Negative
d3-N-MeFOSAA	No	572.99	Unit/Enh (6490)	418.8	Unit/Enh (6490)	Yes	No	130	20	4	7.17	3	Negative
d5-NEtFOSA	No	531	Unit/Enh (6490)	219	Unit/Enh (6490)	Yes	No	150	20	4	8.52	3	Negative
d5-NEtFOSA	No	531	Unit/Enh (6490)	169	Unit/Enh (6490)	Yes	No	150	20	4	8.52	3	Negative
d5-N-EtFOSAA	No	589.02	Unit/Enh (6490)	530.9	Unit/Enh (6490)	Yes	No	130	20	4	7.36	3	Negative
d5-N-EtFOSAA	No	589.02	Unit/Enh (6490)	418.8	Unit/Enh (6490)	Yes	No	130	20	4	7.36	3	Negative
d7-NMeFOSE	No	623	Unit/Enh (6490)	310	Unit/Enh (6490)	Yes	No	150	15	4	8.28	3	Negative
d7-NMeFOSE	No	623	Unit/Enh (6490)	59	Unit/Enh (6490)	Yes	No	88	15	4	8.28	3	Negative
d9-NEtFOSE	No	639	Unit/Enh (6490)	59	Unit/Enh (6490)	Yes	No	150	15	4	8.6	3	Negative
HFPO-DA	No	285	Unit/Enh (6490)	169.1	Unit/Enh (6490)	Yes	No	100	20	4	4.95	3	Negative
M2-4-2FTS	No	329	Unit/Enh (6490)	309	Unit/Enh (6490)	Yes	No	156	20	4	4.787	3	Negative
M2-4-2FTS	No	329	Unit/Enh (6490)	81	Unit/Enh (6490)	Yes	No	156	28	4	4.787	3	Negative
M2-6-2FTS	No	429	Unit/Enh (6490)	409	Unit/Enh (6490)	Yes	No	162	24	4	6.01	3	Negative
M2-6-2FTS	No	429	Unit/Enh (6490)	81	Unit/Enh (6490)	Yes	No	162	40	4	6.01	3	Negative
M2-8-2FTS	No	529	Unit/Enh (6490)	509	Unit/Enh (6490)	Yes	No	165	28	4	6.98	3	Negative
M2-8-2FTS	No	529	Unit/Enh (6490)	81	Unit/Enh (6490)	Yes	No	165	40	4	6.98	3	Negative
M2PFTeDA	No	715	Unit/Enh (6490)	670	Unit/Enh (6490)	Yes	No	62	12	4	8.25	3	Negative
M3-HFPO-DA	No	287	Unit/Enh (6490)	169	Unit/Enh (6490)	Yes	No	90	5	4	4.99	3	Negative
M3PFBA	Yes	216	Unit/Enh (6490)	172	Unit/Enh (6490)	Yes	No	90	5	4	1.2	2	Negative
M3PFBS	No	302	Unit/Enh (6490)	98.9	Unit/Enh (6490)	Yes	No	114	32	4	3.94	3	Negative
M3PFBS	No	302	Unit/Enh (6490)	79.9	Unit/Enh (6490)	Yes	No	114	40	4	3.94	3	Negative
M3PFHxS	No	402	Unit/Enh (6490)	98.9	Unit/Enh (6490)	Yes	No	165	40	4	5.55	3	Negative
M3PFHxS	No	402	Unit/Enh (6490)	80	Unit/Enh (6490)	Yes	No	165	48	4	5.55	3	Negative
M4PFHpA	No	367	Unit/Enh (6490)	322	Unit/Enh (6490)	Yes	No	124	8	4	5.601	3	Negative
M5PFHxA	No	318	Unit/Enh (6490)	273	Unit/Enh (6490)	Yes	No	70	4	4	5.47	3	Negative
M5PFHxA	No	318	Unit/Enh (6490)	120	Unit/Enh (6490)	Yes	No	70	4	4	5.47	3	Negative
M6PFDA	No	519	Unit/Enh (6490)	473.9	Unit/Enh (6490)	Yes	No	59	8	4	6.99	3	Negative
M7PFUdA	No	570	Unit/Enh (6490)	525	Unit/Enh (6490)	Yes	No	64	8	4	7.38	3	Negative
MPFDA	Yes	514.98	Unit/Enh (6490)	469.8	Unit/Enh (6490)	Yes	No	94	5	4	6.972	2	Negative
MPFHxA	Yes	314.99	Unit/Enh (6490)	269.8	Unit/Enh (6490)	Yes	No	86	4	4	4.705	2	Negative
MPFHxA	Yes	314.99	Unit/Enh (6490)	120	Unit/Enh (6490)	Yes	No	86	4	4	4.705	2	Negative
MPFHxS	Yes	403	Unit/Enh (6490)	103	Unit/Enh (6490)	Yes	No	110	37	4	5.63	2	Negative
MPFHxS	Yes	403	Unit/Enh (6490)	84	Unit/Enh (6490)	Yes	No	110	40	4	5.63	2	Negative
MPFNA	Yes	468	Unit/Enh (6490)	423	Unit/Enh (6490)	Yes	No	66	4	4	6.541	2	Negative
MPFOA	Yes	417	Unit/Enh (6490)	372	Unit/Enh (6490)	Yes	No	84	4	4	6.03	2	Negative
MPFOS	Yes	502.96	Unit/Enh (6490)	99	Unit/Enh (6490)	Yes	No	148	48	4	6.57	3	Negative

Acquisition Method Report

Agilent Technologies

Cpd Name	ISTD?	Prec Ion	MS1 Res	Prod Ion	MS2 Res	Primary	Trigger	Frag (V)	CE (V)	Cell Acc (V)	Ret Time (min)	Ret Window	Polarity
MPFOS	Yes	502.96	Unit/Enh (6490)	80	Unit/Enh (6490)	Yes	No	148	54	4	6.57	3	Negative
NEtFOSA	No	526	Unit/Enh (6490)	219	Unit/Enh (6490)	Yes	No	120	20	4	8.528	3	Negative
NEtFOSA	No	526	Unit/Enh (6490)	169	Unit/Enh (6490)	Yes	No	120	20	4	8.528	3	Negative
N-EtFOSAA	No	584	Unit/Enh (6490)	525.9	Unit/Enh (6490)	Yes	No	130	20	4	7.521	3	Negative
N-EtFOSAA	No	584	Unit/Enh (6490)	418.8	Unit/Enh (6490)	Yes	No	130	20	4	7.521	3	Negative
NEtFOSE	No	630	Unit/Enh (6490)	59	Unit/Enh (6490)	Yes	No	120	20	4	8.301	3	Negative
NFDHA	No	295	Unit/Enh (6490)	201.1	Unit/Enh (6490)	Yes	No	92	2	4	4.641	3	Negative
NFDHA	No	295	Unit/Enh (6490)	84.9	Unit/Enh (6490)	Yes	No	92	34	4	4.641	3	Negative
NMeFOSA	No	512	Unit/Enh (6490)	219	Unit/Enh (6490)	Yes	No	120	20	4	8.298	3	Negative
NMeFOSA	No	512	Unit/Enh (6490)	169	Unit/Enh (6490)	Yes	No	120	20	4	8.298	3	Negative
N-MeFOSAA	No	570	Unit/Enh (6490)	511.9	Unit/Enh (6490)	Yes	No	150	20	4	7.335	3	Negative
N-MeFOSAA	No	570	Unit/Enh (6490)	418.9	Unit/Enh (6490)	Yes	No	150	20	4	7.335	3	Negative
NMeFOSE	No	616	Unit/Enh (6490)	59	Unit/Enh (6490)	Yes	No	120	20	4	8.301	3	Negative
Perfluoro-1-[13C8]octanesulfonamide (M8FOSA)	No	506	Unit/Enh (6490)	78	Unit/Enh (6490)	Yes	No	162	48	4	7.59	3	Negative
Perfluoro-1-[13C8]octanesulfonic acid (M8PFOS)	No	507	Unit/Enh (6490)	98.9	Unit/Enh (6490)	Yes	No	174	48	4	6.59	3	Negative
Perfluoro-1-[13C8]octanesulfonic acid (M8PFOS)	No	507	Unit/Enh (6490)	80	Unit/Enh (6490)	Yes	No	174	54	4	6.59	3	Negative
Perfluoro-1-decanesulfonate (L-PFDS)	No	598.9	Unit/Enh (6490)	98.9	Unit/Enh (6490)	Yes	No	156	50	4	7.546	3	Negative
Perfluoro-1-decanesulfonate (L-PFDS)	No	598.9	Unit/Enh (6490)	98.9	Unit/Enh (6490)	Yes	No	100	60	4	7.546	3	Negative
Perfluoro-1-heptanesulfonate (L-PFHpS)	No	448.9	Unit/Enh (6490)	98.9	Unit/Enh (6490)	Yes	No	162	48	4	6.252	3	Negative
Perfluoro-1-heptanesulfonate (L-PFHpS)	No	448.9	Unit/Enh (6490)	80	Unit/Enh (6490)	Yes	No	162	48	4	6.252	3	Negative
Perfluoro-1-octanesulfonamide (FOSA)	No	497.9	Unit/Enh (6490)	478	Unit/Enh (6490)	Yes	No	156	100	4	7.651	3	Negative
Perfluoro-1-octanesulfonamide (FOSA)	No	497.9	Unit/Enh (6490)	78	Unit/Enh (6490)	Yes	No	156	40	4	7.651	3	Negative
Perfluoro-1-pentanesulfonate (L-PFPeS)	No	348.9	Unit/Enh (6490)	98.9	Unit/Enh (6490)	Yes	No	150	36	4	5.042	3	Negative
Perfluoro-1-pentanesulfonate (L-PFPeS)	No	348.9	Unit/Enh (6490)	79.9	Unit/Enh (6490)	Yes	No	150	40	4	5.042	3	Negative

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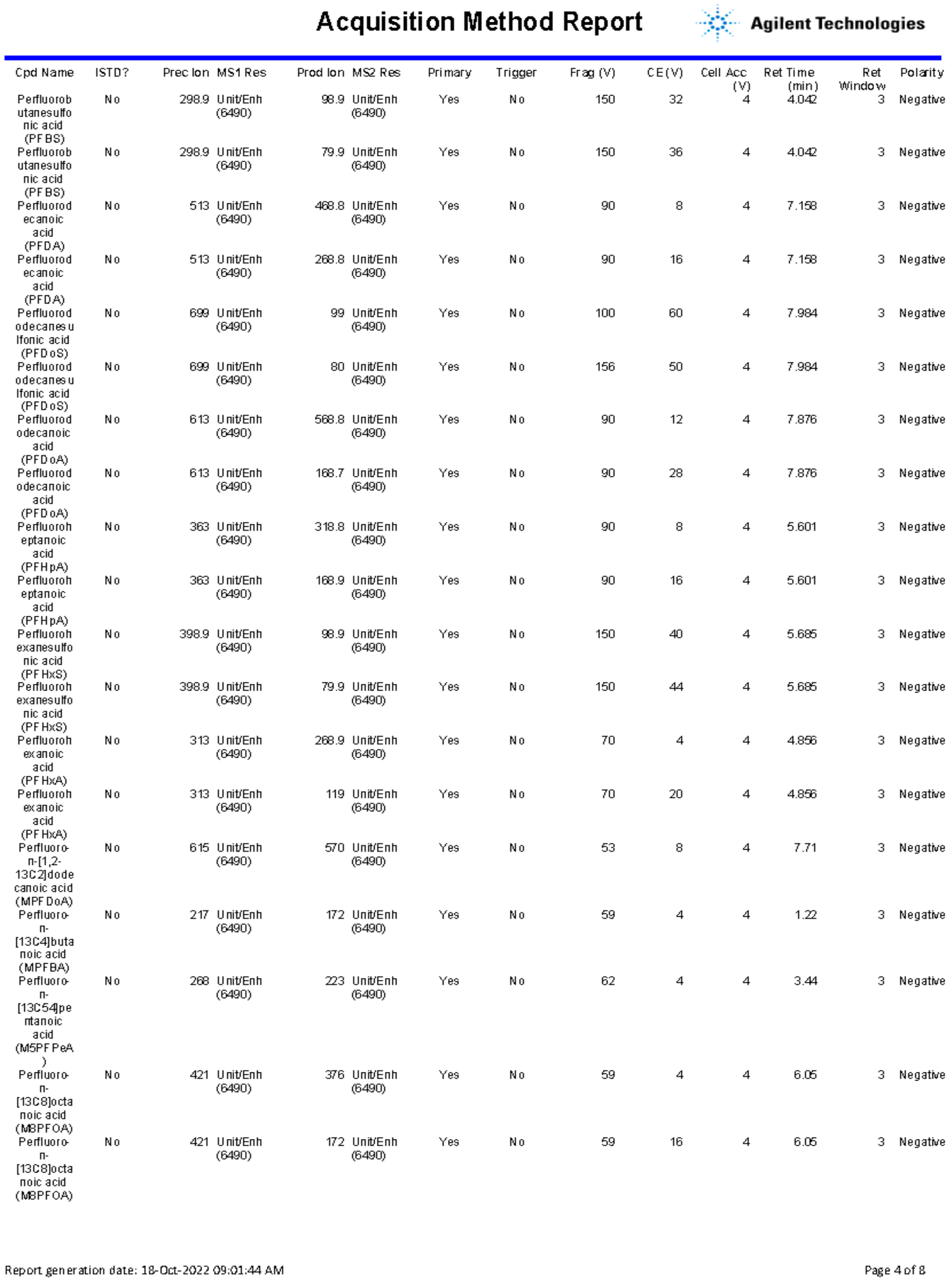

Acquisition Method Report

Agilent Technologies

Cpd Name	ISTD?	Prec Ion	MS1 Res	Prod Ion	MS2 Res	Primary	Trigger	Frag (V)	CE(V)	Cell Acc (V)	Ret Time (min)	Ret Window	Polarity
Perfluorobutanesulfonic acid (PFBS)	No	298.9	Unit/Enh (6490)	98.9	Unit/Enh (6490)	Yes	No	150	32	4	4.042	3	Negative
Perfluorobutanesulfonic acid (PFBS)	No	298.9	Unit/Enh (6490)	79.9	Unit/Enh (6490)	Yes	No	150	36	4	4.042	3	Negative
Perfluorodecanoic acid (PFDA)	No	513	Unit/Enh (6490)	468.8	Unit/Enh (6490)	Yes	No	90	8	4	7.158	3	Negative
Perfluorodecanoic acid (PFDA)	No	513	Unit/Enh (6490)	268.8	Unit/Enh (6490)	Yes	No	90	16	4	7.158	3	Negative
Perfluorododecanesulfonic acid (PFDoS)	No	699	Unit/Enh (6490)	99	Unit/Enh (6490)	Yes	No	100	60	4	7.984	3	Negative
Perfluorododecanesulfonic acid (PFDoS)	No	699	Unit/Enh (6490)	80	Unit/Enh (6490)	Yes	No	156	50	4	7.984	3	Negative
Perfluorododecanoic acid (PFDoA)	No	613	Unit/Enh (6490)	568.8	Unit/Enh (6490)	Yes	No	90	12	4	7.876	3	Negative
Perfluorododecanoic acid (PFDoA)	No	613	Unit/Enh (6490)	168.7	Unit/Enh (6490)	Yes	No	90	28	4	7.876	3	Negative
Perfluoroheptanoic acid (PFHpA)	No	363	Unit/Enh (6490)	318.8	Unit/Enh (6490)	Yes	No	90	8	4	5.601	3	Negative
Perfluoroheptanoic acid (PFHpA)	No	363	Unit/Enh (6490)	168.9	Unit/Enh (6490)	Yes	No	90	16	4	5.601	3	Negative
Perfluorohexanesulfonic acid (PFHxS)	No	398.9	Unit/Enh (6490)	98.9	Unit/Enh (6490)	Yes	No	150	40	4	5.685	3	Negative
Perfluorohexanesulfonic acid (PFHxS)	No	398.9	Unit/Enh (6490)	79.9	Unit/Enh (6490)	Yes	No	150	44	4	5.685	3	Negative
Perfluorohexanoic acid (PFHxA)	No	313	Unit/Enh (6490)	268.9	Unit/Enh (6490)	Yes	No	70	4	4	4.856	3	Negative
Perfluorohexanoic acid (PFHxA)	No	313	Unit/Enh (6490)	119	Unit/Enh (6490)	Yes	No	70	20	4	4.856	3	Negative
Perfluoro-n-[1,2-13C2]dodecanoic acid (MPFDoA)	No	615	Unit/Enh (6490)	570	Unit/Enh (6490)	Yes	No	53	8	4	7.71	3	Negative
Perfluoro-n-[13C4]butanoic acid (MPFBA)	No	217	Unit/Enh (6490)	172	Unit/Enh (6490)	Yes	No	59	4	4	1.22	3	Negative
Perfluoro-n-[13C54]pentanoic acid (M5PFPeA)	No	268	Unit/Enh (6490)	223	Unit/Enh (6490)	Yes	No	62	4	4	3.44	3	Negative
Perfluoro-n-[13C8]octanoic acid (M8PFOA)	No	421	Unit/Enh (6490)	376	Unit/Enh (6490)	Yes	No	59	4	4	6.05	3	Negative
Perfluoro-n-[13C8]octanoic acid (M8PFOA)	No	421	Unit/Enh (6490)	172	Unit/Enh (6490)	Yes	No	59	16	4	6.05	3	Negative

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Acquisition Method Report

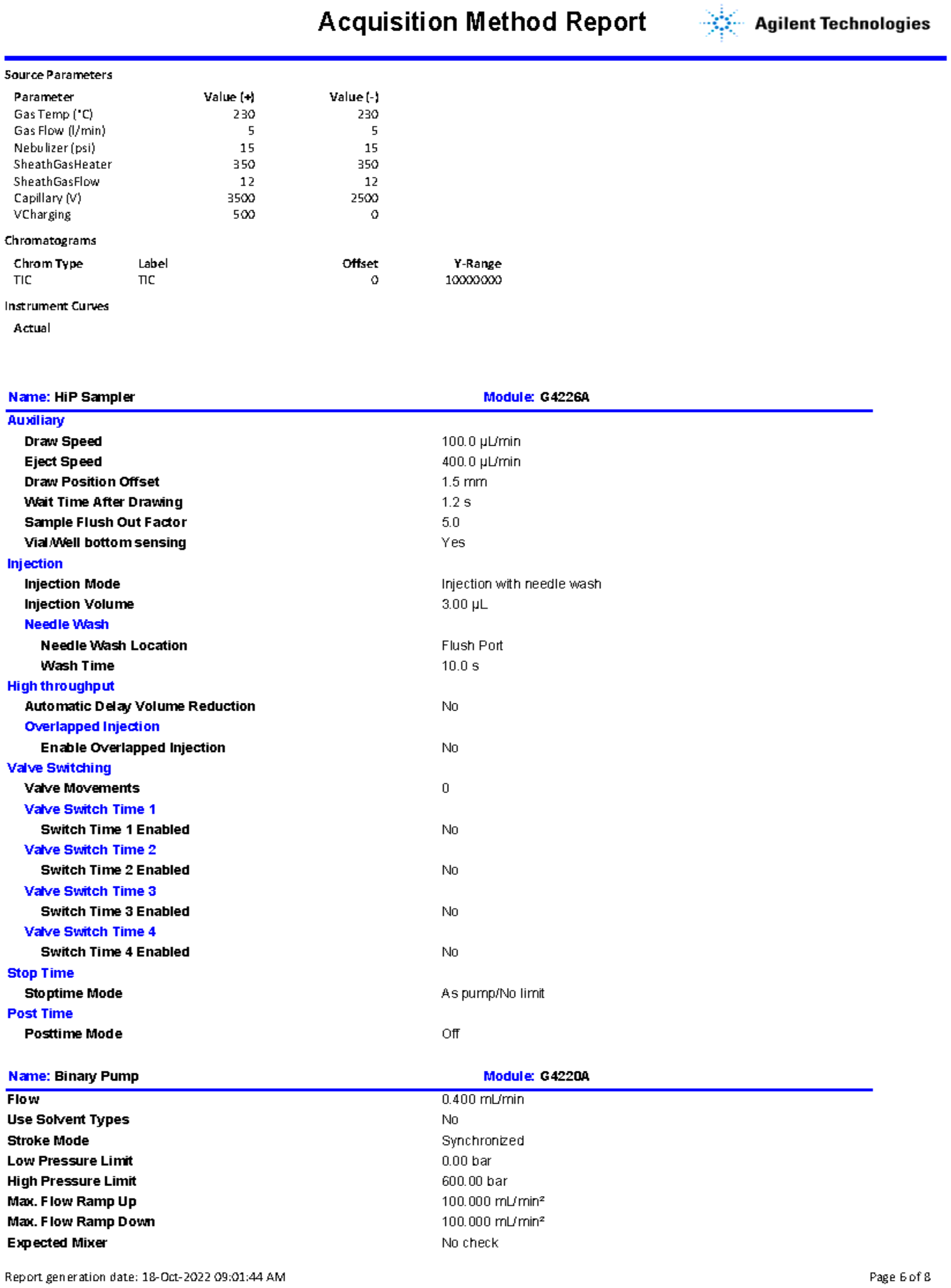
Agilent Technologies

Cpd Name	ISTD?	Prec Ion	MS1 Res	Prod Ion	MS2 Res	Primary	Trigger	Frag (V)	CE (V)	Cell Acc (V)	Ret Time (min)	Ret Window	Polarity
Perfluoro-n-[13C9]nonanoic acid (M9PFNA)	No	472	Unit/Enh (6490)	427	Unit/Enh (6490)	Yes	No	59	8	4	6.56	3	Negative
Perfluoro-n-[13C9]nonanoic acid (M9PFNA)	No	472	Unit/Enh (6490)	223	Unit/Enh (6490)	Yes	No	59	16	4	6.56	3	Negative
Perfluoro-n-butanoic acid (PFBA)	No	213	Unit/Enh (6490)	168.9	Unit/Enh (6490)	Yes	No	70	4	4	1.246	3	Negative
Perfluorononanesulfonate (L-PFNS)	No	548.9	Unit/Enh (6490)	98.9	Unit/Enh (6490)	Yes	No	159	48	4	7.174	3	Negative
Perfluorononanesulfonate (L-PFNS)	No	548.9	Unit/Enh (6490)	79.9	Unit/Enh (6490)	Yes	No	159	48	4	7.174	3	Negative
Perfluorononanoic acid (PFNA)	No	463	Unit/Enh (6490)	418.8	Unit/Enh (6490)	Yes	No	90	8	4	6.718	3	Negative
Perfluorononanoic acid (PFNA)	No	463	Unit/Enh (6490)	218.8	Unit/Enh (6490)	Yes	No	90	16	4	6.718	3	Negative
Perfluoro-n-pentanoic acid (PFPeA)	No	263	Unit/Enh (6490)	219	Unit/Enh (6490)	Yes	No	62	4	4	3.526	3	Negative
Perfluorooctanesulfonic acid (PFOS)	No	498.9	Unit/Enh (6490)	98.9	Unit/Enh (6490)	Yes	No	150	44	4	6.743	3	Negative
Perfluorooctanesulfonic acid (PFOS)	No	498.9	Unit/Enh (6490)	79.9	Unit/Enh (6490)	Yes	No	150	84	4	6.743	3	Negative
Perfluorooctanoic acid (PFOA)	No	413	Unit/Enh (6490)	368.8	Unit/Enh (6490)	Yes	No	90	8	4	6.202	3	Negative
Perfluorooctanoic acid (PFOA)	No	413	Unit/Enh (6490)	168.9	Unit/Enh (6490)	Yes	No	90	16	4	6.202	3	Negative
Perfluorotetradecanoic acid (PFTA)	No	713	Unit/Enh (6490)	669	Unit/Enh (6490)	Yes	No	110	12	4	8.414	3	Negative
Perfluorotetradecanoic acid (PFTA)	No	713	Unit/Enh (6490)	168.8	Unit/Enh (6490)	Yes	No	110	28	4	8.414	3	Negative
Perfluorotridecanoic acid (PFTrDA)	No	663	Unit/Enh (6490)	618.8	Unit/Enh (6490)	Yes	No	90	12	4	8.164	3	Negative
Perfluoroundecanoic acid (PFUnA)	No	563	Unit/Enh (6490)	519	Unit/Enh (6490)	Yes	No	90	8	4	7.538	3	Negative
Perfluoroundecanoic acid (PFUnA)	No	563	Unit/Enh (6490)	169	Unit/Enh (6490)	Yes	No	90	24	4	7.538	3	Negative
PFEESA	No	315	Unit/Enh (6490)	135	Unit/Enh (6490)	Yes	No	112	26	4	4.464	3	Negative
PFEESA	No	315	Unit/Enh (6490)	83	Unit/Enh (6490)	Yes	No	112	14	4	4.464	3	Negative
PFMBA	No	279	Unit/Enh (6490)	85	Unit/Enh (6490)	Yes	No	75	18	4	4.011	3	Negative
PFMPA	No	229	Unit/Enh (6490)	85	Unit/Enh (6490)	Yes	No	59	6	4	2.15	3	Negative

Scan Parameters

Data Stg	Threshold
Centroid	0

Report generation date: 18-Oct-2022 09:01:44 AM



Acquisition Method Report

Agilent Technologies

Source Parameters

Parameter	Value (+)	Value (-)
Gas Temp (°C)	230	230
Gas Flow (l/min)	5	5
Nebulizer (psi)	15	15
SheathGasHeater	350	350
SheathGasFlow	12	12
Capillary (V)	3500	2500
VCharging	500	0

Chromatograms

Chrom Type	Label	Offset	Y-Range
TIC	TIC	0	10000000

Instrument Curves

Actual

Name: HiP Sampler **Module:** G4226A

Auxiliary	
Draw Speed	100.0 µL/min
Eject Speed	400.0 µL/min
Draw Position Offset	1.5 mm
Wait Time After Drawing	1.2 s
Sample Flush Out Factor	5.0
Vial/Well bottom sensing	Yes
Injection	
Injection Mode	Injection with needle wash
Injection Volume	3.00 µL
Needle Wash	
Needle Wash Location	Flush Port
Wash Time	10.0 s
High throughput	
Automatic Delay Volume Reduction	No
Overlapped Injection	
Enable Overlapped Injection	No
Valve Switching	
Valve Movements	0
Valve Switch Time 1	
Switch Time 1 Enabled	No
Valve Switch Time 2	
Switch Time 2 Enabled	No
Valve Switch Time 3	
Switch Time 3 Enabled	No
Valve Switch Time 4	
Switch Time 4 Enabled	No
Stop Time	
Stoptime Mode	As pump/No limit
Post Time	
Posttime Mode	Off

Name: Binary Pump **Module:** G4220A

Flow	0.400 mL/min
Use Solvent Types	No
Stroke Mode	Synchronized
Low Pressure Limit	0.00 bar
High Pressure Limit	600.00 bar
Max. Flow Ramp Up	100.000 mL/min²
Max. Flow Ramp Down	100.000 mL/min²
Expected Mixer	No check

Report generation date: 18-Oct-2022 09:01:44 AM

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ATTACHMENT 3

LABORATORY CERTIFICATION AND REPORTING LIMITS FOR PFAS

NEW YORK STATE DEPARTMENT OF HEALTH
WADSWORTH CENTER

Expires 12:01 AM April 01, 2024
Issued April 01, 2023

CERTIFICATE OF APPROVAL FOR LABORATORY SERVICE

Issued in accordance with and pursuant to section 502 Public Health Law of New York State

MR. KRZYSZTOF TRAFALSKI
YORK ANALYTICAL LABORATORIES, INC. (II)
132-02 89TH AVENUE SUITE 217
RICHMOND HILL, NY 11418

NY Lab Id No: 12058

is hereby APPROVED as an Environmental Laboratory for the category
ENVIRONMENTAL ANALYSES NON POTABLE WATER
All approved subcategories and/or analytes are listed below:

Perfluorinated Alkyl Acids

11CL-PF3OUDS	EPA 1633 (Draft)
4:2FTS	EPA 1633 (Draft)
6:2FTS	EPA 1633 (Draft)
8:2FTS	EPA 1633 (Draft)
9CL-PF3ONS	EPA 1633 (Draft)
ADONA	EPA 1633 (Draft)
Hexafluoropropylene Oxide Dimer Aci	EPA 1633 (Draft)
NETFOSAA	EPA 1633 (Draft)
NMEFOSAA	EPA 1633 (Draft)
Nonafluoro-3,6-Dioxaheptanoic Acid	EPA 1633 (Draft)
Perflourotridecanoic Acid (PFTRDA)	EPA 1633 (Draft)
Perfluordecanoic Acid (PFDA)	EPA 1633 (Draft)
Perfluoro-3-Methoxypropanoic Acid	EPA 1633 (Draft)
Perfluoro-4-Methoxybutanoic Acid	EPA 1633 (Draft)
Perfluorobutanesulfonic Acid (PFBS)	EPA 1633 (Draft)
Perfluorobutanoic Acid (PFBA)	EPA 1633 (Draft)
Perfluorododecanoic Acid (PFDOA)	EPA 1633 (Draft)
Perfluoroheptanesulfonic Acid (PFHPS	EPA 1633 (Draft)
Perfluoroheptanoic Acid (PFHPA)	EPA 1633 (Draft)
Perfluorohexanesulfonic Acid (PFHXS	EPA 1633 (Draft)
Perfluorohexanoic Acid (PFHXA)	EPA 1633 (Draft)
Perfluorononanoic Acid (PFNA)	EPA 1633 (Draft)
Perfluorooctanesulfonic Acid (PFOS)	EPA 1633 (Draft)
Perfluorooctanoic Acid (PFOA)	EPA 1633 (Draft)
Perfluoropentanesulfonic Acid (PFPES	EPA 1633 (Draft)
Perfluoropentanoic Acid (PFPEA)	EPA 1633 (Draft)
Perfluoroundecanoic Acid (PFUNA)	EPA 1633 (Draft)

Serial No.: 67325

NEW YORK STATE DEPARTMENT OF HEALTH
WADSWORTH CENTER

Expires 12:01 AM April 01, 2024
Issued April 01, 2023

CERTIFICATE OF APPROVAL FOR LABORATORY SERVICE

Issued in accordance with and pursuant to section 502 Public Health Law of New York State

MR. KRZYSZTOF TRAFALSKI
YORK ANALYTICAL LABORATORIES, INC. (II)
132-02 89TH AVENUE SUITE 217
RICHMOND HILL, NY 11418

NY Lab Id No: 12058

is hereby APPROVED as an Environmental Laboratory for the category
ENVIRONMENTAL ANALYSES NON POTABLE WATER
All approved subcategories and/or analytes are listed below:

Perfluorinated Alkyl Acids

PFEESA	EPA 1633 (Draft)

Serial No.: 67325

NEW YORK STATE DEPARTMENT OF HEALTH
WADSWORTH CENTER

Expires 12:01 AM April 01, 2024
Issued April 01, 2023

CERTIFICATE OF APPROVAL FOR LABORATORY SERVICE

Issued in accordance with and pursuant to section 502 Public Health Law of New York State

MR. KRZYSZTOF TRAFALSKI
YORK ANALYTICAL LABORATORIES, INC. (II)
132-02 89TH AVENUE SUITE 217
RICHMOND HILL, NY 11418

NY Lab Id No: 12058

is hereby APPROVED as an Environmental Laboratory for the category
ENVIRONMENTAL ANALYSES SOLID AND HAZARDOUS WASTE
All approved subcategories and/or analytes are listed below:

Perfluorinated Alkyl Acids

8:2FTS	EPA 1633 (Draft)
NETFOSAA	EPA 1633 (Draft)
NMEFOSAA	EPA 1633 (Draft)
Perflourotridecanoic Acid (PFTRDA)	EPA 1633 (Draft)
Perfluordecanoic Acid (PFDA)	EPA 1633 (Draft)
Perfluorobutanoic Acid (PFBA)	EPA 1633 (Draft)
Perfluorododecanoic Acid (PFDOA)	EPA 1633 (Draft)
Perfluoroheptanoic Acid (PFHPA)	EPA 1633 (Draft)
Perfluorohexanoic Acid (PFHXA)	EPA 1633 (Draft)
Perfluorononanoic Acid (PFNA)	EPA 1633 (Draft)
Perfluorooctanesulfonic Acid (PFOS)	EPA 1633 (Draft)
Perfluorooctanoic Acid (PFOA)	EPA 1633 (Draft)
Perfluoropentanoic Acid (PFPEA)	EPA 1633 (Draft)
Perfluorotetradecanoic Acid (PFTA)	EPA 1633 (Draft)
Perfluoroundecanoic Acid (PFUNA)	EPA 1633 (Draft)

Serial No.: 67327

Property of the New York State Department of Health. Certificates are valid only at the address shown and must be conspicuously posted by the laboratory. Continued accreditation depends on the laboratory's successful ongoing participation in the Program. Consumers may verify a laboratory's accreditation status online at https://apps.health.ny.gov/pubdoh/applinks/wc/elappublicweb/, by phone (518) 485-5570 or by email to elap@health.ny.gov.

York Analytical Laboratories, Inc. - Stratford

1/18/2023

Analytical Method Information

PFAS Target compounds by LC/MS-MS

PFAS, EPA 1633 Target List in Water (EPA 1633 Draft)

Units: **ng/L**

Preservation: Cool 4°C

Hold Time to Analysis 28 days

Container: 10_250mL Plastic Cool to 4° C

Amount Required: 250 mL

Hold Time to Extr. 28 days

Analyte	MDL	Reporting Limit	Surrogate %R	Duplicate RPD	Matrix Spike %R	Matrix Spike RPD	Blank Spike / LCS %R	Blank Spike / LCS RPD
11CL-PF3OUdS	1.38	8.00 ng/L		30	25 - 150	30	50 - 150	30
1H,1H,2H,2H-Perfluorodecanesulfonic acid (8:2 FTS)	2.05	8.00 ng/L		30	25 - 150	35	50 - 150	30
1H,1H,2H,2H-Perfluorohexanesulfonic acid (4:2 FTS)	1.79	8.00 ng/L		30	25 - 150	30	50 - 150	30
1H,1H,2H,2H-Perfluorooctanesulfonic acid (6:2 FTS)	1.06	8.00 ng/L		30	25 - 150	35	50 - 150	30
3-Perfluoroheptyl propanoic acid (FHpPA)	9.47	25.0 ng/L		30	25 - 150	30	50 - 150	30
3-Perfluoropentyl propanoic acid (FPePA)	7.33	25.0 ng/L		30	25 - 150	30	50 - 150	30
3-Perfluoropropyl propanoic acid (FPrPA)	2.03	5.00 ng/L		30	25 - 150	30	50 - 150	30
9CL-PF3ONS	0.700	8.00 ng/L		30	25 - 150	30	50 - 150	30
ADONA	0.530	8.00 ng/L		30	25 - 150	30	50 - 150	30
HFPO-DA (Gen-X)	3.23	8.00 ng/L		30	25 - 150	30	50 - 150	30
N-EtFOSA	1.80	0.200 ng/L		30	25 - 150	30	50 - 150	30
N-EtFOSAA	1.03	2.00 ng/L		30	25 - 150	35	50 - 150	30
N-EtFOSE	3.99	20.0 ng/L		30	25 - 150	30	50 - 150	30
N-MeFOSA	1.58	2.00 ng/L		30	25 - 150	30	50 - 150	30
N-MeFOSAA	0.790	2.00 ng/L		30	25 - 150	35	50 - 150	30
N-MeFOSE	3.99	20.0 ng/L		30	25 - 150	30	50 - 150	30
Perfluoro(2-ethoxyethane)sulfonic acid (PFEESA)	0.500	4.00 ng/L		30	25 - 150	30	50 - 150	30
Perfluoro-1-decanesulfonic acid (PFDS)	1.32	2.00 ng/L		30	25 - 150	35	50 - 150	30
Perfluoro-1-heptanesulfonic acid (PFHpS)	0.910	2.00 ng/L		30	25 - 150	35	50 - 150	30
Perfluoro-1-nonanesulfonic acid (PFNS)	0.860	2.00 ng/L		30	25 - 150	30	50 - 150	30
Perfluoro-1-octanesulfonamide (FOSA)	0.880	2.00 ng/L		30	25 - 150	35	50 - 150	30
Perfluoro-1-pentanesulfonate (PFPeS)	0.760	2.00 ng/L		30	25 - 150	30	50 - 150	30
Perfluoro-3,6-dioxaheptanoic acid (NFDHA)	2.14	4.00 ng/L		30	25 - 150	30	50 - 150	30
Perfluoro-4-oxapentanoic acid (PFMPA)	0.250	4.00 ng/L		30	25 - 150	30	50 - 150	30
Perfluoro-5-oxahexanoic acid (PFMBA)	0.370	4.00 ng/L		30	25 - 150	30	50 - 150	30
Perfluorobutanesulfonic acid (PFBS)	0.470	2.00 ng/L		30	25 - 150	35	50 - 150	30
Perfluorodecanoic acid (PFDA)	0.750	2.00 ng/L		30	25 - 150	35	50 - 150	30
Perfluorododecanesulfonic acid (PFDoS)	0.930	2.00 ng/L		30	25 - 150	30	50 - 150	30
Perfluorododecanoic acid (PFDoA)	0.880	2.00 ng/L		30	25 - 150	35	50 - 150	30
Perfluoroheptanoic acid (PFHpA)	0.710	2.00 ng/L		30	25 - 150	35	50 - 150	30
Perfluorohexanesulfonic acid (PFHxS)	0.680	2.00 ng/L		30	25 - 150	35	50 - 150	30
Perfluorohexanoic acid (PFHxA)	0.350	2.00 ng/L		30	25 - 150	35	50 - 150	30
Perfluoro-n-butanoic acid (PFBA)	0.330	8.00 ng/L		30	25 - 150	35	50 - 150	30
Perfluorononanoic acid (PFNA)	0.520	2.00 ng/L		30	25 - 150	35	50 - 150	30
Perfluorooctanesulfonic acid (PFOS)	0.820	2.00 ng/L		30	25 - 150	35	50 - 150	30
Perfluorooctanoic acid (PFOA)	0.420	2.00 ng/L		30	25 - 150	35	50 - 150	30
Perfluoropentanoic acid (PFPeA)	0.230	4.00 ng/L		30	25 - 150	35	50 - 150	30
Perfluorotetradecanoic acid (PFTA)	0.690	2.00 ng/L		30	25 - 150	35	50 - 150	30
Perfluorotridecanoic acid (PFTrDA)	0.740	2.00 ng/L		30	25 - 150	35	50 - 150	30
Perfluoroundecanoic acid (PFUnA)	1.13	2.00 ng/L		30	25 - 150	35	50 - 150	30

Analytical Method Information

PFAS Target compounds by LC/MS-MS

PFAS, EPA 1633 Target List in Soil (EPA 1633 Draft)

Units: **ug/kg**

Preservation: Cool 4°C

Container: 10_250mL Plastic Cool to 4° C

Amount Required: 250 mL

Hold Time to Analysis 28 days

Hold Time to Extr. 28 days

Analyte	MDL	Reporting Limit	Surrogate %R	Duplicate RPD	Matrix Spike %R	Matrix Spike RPD	Blank Spike / LCS %R	Blank Spike / LCS RPD
11CL-PF3OUdS	0.311	0.800 ug/kg		30	25 - 150	30	50 - 150	30
1H,1H,2H,2H-Perfluorodecanesulfonic acid (8:2 FTS)	0.755	0.800 ug/kg		30	25 - 150	35	50 - 150	30
1H,1H,2H,2H-Perfluorohexanesulfonic acid (4:2 FTS)	0.595	0.800 ug/kg		30	25 - 150	30	50 - 150	30
1H,1H,2H,2H-Perfluorooctanesulfonic acid (6:2 FTS)	0.595	0.800 ug/kg		30	25 - 150	35	50 - 150	30
3-Perfluoroheptyl propanoic acid (FHpPA)	1.50	5.00 ug/kg		30	25 - 150	30	50 - 150	30
3-Perfluoropentyl propanoic acid (FPePA)	2.10	5.00 ug/kg		30	25 - 150	30	50 - 150	30
3-Perfluoropropyl propanoic acid (FPrPA)	0.634	1.00 ug/kg		30	25 - 150	30	50 - 150	30
9CL-PF3ONS	0.246	0.800 ug/kg		30	25 - 150	30	50 - 150	30
ADONA	0.174	0.800 ug/kg		30	25 - 150	30	50 - 150	30
HFPO-DA (Gen-X)	0.608	0.800 ug/kg		30	25 - 150	30	50 - 150	30
N-EtFOSA	0.198	0.200 ug/kg		30	25 - 150	30	50 - 150	30
N-EtFOSAA	0.194	0.200 ug/kg		30	25 - 150	35	50 - 150	30
N-EtFOSE	0.697	2.00 ug/kg		30	25 - 150	30	50 - 150	30
N-MeFOSA	0.180	0.200 ug/kg		30	25 - 150	30	50 - 150	30
N-MeFOSAA	0.148	0.200 ug/kg		30	25 - 150	35	50 - 150	30
N-MeFOSE	0.611	2.00 ug/kg		30	25 - 150	30	50 - 150	30
Perfluoro(2-ethoxyethane)sulfonic acid (PFEESA)	0.139	0.400 ug/kg		30	25 - 150	30	50 - 150	30
Perfluoro-1-decanesulfonic acid (PFDS)	0.191	0.200 ug/kg		30	25 - 150	35	50 - 150	30
Perfluoro-1-heptanesulfonic acid (PFHpS)	0.155	0.200 ug/kg		30	25 - 150	35	50 - 150	30
Perfluoro-1-nonanesulfonic acid (PFNS)	0.124	0.200 ug/kg		30	25 - 150	30	50 - 150	30
Perfluoro-1-octanesulfonamide (FOSA)	0.146	0.200 ug/kg		30	25 - 150	35	50 - 150	30
Perfluoro-1-pentanesulfonate (PFPeS)	0.157	0.200 ug/kg		30	25 - 150	30	50 - 150	30
Perfluoro-3,6-dioxaheptanoic acid (NFDHA)	0.193	0.400 ug/kg		30	25 - 150	30	50 - 150	30
Perfluoro-4-oxapentanoic acid (PFMPA)	0.0620	0.400 ug/kg		30	25 - 150	30	50 - 150	30
Perfluoro-5-oxahexanoic acid (PFMBA)	0.0960	0.400 ug/kg		30	25 - 150	30	50 - 150	30
Perfluorobutanesulfonic acid (PFBS)	0.111	0.200 ug/kg		30	25 - 150	35	50 - 150	30
Perfluorodecanoic acid (PFDA)	0.191	0.200 ug/kg		30	25 - 150	35	50 - 150	30
Perfluorododecanesulfonic acid (PFDoS)	0.199	0.200 ug/kg		30	25 - 150	30	50 - 150	30
Perfluorododecanoic acid (PFDoA)	0.163	0.200 ug/kg		30	25 - 150	35	50 - 150	30
Perfluoroheptanoic acid (PFHpA)	0.105	0.200 ug/kg		30	25 - 150	35	50 - 150	30
Perfluorohexanesulfonic acid (PFHxS)	0.179	0.200 ug/kg		30	25 - 150	35	50 - 150	30
Perfluorohexanoic acid (PFHxA)	0.0530	0.200 ug/kg		30	25 - 150	35	50 - 150	30
Perfluoro-n-butanoic acid (PFBA)	0.109	0.800 ug/kg		30	25 - 150	35	50 - 150	30
Perfluorononanoic acid (PFNA)	0.189	0.200 ug/kg		30	25 - 150	35	50 - 150	30
Perfluorooctanesulfonic acid (PFOS)	0.167	0.200 ug/kg		30	25 - 150	35	50 - 150	30
Perfluorooctanoic acid (PFOA)	0.172	0.200 ug/kg		30	25 - 150	35	50 - 150	30
Perfluoropentanoic acid (PFPeA)	0.109	0.400 ug/kg		30	25 - 150	35	50 - 150	30
Perfluorotetradecanoic acid (PFTA)	0.103	0.200 ug/kg		30	25 - 150	35	50 - 150	30
Perfluorotridecanoic acid (PFTrDA)	0.125	0.200 ug/kg		30	25 - 150	35	50 - 150	30
Perfluoroundecanoic acid (PFUnA)	0.198	0.200 ug/kg		30	25 - 150	35	50 - 150	30

ATTACHMENT 4

CHAIN OF CUSTODY EXAMPLES

York Analytical Laboratories, Inc.
120 Research Drive
Stratford, CT 06615
132-02 89th Ave Queens,
NY 11418
clientservices@yorklab.com
www.yorklab.com

YORK
ANALYTICAL LABORATORIES INC

Field Chain-of-Custody Record - AIR

YORK Project No.

NOTE: YORK's Standard Terms & Conditions are listed on the back side of this document. This document serves as your written authorization for YORK to proceed with the analyses requested below. Your signature binds you to YORK's Standard Terms & Conditions.

Page _____ of _____

YOUR Information	**Report To:**	**Invoice To:**
Company:	Company:	Company:
Address:	Address:	Address:
Phone.:	Phone.:	Phone.:
Contact:	Contact:	Contact:
E-mail:	E-mail:	E-mail:

YOUR Project Number

YOUR Project Name

YOUR PO#:

Turn-Around Time	
RUSH - Next Day	☐
RUSH - Two Day	☐
RUSH - Three Day	☐
RUSH - Four Day	☐
Standard (5-7 Day)	☐

Please print clearly and legibly. All information must be complete. Samples will not be logged in and the turn-around-time clock will not begin until any questions by YORK are resolved.

Samples Collected by: (print your name above and sign below)

Air Matrix Codes

- AI - Indoor Ambient Air
- AO - Outdoor Amb. Air
- AE - Vapor Extraction Well/ Process Gas/Effluent
- AS - Soil Vapor/Sub-Slab

Samples From	
New York	☐
New Jersey	☐
Connecticut	☐
Pennsylvania	☐
Other	☐

Report / EDD Type (circle selections)

Summary Report	CT RCP	Standard Excel EDD
QA Report	CT RCP DQA/DUE	EQuIS (Standard)
NY ASP A Package	NJDEP Reduced Deliv.	NYSDEC EQuIS
NY ASP B Package	NJDKQP	NJDEP SRP HazSite
Other:		

YORK Reg. Comp.

Compared to the following Regulation(s): (please fill in)

Certified Canisters: Batch ___ Individual ___

Please enter the following REQUIRED Field Data

Reporting Units: ug/m^3 ___ ppbv ___ ppmv ___

Sample Identification	**Date/Time Sampled**	**Air Matrix**	**Canister Vacuum** Before Sampling (in Hg)	**Canister Vacuum** After Sampling (in Hg)	**Canister ID**	**Flow Cont. ID**	**Analysis Requested**

Comments:

Detection Limits Required

≤ 1 ug/m^3 _____ NYSDEC V1 Limits _____
Routine Survey _____ Other ___________

Sampling Media	
6 Liter Canister	☐
Tedlar Bag	☐

Samples Relinquished by / Company	Date/Time	Samples Received by / Company	Date/Time	Samples Relinquished by / Company	Date/Time
Samples Received by / Company	Date/Time	Samples Relinquished by / Company	Date/Time	Samples Received by / Company	Date/Time
Samples Relinquished by / Company	Date/Time	Samples Received by / Company	Date/Time	Samples Received in LAB by	Date/Time

YORK
ANALYTICAL LABORATORIES INC

York Analytical Laboratories, Inc.
120 Research Drive
Stratford, CT 06615
132-02 89th Ave
Queens, NY 11418
clientservices@yorklab.com
www.yorklab.com

Field Chain-of-Custody Record

NOTE: YORK's Standard Terms & Conditions are listed on the back side of this document.
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YORK Project No.

Page _____ of _____

YOUR Information	**Report To:**	**Invoice To:**
Company:	Company:	Company:
Address:	Address:	Address:
Phone.:	Phone.:	Phone.:
Contact:	Contact:	Contact:
E-mail:	E-mail:	E-mail:

YOUR Project Number

YOUR Project Name

YOUR PO#:

Turn-Around Time

RUSH - Next Day	☐
RUSH - Two Day	☐
RUSH - Three Day	☐
RUSH - Four Day	☐
Standard (5-7 Day)	☐

Please print clearly and legibly. All information must be complete. Samples will not be logged in and the turn-around-time clock will not begin until any questions by YORK are resolved.

Samples Collected by: (print your name above and sign below)

Matrix Codes

- S - soil / solid
- GW - groundwater
- DW - drinking water
- WW - wastewater
- O - Oil
- Other

Samples From

New York	☐
New Jersey	☐
Connecticut	☐
Pennsylvania	☐
Other	☐

Report / EDD Type (circle selections)

Summary Report	CT RCP	Standard Excel EDD
QA Report	CT RCP DQA/DUE	EQuIS (Standard)
NY ASP A Package	NJDEP Reduced Deliverables	NYSDEC EQuIS
NY ASP B Package		NJDEP SRP HazSite
	NJDKQP	Other:

YORK Reg. Comp.

Compared to the following Regulation(s): (please fill in)

Sample Identification	**Sample Matrix**	**Date/Time Sampled**	**Analysis Requested**	**Container Description**

Comments:

Preservation: (check all that apply)

HCl ___ MeOH ___ HNO_3 ___ H_2SO_4 ___ NaOH ___ ZnAc ___
Ascorbic Acid ___ Other: ____________

Special Instruction

Field Filtered ____
Lab to Filter _____

Samples Relinquished by / Company	Date/Time	Samples Received by / Company	Date/Time	Samples Relinquished by / Company	Date/Time
Samples Received by / Company	Date/Time	Samples Relinquished by / Company	Date/Time	Samples Received by / Company	Date/Time
Samples Relinquished by / Company	Date/Time	Samples Received by / Company	Date/Time	Samples Received in LAB by Date/Time	**Temp. Received at Lab** Degrees C

ATTACHMENT 5

RESUMES

Ezgi Karayel

Principal

Contact

347.871.0750
ezgi@vektorconsultants.com

Ezgi Karayel is an environmental engineer with extensive experience in brownfield redevelopment. She is the founder and Principal of Vektor Consultants and serves as Operations Officer of the firm. Ms. Karayel guides firm's clients through their due diligence processes. She manages all aspects of the firm strongly focusing on brownfield redevelopment and E-Designation projects across New York Metropolitan area. She has worked with major real estate developers and shareholders by developing strategic approaches to the environmental challenges of complex real estate transactions and brownfield redevelopment. Her experience also includes a broad range of environmental services including regulatory compliance, due diligence assessments, acquisition support, design and implementation of engineering controls and remediation systems, excavation support and soil disposal plans, and facility decommissioning.

She is the chair of the Partnership's Scholarship Program and works closely with committee members to support the education and training of students who are pursuing environmental careers.

Education

B.S. Environmental Engineering
University at Buffalo

Professional Registration

OSHA 10-hour Construction and 40-hour General Industry
OSHA 40-hour HAZWOPER and 8-hour HAZWOPER Refresher
Certified Environmental Manager and Certified Environmental Inspector

Affiliations

New York City Brownfield Partnership, President

Brownfield Coalition of the Northeast, Advisory Board Member

Select Projects

Linden Boulevard, Queens, New York – Site Investigation and Remediation of a 7-acre former landfill with a Restrictive Declaration. The scope of work for the project included preparation of a Remedial Investigation Work Plan for review and approval by the NYCOER, NYSDEC and NYCDOH, implementation of Remedial Investigation, preparation of Remedial Investigation Report, Remedial Action Work Plan, preparation and implementation of a waste characterization plan for soils for proper disposal, supervision of site remediation activities, coordination with remediation engineer to design a methane mitigation system as well as vapor barrier system and managing field staff during remediation.

Ezgi Karayel, Principal

Former Tunnel Diner, Jersey City, New Jersey – Remedial Investigation (RI) of a 1⁄2-acre property in accordance with the New Jersey Technical Requirements for Site Remediation. Ms. Karayel worked closely with the Licensed Site Remediation Professional (LSRP) of the project. Followed by the approval of the RAWP prepared by her, Ms. Karayel directed remediation activities at the site and managed field staff on a daily basis. Upon completion of remediation, she has prepared Remedial Action Outcome for review and certification of the LSRP.

249 North 7th Street, Brooklyn, New York – As a Project Director for a Remedial Investigation of a former auto repair shop with an active spill, Ms. Karayel was responsible for remediation of the property under the direct supervision of NYCOER and NYSDEC. Her responsibilities consisted of preparing the required reports and supervision of remediation including excavation, and installation of engineering controls. By successful coordination with NYCOER, she has managed to enroll the project in City's Clean Soil Bank program and saving the client over $160,000 for soil disposal.

9029 Flatlands Avenue, Brooklyn, New York – E-Designation for HazMat. She conducted a Phase I ESA prior to development, followed by remedial investigation and preparation of Remedial Investigation Report and Remedial Action Work Plan for the remediation. Remediation for the project included design and implementation of an active sub-slab depressurization system. For the engineering controls design and implementation, Ms. Karayel worked closely with the Professional Engineer for the project and performed all required pilot tests, initial start-up and inspections.

37-23 33rd Street, Queens, New York – Removal of "P" Designation. Ms. Karayel managed to prevent the property from becoming a Class II site by performing a thorough due-diligence and disproving the prior consultant's findings and recommendations. Furthermore, her due-diligence study and evaluation saved the client over $1,000,000 clean-up costs, regulatory and legal fees.

261 Grand Concourse, Bronx, New York – Brownfield Redevelopment
1-9 Wythe Avenue, Brooklyn, New York – Brownfield Redevelopment
42 Reeve Place, Brooklyn, New York – Spill Closure
21-01 21st Street, Queens, New York – Former Gasoline Station Decommissioning and Storage Tank Removal
260-262 Van Brunt Street, Brooklyn, New York – Brownfield Cleanup
299 East 161st Street, Bronx, New York – Voluntary Cleanup Program
122 East 32nd Street, New York, New York – Community Center, Remediation under Voluntary Cleanup Program
346 Metropolitan Avenue, Brooklyn, New York – Voluntary Cleanup Program
574 Broome Street, New York, New York – Voluntary Cleanup Program
173-175 McGuinness Boulevard, Brooklyn, New York – Voluntary Cleanup Program
4790 Broadway, New York, New York – Voluntary Cleanup Program

David B. Klein

Project Manager

Contact

347.871.0750
dklein@vektorconsultants.com

David B. Klein is a project manager with Vektor Consultants. David authored Remedial Action Work Plans, Remedial Investigation Reports, Remedial Action Reports, Final Engineering Reports, Noise Sampling Reports, Soil Vapor/Air Sampling Work Plans, Construction Health and Safety Plans, Interim Remedial Measures Summary Reports, Brownfield Cleanup Program Applications, Volunteer Cleanup Program Applications, Disposal Facility Applications, Underground Storage Tank Closure Reports, Phase I and Phase II Environmental Site Assessment Reports. David manages construction activities, drilling teams, excavations, tank removals, and waste disposals at multiple sites concurrently.

Education

B.S. Environmental Science &
Minor in Geology
University at Albany

Professional Registration

OSHA 10-hour Construction
OSHA 40-hour HAZWOPER and 8-hour HAZWOPER Refresher
10-Hour Site Safety Training
SWPPP Certification

Affiliations

New York City Brownfield Partnership

Select Projects

Far Rockaway Project Phases I, II, III, IV, and V, Queens, New York
Responsible for oversight and preparation of the Remedial Action Work Plan, Remedial Action Report, Final Engineering Report, Interim Remedial Measures Summary Report, NYSDEC Letter reports, and daily reports. Managed construction, drilling, excavation, waste disposal oversight of multiple phases concurrently.

Cropsey Avenue LLC, Brooklyn, New York
Authored Indoor Air Sampling Work Plan, Construction Health and Safety Plan, Interim Remedial Measures Summary Report and managed pilot tests for sub-slab depressurization system design and provided oversight during the installation of the engineering controls.

1815 West Farms Road, Bronx, New York – Voluntary Cleanup Program
315 Grand Concourse, Bronx, New York – Brownfield Redevelopment
261 Grand Concourse, Bronx, New York – Brownfield Redevelopment
960 Franklin Avenue, Brooklyn, New York – Brownfield Redevelopment

Peter Rathsack

Project Manager

Contact

347.871.0750
prathsack@vektorconsultants.com

Education

B.A. Environmental Studies
Urban Planning
University of Toledo

Affiliations

Brownfield Coalition of the Northeast

Peter Rathsack is a project manager with Vektor Consultants, he is responsible for conducting field investigations and site assessments. His responsibilities include providing environmental oversight at construction project sites in New York City Metropolitan area, performing site visits and preparing Phase I Environmental Site Assessments, as well as, performing Phase II Environmental Site Assessments, Remedial Investigations, waste characterization sampling, and preparing associated reports. His experience and education with sampling processes and urban development provides knowledge and insight for navigating projects through different regulatory programs.

Professional Registration

OSHA 30-hour Construction

OSHA 40-hour HAZWOPER

10-Hour Site Safety Training (SST)

NYSDEC SWPPP Certification

Select Projects

Prior to joining Vektor, Peter oversaw water quality sampling program to maintain excellent watershed health. Collected and organized data for over half a century historic water quality information. Carried out sampling of multiple sites throughout watershed and coordinated with team members for efficient sampling processes. Communicated with University of New Hampshire for further sampling including cyanobacteria monitoring. Partnered with stakeholders through education and outreach.

447 Euclid Avenue, Brooklyn, New York – Voluntary Cleanup Program
261 Grand Concourse, Bronx, New York – Brownfield Cleanup Program
260-262 Van Brunt Street, Brooklyn, New York – Brownfield Cleanup Program
1-9 Wythe Avenue, Brooklyn, New York – Brownfield Cleanup Program

Dominick Basilone

Environmental Scientist

Contact

914.539.1023
dbasilone@vektorconsultants.com

Education

M.S. Biological Sciences
Ecology Concentration
Fordham University

B.S. Environmental Science
Sustainable Business Minor
Fordham University

Dominick Basilone is an environmental scientist with Vektor Consultants, and he is responsible for conducting field investigations and site assessments. His responsibilities include providing environmental oversight at construction project sites in New York City Metropolitan area, performing site visits and performing Phase II Environmental Site Assessments, as well as, Remedial Investigations, waste characterization sampling, and preparing associated reports. His experience and education with environmental sampling, laboratory analysis, and hazardous waste handling provides knowledge and insight for navigating projects through different regulatory programs.

Professional Registration

OSHA 30-hour Construction

OSHA 40-hour HAZWOPER

10-Hour Site Safety Training (SST)

Select Projects

Prior to joining Vektor, Dominick conducted research on White-nose Syndrome in Northeastern little brown bat communities with a focus on the role of subcutaneous lipids in resistance to infection by *P. destructans* and the seasonal variation in lipid content of dietary insects. In this role, Dominick conducted independent field sampling, laboratory analysis of samples, and managed and analyzed experimental data.

As Laboratory Coordinator for Fordham University's Introductory Biology Program, Dominick directed the scheduling and preparation of weekly lab exercises and lectures. He was also responsible for overseeing the proper handling, storage, and disposal of hazardous wastes according to lab SOPs and regulations.

DHURBA RAJ PANDEY

Levittown, NY,11756
Mobile: 937-260-6902 │Email: dhurbarajpandey@gmail.com │LinkedIn

SKILLS

Air and Water Analysis, Field visits and sampling, Data collection and analysis, Writing (technical reports, protocols, standard operating procedure and troubleshooting documents of instruments), Presentations (technical and nontechnical audiences), Review of analytical data, LIMS, Advanced Excel, Operation and maintenance of laboratory instruments (GC-MS, HPLC-MS/MS, UPLC, GC-ECD/FID, AAS, Membrane Inlet Mass Spectrometer, Felume, UV-Vis Spectrophotometer)

Relevant Work Experiences

Environmental Chemist/PFAS and Air Analysis April 2023- till date
York Analytical Laboratories, Inc. Richmond Hill, NY

- Collaborate with cross functional teams to identify quality issues and implement corrective actions.
    - ISO/IEC 17025:2017 Overview Course (12 Hours) from PJLA
- Cleaning and preparation of summa canisters and flow controllers for indoor and outdoor air sample collection.
- Analysis of VOCs following EPA TO-15 method on GC-MS
- Preparation and analysis of water and soil samples for PFAS following EPA 537.1, 537.M, 533 and 1633 methods on HPLC-MS/MS.
- Operation and maintenance of laboratory instruments, including Promochrom's SPE system and Turbovap. Develop troubleshooting guides to increase efficiency in future problem-solving efforts.
- Using LIMS software for data entry, sample tracking and analysis for multiple laboratory projects.
- Developed a PFAS laboratory inventory system to efficiently track supplies, adapting to changing demands driven by the influx of samples.
- Developed a preventative maintenance program for laboratory instruments.
- Training newly hired lab technicians on laboratory procedures, equipment operation, and safety protocols.

Graduate Research Assistant 2018- 2022
Department of Earth and Environmental Sciences, University of Michigan Ann Arbor, Michigan

- Served as the laboratory point of contact for a ~$600k collaborative harmful algal bloom project involving multiple labs and federal agencies. Responsibilities included ordering/managing supplies, managing personnel, communication with other parties, and data organization.
- Developed and prepared comprehensive sampling and analysis plans for the Maumee River during two consecutive spring and summer seasons. Provided diligent oversight of field personnel involved in sampling activities, ensuring adherence to established protocols.
- Reviewed literature to identify knowledge gaps, designed research studies and conducted experiments to study sources and sinks of hydrogen peroxide in natural waters.
- Cleaned and preprocessed data using MATLAB scripts. Analyzed data using advanced Excel techniques and summarized findings in the form of presentation and reports. Published findings of research work as a first author in a peer-reviewed journal.
- Trained two undergraduate students in the operation of laboratory instruments, laboratory safety practices, review of analytical data and data management.
- Operated and maintained multiple laboratory instruments. Developed operating protocols, troubleshooting documents and data saving protocols for laboratory instruments.
- Successfully developed a dissolved $H_2{}^{18}O_2$ measurement method using membrane inlet mass spectrometer.

Master's Research Student 2016-2018
Department of Earth and Environmental Sciences, Wright State University Dayton, Ohio

- Performed laboratory tasks for research including preparation of stock solutions and iron oxides minerals, execution of bench scale experiments, sampling and analysis in GC-ECD/FID or HPLC.
- Designed and executed bench scale experiments for removal of chlorinated hydrocarbons (TCE, PCE, cis-DCE, trans-DCE and 1,1-DCE) and insensitive ammunition such as DNAN by oxidation of reduced iron oxides. This method yielded substantial removal of doubly bonded chlorinated hydrocarbons with no detectable chlorinated daughter products.
- Prepared a proposal for a study examining microplastics distribution in the Ohio River Basin and adsorption of emerging contaminants like PFAS on microplastics.

Assistant Research Fellow 2015- 2016
Nepal Academy of Science and Technology Kathmandu, Nepal

- Implemented the Standard Methods protocol to measure analytes such as arsenic and fluoride in drinking water.
- Performed routine analysis on drinking water samples obtained from clients in accordance to drinking water quality standards and communicated the results to them.
- Provided support to research fellows and senior scientists in their scientific pursuits, from developing research questions to scientific writing. Performed the laboratory component of the experiments and sample analysis.

Consultant Hydrologist 2015 (4 months)
Conservation Development Foundation Kathmandu, Nepal

- Collected environmental data from the field and developed profiles of twenty-six lakes in three districts of Nepal. Discovered two new lakes in the remote regions of Nepal.
- Collected water samples and prepared a technical report based on the results adhering to federal environmental regulations to assist in developing integrated lake basin master plan of Gaidahawa Lake, Nepal

Environmental Chemist 2013-2014
Water Engineering and Training Centre Pvt ltd Kathmandu, Nepal

- Conducted sample preparation and extraction to analyze residual pesticides in water, soil, vegetables, fruits and natural herbs.
- Performed field sampling, sample preparation and AAS analysis of water to determine Hg levels in groundwater of Kathmandu Valley. Presented the findings in a seminar.
- Performed field sampling and collected field environmental data for a large-scale hydroelectric project (>100 MW) in remote region of Nepal.

Research Intern 2012-2013
Centre of Research for Environment Energy and Water (CREEW) Kathmandu, Nepal

- Performed field sampling (river water, groundwater, rainwater) for multiple water quality and treatment research projects.
- Prepared reagents and analyzed water samples to measure various parameters including pH, EC, COD, ammonia, iron, nitrate, nitrite, phosphate, total coliforms and *E. Coli.*
- Recorded and analyzed data collected from water samples.

Education

- University of Michigan-Ann Arbor, Graduate coursework and research in Earth and Environmental Science (3.9/4.0), 2018-2022. **Awards:** Gold Star Award -$1900 for the best research proposal in the Department (2020); William Herbert Hobbs Fellowship in Geology (2019 and 2022).
- Wright State University, Dayton, Ohio, MS in Earth and Environmental Science (4.0/4.0), 2018.
- Tribhuvan University, MS in Environmental Science (US bachelor's degree equivalent), Distinction (3.8/4.0), 2015. **Awards:** India Science and Research Fellowship -$6000 (2016), Assistant Research Fellowship at Nepal Academy of Science and Technology- $1800 (2015-2016)

Relevant Coursework

Quality Assurance of Environmental Analysis, Remediation and Management, Groundwater Contamination, Subsurface Fluid Flow, Modeling Subsurface Fluid Flow, Pumping Tests & Analyses, Aquatic Geochemistry, Environmental Organic Chemistry, Environmental Microbiology, Isotope Geochemistry.

Publications

- **Pandey DR**, Pollik C and Cory RM (2022). Controls on the photochemical production of hydrogen peroxide in Lake Erie. *Environmental Science: Processes & Impacts*, 24 (Impact Factor = 5.3)
- Pant, BR, Rawal, DS, Thapa, K, Shrestha, SM, Koju, R, & **Pandey DR** (2019). Post-Earthquake Water Quality in Bhaktapur District, Nepal. *Journal of Water Security,* 5. (Impact Factor =1.0)

Conference Presentations, Posters and Proceedings Publications

- **Dhurba Raj Pandey** and Rose M. Cory. *Photochemical yields of hydrogen peroxide production in Lake Erie.* 18th Annual Michigan Geophysical Union, April 15, 2021, Ann Arbor, Michigan **(Asynchronous Presentation)** DOI: 10.7302/879.
- **Dhurba Raj Pandey,** Derek Smith, McKenzie Powers, Greg Dick, George Kling and Rose M. Cory. *Controls on the photochemical production of hydrogen peroxide yields in Lake Erie,* 16th Annual Michigan Geophysical Union, April 17, 2019, Ann Arbor, Michigan **(Poster)**
- **Pandey DR**, Chetry AB and Pant BR. *Removal of Arsenic from Aqueous Solution Using Chemically Modified Sugarcane Bagasse*, **presented** in the 7th National Conference on Science and Technology, March 29-31, 2016. Nepal Academy of Science and Technology, Kathmandu, Nepal
- **Pandey DR** and Malla R. *Examination of free residual chlorine and pH at consumer ends in piped drinking water supply of Kathmandu Metropolitan City*. In: The Proceedings of 2nd International Young Researchers' Workshop on River Basin Environment and Management January 5-6, 2015. Hanoi University of Science, Vietnam National University, Vietnam
- Paudyal BN, Parajuli S, **Pandey DR** and Tuladhar A. *An Investigation of Mercury in Groundwater of Kathmandu.* **Presented** in the National Seminar on Water and Energy March 24, 2014. Nepal Academy of Science and Technology, Nepal
- **Pandey DR.** *Water and Sanitation Issues in Nepal*. **Presented** in the Knowledge Sharing Workshop on Integrated River Basin Management in Asian Monsoon Region January 5-6, 2013. Asian Institute of Technology, Thailand.

Zachary Scott

1062 James Street
Stratford, CT 06614
(203) 909-5114
scottza@outlook.com

SUMMARY

A talented analytical chemist with over five years of experience in environmental testing at York Analytical Laboratories. Very skilled in wet chemistry practices, extractions procedures, and common instrumentation due to training in multiple departments. Has a strong work ethic and thrives on responsibility, earning multiple positions of trust and leadership.

EDUCATION

University of Connecticut - Storrs, CT *May 2019*

Bachelor of Science in Chemistry, Associate's Degree in Mathematics

EXPERIENCE

York Analytical Laboratories - Stratford, CT *May 2019 - Present*

Extractions Laboratory Technician *(May 2019 - Feb. 2020)*

- Performed liquid-to-liquid and solid-to-liquid extractions of petroleums and other semi-volatile organic compounds for analysis by GC and GCMS.
- Was the head of second shift extractions from November 2019 to February 2020, which entailed the compilation of raw data and paperwork into organized digital packages for the client as well

Wet Chemistry Laboratory Technician *(Feb. 2020 - Nov. 2024)*

- Tasked with balancing the due dates and hold times of client samples to construct a workload that is conducive to smooth operation of the department.
- Holds nearly twenty certifications of analysis in the department of wet chemistry, and most often analyzing the presence of cyanide, hexavalent chromium, oil and grease, non-polar material, pH, and ammonia.
- Frequently operates Ion Chromatographers and Direct Mercury Analyzers.
- Adept in all common practices of a wet chemistry lab, such as titrations, reagent preparation, instrument calibrations, the use of spectrophotometers, and the calculation of sample dilutions.
- Frequently prepares TCLP and SPLP soil leachates.

Second Shift Supervisor *(March 2022 - Nov. 2024)*

- Acts as a direct line of communication between the lab director and second shift, relaying information regarding work progress and data uploading across all departments.
- Ensures that samples received during second shift which have short hold or short turnaround times are analyzed before lab closing for all departments.
- Trusted with taking immediate action on potential safety issues and unforeseen human and instrument error.
- Still fulfills the typical expectations of a wet chemistry lab technician, requiring great time management skills and the presence of mind to balance many responsibilities.

TRAITS AND SKILLS

- Has an analytical mind that learns new skills very quickly and adapts well to unique situations.
- Fluent in the use of the Element LIMS system and Microsoft Excel.
- Extremely organized and a talented planner and time manager.
- Always volunteers to work overtime and weekends when necessary.

APPENDIX C

HEALTH AND SAFETY PLAN (HASP)

vEKtor consultants
t: +1.347.871.0750 info@vektorconsultants.com
f: +1.347.402.7735 www.vektorconsultants.com

HEALTH AND SAFETY PLAN

Prepared For: 38-18 33rd Street LLC and 32-20 38th Avenue LLC
c/o Cavu Property Group

Project Name: Former Refron Inc. Gas Reclamation Site

BCP Site No: C241285

Project Location: 38-18 33rd Street and 32-20 38th Avenue, Queens
New York 11101

Date: April 2025

37 West 37th Street, 6th Floor, New York, NY 10018

Table of Contents

Emergency Contacts			
Position	**Name**	**Organization**	**Phone/E-mail**
Project Director	Ezgi Karayel	Vektor Consultants	(347) 871-0750/ ezgi@vektorconsultants.com
Project Manager	David Klein	Vektor Consultants	(347) 871-0750/ dklein@vektorconsultants.com
Field Representative	Dominick Basilone	Vektor Consultants	(347) 871-0750/ dbasilone@vektorconsultants.com
Site Health and Safety Supervisor	Dominick Basilone	Vektor Consultants	(347) 871-0750/ dbasilone@vektorconsultants.com
Client Contact	Alex Bancu	38-18 33rd Street LLC & 32-20 38th Avenue LLC c/o Cavu Property Group	(212) 837-4509/ abancu@cavupg.com
Project Manager	Haala Al-Hadithy	NYSDEC	(718) 482-4995 / haala.al-hadithy@dec.ny.gov
Project Manager	Josephine McCarthy	NYSDOH	(518) 402-7860 / beei@health.ny.gov
Emergency Response		FDNY	911
Spill Hotline		NYSDEC	(800) 457-7362

Emergency Medical Facility	
Primary	***Alternate***
NYC Health + Hospitals - Bellevue 462 1st Avenue, New York, NY 10016 Tel: (212) 562-4141 Open 24 Hours	CityMD Long Island City Urgent Care – Queens 25-18 Queens Plaza S, Long Island City, NY 11101 Tel: (646) 647-1261 Open 7 Days a Week 8AM–8PM
Route to emergency medical facility map attached to back of this health & safety plan	

Sign-in Sheet

Name	Signature	Company	Date

1.0 INTRODUCTION

This Health and Safety Plan (HASP) was prepared on behalf of 38-18 33rd Street LLC and 32-20 38th Avenue LLC (the Requestor) for the implementation of a Remedial Investigative Work Plan (RIWP) by Vektor Consultants (Vektor) and its subcontractors for the Former Refron Inc. Gas Reclamation Site located at 38-18 33rd Street and 32-20 38th Avenue in the Long Island City section of Queens County, New York (the Site). The Site is identified by the City of New York as Borough of Brooklyn, Tax Block 381, Lots 5 and 16.

This HASP describes lines of authority, responsibility, and communication as they pertain to health and safety functions at this site in compliance with *29 CFR 1910.120(b)(2) and 29 CFR 1926.65(b)(2)*. This plan also details key personnel who are responsible for the development and implementation of the HASP. Vektor field personnel will implement this HASP during the implementation of RI.

1.1 Site Location and Description

The Site, addressed as 38-18 33rd Street and 32-20 38th Avenue, is located on the southwest corner of the 38th Avenue and 33rd Street intersection in Queens County, New York. The Site consists of two tax lots totaling approximately 29,375 square feet. The legal description of the Subject Property is New York City Department of Finance Tax Block 381, Lots 5 and 16. A Site location map is provided as Figure 1.

1.2 Summary of Previous Investigations

The previous investigations performed at the Site include the following:

Phase I Environmental Site Assessment at 32-20 38th Avenue, Queens, New York, by H2M Architects + Engineers, January 2023

- H2M architects + engineers (H2M) prepared this report for Lot 16 on behalf of Venta Industries, LLC, in accordance with ASTM Standard E1527-13 Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process.
- The following Recognized Environmental Conditions (RECs) were identified during the Phase I:
    - Presence of possibly impacted soil vapor beneath the Site and the potential soil vapor intrusion due to the reported petroleum-related releases, dry cleaning, and auto repair operations in the vicinity of the property.
    - Listing of the property on the NYC E-Designation database. Future development activities at the subject property will require formal environmental investigations, including soil vapor and soil and groundwater sampling, and approvals obtained through the New York City Mayor's Office of Environmental Remediation.

- The following Business Environmental Risks (BERs) were identified during the Phase I ESA:
    - The building's historical uses as a chemical laboratory, a jewelry manufacturing company, and a storage and reclamation of refrigerant gases.
    - The building's floor drains are also reportedly capped due to stormwater runoff causing floods. H2M considered this a BER due to the unknown conditions of the bottom sediments within the floor drains.

Phase I Environmental Site Assessment at 38-18 33rd Street, Queens, New York by H2M Architects + Engineers, January 2023

- H2M architects + engineers (H2M) prepared this report for Lot 5 on behalf of Vecta Industries, LLC, in accordance with ASTM Standard E1527-13 Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process.
- The following Recognized Environmental Conditions (RECs) were identified during the Phase I:
    - Presence of possibly impacted soil vapor beneath the Site and the potential soil vapor intrusion due to the reported petroleum-related releases, dry cleaning, and auto repair operations in the vicinity of the property.
    - Listing of the property on the NYC E-Designation database. Future development activities at the subject property will require formal environmental investigations, including soil vapor and soil and groundwater sampling, and approvals obtained through the New York City Mayor's Office of Environmental Remediation.
- The following Historical Recognized Environmental Condition (HREC) was identified during the Phase I ESA:
    - Former spill on the property that occurred on March 20, 2019. According to the report, 25 gallons of diesel fuel were released due to a ruptured tank, and a large amount of absorbent was spread out to cover the fuel staining on the street. DEP's Division of Emergency Response and Technical Assessment (DERTA) verified that no underground structures were impacted by the fuel spill, and any remaining fuel was returned to the vehicle's gas tank. All materials regarding the fuel spill were removed from the location, and the New York City Department of Sanitation (DOS) was contacted for additional clean-up.
- The following Business Environmental Risks (BERs) were identified during the Phase I ESA:
    - The building's historical uses as storage and reclamation of refrigerant gases.
    - The subject building currently operates with a fuel oil aboveground storage tank in the basement to supply fuel for a backup generator. During the visual

  - inspection of this system, no evidence of leaking or damage was noted. Therefore, the presence of an active fuel oil AST is considered a BER.
  - The building's floor drains are also reportedly capped due to stormwater runoff causing floods. H2M considers this a BER due to the unknown conditions of the bottom sediments within the floor drains.
- The following De Minimis Condition was identified during the Phase I ESA:
  - During the visual site inspection, pools of water were observed on the floor in both boiler rooms. Water was leaking overhead from the pipes in the boiler room located in the basement. No sheens or unusual odors indicative of a fuel oil release were observed.

Phase II Investigation Report at 38-18 33rd Street and 32-20 38th Avenue, Queens, New York 11101 by Vektor Consultants, September 2024

Impacts to groundwater and soil vapor were identified beneath the Site. The conclusions of the investigations were as follows:

- The subsurface materials were generally described from surface grade to 17 feet below grade as light brown fine-grained sand with varying amounts of fine gravel, concrete, asphalt, glass, fine to medium-grained sand, weathered rock, and silt. From 17 to 25 feet below grade, brown fine sand with varying amounts of fine gravel, silt, and clay is described.
- The geophysical survey did not identify any anomalies or areas of concern indicative of underground storage tanks.
- Groundwater was encountered at a range of approximately 13.8 to 15.2 feet.
- No PID readings were detected in the soil samples, except for SB-2 at the 2-4 feet interval and 22-23 feet interval, which was detected at 19.1 and 0.5 parts per million (ppm), respectively.
- No VOCs or SVOCs were detected in the soil samples above their respective NYSDEC Part 375 Unrestricted Use SCOs.
- One heavy metal, arsenic, was detected in one soil sample at a concentration above its respective Part 375 Restricted Residential Use SCO.
- Chlorinated VOC impacts (PCE, TCE, and trans-1,2-dichloroethylene) were identified in the groundwater, specifically in the western portion of the Site.
- Results showed low concentrations of petroleum-related VOCs and elevated concentrations of chlorinated VOCs (CVOCs) in all soil vapor samples. Furthermore, Freon was detected at elevated concentrations in almost all soil vapor samples. Although Freon does not have a regulatory standard, it was utilized during the historical operations at the Site, and therefore, the results suggest a release from former uses of the Site.

Phase I Environmental Site Assessment at 38-18 33rd Street and 32-20 38th Avenue, Queens, New York 11101 by Vektor Consultants, September 2024

- Vektor prepared this report for 38-18 33rd Street LLC and 38-18 33rd Street LLC in accordance with ASTM Standard E1527-21 Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process.
- The following Recognized Environmental Conditions (RECs) were identified during the Phase I:
    - Based on the available records, historical uses of the Subject Property include a chain manufacturing business, plumbing and heating supplies business, a refrigerant supply business, chemical lab and an equipment supply business. These facilities typically utilize hazardous substances or petroleum products as part of their operations, and potential historic releases from these facilities could have affected the subsurface conditions. The EDR database also indicates that the Subject Property has a history of generating Sodium Cyanide, ignitable, corrosive material and halogenated solvents as waste. Therefore, the historical uses of the Subject Property and associated soil vapor contamination represent a REC.
- The Phase I ESA revealed the following environmental issues in connection with the Subject Property:

    - The Subject Property, identified as Tax Block 381, Lots 5 and 16, is listed on the E-designation database under E-number E-218 for noise, air quality, and hazardous materials regarding Phase I and Phase II testing protocol as a result of rezoning of the general surrounding area (Dutch Kills Rezoning and Related Actions (CEQR # 08DCP021Q)). An E-Designation is a New York City zoning map designation that indicates the presence of an environmental requirement pertaining to potential hazardous materials contamination, window/wall noise attenuation, or air quality impacts. Any future redevelopment and/or alteration work must also be coordinated with the NYCOER in order to obtain construction permits from the New York City Department of Buildings (NYCDOB).
    - Based on the age of the building, building materials may contain asbestos containing materials (ACM) and lead based paint (LBP). Readily visible suspect ACMs and painted surfaces were observed to be in good condition. Should these materials be replaced, a pre-demolition survey would need to be conducted prior to any renovation or demolition activities.

- Vektor recommended the following:
    - A subsurface investigation, including, but not limited to, a geophysical survey, soil, and groundwater sampling, should be conducted at the Subject Property to investigate potential impacts to the subsurface due to the historical uses.
    - An Operations and Maintenance (O&M) Plan should be prepared and implemented in order to safely manage the suspect ACMs and LBP at the Subject Property. If redevelopment or renovation of the Subject Property is planned, suspect ACMs and LBP should be surveyed and abated in accordance with federal and NYC regulations.

2.0 ORGANIZATIONAL STRUCTURE

Vektor will provide a copy of this HASP to each contractor and subcontractor in accordance with 29 CFR 1910.120(b)(1)(iv) and 29 CFR 1926.65(b)(1)(iv) to inform them of site hazards and emergency procedures. All contractors and subcontractors are solely responsible for the safe and healthful performance of all work by each of its employees and/or support personnel who may enter the Site. Each contractor and subcontractor shall provide its own HASP as required by 29 CFR 1910.120 and 29 CFR 1926.65. However, they need to submit a copy of their HASP to Vektor or they can adopt this HASP during the RI activities.

2.1 Site Supervisor

As required by *29 CFR 1910.120(b)(2)(i)(A) and 29 CFR 1926.65(b)(2)(i)(A)*, a Site Supervisor will be assigned to the project prior to RI. The Site Supervisor is responsible for directing all hazardous waste operations. All other site personnel report directly to the Site Supervisor unless otherwise noted. The Site Supervisor is directly responsible for:

- Ensuring the pre-entry briefing and/or tailgate-safety meetings are held prior to initiating any site activity, and at such other times as necessary to ensure that employees are apprised of site hazards
- Ensuring that all work activities conducted are consistent with this HASP and making any modifications as necessary
- Verifying all Job Hazard Analyses and ensuring that ongoing Hazard Analysis is conducted at this Site
- Overseeing the training program and ensuring that employees are trained for all tasks or operations they are asked to perform
- Providing a copy of this HASP to each contractor and subcontractor
- Updating the Site Control Program as needed
- Granting site workers site and zone access approval
- Registering all site visitors
- Establishing and maintaining security measures for this Site
- Directing how each work zone is adjusted
- Notified if emergency assistance is needed
- Supervising PPE use on this Site
- Approving any changes in PPE used on this Site
- Notified when any hazardous-substance spill occurs
- Evaluating the quality and safety of response activities after every emergency incident or evacuation of this Site
- Providing site workers with notifications and training on changes to the emergency response plan

- Evaluating confined spaces and responsible for the confined space permit program
- Performing initial monitoring to identify and evaluate any hazardous atmospheres during confined space operations
- Implementing the thermal stress program
- Authorizing the hot-work plan and cutting and welding operations
- Inspecting the hot-work permit area before work is authorized
- Monitoring site activities as they pertain to health and safety at this site
- Stopping any unsafe acts that pose an immediate or imminent health and safety hazard to anyone at this site
- Ensuring that all elements of this HASP are followed and correctly implemented
- Updating the Site Health and Safety Supervisor and other applicable personnel as to changes or work progress reports that may pertain to health and safety functions at this site
- Setting up decontamination lines and the solutions appropriate for the type of chemical contamination on Site
- Controlling the decontamination of all equipment, personnel and samples from the contaminated areas
- Ensuring that all required decontamination equipment is available and in working order
- Providing for collection, storage and disposal of decontamination waste (e.g., rinse water, contaminated sediment, etc.)

2.2 Site Health and Safety Supervisor

As required by *29 CFR 1910.120(b)(2)(i)(B) and 29 CFR 1926.65(b)(2)(i)(B)*, Dominick Basilone (or designated alternate) is the Site Health and Safety Supervisor who has the responsibility and authority for all functions that may pertain to health and safety at this site. This is the individual located on a hazardous waste site that is responsible to the Site Supervisor and has the authority and knowledge necessary to implement the HASP and verify compliance with applicable safety and health requirements. The Site Health and Safety Supervisor is directly responsible for:

- Providing a copy of this HASP to each contractor and subcontractor
- Updating the Site Control Program as needed
- Notified if emergency assistance is needed
- Supervising PPE use on this Site
- Approving any changes in PPE used on this Site
- Notified when any hazardous-substance spill occurs
- Providing site workers with notifications and training on changes to the emergency response plan
- Performing initial monitoring to identify and evaluate any hazardous atmospheres during confined space operations
- Developing and implementing the HASP

- Monitoring site activities as they pertain to health and safety at this Site
- Stopping any unsafe acts that pose an immediate or imminent health and safety hazard to anyone at this Site
- Ensuring that all elements of this HASP are followed and correctly implemented
- Verifying compliance of subcontractors with respect to this HASP and reporting deviations to the Site Supervisor
- Evaluating site incidents including spills, releases of hazardous substances
- Determining the appropriate response including site evacuations
- Implementing the Emergency Response Plan
- Coordinating emergency response activities on this Site

2.3 Contractors and Subcontractors

Each contractor and subcontractor shall designate a Contractor Site Representative. The Contractor Site Representative will interface directly with the Site Supervisor, and Vektor Consultants, the Site Health and Safety Supervisor, with regards to all areas that relate to this HASP and safe and healthful performance of work conducted by the contractor and/or subcontractor workforce. Contractor/Subcontractor Site Representatives for this site are listed in the Contact Summary Table at the end of this section.

2.4 Local/State/Federal Agency Representative

Local, state, and/or federal agencies are responsible for ensuring the Site is in compliance with appropriate regulatory requirements, permits, and/or legal ruling(s). Local/State/Federal Agency Representatives for this Site are listed in the Contact Summary Table at the end of this section.

The organizational structure shall be reviewed and updated as necessary to reflect the current status of site operations.

Contact Summary Table

Position	Name	Organization	Phone/Email
Project Director	Ezgi Karayel	Vektor Consultants	(347) 871-0750/ ezgi@vektorconsultants.com
Project Manager	David Klein	Vektor Consultants	(347) 871-0750/ dklein@vektorconsultants.com
Field Representative	Dominick Basilone	Vektor Consultants	(347) 871-0750/ dbasilone@vektorconsultants.com
Site Health and Safety Supervisor	Dominick Basilone	Vektor Consultants	(347) 871-0750/ dbasilone@vektorconsultants.com
Client Contact	Alex Bancu	38-18 33rd Street LLC & 32-20 38th Avenue LLC c/o Cavu Property Group	(212) 837-4509/ abancu@cavupg.com
Project Manager	Haala Al-Hadithy	NYSDEC	(718) 482-4995 / haala.al-hadithy@dec.ny.gov
Project Manager	Josephine McCarthy	NYSDOH	(518) 402-7860 / beei@health.ny.gov
Emergency Response		FDNY	911
Spill Hotline		NYSDEC	(800) 457-7362

3.0 HAZARD ANALYSIS

This section describes the safety and health hazards associated with site work and the control measures selected to protect workers in compliance with *29 CFR 1910.120(b)(4)(ii)(A) and 29 CFR 1926.65(b)(4)(ii)(A)*. This is accomplished by creating a specific Job Hazard Analysis for each task and operation to be conducted at the Site.

The purpose of the Job Hazard Analysis is to identify and, to the extent practicable, quantify the health and safety hazards associated with each site task and operation, and to evaluate the risks of each hazard to workers. With this information, appropriate control methods are selected to eliminate the identified risks if possible, or to effectively control them. The control methods are documented in each task-specific Job Hazard Analysis.

Job Hazard Analyses contained in this HASP have been developed by Vektor Consultants, the Site Health and Safety Supervisor. The Site Supervisor is the individual responsible for reviewing and "verifying" that all Job Hazard Analyses are complete and to ensure that ongoing hazard analyses are conducted at this site.

3.1 Hazard Notification Process

The information in the Job Hazard Analysis Worksheets, Hazardous Substance Profiles, and Safety Data Sheets (SDS) is made available to all employees who could be affected in the scope of their work at the Site. This shall be done prior to beginning work activities.

New, or modifications to existing, Job Hazard Analysis Worksheets, Hazardous Substance Profiles, or SDS are communicated during routine briefings. Consistent with *29 CFR 1910.120(i) and 29 CFR 1926.65(i)*, this information will also be made available to contractors and subcontractors.

The Site Supervisor is the person responsible for providing Site information, this HASP, and any modifications to this HASP to contractors and/or subcontractors working on this Site.

3.2 Phases, Site Tasks and Hazard Analysis

This HASP applies to the Remedial Investigation phase at the Site. This HASP will apply to the following Tasks and/or Operations that will be accomplished during the RI:

- Drilling (installation of soil borings, monitoring wells, and soil vapor points)
- Test pits, if necessary
- Decontamination
- Inspection
- Sampling (soil, groundwater, soil vapor, air, investigative derived waste)

3.3 Chemical Hazards

Exposure to chemical hazards should always be avoided. When working around chemical hazards it is important to be protected by administrative and/or engineered controls or, if administrative and/or engineered controls are not practicable or fully protective, by use of proper personal protective equipment (PPE). A direct reading instrument must be used, as necessary, to establish potential worker exposure.

No chemical hazards were identified at the time this HASP was prepared.

OSHA PEL. OSHA sets permissible exposure limits (PELs) to protect workers against the health effects of exposure to hazardous substances. PELs are regulatory limits on the amount or concentration of a substance in the air. They may also contain a skin designation. PELs are enforceable. OSHA PELs are based on an 8-hour time weighted average (TWA) exposure.

IDLH. Immediately dangerous to life or health (IDLH) is a regulatory value defined as the maximum exposure concentration in the workplace from which one could escape within 30 minutes without any escape-impairing symptoms or any irreversible health effects. This value should be referred to in respirator selection.

More specific chemical information is available in the Hazardous Substance Profiles included in Attachment 1 of this HASP. The Hazardous Substance Profiles are designed to assist with "chemical guidelines" in which further information may be needed, including but not limited to an SDS. This information is not intended to replace an SDS, rather to augment one.

3.4 Physical Hazards

Below is a list of physical hazards that may be encountered during RI activities at this Site. Personal awareness, strict adherence to all safety requirements, and the use of proper PPE when applicable will help keep this work site safe.

- Hand Tool Use
- Heavy Manual Lifting/Moving
- Material Handling
- Noise (Sound Pressure Level), dBA
- Sharp Objects
- Slips/Trips/Falls
- Traffic - On or Near Site
- Utilities (electrical, gas, water, etc.) – Overhead
- Utilities (electrical, gas, water, etc.) – Underground

3.5 Biological Hazards

Below is a list of biological hazards that may be encountered during RI activities at this Site. Personal awareness, strict adherence to all safety requirements, and the use of proper PPE when applicable will help keep this work site safe.

3.6 Radiological Hazards

Job hazard analysis indicates that workers are not expected to encounter radiological hazards at this Site for the phases, tasks and/or operations and work locations covered by this HASP.

3.7 Job Hazard Analysis Worksheets

The site-specific Job Hazard Analysis Worksheet is included in Attachment 2. A single Job Hazard Analysis Worksheet may be used for multiple locations provided that the task or operation, and hazards and control measures, are the same in each location.

The Job Hazard Analysis Worksheet lists the following information:

- Phase description
- Specific task or operation
- Specific location for task or operation
- Hazard analysis date(s) of task or operation
- Task or operation date(s)
- Person responsible for developing Job Hazard Analysis
- Person responsible for reviewing the Job Hazard Analysis
- Chemical, physical, biological and radiological hazards for each task or operation
- Specific control measures for each task or operation
- Required permit(s), if any

The Job Hazard Analysis Worksheet should be kept updated as information changes and previous copies should be retained.

4.0 TRAINING PROGRAM

The Site Safety and Health Training Program is designed to provide workers with the training necessary to work safely on this Site in compliance with *29 CFR 1910.120(b)(4)(ii)(B) and 29 CFR 1926.65(b)(4)(ii)(B)*. Training requirements for this site are based on the Job Hazard Analysis, contained in Attachment 2 of this HASP, and relevant OSHA requirements. Employees who have not been trained to a level required by their job function and responsibility are not permitted to participate in or supervise field activities.

4.1 Initial HazWoper Training

Initial training requirements for field personnel are based on the personnel's potential for exposure and compliance with the requirements of *29 CFR 1910.120(e)(3) and 29 CFR 1926.65(e)(3)*.

General Site Workers (such as equipment operators, general laborers and supervisory personnel) engaged in hazardous substance removal or other activities that expose, or potentially expose, them to hazardous substances and health hazards shall receive a minimum of 40 hours of instruction off site, and a minimum of three days of actual field experience under direct supervision of a trained, experienced supervisor as per *29 CFR 1910.120(e)(3)(i) and 29 CFR 1926.65(e)(3)(i)*.

Specific Limited Task Workers on site only occasionally for a specific limited task (such as, but not limited to, field sampling, land surveying, geophysical surveying, or drilling) and who are unlikely to be exposed over permissible exposure limits and published exposure limits shall receive a minimum of 24 hours of instruction off site, and a minimum of one day of actual field experience under direct supervision of a trained, experienced supervisor as per *29 CFR 1910.120(e)(3)(ii) and 29 CFR 1926.65(e)(3)(ii)*.

4.2 Site-Specific Training

In addition to the initial HAZWOPER training requirements outlined above, site personnel shall be trained on the following site-specific elements:

- Names of personnel and alternates responsible for site safety and health
- Health, safety, and other hazards present
- Use of specific personal protective equipment (PPE) detailed in this HASP
- Standard work practices by which the personnel can minimize risks from the hazards detailed in this HASP
- Safe use of administrative and/or engineering controls and equipment detailed in this HASP
- Medical surveillance requirements detailed in this HASP
- Decontamination procedures detailed in this HASP
- The emergency response plan detailed in this HASP

- Heat and cold stress prevention
- Working safely around heavy equipment

4.3 Site Briefings

A site-specific briefing shall be provided to visitors who enter this Site beyond the designated entry point. For visitors, the site-specific briefing shall include information about site hazards, the site layout including work zones and places of refuge, the emergency alarm system and emergency evacuation procedures, and other pertinent safety and health requirements, as appropriate.

5.0 MEDICAL SURVEILLANCE PROGRAM

The Medical Surveillance Program is designed to medically monitor worker health to ensure that personnel are not adversely affected by site hazards in compliance with *29 CFR 1910.120(b)(4)(ii)(D) and 29 CFR 1926.65(b)(4)(ii)(D)*.

Medical surveillance is not required at this site due to:

- There is NO potential for worker exposure to hazardous substances at levels above OSHA permissible exposure limits or other published limits for 30 days or more per year, without regard to use of respiratory protection.
- Personnel DO NOT wear a respirator for 30 days or more a year or as required by *29 CFR 1910.134 and 29 CFR 1926.103*.

Any worker who is injured, becomes ill, or develops signs or symptoms of possible over-exposure to hazardous substances or health hazards on this Site shall receive a medical examination as soon as possible after the occurrence, with follow-up examinations provided as required by the attending physician. Physical Exams shall be consistent with *29 CFR 1910.120(f) and 29 CFR 1926.65(f)*.

6.0 PERSONAL PROTECTIVE EQUIPMENT

Personal protective equipment (PPE) will be used at this Site to protect employees from biological, chemical and physical hazards in compliance with *29 CFR 1910.120(b)(4)(ii)(C) and 29 CFR 1926.65(b)(4)(ii)(C)*. This includes hazards associated with, but not limited to, RI work plan activities.

With employee safety being the number one priority, site health hazards will be eliminated or reduced to the greatest extent possible through administrative and/or engineering controls and safe work practices. Where hazards are still present, a combination of administrative and/or engineering controls, work practices, and PPE will be used to protect employees.

The Site Supervisor and/or Health and Safety Supervisor are responsible for PPE use on this Site.

6.1 PPE Selection Criteria

PPE shall be selected and used to protect site workers from the hazards and potential hazards they are likely to encounter, as identified during the site characterization and Job Hazard Analysis (see Attachment 2). A PPE ensemble shall be assigned to each work task or operation.

PPE selection shall be based upon many factors. Materials providing the greatest duration of protection shall be used. Tear and seam strength of the PPE shall also be considered to ensure ensemble durability while work is performed.

When necessary, multiple layers of protection shall be used to accommodate the range of hazards that may be encountered. All PPE shall be properly fitted.

PPE selection criteria shall also include:

- Level of PPE required (Level A, B, C, or D)
- PPE components
- Chemical suit and glove compatibility

All PPE ensembles shall be consistent with Appendix B of *29 CFR 1910.120 and 29 CFR 1926.65* and used in accordance with manufacturers' recommendations.

The following criteria were used to select PPE levels at this Site:

Level D Protection was selected due to the following:

- The atmosphere contains no known or suspected hazardous substances at concentrations that meet or exceed the published exposure limits

- Contact with hazardous levels of any chemicals through splashes, immersion, or by other means will not occur
- There is no potential for unexpected inhalation or contact with hazardous levels of any chemical

Training In Use of PPE

Employees receive general training regarding proper selection, use and inspection of PPE during initial HAZWOPER training and subsequent refresher training. Site-specific PPE requirements, including task-specific PPE, ensemble components, cartridge and canister service times, and inspection and maintenance procedures, as applicable, shall be communicated as identified in the Training Program.

Because chemical exposure levels present do not create a substantial possibility of immediate death, immediate serious illness or injury, or impair the ability to escape, positive pressure self-contained breathing apparatus or positive-pressure air-line respirators equipped with an escape air supply are not required.

7.0 ENVIRONMENTAL MONITORING

This section of the HASP describes how site worker exposures to hazardous substances will be monitored in compliance with *29 CFR 1910.120(b)(4)(ii)(E) and 29 CFR 1926.65(b)(4)(ii)(E)*.

7.1 Air Monitoring Procedures

Exposures to airborne hazardous substances shall be fully characterized throughout site operations to ensure that exposure controls are effectively selected and modified as needed. Air monitoring shall be used to identify and quantify airborne levels of hazardous substances and safety and health hazards to determine the appropriate level of site worker protection needed on site. Air monitoring procedures shall be consistent with OSHA requirements in *29 CFR 1910.120(c)(6) and 29 CFR 1926.65(c)(6)*.

Air monitoring shall be conducted using direct-reading instruments. Air monitoring includes:

- Initial monitoring prior to the beginning of RI work plan activities to identify conditions that may cause death or serious harm and to permit preliminary selection of site controls
- Periodic monitoring throughout RI work plan

7.2 Initial Monitoring Procedures

Upon initial entry, representative air monitoring shall be conducted to identify any IDLH condition, exposure over permissible exposure limits or published exposure levels, exposure over a radioactive material's dose limits, or other dangerous condition such as the presence of flammable atmospheres or oxygen-deficient environments.

7.3 Periodic Monitoring

Periodic monitoring shall be conducted when the possibility of an IDLH condition or flammable atmosphere has developed, or when there is indication that exposure may have risen over permissible exposure limits or published exposure levels since previous monitoring was conducted. Situations where it shall be considered that the possibility exposures have risen are as follows:

- When work begins on a portion of the Site that has not been previously monitored
- When contaminants other than those previously identified are being handled
- When a change in environmental conditions exist
- When site workers handle leaking drums or containers, or work in areas with obvious liquid contamination

- When site workers report or exhibit signs of exposure

7.4 Direct-Reading Instrument Monitoring Procedures

Direct-reading instrument monitoring will be used on this site as follows:

- VOCs by photoionization detector (PID)

Monitoring equipment calibration and maintenance procedures on this site are:

- Every morning (PID)

8.0 DECONTAMINATION

This HASP element describes procedures for decontaminating site workers and equipment when exiting the Exclusion Zone in compliance with *29 CFR 1910.120(b)(4)(ii)(G) and 29 CFR 1926.65(b)(4)(ii)(G)*. This section also describes disposal of waste from decontamination processes. Site decontamination procedures are designed to achieve a safe, logical removal or neutralization of contaminants that may accumulate on site workers and/or equipment. The Site Supervisor is responsible for decontamination procedures at this site.

These procedures are intended to minimize site worker contact with contaminants and protect against the transfer of contamination to clean areas of the site and away from the site. They may also extend the useful life of personal protective equipment (PPE) by reducing the amount of time that contaminants contact and permeate or otherwise affect the surfaces of PPE.

Decontamination procedures shall be communicated to site workers and implemented before any site workers or equipment are permitted to enter areas on site where potential for exposure to hazardous substances exists.

Emergency decontamination procedures are detailed in Section 8, the Emergency Response Plan of this HASP.

The decontamination procedures described below are designed to meet the requirements of *29 CFR 1910.120(k) and 29 CFR 1926.65(k)* and include site-specific information about:

- General and Specific Decontamination Procedures for Personnel and PPE
- General and Specific Decontamination Procedures for Equipment
- Location and Type of Site Decontamination Procedures
- Disposal of Residual Waste from Decontamination
- Monitoring the Effectiveness of Decontamination Procedures

8.1 General and Specific Decontamination Procedures for Site Workers and PPE

All site workers and PPE leaving a contaminated area shall be appropriately decontaminated. General decontamination guidelines for site workers and PPE include:

- Decontamination is required for all site workers exiting a contaminated area. Site workers may only re-enter uncontaminated areas after undergoing the decontamination procedures described in the next section.
- Protective clothing is decontaminated, cleaned, laundered, maintained and/or replaced as needed to ensure its effectiveness.
- PPE used at this site is decontaminated or prepared for proper disposal.

- The site requires and trains site workers that if their permeable clothing is splashed or becomes wetted with a hazardous substance, they will immediately exit the work zone, perform applicable decontamination procedures, shower, and change into uncontaminated clothing.

8.2 General and Specific Decontamination Procedures for Equipment

All contaminated clothing and equipment leaving a contaminated area shall be appropriately disposed of or decontaminated. General decontamination guidelines for equipment include:

- Decontamination is required for all equipment exiting a contaminated area. Equipment may only re-enter uncontaminated areas after undergoing specific decontamination as described in the Job Hazard Analysis Worksheets.
- Particular attention is given to decontaminating tires, scoops, and other parts of heavy equipment that are directly exposed to contaminants and contaminated soil.

8.3 Location and Type of Site Decontamination Procedures

Decontamination shall be performed in areas that will minimize the exposure of uncontaminated site workers or equipment to contaminated site workers or equipment. Decontamination on this site shall be conducted in the Contamination Reduction Zone. The Contamination Reduction Zone acts as a buffer between the Exclusion Zone and Support Zone. The location and design of decontamination stations minimize the spread of contamination beyond these stations.

8.4 Disposal of Waste from Decontamination

Procedures for disposal of decontamination waste shall meet applicable local, State, and Federal regulations.

8.5 Monitoring the Effectiveness of Decontamination Procedures

Decontamination procedures shall be monitored by a representative of Vektor Consultants, the Site Health and Safety Supervisor, to determine effectiveness. If procedures are found to be deficient, appropriate steps shall be taken to correct any deficiencies.

9.0 EMERGENCY RESPONSE PLAN

This section describes the site-specific Emergency Response Plan in compliance with *29 CFR 1910.120(b)(4)(ii)(H) and 29 CFR 1926.65(b)(4)(ii)(H)*. Specifically, the Emergency Response Plan addresses potential emergencies at this site, procedures for responding to these emergencies, roles and responsibilities during emergency response, and training. This element also describes the provisions this site has made to coordinate its emergency response planning with other contractors on site and with off-site emergency response organizations.

This Emergency Response Plan shall be available for inspection and copying by site workers, their representatives, OSHA personnel, and other governmental agencies with relevant responsibilities as required by *29 CFR 1910.120(l)(1)(i) and 29 CFR 1926.65(l)(1)(i)*.

In accordance with *29 CFR 1910.120(l)(3)(ii) and 29 CFR 1926.65(l)(3)(ii)*, this Emergency Response Plan is a separate section of the HASP.

9.1 Pre-Emergency Planning

This Emergency Response Plan is compatible and integrated with the disaster, fire and/or emergency response plans of local, state, and federal agencies.

This Site has been evaluated for potential emergency occurrences based on site hazards, the tasks within the work plan, the site topography, and prevailing weather conditions.

9.2 Personnel Roles, Lines of Authority, and Communication

Anyone may activate the Emergency Response Plan; however, Dominick Basilone (or designated alternate), Site Health and Safety Supervisor, is responsible for implementing the Emergency Response Plan and coordinating emergency response activities on this Site. Dominick Basilone (or designated alternate) also provides specific direction for emergency action based upon information available regarding the incident and response capabilities, initiates emergency procedures including protection of the public, and ensures appropriate authorities are notified.

In accordance with *29 CFR 1910.38(a) and 29 CFR 1926.35*, in the event of an emergency, site workers are evacuated and do not participate in emergency response activities.

This Site relies upon the off-site emergency response organizations listed in the Emergency Response Contact Information list to respond to site emergencies. These organizations are appropriately trained, staffed, and equipped to provide emergency response to this site.

These organizations are contacted at least annually to verify the accuracy of phone numbers and contact names.

Communication on this site will be conducted by the following methods:

- Face to face
- Cell phone
- Hand signals

9.3 Site Security and Control

In case of an on-site emergency, site security and control for this site shall be provided by:

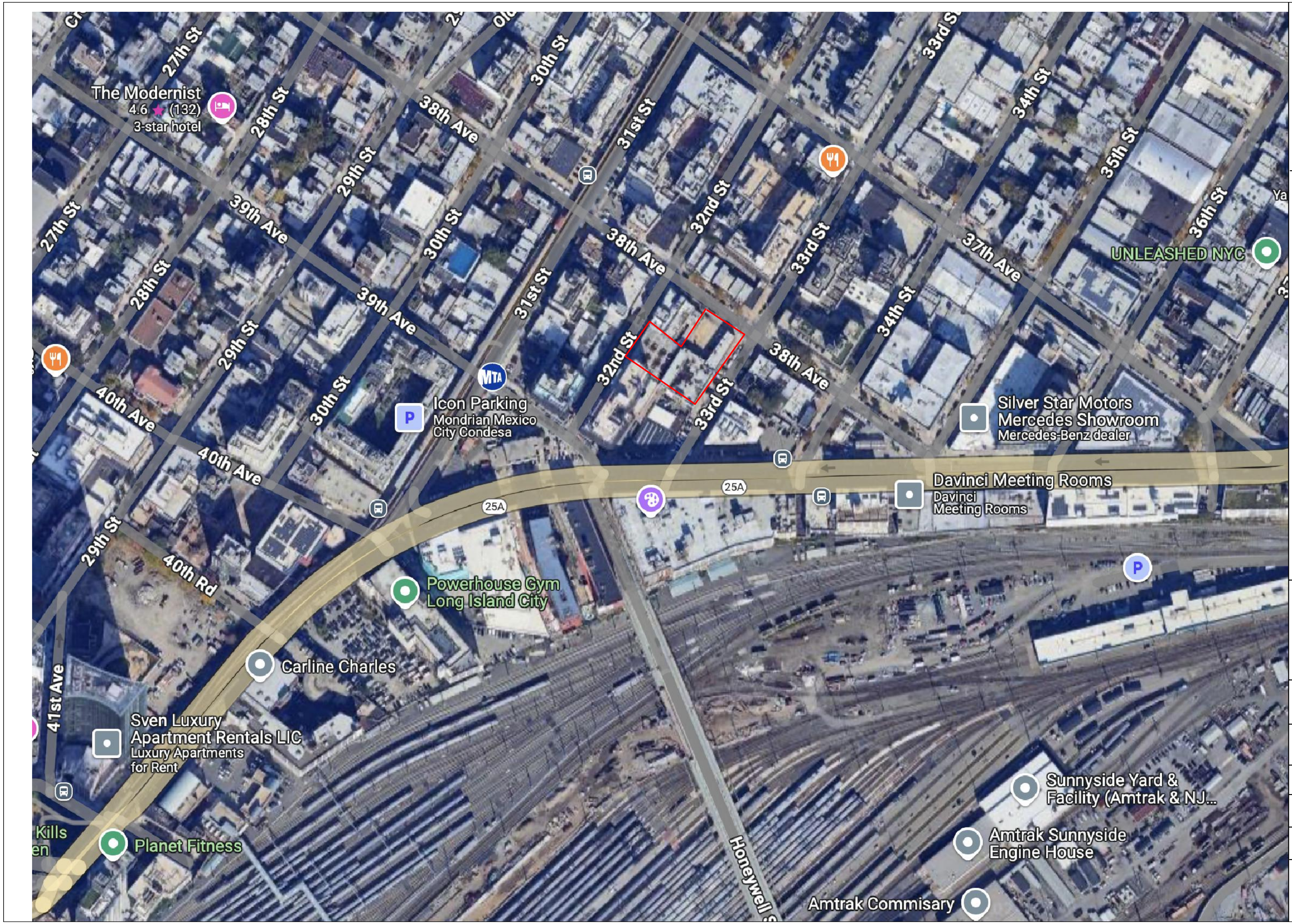
- Warning Signs
- Barrier Tape
- Locked Doors and Gates

9.4 Emergency Medical Treatment and First Aid

Any site worker who requires medical care and/or is transferred to a medical facility shall be accompanied by Hazardous Substance Profiles included in Attachment 1 of this HASP and other applicable information to apprise caregivers of the chemicals and hazards to which the victim has potentially been exposed. The emergency medical care facility for this site is:

NYC Health + Hospitals - Bellevue
462 1st Avenue, New York, NY 10016
Tel: (212) 562-4141
Open 24 Hours

The route to the facility is shown in on the map included in Attachment 3 of this HASP.



vEKtor consultants

t: +1.347.871.0750
f: +1.347.402.7735
e: info@vektorconsultants.com
www.vektorconsultants.com

Legend:

🟥 Site Boundary

Notes:

1. Base Map provided by Google Earth

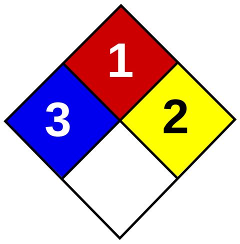
Scale:

NOT TO SCALE

Figure No.	1
Figure Name:	Site Location Map
Report:	HASP
Date:	9/20/2024
Drawn By:	KB
Site Address:	32-20 38th Avenue and 38-18 33rd Street Queens, New York

Attachment 1

Hazardous Substance Profiles and/or SDS



Health	3
Fire	1
Reactivity	2
Personal Protection	E

Material Safety Data Sheet

Arsenic MSDS

Section 1: Chemical Product and Company Identification

Product Name: Arsenic

Catalog Codes: SLA1006

CAS#: 7440-38-2

RTECS: CG0525000

TSCA: TSCA 8(b) inventory: Arsenic

CI#: Not applicable.

Synonym:

Chemical Name: Arsenic

Chemical Formula: As

Contact Information:

Sciencelab.com, Inc.
14025 Smith Rd.
Houston, Texas 77396

US Sales: **1-800-901-7247**
International Sales: **1-281-441-4400**

Order Online: ScienceLab.com

CHEMTREC (24HR Emergency Telephone), call:
1-800-424-9300

International CHEMTREC, call: 1-703-527-3887

For non-emergency assistance, call: 1-281-441-4400

Section 2: Composition and Information on Ingredients

Composition:

Name	CAS #	% by Weight
Arsenic	7440-38-2	100

Toxicological Data on Ingredients: Arsenic: ORAL (LD50): Acute: 763 mg/kg [Rat]. 145 mg/kg [Mouse].

Section 3: Hazards Identification

Potential Acute Health Effects:
Very hazardous in case of ingestion, of inhalation. Slightly hazardous in case of skin contact (irritant), of eye contact (irritant).

Potential Chronic Health Effects:
CARCINOGENIC EFFECTS: Classified A1 (Confirmed for human.) by ACGIH. MUTAGENIC EFFECTS: Not available. TERATOGENIC EFFECTS: Not available. DEVELOPMENTAL TOXICITY: Not available. The substance is toxic to kidneys, lungs, the nervous system, mucous membranes. Repeated or prolonged exposure to the substance can produce target organs damage.

Section 4: First Aid Measures

Eye Contact:
Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Get medical attention if irritation occurs.

Skin Contact: Wash with soap and water. Cover the irritated skin with an emollient. Get medical attention if irritation develops.

Serious Skin Contact: Not available.

Inhalation:
If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.

Serious Inhalation:
Evacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. Seek medical attention.

Ingestion:
Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. If large quantities of this material are swallowed, call a physician immediately. Loosen tight clothing such as a collar, tie, belt or waistband.

Serious Ingestion: Not available.

Section 5: Fire and Explosion Data

Flammability of the Product: May be combustible at high temperature.

Auto-Ignition Temperature: Not available.

Flash Points: Not available.

Flammable Limits: Not available.

Products of Combustion: Some metallic oxides.

Fire Hazards in Presence of Various Substances: Flammable in presence of open flames and sparks, of heat, of oxidizing materials.

Explosion Hazards in Presence of Various Substances:
Risks of explosion of the product in presence of mechanical impact: Not available. Risks of explosion of the product in presence of static discharge: Not available.

Fire Fighting Media and Instructions:
SMALL FIRE: Use DRY chemical powder. LARGE FIRE: Use water spray, fog or foam. Do not use water jet.

Special Remarks on Fire Hazards:
Material in powder form, capable of creating a dust explosion. When heated to decomposition it emits highly toxic fumes.

Special Remarks on Explosion Hazards: Not available.

Section 6: Accidental Release Measures

Small Spill: Use appropriate tools to put the spilled solid in a convenient waste disposal container.

Large Spill:
Use a shovel to put the material into a convenient waste disposal container. Be careful that the product is not present at a concentration level above TLV. Check TLV on the MSDS and with local authorities.

Section 7: Handling and Storage

Precautions:
Keep locked up.. Keep away from heat. Keep away from sources of ignition. Empty containers pose a fire risk, evaporate the residue under a fume hood. Ground all equipment containing material. Do not ingest. Do not breathe dust. Wear suitable

protective clothing. In case of insufficient ventilation, wear suitable respiratory equipment. If ingested, seek medical advice immediately and show the container or the label. Keep away from incompatibles such as oxidizing agents, acids, moisture.

Storage: Keep container tightly closed. Keep container in a cool, well-ventilated area.

Section 8: Exposure Controls/Personal Protection

Engineering Controls:
Use process enclosures, local exhaust ventilation, or other engineering controls to keep airborne levels below recommended exposure limits. If user operations generate dust, fume or mist, use ventilation to keep exposure to airborne contaminants below the exposure limit.

Personal Protection: Safety glasses. Lab coat. Dust respirator. Be sure to use an approved/certified respirator or equivalent. Gloves.

Personal Protection in Case of a Large Spill:
Splash goggles. Full suit. Dust respirator. Boots. Gloves. A self contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

Exposure Limits:
TWA: 0.01 from ACGIH (TLV) [United States] [1995] Consult local authorities for acceptable exposure limits.

Section 9: Physical and Chemical Properties

Physical state and appearance: Solid. (Lustrous solid.)

Odor: Not available.

Taste: Not available.

Molecular Weight: 74.92 g/mole

Color: Silvery.

pH (1% soln/water): Not applicable.

Boiling Point: Not available.

Melting Point: Sublimation temperature: 615°C (1139°F)

Critical Temperature: Not available.

Specific Gravity: 5.72 (Water = 1)

Vapor Pressure: Not applicable.

Vapor Density: Not available.

Volatility: Not available.

Odor Threshold: Not available.

Water/Oil Dist. Coeff.: Not available.

Ionicity (in Water): Not available.

Dispersion Properties: Not available.

Solubility: Insoluble in cold water, hot water.

Section 10: Stability and Reactivity Data

Stability: The product is stable.

Instability Temperature: Not available.

Conditions of Instability: Not available.

Incompatibility with various substances: Reactive with oxidizing agents, acids, moisture.

Corrosivity: Non-corrosive in presence of glass.

Special Remarks on Reactivity: Not available.

Special Remarks on Corrosivity: Not available.

Polymerization: Will not occur.

Section 11: Toxicological Information

Routes of Entry: Inhalation. Ingestion.

Toxicity to Animals: Acute oral toxicity (LD50): 145 mg/kg [Mouse].

Chronic Effects on Humans:
CARCINOGENIC EFFECTS: Classified A1 (Confirmed for human.) by ACGIH. Causes damage to the following organs: kidneys, lungs, the nervous system, mucous membranes.

Other Toxic Effects on Humans:
Very hazardous in case of ingestion, of inhalation. Slightly hazardous in case of skin contact (irritant).

Special Remarks on Toxicity to Animals: Not available.

Special Remarks on Chronic Effects on Humans: Not available.

Special Remarks on other Toxic Effects on Humans: Not available.

Section 12: Ecological Information

Ecotoxicity: Not available.

BOD5 and COD: Not available.

Products of Biodegradation:
Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.

Toxicity of the Products of Biodegradation: The products of degradation are as toxic as the original product.

Special Remarks on the Products of Biodegradation: Not available.

Section 13: Disposal Considerations

Waste Disposal:

Section 14: Transport Information

DOT Classification: CLASS 6.1: Poisonous material.

Identification: : Arsenic UNNA: UN1558 PG: II

Special Provisions for Transport: Not available.

Section 15: Other Regulatory Information

Federal and State Regulations:
California prop. 65: This product contains the following ingredients for which the State of California has found to cause cancer, birth defects or other reproductive harm, which would require a warning under the statute: Arsenic California prop. 65: This product contains the following ingredients for which the State of California has found to cause cancer which would require a warning under the statute: Arsenic Pennsylvania RTK: Arsenic Massachusetts RTK: Arsenic TSCA 8(b) inventory: Arsenic

Other Regulations: OSHA: Hazardous by definition of Hazard Communication Standard (29 CFR 1910.1200).

Other Classifications:

WHMIS (Canada):
CLASS D-1A: Material causing immediate and serious toxic effects (VERY TOXIC). CLASS D-2A: Material causing other toxic effects (VERY TOXIC).

DSCL (EEC):
R22- Harmful if swallowed. R45- May cause cancer.

HMIS (U.S.A.):

Health Hazard: 3

Fire Hazard: 1

Reactivity: 2

Personal Protection: E

National Fire Protection Association (U.S.A.):

Health: 3

Flammability: 1

Reactivity: 2

Specific hazard:

Protective Equipment:
Gloves. Lab coat. Dust respirator. Be sure to use an approved/certified respirator or equivalent. Wear appropriate respirator when ventilation is inadequate. Safety glasses.

Section 16: Other Information

References:
-Hawley, G.G.. The Condensed Chemical Dictionary, 11e ed., New York N.Y., Van Nostrand Reinold, 1987. -Liste des produits purs tératogènes, mutagènes, cancérogènes. Répertoire toxicologique de la Commission de la Santé et de la Sécurité du Travail du Québec. -Material safety data sheet emitted by: la Commission de la Santé et de la Sécurité du Travail du Québec. -SAX, N.I. Dangerous Properties of Indutrial Materials. Toronto, Van Nostrand Reinold, 6e ed. 1984. -The Sigma-Aldrich Library of Chemical Safety Data, Edition II. -Guide de la loi et du règlement sur le transport des marchandises dangeureuses au canada. Centre de conformité internatinal Ltée. 1986.

Other Special Considerations: Not available.

Created: 10/09/2005 04:16 PM

Last Updated: 06/09/2012 12:00 PM

Material Safety Data Sheet
PAH Contaminated Soil

ACC# 17974

Section 1 - Chemical Product and Company Identification

MSDS Name: PAH Contaminated Soil
Catalog Numbers: SRS103100
Synonyms: API separator sludge
Company Identification:

Fisher Scientific
1 Reagent Lane
Fair Lawn, NJ 07410

For information, call: 201-796-7100
Emergency Number: 201-796-7100
For CHEMTREC assistance, call: 800-424-9300
For International CHEMTREC assistance, call: 703-527-3887

Section 2 - Composition, Information on Ingredients

CAS#	Chemical Name	Percent	EINECS/ELINCS
Not available	Soil	78-99	unlisted
120-12-7	Anthracene	0-2	204-371-1
129-00-0	Pyrene	0-2	204-927-3
132-64-9	Dibenzofuran	0-2	205-071-3
205-99-2	Benzo(b)fluoranthene	0-2	205-911-9
206-44-0	Fluoranthene	0-2	205-912-4
208-96-8	Acenaphthylene	0-2	205-917-1
218-01-9	1,2-benzphenanthrene	0-2	205-923-4
50-32-8	Benzo(a)pyrene	0-2	200-028-5
56-55-3	1,2-Benzanthracene	0-2	200-280-6
83-32-9	Acenaphthene	0-2	201-469-6
85-01-8	Phenanthrene	0-2	201-581-5
86-73-7	Fluorene	0-2	201-695-5
87-86-5	Pentachlorophenol	0-2	201-778-6
91-20-3	Naphthalene	0-2	202-049-5
91-57-6	2-methylnaphthalene	0-2	202-078-3

Section 3 - Hazards Identification

EMERGENCY OVERVIEW

Appearance: not available solid.

Warning! May cause allergic skin reaction. Causes eye and skin irritation. May cause cancer based on animal studies.

Target Organs: Eyes, skin.

Potential Health Effects

Eye: May cause eye irritation.
Skin: May cause skin irritation. May cause skin sensitization, an allergic reaction, which becomes evident upon re-exposure to this material.
Ingestion: May cause gastrointestinal irritation with nausea, vomiting and diarrhea. Naphthalene can cause cataracts, optical neuritis, and cornea injuries. Ingestion of large quantities may cause severe hemolytic anemia and
Inhalation: Causes respiratory tract irritation. May cause effects similar to those described for ingestion.
Chronic: May cause cancer according to animal studies. Prolonged exposure to respirable crystalline quartz may cause delayed lung injury/fibrosis (silicosis).

Section 4 - First Aid Measures

Eyes: Immediately flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower eyelids. Get medical aid.
Skin: Immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Get medical aid if irritation develops or persists.
Ingestion: If victim is conscious and alert, give 2-4 cupfuls of milk or water. Never give anything by mouth to an unconscious person. Get medical aid.
Inhalation: Remove from exposure and move to fresh air immediately. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical aid.
Notes to Physician: Treat symptomatically and supportively.

Section 5 - Fire Fighting Measures

General Information: As in any fire, wear a self-contained breathing apparatus in pressure-demand, MSHA/NIOSH (approved or equivalent), and full protective gear.
Extinguishing Media: For small fires, use dry chemical, carbon dioxide, water spray or alcohol-resistant foam.
Flash Point: Not applicable.
Autoignition Temperature: Not applicable.
Explosion Limits, Lower: Not available.
Upper: Not available.
NFPA Rating: Not published.

Section 6 - Accidental Release Measures

General Information: Use proper personal protective equipment as indicated in Section 8.
Spills/Leaks: Vacuum or sweep up material and place into a suitable disposal container. Avoid generating dusty conditions.

Section 7 - Handling and Storage

Handling: Avoid generating dusty conditions. Use with adequate ventilation. Avoid contact with skin and

eyes. Keep container tightly closed. Avoid ingestion and inhalation.
Storage: Store in a cool, dry place.

Section 8 - Exposure Controls, Personal Protection

Engineering Controls: Use adequate ventilation to keep airborne concentrations low.
Exposure Limits

Chemical Name	ACGIH	NIOSH	OSHA - Final PELs
Soil	none listed	none listed	none listed
Anthracene	0.2 mg/m3 TWA (as benzene soluble aerosol) (listed under Coal tar pitches).	0.1 mg/m3 TWA (cyclohexane-extractable fraction) (listed under Coal tar pitches).80 mg/m3 IDLH (listed under Coal tar pitches).	0.2 mg/m3 TWA (benzene soluble fraction) (listed under Coal tar pitches).
Pyrene	0.2 mg/m3 TWA (as benzene soluble aerosol) (listed under Coal tar pitches).	0.1 mg/m3 TWA (cyclohexane-extractable fraction) (listed under Coal tar pitches).80 mg/m3 IDLH (listed under Coal tar pitches).	0.2 mg/m3 TWA (benzene soluble fraction) (listed under Coal tar pitches).
Dibenzofuran	none listed	none listed	none listed
Benzo(b)fluoranthene	none listed	none listed	none listed
Fluoranthene	none listed	none listed	none listed
Acenaphthylene	none listed	none listed	none listed
1,2-benzphenanthrene	0.2 mg/m3 TWA (as benzene soluble aerosol) (listed under Coal tar pitches).	0.1 mg/m3 TWA (cyclohexane-extractable fraction) (listed under Coal tar pitches).80 mg/m3 IDLH (listed under Coal tar pitches).	0.2 mg/m3 TWA (benzene soluble fraction) (listed under Coal tar pitches).
Benzo(a)pyrene	0.2 mg/m3 TWA (as benzene soluble aerosol) (listed under Coal tar pitches).	0.1 mg/m3 TWA (cyclohexane-extractable fraction) (listed under Coal tar pitches).80 mg/m3 IDLH (listed under Coal tar pitches).	0.2 mg/m3 TWA (benzene soluble fraction) (listed under Coal tar pitches).
1,2-Benzanthracene	none listed	none listed	none listed
Acenaphthene	none listed	none listed	none listed
Phenanthrene	0.2 mg/m3 TWA (as benzene soluble aerosol) (listed under Coal tar pitches).	0.1 mg/m3 TWA (cyclohexane-extractable fraction) (listed under Coal tar pitches).80 mg/m3 IDLH (listed under Coal tar pitches).	0.2 mg/m3 TWA (benzene soluble fraction) (listed under Coal tar pitches).
Fluorene	none listed	none listed	none listed
Pentachlorophenol	0.5 mg/m3 TWA; Skin - potential significant contribution to overall exposure by the cutaneous r oute	0.5 mg/m3 TWA 2.5 mg/m3 IDLH	0.5 mg/m3 TWA
	10 ppm TWA; 15 ppm STEL; Skin - potential	10 ppm TWA; 50 mg/m3	10 ppm TWA; 50 mg/m3

Naphthalene	significant contribution to overall exposure by the cutaneous r oute	TWA 250 ppm IDLH	TWA
2-methylnaphthalene	0.5 ppm TWA; Skin - potential significant contribution to overall exposure by the cutaneous r oute	none listed	none listed

OSHA Vacated PELs: Soil: No OSHA Vacated PELs are listed for this chemical. Anthracene: No OSHA Vacated PELs are listed for this chemical. Pyrene: No OSHA Vacated PELs are listed for this chemical. Dibenzofuran: No OSHA Vacated PELs are listed for this chemical. Benzo(b)fluoranthene: No OSHA Vacated PELs are listed for this chemical. Fluoranthene: No OSHA Vacated PELs are listed for this chemical. Acenaphthylene: No OSHA Vacated PELs are listed for this chemical. 1,2-benzphenanthrene: No OSHA Vacated PELs are listed for this chemical. Benzo(a)pyrene: No OSHA Vacated PELs are listed for this chemical. 1,2-Benzanthracene: No OSHA Vacated PELs are listed for this chemical. Acenaphthene: No OSHA Vacated PELs are listed for this chemical. Phenanthrene: No OSHA Vacated PELs are listed for this chemical. Fluorene: No OSHA Vacated PELs are listed for this chemical. Pentachlorophenol: 0.5 mg/m3 TWA Naphthalene: 10 ppm TWA; 50 mg/m3 TWA 2-methylnaphthalene: No OSHA Vacated PELs are listed for this chemical.

Personal Protective Equipment

Eyes: Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166.

Skin: Wear appropriate gloves to prevent skin exposure.

Clothing: Wear appropriate protective clothing to prevent skin exposure.

Respirators: Follow the OSHA respirator regulations found in 29 CFR 1910.134 or European Standard EN 149. Use a NIOSH/MSHA or European Standard EN 149 approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced.

Section 9 - Physical and Chemical Properties

Physical State: Solid
Appearance: not available
Odor: none reported
pH: Not available.
Vapor Pressure: Not applicable.
Vapor Density: Not available.
Evaporation Rate: Not applicable.
Viscosity: Not applicable.
Boiling Point: Not available.
Freezing/Melting Point: Not available.
Decomposition Temperature: Not available.
Solubility: Insoluble in water.
Specific Gravity/Density: Not available.
Molecular Formula: Mixture
Molecular Weight: Not available.

Section 10 - Stability and Reactivity

Chemical Stability: Stable under normal temperatures and pressures.
Conditions to Avoid: High temperatures.
Incompatibilities with Other Materials: None reported.

Hazardous Decomposition Products: No data available.
Hazardous Polymerization: Has not been reported.

Section 11 - Toxicological Information

RTECS#:
CAS# 120-12-7: CA9350000
CAS# 129-00-0: UR2450000; UR2450100
CAS# 132-64-9: HP4430000
CAS# 205-99-2: CU1400000
CAS# 206-44-0: LL4025000
CAS# 208-96-8: AB1254000; AB1254200
CAS# 218-01-9: GC0700000
CAS# 50-32-8: DJ3675000
CAS# 56-55-3: CV9275000
CAS# 83-32-9: AB1000000
CAS# 85-01-8: SF7175000
CAS# 86-73-7: LL5670000
CAS# 87-86-5: SM6300000; SM6314000; SM6321000
CAS# 91-20-3: QJ0525000
CAS# 91-57-6: QJ9635000
LD50/LC50:
CAS# 120-12-7:
Oral, mouse: LD50 = 4900 mg/kg;
.

CAS# 129-00-0:
Draize test, rabbit, skin: 500 mg/24H Mild;
Inhalation, rat: LC50 = 170 mg/m3;
Inhalation, rat: LC50 = 170 mg/m3;
Oral, mouse: LD50 = 800 mg/kg;
Oral, rat: LD50 = 2700 mg/kg;
.

CAS# 132-64-9:
.

CAS# 205-99-2:
.

CAS# 206-44-0:
Oral, rat: LD50 = 2 gm/kg;
Skin, rabbit: LD50 = 3180 mg/kg;
.

CAS# 208-96-8:
Oral, mouse: LD50 = 1760 mg/kg;
.

CAS# 218-01-9:
.

CAS# 50-32-8:
.

CAS# 56-55-3:
.

CAS# 83-32-9:
.

CAS# 85-01-8:
Oral, mouse: LD50 = 700 mg/kg;
Oral, rat: LD50 = 1.8 gm/kg;
.

CAS# 86-73-7:
.

CAS# 87-86-5:
Draize test, rabbit, eye: 100 uL/24H Mild;
Inhalation, mouse: LC50 = 225 mg/m3;
Inhalation, mouse: LC50 = 225 mg/m3;
Inhalation, rat: LC50 = 355 mg/m3;
Inhalation, rat: LC50 = 200 mg/m3;
Inhalation, rat: LC50 = 335 mg/m3;
Oral, mouse: LD50 = 36 mg/kg;
Oral, mouse: LD50 = 117 mg/kg;
Oral, mouse: LD50 = 30 mg/kg;
Oral, rabbit: LD50 = 200 mg/kg;
Oral, rat: LD50 = 27 mg/kg;
Oral, rat: LD50 = 27 mg/kg;
Oral, rat: LD50 = 50 mg/kg;
Skin, rat: LD50 = 96
CAS# 91-20-3:
Draize test, rabbit, eye: 100 mg Mild;
Inhalation, rat: LC50 = >340 mg/m3/1H;
Oral, mouse: LD50 = 316 mg/kg;
Oral, rat: LD50 = 490 mg/kg;
Skin, rabbit: LD50 = >20 gm/kg;
Skin, rat: LD50 = >2500 mg/kg;
.

CAS# 91-57-6:
Oral, rat: LD50 = 1630 mg/kg;
.

Carcinogenicity:
CAS# 120-12-7:

- **ACGIH:** A1 - Confirmed Human Carcinogen (listed as 'Coal tar pitches').
- **California:** Not listed.
- **NTP:** Known carcinogen (listed as Coal tar pitches).
- **IARC:** Group 1 carcinogen (listed as Coal tar pitches).

CAS# 129-00-0:

- **ACGIH:** A1 - Confirmed Human Carcinogen (listed as 'Coal tar pitches').
- **California:** Not listed.
- **NTP:** Known carcinogen (listed as Coal tar pitches).
- **IARC:** Group 1 carcinogen (listed as Coal tar pitches).

CAS# 132-64-9: Not listed by ACGIH, IARC, NTP, or CA Prop 65.
CAS# 205-99-2:

- **ACGIH:** A2 - Suspected Human Carcinogen
- **California:** carcinogen, initial date 7/1/87
- **NTP:** Suspect carcinogen
- **IARC:** Group 2B carcinogen

CAS# 206-44-0: Not listed by ACGIH, IARC, NTP, or CA Prop 65.
CAS# 208-96-8: Not listed by ACGIH, IARC, NTP, or CA Prop 65.
CAS# 218-01-9:

- **ACGIH:** A3 - Confirmed Animal Carcinogen with Unknown Relevance to Humans
- **California:** carcinogen, initial date 1/1/90
- **NTP:** Known carcinogen (listed as Coal tar pitches).
- **IARC:** Group 1 carcinogen (listed as Coal tar pitches).

CAS# 50-32-8:

- **ACGIH:** A2 - Suspected Human Carcinogen
- **California:** carcinogen, initial date 7/1/87
- **NTP:** Suspect carcinogen
- **IARC:** Group 1 carcinogen

CAS# 56-55-3:

- **ACGIH:** A2 - Suspected Human Carcinogen
- **California:** carcinogen, initial date 7/1/87
- **NTP:** Suspect carcinogen
- **IARC:** Group 2B carcinogen

CAS# 83-32-9: Not listed by ACGIH, IARC, NTP, or CA Prop 65.
CAS# 85-01-8:

- **ACGIH:** A1 - Confirmed Human Carcinogen (listed as 'Coal tar pitches').
- **California:** Not listed.
- **NTP:** Known carcinogen (listed as Coal tar pitches).
- **IARC:** Group 1 carcinogen (listed as Coal tar pitches).

CAS# 86-73-7: Not listed by ACGIH, IARC, NTP, or CA Prop 65.
CAS# 87-86-5:

- **ACGIH:** A3 - Confirmed Animal Carcinogen with Unknown Relevance to Humans
- **California:** carcinogen, initial date 1/1/90
- **NTP:** Not listed.
- **IARC:** Group 2B carcinogen

CAS# 91-20-3:

- **ACGIH:** Not listed.
- **California:** carcinogen, initial date 4/19/02
- **NTP:** Suspect carcinogen
- **IARC:** Group 2B carcinogen

CAS# 91-57-6: Not listed by ACGIH, IARC, NTP, or CA Prop 65.

Epidemiology: No information available.
Teratogenicity: No information available.
Reproductive Effects: No information available.

Mutagenicity: No information available.
Neurotoxicity: No information available.
Other Studies:

Section 12 - Ecological Information

No information available.

Section 13 - Disposal Considerations

Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. US EPA guidelines for the classification determination are listed in 40 CFR Parts 261.3. Additionally, waste generators must consult state and local hazardous waste regulations to ensure complete and accurate classification.
RCRA P-Series: None listed.
RCRA U-Series:
CAS# 206-44-0: waste number U120.
CAS# 218-01-9: waste number U050.
CAS# 50-32-8: waste number U022.
CAS# 56-55-3: waste number U018.
CAS# 91-20-3: waste

Section 14 - Transport Information

	US DOT	Canada TDG
Shipping Name:	Not regulated as a hazardous material	No information available.
Hazard Class:		
UN Number:		
Packing Group:		

Section 15 - Regulatory Information

US FEDERAL

TSCA
Soil is not listed on the TSCA inventory. It is for research and development use only.
CAS# 120-12-7 is listed on the TSCA inventory.
CAS# 129-00-0 is listed on the TSCA inventory.
CAS# 132-64-9 is listed on the TSCA inventory.
CAS# 205-99-2 is not listed on the TSCA inventory. It is for research and development use only.
CAS# 206-44-0 is listed on the TSCA inventory.
CAS# 208-96-8 is listed on the TSCA inventory.
CAS# 218-01-9 is listed on the TSCA inventory.
CAS# 50-32-8 is listed on the TSCA inventory.
CAS# 56-55-3 is listed on the TSCA inventory.
CAS# 83-32-9 is listed on the TSCA inventory.
CAS# 85-01-8 is listed on the TSCA inventory.
CAS# 86-73-7 is listed on the TSCA inventory.

CAS# 87-86-5 is listed on the TSCA inventory.
CAS# 91-20-3 is listed on the TSCA inventory.
CAS# 91-57-6 is listed on the TSCA inventory.

Health & Safety Reporting List

CAS# 129-00-0: Effective 6/1/87, Sunset 6/1/97 CAS# 91-20-3: Effective 6/1/87, Sunset 6/1/97

Chemical Test Rules

CAS# 91-20-3: 40 CFR 799.5115

Section 12b

CAS# 91-20-3: Section 4, 0.1 % de minimus concentration

TSCA Significant New Use Rule

None of the chemicals in this material have a SNUR under TSCA.

CERCLA Hazardous Substances and corresponding RQs

CAS# 120-12-7: 5000 lb final RQ; 2270 kg final RQ CAS# 129-00-0: 5000 lb final RQ; 2270 kg final RQ CAS# 132-64-9: 100 lb final RQ; 45.4 kg final RQ CAS# 205-99-2: 1 lb final RQ; 0.454 kg final RQ CAS# 206-44-0: 100 lb final RQ; 45.4 kg final RQ CAS# 208-96-8: 5000 lb final RQ; 2270 kg final RQ CAS# 218-01-9: 100 lb final RQ; 45.4 kg final RQ CAS# 50-32-8: 1 lb final RQ; 0.454 kg final RQ CAS# 56-55-3: 10 lb final RQ; 4.54 kg final RQ CAS# 83-32-9: 100 lb final RQ; 45.4 kg final RQ CAS# 85-01-8: 5000 lb final RQ; 2270 kg final RQ CAS# 86-73-7: 5000 lb final RQ; 2270 kg final RQ CAS# 87-86-5: 10 lb final RQ; 4.54 kg final RQ CAS# 91-20-3: 100 lb final RQ; 45.4 kg final RQ

SARA Section 302 Extremely Hazardous Substances

CAS# 129-00-0: 1000 lb lower threshold TPQ; 10000 lb upper threshold T PQ

SARA Codes

CAS # 120-12-7: immediate.
CAS # 129-00-0: immediate, delayed.
CAS # 206-44-0: immediate.
CAS # 50-32-8: immediate, delayed.
CAS # 56-55-3: delayed.
CAS # 83-32-9: immediate.
CAS # 85-01-8: immediate.
CAS # 91-20-3: immediate, delayed, fire.
CAS # 91-57-6: immediate.

Section 313

This material contains Anthracene (CAS# 120-12-7, 0-2%),which is subject to the reporting requirements of Section 313 of SARA Title III and 40 CFR Part 373.

This material contains Dibenzofuran (CAS# 132-64-9, 0-2%),which is subject to the reporting requirements of Section 313 of SARA Title III and 40 CFR Part 373.

This material contains Benzo(b)fluoranthene (CAS# 205-99-2, 0-2%),which is subject to the reporting requirements of Section 313 of SARA Title III and 40 CFR

This material contains Fluoranthene (CAS# 206-44-0, 0-2%),which is subject to the reporting requirements of Section 313 of SARA Title III and 40 CFR Part 373.

This material contains 1,2-benzphenanthrene (CAS# 218-01-9, 0-2%),which is subject to the reporting requirements of Section 313 of SARA Title III and 40 CFR

This material contains Benzo(a)pyrene (CAS# 50-32-8, 0-2%),which is subject to the reporting requirements of Section 313 of SARA Title III and 40 CFR

This material contains 1,2-Benzanthracene (CAS# 56-55-3, 0-2%),which is subject to the reporting requirements of Section 313 of SARA Title III and 40 CFR

This material contains Phenanthrene (CAS# 85-01-8, 0-2%),which is subject to the reporting requirements of Section 313 of SARA Title III and 40 CFR Part 373.

This material contains Pentachlorophenol (CAS# 87-86-5, 0-2%),which is subject to the reporting requirements of Section 313 of SARA Title III and 40 CFR

This material contains Naphthalene (CAS# 91-20-3, 0-2%),which is subject to the reporting requirements of Section 313 of SARA Title III and 40 CFR Part 373.

Clean Air Act:

CAS# 132-64-9 is listed as a hazardous air pollutant (HAP).

CAS# 87-86-5 is listed as a hazardous air pollutant (HAP).
CAS# 91-20-3 is listed as a hazardous air pollutant (HAP).

This material does not contain any Class 1 Ozone depletors.
This material does not contain any Class 2 Ozone depletors.

Clean Water Act:

CAS# 87-86-5 is listed as a Hazardous Substance under the CWA. CAS# 91-20-3 is listed as a Hazardous Substance under the CWA. CAS# 120-12-7 is listed as a Priority Pollutant under the Clean Water Act. CAS# 129-00-0 is listed as a Priority Pollutant under the Clean Water Act. CAS# 205-99-2 is listed as a Priority Pollutant under the Clean Water Act. CAS# 206-44-0 is listed as a Priority Pollutant under the Clean Water Act. CAS# 208-96-8 is listed as a Priority Pollutant under the Clean Water Act. CAS# 218-01-9 is listed as a Priority Pollutant under the Clean Water Act. CAS# 50-32-8 is listed as a Priority Pollutant under the Clean Water Act. CAS# 56-55-3 is listed as a Priority Pollutant under the Clean Water Act. CAS# 83-32-9 is listed as a Priority Pollutant under the Clean Water Act. CAS# 85-01-8 is listed as a Priority Pollutant under the Clean Water Act. CAS# 86-73-7 is listed as a Priority Pollutant under the Clean Water Act. CAS# 87-86-5 is listed as a Priority Pollutant under the Clean Water Act. CAS# 91-20-3 is listed as a Priority Pollutant under the Clean Water Act. CAS# 206-44-0 is listed as a Toxic Pollutant under the Clean Water Act. CAS# 83-32-9 is listed as a Toxic Pollutant under the Clean Water Act. CAS# 87-86-5 is listed as a Toxic Pollutant under the Clean Water Act. CAS# 91-20-3 is listed as a Toxic Pollutant under the Clean Water Act.

OSHA:

None of the chemicals in this product are considered highly hazardous by OSHA.

STATE

CAS# 120-12-7 can be found on the following state right to know lists: California, New Jersey, Pennsylvania, Minnesota, (listed as Coal tar pitches), Massachusetts.

CAS# 129-00-0 can be found on the following state right to know lists: California, New Jersey, Pennsylvania, Minnesota, (listed as Coal tar pitches), Massachusetts.

CAS# 132-64-9 can be found on the following state right to know lists: New Jersey, Pennsylvania, Massachusetts.

CAS# 205-99-2 can be found on the following state right to know lists: California, New Jersey, Pennsylvania, Minnesota, Massachusetts.

CAS# 206-44-0 can be found on the following state right to know lists: California, New Jersey, Pennsylvania, Massachusetts.

CAS# 208-96-8 can be found on the following state right to know lists: New Jersey, Pennsylvania, Massachusetts.

CAS# 218-01-9 can be found on the following state right to know lists: California, New Jersey, Pennsylvania, Minnesota, Massachusetts.

CAS# 50-32-8 can be found on the following state right to know lists: California, New Jersey, Pennsylvania, Minnesota, Massachusetts.

CAS# 56-55-3 can be found on the following state right to know lists: California, New Jersey, Pennsylvania, Minnesota, Massachusetts.

CAS# 83-32-9 can be found on the following state right to know lists: California, New Jersey, Pennsylvania, Massachusetts.

CAS# 85-01-8 can be found on the following state right to know lists: California, New Jersey, Pennsylvania, Minnesota, (listed as Coal tar pitches), Massachusetts.

CAS# 86-73-7 can be found on the following state right to know lists: New Jersey, Pennsylvania, Massachusetts.

CAS# 87-86-5 can be found on the following state right to know lists: California, New Jersey, Pennsylvania, Minnesota, Massachusetts.

CAS# 91-20-3 can be found on the following state right to know lists: California, New Jersey, Pennsylvania, Minnesota, Massachusetts.

CAS# 91-57-6 is not present on state lists from CA, PA, MN, MA, FL, or NJ.

California Prop 65

WARNING: This product contains Benzo(b)fluoranthene, a chemical known to the state of California to cause cancer. WARNING: This product contains 1,2-benzphenanthrene, a chemical known to the state of California to cause cancer. WARNING: This product contains Benzo(a)pyrene, a chemical known to the state of California to cause cancer. WARNING: This product contains 1,2-Benzanthracene, a chemical known to the state of California to cause cancer. WARNING: This product contains Pentachlorophenol, a chemical known to the state of California to cause cancer. WARNING: This product contains Naphthalene, a chemical known to the state of California to cause cancer.

California No Significant Risk Level: CAS# 205-99-2: 0.096 æg/day NSRL (oral) CAS# 218-01-9: 0.35 æg/day NSRL (oral) CAS# 50-32-8: 0.06 æg/day NSRL CAS# 56-55-3: 0.033 æg/day NSRL (oral) CAS# 87-86-5: 40 æg/day NSRL CAS# 91-20-3: 5.8 æg/day NSRL

European/International Regulations

European Labeling in Accordance with EC Directives

Hazard Symbols:

Not available.

Risk Phrases:

Safety Phrases:

WGK (Water Danger/Protection)

CAS# 120-12-7: 2
CAS# 129-00-0: No information available.
CAS# 132-64-9: No information available.
CAS# 205-99-2: No information available.
CAS# 206-44-0: No information available.
CAS# 208-96-8: No information available.
CAS# 218-01-9: No information available.
CAS# 50-32-8: No information available.
CAS# 56-55-3: No information available.
CAS# 83-32-9: No information available.
CAS# 85-01-8: No information available.
CAS# 86-73-7: No information available.
CAS# 87-86-5: 3
CAS# 91-20-3: 2
CAS# 91-57-6: No information available.

Canada - DSL/NDSL

CAS# 120-12-7 is listed on Canada's DSL List.
CAS# 129-00-0 is listed on Canada's DSL List.
CAS# 132-64-9 is listed on Canada's DSL List.
CAS# 218-01-9 is listed on Canada's DSL List.
CAS# 50-32-8 is listed on Canada's DSL List.
CAS# 83-32-9 is listed on Canada's DSL List.
CAS# 85-01-8 is listed on Canada's DSL List.
CAS# 86-73-7 is listed on Canada's DSL List.
CAS# 87-86-5 is listed on Canada's DSL List.
CAS# 91-20-3 is listed on Canada's DSL List.
CAS# 91-57-6 is listed on Canada's DSL List.
CAS# 206-44-0 is listed on Canada's NDSL List.
CAS# 208-96-8 is listed on Canada's NDSL List.
CAS# 56-55-3 is listed on Canada's NDSL List.

Canada - WHMIS

This product has a WHMIS classification of D2A.

This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations and the MSDS contains all of the information required by those regulations.

Canadian Ingredient Disclosure List

CAS# 120-12-7 is listed on the Canadian Ingredient Disclosure List.
CAS# 129-00-0 is listed on the Canadian Ingredient Disclosure List.
CAS# 205-99-2 is listed on the Canadian Ingredient Disclosure List.
CAS# 206-44-0 is listed on the Canadian Ingredient Disclosure List.
CAS# 208-96-8 is not listed on the Canadian Ingredient Disclosure List.
CAS# 218-01-9 is listed on the Canadian Ingredient Disclosure List.
CAS# 50-32-8 is listed on the Canadian Ingredient Disclosure List.
CAS# 56-55-3 is listed on the Canadian Ingredient Disclosure List.
CAS# 83-32-9 is listed on the Canadian Ingredient Disclosure List.
CAS# 85-01-8 is listed on the Canadian Ingredient Disclosure List.
CAS# 86-73-7 is not listed on the Canadian Ingredient Disclosure List.
CAS# 87-86-5 is not listed on the Canadian Ingredient Disclosure List.
CAS# 91-20-3 is listed on the Canadian Ingredient Disclosure List.

Section 16 - Additional Information

MSDS Creation Date: 9/02/1997
Revision #5 Date: 11/20/2008

SAFETY DATA SHEET

Creation Date 10-Dec-2009 **Revision Date** 28-Dec-2021 **Revision Number** 6

1. Identification

Product Name	**Tetrachloroethylene**
Cat No. :	**AC445690000; ACR445690010; AC445690025; AC445691000**
CAS No	127-18-4
Synonyms	Perchloroethylene
Recommended Use	Laboratory chemicals.
Uses advised against	Food, drug, pesticide or biocidal product use.

Details of the supplier of the safety data sheet

Company

Fisher Scientific Company
One Reagent Lane
Fair Lawn, NJ 07410
Tel: (201) 796-7100

Acros Organics
One Reagent Lane
Fair Lawn, NJ 07410

Emergency Telephone Number

For information **US** call: 001-800-ACROS-01 / **Europe** call: +32 14 57 52 11
Emergency Number **US:**001-201-796-7100 / **Europe:** +32 14 57 52 99
CHEMTREC Tel. No.**US:**001-800-424-9300 / **Europe:**001-703-527-3887

2. Hazard(s) identification

Classification

This chemical is considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200)

Skin Corrosion/Irritation	Category 2
Serious Eye Damage/Eye Irritation	Category 2
Skin Sensitization	Category 1
Carcinogenicity	Category 1B
Specific target organ toxicity (single exposure)	Category 3
Target Organs - Central nervous system (CNS).	
Specific target organ toxicity - (repeated exposure)	Category 2
Target Organs - Kidney, Liver, Blood.	

Label Elements

Signal Word

Danger

Hazard Statements
Causes skin irritation
Causes serious eye irritation
May cause an allergic skin reaction
May cause drowsiness or dizziness
May cause cancer
May cause damage to organs through prolonged or repeated exposure

Precautionary Statements
Prevention
Obtain special instructions before use
Do not handle until all safety precautions have been read and understood
Use personal protective equipment as required
Wash face, hands and any exposed skin thoroughly after handling
Contaminated work clothing should not be allowed out of the workplace
Do not breathe dust/fume/gas/mist/vapors/spray
Use only outdoors or in a well-ventilated area
Wear protective gloves/protective clothing/eye protection/face protection
Response
IF exposed or concerned: Get medical attention/advice
Inhalation
IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing
Skin
IF ON SKIN: Wash with plenty of soap and water
Take off contaminated clothing and wash before reuse
If skin irritation or rash occurs: Get medical advice/attention
Eyes
IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
If eye irritation persists: Get medical advice/attention
Storage
Store locked up
Store in a well-ventilated place. Keep container tightly closed
Disposal
Dispose of contents/container to an approved waste disposal plant
Hazards not otherwise classified (HNOC)
Toxic to aquatic life with long lasting effects
WARNING. Cancer - https://www.p65warnings.ca.gov/.

3. Composition/Information on Ingredients

Component	CAS No	Weight %
Tetrachloroethylene	127-18-4	>95

4. First-aid measures

General Advice	If symptoms persist, call a physician.
Eye Contact	Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Get medical attention.

Skin Contact	Wash off immediately with plenty of water for at least 15 minutes. If skin irritation persists, call a physician.
Inhalation	Remove to fresh air. If not breathing, give artificial respiration. Get medical attention if symptoms occur.
Ingestion	Clean mouth with water and drink afterwards plenty of water.
Most important symptoms and effects	None reasonably foreseeable. May cause allergic skin reaction. Inhalation of high vapor concentrations may cause symptoms like headache, dizziness, tiredness, nausea and vomiting: Symptoms of allergic reaction may include rash, itching, swelling, trouble breathing, tingling of the hands and feet, dizziness, lightheadedness, chest pain, muscle pain or flushing
Notes to Physician	Treat symptomatically

5. Fire-fighting measures

Suitable Extinguishing Media	Water spray, carbon dioxide (CO2), dry chemical, alcohol-resistant foam.
Unsuitable Extinguishing Media	No information available
Flash Point	No information available
Method -	No information available
Autoignition Temperature	No information available
Explosion Limits	
Upper	No data available
Lower	No data available
Sensitivity to Mechanical Impact	No information available
Sensitivity to Static Discharge	No information available

Specific Hazards Arising from the Chemical
Thermal decomposition can lead to release of irritating gases and vapors. Containers may explode when heated.

Hazardous Combustion Products
Chlorine. Phosgene. Hydrogen chloride gas.
Protective Equipment and Precautions for Firefighters
As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear.

NFPA

Health	Flammability	Instability	Physical hazards
2	0	0	N/A

6. Accidental release measures

Personal Precautions	Use personal protective equipment as required. Ensure adequate ventilation.
Environmental Precautions	Do not flush into surface water or sanitary sewer system.
Methods for Containment and Clean Up	Soak up with inert absorbent material. Keep in suitable, closed containers for disposal.

7. Handling and storage

Handling	Wear personal protective equipment/face protection. Do not get in eyes, on skin, or on clothing. Ensure adequate ventilation. Avoid ingestion and inhalation.
Storage.	Keep containers tightly closed in a dry, cool and well-ventilated place. Protect from sunlight. Incompatible Materials. Strong acids. Strong oxidizing agents. Strong bases. Metals. Zinc.

Amines. Aluminium.

8. Exposure controls / personal protection

Exposure Guidelines

Component	ACGIH TLV	OSHA PEL	NIOSH IDLH	Mexico OEL (TWA)
Tetrachloroethylene	TWA: 25 ppm STEL: 100 ppm	(Vacated) TWA: 25 ppm (Vacated) TWA: 170 mg/m^3 Ceiling: 200 ppm TWA: 100 ppm	IDLH: 150 ppm	TWA: 25 ppm STEL: 100 ppm

Legend

ACGIH - American Conference of Governmental Industrial Hygienists
OSHA - Occupational Safety and Health Administration
NIOSH IDLH: NIOSH - National Institute for Occupational Safety and Health

Engineering Measures Use only under a chemical fume hood. Ensure adequate ventilation, especially in confined areas. Ensure that eyewash stations and safety showers are close to the workstation location.

Personal Protective Equipment

Eye/face Protection Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166.

Skin and body protection Wear appropriate protective gloves and clothing to prevent skin exposure.

Respiratory Protection Follow the OSHA respirator regulations found in 29 CFR 1910.134 or European Standard EN 149. Use a NIOSH/MSHA or European Standard EN 149 approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced.

Hygiene Measures Handle in accordance with good industrial hygiene and safety practice.

9. Physical and chemical properties

Physical State	Liquid
Appearance	Colorless
Odor	Characteristic, sweet
Odor Threshold	No information available
pH	No information available
Melting Point/Range	-22 °C / -7.6 °F
Boiling Point/Range	120 - 122 °C / 248 - 251.6 °F @ 760 mmHg
Flash Point	No information available
Evaporation Rate	6.0 (Ether = 1.0)
Flammability (solid,gas)	Not applicable
Flammability or explosive limits	
Upper	No data available
Lower	No data available
Vapor Pressure	18 mbar @ 20 °C
Vapor Density	No information available
Density	1.619
Specific Gravity	1.625
Solubility	0.15 g/L water (20°C)
Partition coefficient; n-octanol/water	No data available
Autoignition Temperature	No information available
Decomposition Temperature	> 150°C
Viscosity	0.89 mPa s at 20 °C
Molecular Formula	C2 Cl4

Molecular Weight 165.83

10. Stability and reactivity

Reactive Hazard None known, based on information available

Stability Stable under normal conditions.

Conditions to Avoid Incompatible products. Excess heat. Exposure to moist air or water.

Incompatible Materials Strong acids, Strong oxidizing agents, Strong bases, Metals, Zinc, Amines, Aluminium

Hazardous Decomposition Products Chlorine, Phosgene, Hydrogen chloride gas

Hazardous Polymerization Hazardous polymerization does not occur.

Hazardous Reactions None under normal processing.

11. Toxicological information

Acute Toxicity

Product Information
Component Information

Component	LD50 Oral	LD50 Dermal	LC50 Inhalation
Tetrachloroethylene	LD50 = 2629 mg/kg (Rat)	LD50 > 10000 mg/kg (Rat)	LC50 = 27.8 mg/L (Rat) 4 h

Toxicologically Synergistic Products No information available

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Irritation Irritating to eyes and skin

Sensitization No information available

Carcinogenicity The table below indicates whether each agency has listed any ingredient as a carcinogen.

Component	CAS No	IARC	NTP	ACGIH	OSHA	Mexico
Tetrachloroethylene	127-18-4	Group 2A	Reasonably Anticipated	A3	X	A3

IARC (International Agency for Research on Cancer)	*IARC (International Agency for Research on Cancer)* *Group 1 - Carcinogenic to Humans* *Group 2A - Probably Carcinogenic to Humans* *Group 2B - Possibly Carcinogenic to Humans*
NTP: (National Toxicity Program)	*NTP: (National Toxicity Program)* *Known - Known Carcinogen* *Reasonably Anticipated - Reasonably Anticipated to be a Human Carcinogen*
ACGIH: (American Conference of Governmental Industrial Hygienists)	*A1 - Known Human Carcinogen* *A2 - Suspected Human Carcinogen* *A3 - Animal Carcinogen* *ACGIH: (American Conference of Governmental Industrial Hygienists)*
Mexico - Occupational Exposure Limits - Carcinogens	*Mexico - Occupational Exposure Limits - Carcinogens* *A1 - Confirmed Human Carcinogen* *A2 - Suspected Human Carcinogen* *A3 - Confirmed Animal Carcinogen* *A4 - Not Classifiable as a Human Carcinogen* *A5 - Not Suspected as a Human Carcinogen*

Mutagenic Effects No information available

Reproductive Effects No information available.

Developmental Effects No information available.

Teratogenicity	No information available.
STOT - single exposure	Central nervous system (CNS)
STOT - repeated exposure	Kidney Liver Blood
Aspiration hazard	No information available
Symptoms / effects,both acute and delayed	Inhalation of high vapor concentrations may cause symptoms like headache, dizziness, tiredness, nausea and vomiting: Symptoms of allergic reaction may include rash, itching, swelling, trouble breathing, tingling of the hands and feet, dizziness, lightheadedness, chest pain, muscle pain or flushing

Endocrine Disruptor Information

Component	EU - Endocrine Disrupters Candidate List	EU - Endocrine Disruptors - Evaluated Substances	Japan - Endocrine Disruptor Information
Tetrachloroethylene	Group II Chemical	Not applicable	Not applicable

Other Adverse Effects Tumorigenic effects have been reported in experimental animals.

12. Ecological information

Ecotoxicity

Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment. The product contains following substances which are hazardous for the environment.

Component	Freshwater Algae	Freshwater Fish	Microtox	Water Flea
Tetrachloroethylene	EC50: > 500 mg/L, 96h (Pseudokirchneriella subcapitata)	LC50: 12.4 - 14.4 mg/L, 96h flow-through (Pimephales promelas) LC50: 8.6 - 13.5 mg/L, 96h static (Pimephales promelas) LC50: 11.0 - 15.0 mg/L, 96h static (Lepomis macrochirus) LC50: 4.73 - 5.27 mg/L, 96h flow-through (Oncorhynchus mykiss)	EC50 = 100 mg/L 24 h EC50 = 112 mg/L 24 h EC50 = 120.0 mg/L 30 min	EC50: 6.1 - 9.0 mg/L, 48h Static (Daphnia magna)

Persistence and Degradability	Insoluble in water Persistence is unlikely based on information available.
Bioaccumulation/ Accumulation	No information available.
Mobility	. Is not likely mobile in the environment due its low water solubility. Will likely be mobile in the environment due to its volatility.

Component	log Pow
Tetrachloroethylene	2.88

13. Disposal considerations

Waste Disposal Methods Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. Chemical waste generators must also consult local, regional, and national hazardous waste regulations to ensure complete and accurate classification.

Component	RCRA - U Series Wastes	RCRA - P Series Wastes
Tetrachloroethylene - 127-18-4	U210	-

14. Transport information

DOT

UN-No	UN1897
Proper Shipping Name	TETRACHLOROETHYLENE

Hazard Class	6.1
Packing Group	III

TDG

UN-No	UN1897
Proper Shipping Name	TETRACHLOROETHYLENE
Hazard Class	6.1
Packing Group	III

IATA

UN-No	UN1897
Proper Shipping Name	TETRACHLOROETHYLENE
Hazard Class	6.1
Packing Group	III

IMDG/IMO

UN-No	UN1897
Proper Shipping Name	TETRACHLOROETHYLENE
Hazard Class	6.1
Packing Group	III

15. Regulatory information

United States of America Inventory

Component	CAS No	TSCA	TSCA Inventory notification - Active-Inactive	TSCA - EPA Regulatory Flags
Tetrachloroethylene	127-18-4	X	ACTIVE	-

Legend:
TSCA US EPA (TSCA) - Toxic Substances Control Act, (40 CFR Part 710)
X - Listed
'-' - Not Listed

TSCA 12(b) - Notices of Export Not applicable

International Inventories

Canada (DSL/NDSL), Europe (EINECS/ELINCS/NLP), Philippines (PICCS), Japan (ENCS), Japan (ISHL), Australia (AICS), China (IECSC), Korea (KECL).

Component	CAS No	DSL	NDSL	EINECS	PICCS	ENCS	ISHL	AICS	IECSC	KECL
Tetrachloroethylene	127-18-4	X	-	204-825-9	X	X	X	X	X	KE-33294

KECL - NIER number or KE number (http://ncis.nier.go.kr/en/main.do)

U.S. Federal Regulations

SARA 313

Component	CAS No	Weight %	SARA 313 - Threshold Values %
Tetrachloroethylene	127-18-4	>95	0.1

SARA 311/312 Hazard Categories See section 2 for more information

CWA (Clean Water Act)

Component	CWA - Hazardous Substances	CWA - Reportable Quantities	CWA - Toxic Pollutants	CWA - Priority Pollutants
Tetrachloroethylene	-	-	X	X

Clean Air Act

Component	HAPS Data	Class 1 Ozone Depletors	Class 2 Ozone Depletors
Tetrachloroethylene	X		-

OSHA - Occupational Safety and Health Administration
Not applicable

CERCLA
This material, as supplied, contains one or more substances regulated as a hazardous substance under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) (40 CFR 302)

Component	Hazardous Substances RQs	CERCLA EHS RQs
Tetrachloroethylene	100 lb 1 lb	-

California Proposition 65
This product contains the following Proposition 65 chemicals.

Component	CAS No	California Prop. 65	Prop 65 NSRL	Category
Tetrachloroethylene	127-18-4	Carcinogen	14 µg/day	Carcinogen

U.S. State Right-to-Know Regulations

Component	Massachusetts	New Jersey	Pennsylvania	Illinois	Rhode Island
Tetrachloroethylene	X	X	X	X	X

U.S. Department of Transportation

Reportable Quantity (RQ):	Y
DOT Marine Pollutant	Y
DOT Severe Marine Pollutant	N

U.S. Department of Homeland Security
This product does not contain any DHS chemicals.

Other International Regulations

Mexico - Grade
No information available

Authorisation/Restrictions according to EU REACH

Component	REACH (1907/2006) - Annex XIV - Substances Subject to Authorization	REACH (1907/2006) - Annex XVII - Restrictions on Certain Dangerous Substances	REACH Regulation (EC 1907/2006) article 59 - Candidate List of Substances of Very High Concern (SVHC)
Tetrachloroethylene	-	Use restricted. See item 75. (see link for restriction details)	-

https://echa.europa.eu/substances-restricted-under-reach

Safety, health and environmental regulations/legislation specific for the substance or mixture

Component	CAS No	OECD HPV	Persistent Organic Pollutant	Ozone Depletion Potential	Restriction of Hazardous Substances (RoHS)
Tetrachloroethylene	127-18-4	Listed	Not applicable	Not applicable	Not applicable

Component	CAS No	Seveso III Directive (2012/18/EC) - Qualifying Quantities for Major Accident Notification	Seveso III Directive (2012/18/EC) - Qualifying Quantities for Safety Report Requirements	Rotterdam Convention (PIC)	Basel Convention (Hazardous Waste)
Tetrachloroethylene	127-18-4	Not applicable	Not applicable	Not applicable	Annex I - Y45

16. Other information

Prepared By
Regulatory Affairs
Thermo Fisher Scientific

Email: EMSDS.RA@thermofisher.com

Creation Date	10-Dec-2009
Revision Date	28-Dec-2021
Print Date	28-Dec-2021
Revision Summary	This document has been updated to comply with the US OSHA HazCom 2012 Standard replacing the current legislation under 29 CFR 1910.1200 to align with the Globally Harmonized System of Classification and Labeling of Chemicals (GHS).

End of SDS

SAFETY DATA SHEET

Creation Date 16-Sep-2014 **Revision Date** 26-Dec-2021 **Revision Number** 4

1. Identification

Product Name	**trans-1,2-Dichloroethylene, stabilized**
Cat No. :	**AC406840000; AC406840250; AC406842500**
CAS No	156-60-5
Synonyms	trans-Acetylene dichloride
Recommended Use	Laboratory chemicals.
Uses advised against	Food, drug, pesticide or biocidal product use.

Details of the supplier of the safety data sheet

Company

Fisher Scientific Company
One Reagent Lane
Fair Lawn, NJ 07410
Tel: (201) 796-7100

Acros Organics
One Reagent Lane
Fair Lawn, NJ 07410

Emergency Telephone Number

For information **US** call: 001-800-ACROS-01 / **Europe** call: +32 14 57 52 11
Emergency Number **US:**001-201-796-7100 / **Europe:** +32 14 57 52 99
CHEMTREC Tel. No.**US:**001-800-424-9300 / **Europe:**001-703-527-3887

2. Hazard(s) identification

Classification

This chemical is considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200)

Flammable liquids	Category 2
Acute oral toxicity	Category 4
Acute Inhalation Toxicity - Vapors	Category 4

Label Elements

Signal Word
Danger

Hazard Statements
Highly flammable liquid and vapor
Harmful if swallowed or if inhaled

Precautionary Statements
Prevention
Wash face, hands and any exposed skin thoroughly after handling
Do not eat, drink or smoke when using this product
Avoid breathing dust/fume/gas/mist/vapors/spray
Use only outdoors or in a well-ventilated area
Keep away from heat/sparks/open flames/hot surfaces. - No smoking
Keep container tightly closed
Ground/bond container and receiving equipment
Use explosion-proof electrical/ventilating/lighting equipment
Use only non-sparking tools
Take precautionary measures against static discharge
Wear protective gloves/protective clothing/eye protection/face protection
Inhalation
IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing
Call a POISON CENTER or doctor/physician if you feel unwell
Ingestion
Rinse mouth
IF SWALLOWED: Call a POISON CENTER or doctor/physician if you feel unwell
Fire
In case of fire: Use CO2, dry chemical, or foam for extinction
Explosion risk in case of fire
Fight fire with normal precautions from a reasonable distance
Evacuate area
Storage
Store in a well-ventilated place. Keep cool
Disposal
Dispose of contents/container to an approved waste disposal plant
Hazards not otherwise classified (HNOC)
Harmful to aquatic life with long lasting effects

3. Composition/Information on Ingredients

Component	CAS No	Weight %
trans-1,2-Dichloroethylene	156-60-5	>95

4. First-aid measures

Eye Contact	Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Get medical attention.
Skin Contact	Wash off immediately with plenty of water for at least 15 minutes. Get medical attention.
Inhalation	Remove from exposure, lie down. Remove to fresh air. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Get medical attention. If not breathing, give artificial respiration.
Ingestion	Do NOT induce vomiting. Get medical attention.

Most important symptoms and effects	Difficulty in breathing. Inhalation of high vapor concentrations may cause symptoms like headache, dizziness, tiredness, nausea and vomiting
Notes to Physician	Treat symptomatically

5. Fire-fighting measures

Suitable Extinguishing Media	Water spray. Carbon dioxide (CO_2). Dry chemical. Chemical foam. Water mist may be used to cool closed containers. Water mist may be used to cool closed containers.
Unsuitable Extinguishing Media	No information available
Flash Point	6 °C / 42.8 °F
Method -	No information available
Autoignition Temperature	440 °C / 824 °F
Explosion Limits	
Upper	12.80%
Lower	9.70%
Sensitivity to Mechanical Impact	No information available
Sensitivity to Static Discharge	No information available

Specific Hazards Arising from the Chemical

Flammable. Vapors may travel to source of ignition and flash back. Containers may explode when heated. Vapors may form explosive mixtures with air. Thermal decomposition can lead to release of irritating gases and vapors. Keep product and empty container away from heat and sources of ignition.

Hazardous Combustion Products

Carbon monoxide (CO). Carbon dioxide (CO_2). Phosgene. Hydrogen chloride gas.

Protective Equipment and Precautions for Firefighters

As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear.

NFPA

Health	Flammability	Instability	Physical hazards
2	3	0	N/A

6. Accidental release measures

Personal Precautions	Remove all sources of ignition. Take precautionary measures against static discharges. Use personal protective equipment as required. Ensure adequate ventilation.
Environmental Precautions	Do not flush into surface water or sanitary sewer system. See Section 12 for additional Ecological Information. Avoid release to the environment. Collect spillage.
Methods for Containment and Clean Up	Soak up with inert absorbent material (e.g. sand, silica gel, acid binder, universal binder, sawdust). Keep in suitable, closed containers for disposal. Remove all sources of ignition. Use spark-proof tools and explosion-proof equipment.

7. Handling and storage

Handling	Wear personal protective equipment/face protection. Ensure adequate ventilation. Avoid contact with skin and eyes. Handle product only in closed system or provide appropriate exhaust ventilation. Use spark-proof tools and explosion-proof equipment. Use only non-sparking tools. Keep away from open flames, hot surfaces and sources of ignition. To avoid ignition of vapors by static electricity discharge, all metal parts of the equipment must be grounded. Take precautionary measures against static discharges.
Storage.	Keep in a dry, cool and well-ventilated place. Keep container tightly closed. Keep away

from heat, sparks and flame. Flammables area. Keep container tightly closed in a dry and well-ventilated place. Incompatible Materials. Bases. Strong acids. Strong oxidizing agents.

8. Exposure controls / personal protection

Exposure Guidelines

Component	ACGIH TLV	OSHA PEL	NIOSH IDLH	Mexico OEL (TWA)
trans-1,2-Dichloroethylene	TWA: 200 ppm			TWA: 200 ppm

Legend

ACGIH - American Conference of Governmental Industrial Hygienists

Engineering Measures	Ensure adequate ventilation, especially in confined areas. Use explosion-proof electrical/ventilating/lighting equipment.

Personal Protective Equipment

Eye/face Protection	Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166.
Skin and body protection	Wear appropriate protective gloves and clothing to prevent skin exposure.
Respiratory Protection	Follow the OSHA respirator regulations found in 29 CFR 1910.134 or European Standard EN 149. Use a NIOSH/MSHA or European Standard EN 149 approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced.
Hygiene Measures	Handle in accordance with good industrial hygiene and safety practice.

9. Physical and chemical properties

Physical State	Liquid
Appearance	Colorless
Odor	aromatic
Odor Threshold	No information available
pH	6.5-7.2
Melting Point/Range	-50 °C / -58 °F
Boiling Point/Range	48 °C / 118.4 °F @ 760 mmHg
Flash Point	6 °C / 42.8 °F
Evaporation Rate	No information available
Flammability (solid,gas)	Not applicable
Flammability or explosive limits	
Upper	12.80%
Lower	9.70%
Vapor Pressure	331 mmHg @ 25 °C
Vapor Density	3.34 (Air = 1.0)
Specific Gravity	1.260
Solubility	Immiscible with water
Partition coefficient; n-octanol/water	No data available
Autoignition Temperature	440 °C / 824 °F
Decomposition Temperature	No information available
Viscosity	No information available
Molecular Formula	C2 H2 Cl2
Molecular Weight	96.94

10. Stability and reactivity

Reactive Hazard	None known, based on information available
Stability	Stable under normal conditions.
Conditions to Avoid	Keep away from open flames, hot surfaces and sources of ignition. Exposure to air. Exposure to light. Incompatible products. Exposure to moist air or water.
Incompatible Materials	Bases, Strong acids, Strong oxidizing agents
Hazardous Decomposition Products	Carbon monoxide (CO), Carbon dioxide (CO_2), Phosgene, Hydrogen chloride gas
Hazardous Polymerization	Hazardous polymerization does not occur.
Hazardous Reactions	None under normal processing.

11. Toxicological information

Acute Toxicity

Product Information
Component Information

Component	LD50 Oral	LD50 Dermal	LC50 Inhalation
trans-1,2-Dichloroethylene	LD50 = 1235 mg/kg (Rat)	>5 g/kg (Rabbit)	LC50 = 24100 ppm (Rat) 4 h

Toxicologically Synergistic Products No information available

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Irritation	No information available
Sensitization	No information available
Carcinogenicity	The table below indicates whether each agency has listed any ingredient as a carcinogen.

Component	CAS No	IARC	NTP	ACGIH	OSHA	Mexico
trans-1,2-Dichloroethylene	156-60-5	Not listed	Not listed	Not listed	Not listed	Not listed

Mutagenic Effects	No information available
Reproductive Effects	No information available.
Developmental Effects	No information available.
Teratogenicity	No information available.
STOT - single exposure	None known
STOT - repeated exposure	None known
Aspiration hazard	No information available
Symptoms / effects,both acute and delayed	Inhalation of high vapor concentrations may cause symptoms like headache, dizziness, tiredness, nausea and vomiting
Endocrine Disruptor Information	No information available
Other Adverse Effects	The toxicological properties have not been fully investigated.

12. Ecological information

Ecotoxicity

Harmful to aquatic organisms, may cause long-term adverse effects in the aquatic environment. The product contains following substances which are hazardous for the environment.

Component	Freshwater Algae	Freshwater Fish	Microtox	Water Flea
trans-1,2-Dichloroethylene	Not listed	LC50: = 135 mg/L, 96h static (Lepomis macrochirus)	Not listed	Not listed

Persistence and Degradability Persistence is unlikely based on information available.

Bioaccumulation/ Accumulation No information available.

Mobility Will likely be mobile in the environment due to its volatility.

Component	log Pow
trans-1,2-Dichloroethylene	1.48

13. Disposal considerations

Waste Disposal Methods Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. Chemical waste generators must also consult local, regional, and national hazardous waste regulations to ensure complete and accurate classification.

Component	RCRA - U Series Wastes	RCRA - P Series Wastes
trans-1,2-Dichloroethylene - 156-60-5	U079	-

14. Transport information

DOT

UN-No	UN1150
Proper Shipping Name	1,2-DICHLOROETHYLENE
Hazard Class	3
Packing Group	II

TDG

UN-No	UN1150
Proper Shipping Name	1,2-DICHLOROETHYLENE
Hazard Class	3
Packing Group	II

IATA

UN-No	UN1150
Proper Shipping Name	1,2-DICHLOROETHYLENE
Hazard Class	3
Packing Group	II

IMDG/IMO

UN-No	UN1150
Proper Shipping Name	1,2-DICHLOROETHYLENE
Hazard Class	3
Packing Group	II

15. Regulatory information

United States of America Inventory

Component	CAS No	TSCA	TSCA Inventory notification - Active-Inactive	TSCA - EPA Regulatory Flags
trans-1,2-Dichloroethylene	156-60-5	X	ACTIVE	-

Legend:
TSCA US EPA (TSCA) - Toxic Substances Control Act, (40 CFR Part 710)
X - Listed
'-' - Not Listed

TSCA 12(b) - Notices of Export Not applicable

Component	CAS No	**TSCA 12(b)** - Notices of Export

trans-1,2-Dichloroethylene	156-60-5	Section 4

International Inventories

Canada (DSL/NDSL), Europe (EINECS/ELINCS/NLP), Philippines (PICCS), Japan (ENCS), Japan (ISHL), Australia (AICS), China (IECSC), Korea (KECL).

Component	CAS No	DSL	NDSL	EINECS	PICCS	ENCS	ISHL	AICS	IECSC	KECL
trans-1,2-Dichloroethylene	156-60-5	X	-	205-860-2	X	X	X	X	X	KE-10123

KECL - NIER number or KE number (http://ncis.nier.go.kr/en/main.do)

U.S. Federal Regulations

SARA 313 Not applicable

SARA 311/312 Hazard Categories See section 2 for more information

CWA (Clean Water Act)

Component	CWA - Hazardous Substances	CWA - Reportable Quantities	CWA - Toxic Pollutants	CWA - Priority Pollutants
trans-1,2-Dichloroethylene	-	-	-	X

Clean Air Act Not applicable

OSHA - Occupational Safety and Health Administration Not applicable

CERCLA This material, as supplied, contains one or more substances regulated as a hazardous substance under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) (40 CFR 302)

Component	Hazardous Substances RQs	CERCLA EHS RQs
trans-1,2-Dichloroethylene	1000 lb 1 lb	-

California Proposition 65 This product does not contain any Proposition 65 chemicals.

U.S. State Right-to-Know Regulations

Component	Massachusetts	New Jersey	Pennsylvania	Illinois	Rhode Island
trans-1,2-Dichloroethylene	X	-	X	-	-

U.S. Department of Transportation

Reportable Quantity (RQ):	N
DOT Marine Pollutant	N
DOT Severe Marine Pollutant	N

U.S. Department of Homeland Security This product does not contain any DHS chemicals.

Other International Regulations

Mexico - Grade No information available

Authorisation/Restrictions according to EU REACH

Safety, health and environmental regulations/legislation specific for the substance or mixture

Component	CAS No	OECD HPV	Persistent Organic Pollutant	Ozone Depletion Potential	Restriction of Hazardous Substances (RoHS)
trans-1,2-Dichloroethylene	156-60-5	Listed	Not applicable	Not applicable	Not applicable

Component	CAS No	Seveso III Directive (2012/18/EC) - Qualifying Quantities for Major Accident Notification	Seveso III Directive (2012/18/EC) - Qualifying Quantities for Safety Report Requirements	Rotterdam Convention (PIC)	Basel Convention (Hazardous Waste)
trans-1,2-Dichloroethylene	156-60-5	Not applicable	Not applicable	Not applicable	Annex I - Y45

16. Other information

Prepared By	Regulatory Affairs Thermo Fisher Scientific Email: EMSDS.RA@thermofisher.com
Creation Date	16-Sep-2014
Revision Date	26-Dec-2021
Print Date	26-Dec-2021
Revision Summary	This document has been updated to comply with the US OSHA HazCom 2012 Standard replacing the current legislation under 29 CFR 1910.1200 to align with the Globally Harmonized System of Classification and Labeling of Chemicals (GHS).

Disclaimer

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text

End of SDS

ThermoFisher SCIENTIFIC

SAFETY DATA SHEET

Creation Date 03-Feb-2010 **Revision Date** 24-Dec-2021 **Revision Number** 3

1. Identification

Product Name	**Trichloroethylene**
Cat No. :	**T340-4; T341-4; T341-20; T341-500; T403-4**
CAS No	79-01-6
Synonyms	Trichloroethene (Stabilized/Technical/Electronic/Certified ACS)
Recommended Use	Laboratory chemicals.
Uses advised against	.

Details of the supplier of the safety data sheet

Company
Fisher Scientific Company
One Reagent Lane
Fair Lawn, NJ 07410
Tel: (201) 796-7100

Emergency Telephone Number	CHEMTREC®, Inside the USA: 800-424-9300 CHEMTREC®, Outside the USA: 001-703-527-3887

2. Hazard(s) identification

Classification

This chemical is considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200)

Skin Corrosion/Irritation	Category 2
Serious Eye Damage/Eye Irritation	Category 2
Skin Sensitization	Category 1
Germ Cell Mutagenicity	Category 2
Carcinogenicity	Category 1A
Specific target organ toxicity (single exposure)	Category 3
Target Organs - Central nervous system (CNS).	
Specific target organ toxicity - (repeated exposure)	Category 2
Target Organs - Kidney, Liver, Heart, spleen, Blood.	

Label Elements

Signal Word

Danger

Hazard Statements
Causes skin irritation
Causes serious eye irritation
May cause an allergic skin reaction
May cause drowsiness or dizziness
Suspected of causing genetic defects
May cause cancer
May cause damage to organs through prolonged or repeated exposure

Precautionary Statements
Prevention
Obtain special instructions before use
Do not handle until all safety precautions have been read and understood
Use personal protective equipment as required
Wash face, hands and any exposed skin thoroughly after handling
Contaminated work clothing should not be allowed out of the workplace
Do not breathe dust/fume/gas/mist/vapors/spray
Use only outdoors or in a well-ventilated area
Wear protective gloves/protective clothing/eye protection/face protection
Response
IF exposed or concerned: Get medical attention/advice
Inhalation
IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing
Skin
IF ON SKIN: Wash with plenty of soap and water
Take off contaminated clothing and wash before reuse
If skin irritation or rash occurs: Get medical advice/attention
Eyes
IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
If eye irritation persists: Get medical advice/attention
Storage
Store locked up
Store in a well-ventilated place. Keep container tightly closed
Disposal
Dispose of contents/container to an approved waste disposal plant
Hazards not otherwise classified (HNOC)
Harmful to aquatic life with long lasting effects
WARNING. Cancer and Reproductive Harm - https://www.p65warnings.ca.gov/.

3. Composition/Information on Ingredients

Component	CAS No	Weight %
Trichloroethylene	79-01-6	>95

4. First-aid measures

General Advice	Show this safety data sheet to the doctor in attendance. Immediate medical attention is required.

Eye Contact	In the case of contact with eyes, rinse immediately with plenty of water and seek medical advice.
Skin Contact	Wash off immediately with plenty of water for at least 15 minutes. Immediate medical attention is required.
Inhalation	Remove to fresh air. If not breathing, give artificial respiration. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Immediate medical attention is required.
Ingestion	Do NOT induce vomiting. Call a physician or poison control center immediately.
Most important symptoms and effects	May cause allergic skin reaction. Inhalation of high vapor concentrations may cause symptoms like headache, dizziness, tiredness, nausea and vomiting: Symptoms of allergic reaction may include rash, itching, swelling, trouble breathing, tingling of the hands and feet, dizziness, lightheadedness, chest pain, muscle pain or flushing
Notes to Physician	Treat symptomatically

5. Fire-fighting measures

Suitable Extinguishing Media	Water spray, carbon dioxide (CO2), dry chemical, alcohol-resistant foam.
Unsuitable Extinguishing Media	No information available
Flash Point	No information available
Method -	No information available
Autoignition Temperature	410 °C / 770 °F
Explosion Limits	
Upper	44.8 vol %
Lower	8 vol %
Oxidizing Properties	Not oxidising
Sensitivity to Mechanical Impact	No information available
Sensitivity to Static Discharge	No information available

Specific Hazards Arising from the Chemical
Thermal decomposition can lead to release of irritating gases and vapors. Containers may explode when heated. Keep product and empty container away from heat and sources of ignition.

Hazardous Combustion Products
Chlorine. Phosgene. Carbon monoxide (CO). Carbon dioxide (CO_2). Hydrogen chloride gas.

Protective Equipment and Precautions for Firefighters
As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear. Thermal decomposition can lead to release of irritating gases and vapors.

NFPA

Health	Flammability	Instability	Physical hazards
2	1	0	N/A

6. Accidental release measures

Personal Precautions	Ensure adequate ventilation. Use personal protective equipment as required. Keep people away from and upwind of spill/leak. Evacuate personnel to safe areas.
Environmental Precautions	Should not be released into the environment. Do not flush into surface water or sanitary sewer system.

Methods for Containment and Clean Up	Soak up with inert absorbent material. Keep in suitable, closed containers for disposal.

7. Handling and storage

Handling	Wear personal protective equipment/face protection. Do not get in eyes, on skin, or on clothing. Use only under a chemical fume hood. Do not breathe mist/vapors/spray. Do not ingest. If swallowed then seek immediate medical assistance.
Storage.	Keep containers tightly closed in a dry, cool and well-ventilated place. Protect from light. Do not store in aluminum containers. Incompatible Materials. Strong oxidizing agents. Strong bases. Amines. Alkali metals. Metals. .

8. Exposure controls / personal protection

Exposure Guidelines

Component	ACGIH TLV	OSHA PEL	NIOSH IDLH	Mexico OEL (TWA)
Trichloroethylene	TWA: 10 ppm STEL: 25 ppm	(Vacated) TWA: 50 ppm (Vacated) TWA: 270 mg/m³ Ceiling: 200 ppm (Vacated) STEL: 200 ppm (Vacated) STEL: 1080 mg/m³ TWA: 100 ppm	IDLH: 1000 ppm	TWA: 10 ppm STEL: 25 ppm

Legend

ACGIH - American Conference of Governmental Industrial Hygienists
OSHA - Occupational Safety and Health Administration
NIOSH IDLH: NIOSH - National Institute for Occupational Safety and Health

Engineering Measures	Use only under a chemical fume hood. Ensure adequate ventilation, especially in confined areas. Ensure that eyewash stations and safety showers are close to the workstation location.

Personal Protective Equipment

Eye/face Protection	Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166.
Skin and body protection	Wear appropriate protective gloves and clothing to prevent skin exposure.
Respiratory Protection	Follow the OSHA respirator regulations found in 29 CFR 1910.134 or European Standard EN 149. Use a NIOSH/MSHA or European Standard EN 149 approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced.
Hygiene Measures	Handle in accordance with good industrial hygiene and safety practice.

9. Physical and chemical properties

Physical State	Liquid
Appearance	Colorless
Odor	Characteristic
Odor Threshold	No information available
pH	No information available
Melting Point/Range	-85 °C / -121 °F
Boiling Point/Range	87 °C / 188.6 °F
Flash Point	No information available
Evaporation Rate	0.69 (Carbon Tetrachloride = 1.0)

Flammability (solid,gas)	Not applicable
Flammability or explosive limits	
Upper	44.8 vol %
Lower	8 vol %
Vapor Pressure	77.3 mbar @ 20 °C
Vapor Density	4.5 (Air = 1.0)
Specific Gravity	1.460
Solubility	Insoluble in water
Partition coefficient; n-octanol/water	No data available
Autoignition Temperature	410 °C / 770 °F
Decomposition Temperature	> 120°C
Viscosity	0.55 mPa.s (25°C)
Molecular Formula	C2 H Cl3
Molecular Weight	131.39

10. Stability and reactivity

Reactive Hazard	None known, based on information available
Stability	Light sensitive.
Conditions to Avoid	Incompatible products. Excess heat. Exposure to light. Exposure to moist air or water.
Incompatible Materials	Strong oxidizing agents, Strong bases, Amines, Alkali metals, Metals,
Hazardous Decomposition Products	Chlorine, Phosgene, Carbon monoxide (CO), Carbon dioxide (CO_2), Hydrogen chloride gas
Hazardous Polymerization	Hazardous polymerization does not occur.
Hazardous Reactions	None under normal processing.

11. Toxicological information

Acute Toxicity

Product Information

Component Information

Component	LD50 Oral	LD50 Dermal	LC50 Inhalation
Trichloroethylene	LD50 = 4920 mg/kg (Rat)	LD50 = 29000 mg/kg (Rabbit)	LC50 = 26 mg/L (Rat) 4 h

Toxicologically Synergistic Products No information available

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Irritation	Irritating to eyes and skin
Sensitization	May cause sensitization by skin contact
Carcinogenicity	The table below indicates whether each agency has listed any ingredient as a carcinogen.

Component	CAS No	IARC	NTP	ACGIH	OSHA	Mexico
Trichloroethylene	79-01-6	Group 1	Known	A2	X	A2

IARC (International Agency for Research on Cancer)	*IARC (International Agency for Research on Cancer)* *Group 1 - Carcinogenic to Humans* *Group 2A - Probably Carcinogenic to Humans* *Group 2B - Possibly Carcinogenic to Humans*
NTP: (National Toxicity Program)	*NTP: (National Toxicity Program)* *Known - Known Carcinogen* *Reasonably Anticipated - Reasonably Anticipated to be a Human Carcinogen*
ACGIH: (American Conference of Governmental Industrial Hygienists)	*A1 - Known Human Carcinogen* *A2 - Suspected Human Carcinogen*

A3 - Animal Carcinogen
ACGIH: (American Conference of Governmental Industrial Hygienists)

Mutagenic Effects	Mutagenic effects have occurred in humans.
Reproductive Effects	No information available.
Developmental Effects	No information available.
Teratogenicity	No information available.
STOT - single exposure	Central nervous system (CNS)
STOT - repeated exposure	Kidney Liver Heart spleen Blood
Aspiration hazard	No information available
Symptoms / effects,both acute and delayed	Inhalation of high vapor concentrations may cause symptoms like headache, dizziness, tiredness, nausea and vomiting: Symptoms of allergic reaction may include rash, itching, swelling, trouble breathing, tingling of the hands and feet, dizziness, lightheadedness, chest pain, muscle pain or flushing
Endocrine Disruptor Information	No information available
Other Adverse Effects	The toxicological properties have not been fully investigated.

12. Ecological information

Ecotoxicity

Harmful to aquatic organisms, may cause long-term adverse effects in the aquatic environment. Do not empty into drains. The product contains following substances which are hazardous for the environment. Contains a substance which is:. Harmful to aquatic organisms. Toxic to aquatic organisms.

Component	Freshwater Algae	Freshwater Fish	Microtox	Water Flea
Trichloroethylene	EC50: = 175 mg/L, 96h (Pseudokirchneriella subcapitata) EC50: = 450 mg/L, 96h (Desmodesmus subspicatus)	LC50: 31.4 - 71.8 mg/L, 96h flow-through (Pimephales promelas) LC50: 39 - 54 mg/L, 96h static (Lepomis macrochirus)	EC50 = 0.81 mg/L 24 h EC50 = 115 mg/L 10 min EC50 = 190 mg/L 15 min EC50 = 235 mg/L 24 h EC50 = 410 mg/L 24 h EC50 = 975 mg/L 5 min	EC50: = 2.2 mg/L, 48h (Daphnia magna)

Persistence and Degradability	Persistence is unlikely based on information available.
Bioaccumulation/ Accumulation	No information available.
Mobility	Will likely be mobile in the environment due to its volatility.

Component	log Pow
Trichloroethylene	2.4

13. Disposal considerations

Waste Disposal Methods	Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. Chemical waste generators must also consult local, regional, and national hazardous waste regulations to ensure complete and accurate classification.

Component	RCRA - U Series Wastes	RCRA - P Series Wastes
Trichloroethylene - 79-01-6	U228	-

14. Transport information

DOT

UN-No	UN1710
Proper Shipping Name	TRICHLOROETHYLENE
Hazard Class	6.1

Packing Group	III

TDG

UN-No	UN1710
Proper Shipping Name	TRICHLOROETHYLENE
Hazard Class	6.1
Packing Group	III

IATA

UN-No	UN1710
Proper Shipping Name	TRICHLOROETHYLENE
Hazard Class	6.1
Packing Group	III

IMDG/IMO

UN-No	UN1710
Proper Shipping Name	TRICHLOROETHYLENE
Hazard Class	6.1
Packing Group	III

15. Regulatory information

United States of America Inventory

Component	CAS No	TSCA	TSCA Inventory notification - Active-Inactive	TSCA - EPA Regulatory Flags
Trichloroethylene	79-01-6	X	ACTIVE	R;S

Legend:
TSCA US EPA (TSCA) - Toxic Substances Control Act, (40 CFR Part 710)
X - Listed
'-' - Not Listed
R - Indicates a substance that is the subject of a Section 6 risk management rule under TSCA.

TSCA 12(b) - Notices of Export

Component	CAS No	**TSCA 12(b)** - Notices of Export
Trichloroethylene	79-01-6	Section 5 Section 6

International Inventories

Canada (DSL/NDSL), Europe (EINECS/ELINCS/NLP), Philippines (PICCS), Japan (ENCS), Japan (ISHL), Australia (AICS), China (IECSC), Korea (KECL).

Component	CAS No	DSL	NDSL	EINECS	PICCS	ENCS	ISHL	AICS	IECSC	KECL
Trichloroethylene	79-01-6	X	-	201-167-4	X	X	X	X	X	X

KECL - NIER number or KE number (http://ncis.nier.go.kr/en/main.do)

U.S. Federal Regulations

SARA 313

Component	CAS No	Weight %	SARA 313 - Threshold Values %
Trichloroethylene	79-01-6	>95	0.1

SARA 311/312 Hazard Categories See section 2 for more information

CWA (Clean Water Act)

Component	CWA - Hazardous Substances	CWA - Reportable Quantities	CWA - Toxic Pollutants	CWA - Priority Pollutants
Trichloroethylene	X	100 lb	X	X

Clean Air Act

Component	HAPS Data	Class 1 Ozone Depletors	Class 2 Ozone Depletors

Trichloroethylene	X		-

OSHA - Occupational Safety and Health Administration Not applicable

CERCLA This material, as supplied, contains one or more substances regulated as a hazardous substance under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) (40 CFR 302)

Component	Hazardous Substances RQs	CERCLA EHS RQs
Trichloroethylene	100 lb 1 lb	-

California Proposition 65 This product contains the following Proposition 65 chemicals.

Component	CAS No	California Prop. 65	Prop 65 NSRL	Category
Trichloroethylene	79-01-6	Carcinogen Developmental Male Reproductive	14 µg/day 50 µg/day	Developmental Carcinogen

U.S. State Right-to-Know Regulations

Component	Massachusetts	New Jersey	Pennsylvania	Illinois	Rhode Island
Trichloroethylene	X	X	X	X	X

U.S. Department of Transportation

Reportable Quantity (RQ):	Y
DOT Marine Pollutant	N
DOT Severe Marine Pollutant	N

U.S. Department of Homeland Security This product does not contain any DHS chemicals.

Other International Regulations

Mexico - Grade No information available

Authorisation/Restrictions according to EU REACH

Component	REACH (1907/2006) - Annex XIV - Substances Subject to Authorization	REACH (1907/2006) - Annex XVII - Restrictions on Certain Dangerous Substances	REACH Regulation (EC 1907/2006) article 59 - Candidate List of Substances of Very High Concern (SVHC)
Trichloroethylene	Carcinogenic Category 1B Article 57 Application date: October 21, 2014 Sunset date: April 21, 2016 Exemption - None	Use restricted. See item 28. (see link for restriction details) Use restricted. See item 75. (see link for restriction details)	SVHC Candidate list - 201-167-4 - Carcinogenic, Article 57a

After the sunset date the use of this substance requires either an authorization or can only be used for exempted uses, e.g. use in scientific research and development which includes routine analytics or use as intermediate.

https://echa.europa.eu/authorisation-list
https://echa.europa.eu/substances-restricted-under-reach
https://echa.europa.eu/candidate-list-table

Safety, health and environmental regulations/legislation specific for the substance or mixture

Component	CAS No	OECD HPV	Persistent Organic Pollutant	Ozone Depletion Potential	Restriction of Hazardous Substances (RoHS)
Trichloroethylene	79-01-6	Listed	Not applicable	Not applicable	Not applicable

Component	CAS No	Seveso III Directive	Seveso III Directive	Rotterdam	Basel Convention

		(2012/18/EC) - Qualifying Quantities for Major Accident Notification	**(2012/18/EC) - Qualifying Quantities for Safety Report Requirements**	**Convention (PIC)**	**(Hazardous Waste)**
Trichloroethylene	79-01-6	Not applicable	Not applicable	Not applicable	Annex I - Y45

16. Other information

Prepared By	Regulatory Affairs Thermo Fisher Scientific Email: EMSDS.RA@thermofisher.com
Creation Date	03-Feb-2010
Revision Date	24-Dec-2021
Print Date	24-Dec-2021
Revision Summary	This document has been updated to comply with the US OSHA HazCom 2012 Standard replacing the current legislation under 29 CFR 1910.1200 to align with the Globally Harmonized System of Classification and Labeling of Chemicals (GHS).

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End of SDS

Attachment 2

Job Hazard Analysis Worksheets

JOB HAZARD ANALYSIS WORKSHEET

Phase Description:	RIWP		
Task or Operation:	Mobilization, Drilling, Sampling		
Specific Location:	Entire Site		
Task or Operation Start Date(s):	November 2024	**Task or Operation Duration:**	1 Month
Date of Hazard Analysis:	September 2024		
Job Hazard Analysis Developed by:	PR		
Job Hazard Analysis Reviewed by:	PR		

POTENTIAL HAZARDS DURING THIS TASK and/or OPERATION

Chemical*	Physical	Biological	Radiological
» CVOCs (Groundwater & Vapor) » Metals (Soil)	» Hand Tool Use » Heavy Manual Lifting/Moving » Material Handling » Noise (Sound Pressure Level), dBA » Sharp Objects » Slips/Trips/Falls » Traffic - On or Near Site » Utilities (electrical, gas, water, etc.) - Overhead » Utilities (electrical, gas, water, etc.) - Underground	» N/A	» N/A

HAZARD CONTROL MEASURES USED DURING THIS TASK and/or OPERATION

Administrative Controls: Log In/Out Sheets

PPE Description:

Component	Description
Level A Ensemble	
Boots, chemical-resistant, steel toe and shank	
Gloves, inner, chemical-resistant	
Gloves, outer, chemical-resistant	
Supplied Air Respirator - air-line	
Totally-encapsulating vapor tight chemical protective suit	
Level B Ensemble	
Boots, chemical-resistant, steel toe and shank	
Disposable one-piece hooded chemical resistant splash clothing suit	
Gloves, inner, chemical-resistant	
Gloves, outer, chemical-resistant	

Supplied Air Respirator - air-line

Level C Ensemble	
Air purifying respirator - full face	
Boots, chemical-resistant, steel toe and shank	
Coveralls	
Disposable one-piece hooded chemical resistant splash clothing suit	
Escape Mask	
Gloves, inner, chemical-resistant	
Gloves, outer, chemical-resistant	
Level D Ensemble	
Dust Mask	
Escape Mask	

Gloves

Air-Purifying Respirator Cartridge/Canister Change Schedule:	
Decon Procedures for People & Equipment:	Alconox Tap Water Distilled Water
Required Permit(s):	N/A
Other Information:	

*Detailed Chemical Information is listed on attached Hazardous Substance Profiles and/or SDS

Attachment 3

Directions to Hospital

Directions to Hospital

32-20 38th Ave
Long Island City, NY 11101

⚠ This route has tolls.

Take 31st St to Northern Blvd

2 min (0.3 mi)

1. Head northeast toward 38th Ave

89 ft

2. Turn left onto 38th Ave

430 ft

3. Turn left at the 2nd cross street onto 31st St

0.2 mi

Continue to Jackson Ave

7 min (0.9 mi)

4. Continue onto Northern Blvd

0.2 mi

5. Continue onto Queens Plz E

299 ft

6. Continue onto Jackson Ave

0.7 mi

Get on I-495 W

3 min (0.5 mi)

7. Continue straight to stay on Jackson Ave

0.3 mi

8. Turn left onto 50th Ave
⚠ Toll road

0.1 mi

9. Take the ramp onto I-495 W
⚠ Toll road

0.1 mi

Follow I-495 W to E 37th St in Manhattan. Take the 3 Ave/41 St exit from I-495 W

2 min (1.4 mi)

10. Merge onto I-495 W
⚠ Toll road

256 ft

11. Keep right to stay on I-495 W
⚠ Toll road

1.3 mi

12. Take the 3 Ave/41 St exit toward Uptown/38 St
⚠ Toll road

0.1 mi

13. Take the ramp to 39th St
⚠ Toll road

16 ft

Take 2nd Ave to 1st Ave.

5 min (0.8 mi)

14. Turn right onto E 37th St

430 ft

15. Turn right onto 2nd Ave

0.5 mi

16. Turn left onto E 26th St

0.1 mi

17. Turn left onto 1st Ave.
ⓘ Destination will be on the right

397 ft

NYC Health + Hospitals / Bellevue.
462 1st Ave., New York, NY 10016

APPENDIX D

COMMUNITY AIR MONITORING PLAN (CAMP)

vEKtor consultants

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f: +1.347.402.7735

info@vektorconsultants.com
www.vektorconsultants.com

COMMUNITY AIR MONITORING PLAN

Prepared For:	38-18 33rd Street LLC and 32-20 38th Avenue LLC c/o Cavu Property Group
Project Name:	Former Refron Inc. Gas Reclamation Site
BCP Site No:	C241285
Project Location:	38-18 33rd Street and 32-20 38th Avenue, Queens New York 11101
Date:	March 2025

37 West 37th Street, 6th Floor, New York, NY 10018

Table of Contents

Appendix A: Action Limit Report

1.0 INTRODUCTION

This site-specific Community Air Monitoring Plan (CAMP) has been prepared on behalf of 38-18 33rd Street LLC and 32-20 38th Avenue LLC for the implementation of a Remedial Investigation Work Plan by Vektor Consultants (Vektor) and its subcontractors at the property located at 38-18 33rd Street and 32-20 38th Avenue in Queens, New York (the "Site"). The Site is identified by the New York City Department of Finance Tax Block 381, Lots 5 and 16.

This CAMP was developed in accordance with the New York State Department of Health (NYSDOH) Generic Community Air Monitoring Plan included within DER-10 Technical Guidance for Site Investigation and Remediation (May 2010). All instruments will be operated and calibrated as per the manufacturer's specifications.

A CAMP requires real-time monitoring for volatile organic compounds (VOCs) and particulates (i.e., dust) at the downwind and upwind perimeters of each designated work area when certain activities are in progress at contaminated sites. The CAMP is not intended for use in establishing action levels for worker respiratory protection. Rather, its intent is to provide a measure of protection for the downwind community (i.e., off-site receptors including residences and businesses and on-site workers not directly involved with the subject work activities) from potential airborne contaminant releases as a direct result of investigative and remedial work activities. The action levels specified herein require increased monitoring, corrective actions to abate emissions, and/or work shutdown. Additionally, the CAMP helps to confirm that work activities did not spread contamination off-site through the air.

Reliance on the CAMP should not preclude simple, common-sense measures to keep VOCs, dust, and odors at a minimum around the work areas.

Adjacent buildings are located to the west and south of the subject property. A Special Requirements CAMP (SR-CAMP) will need to be implemented when remedial investigation activities are occurring within 20 feet of any occupied adjacent building.

2.0 COMMUNITY AIR MONITORING PLAN

A Phase II investigation was conducted by Vektor Consultants, LLC in September 2024. Based on their findings, impacts to groundwater, including trichloroethene (TCE) and tetrachloroethene (PCE) and trans-1,2-dichloroethylene, and soil vapor, including low concentrations of petroleum-related VOCs and elevated concentrations of chlorinated VOCs (CVOCs) in all soil vapor samples, were identified beneath the Site. Furthermore, Freon was detected at elevated concentrations in almost all soil vapor samples. Although Freon does not have a regulatory standard, it was utilized during the historical operations at the Site, and therefore, the results suggest a release from former uses of the Site.

Based on the results of the Phase II Environmental Site Assessment, which detail the impacts to groundwater and soil vapor beneath the Site, Vektor recommended reporting the results to the NYSDEC and remediating the Site under one of their available programs. Therefore, real-time air monitoring for VOCs and/or particulate levels at the perimeter of the exclusion zone or work area will be necessary.

Continuous monitoring will be required for all ground intrusive activities. Ground intrusive activities include, but are not limited to, soil/waste excavation and handling, test pitting or trenching, and the installation of soil borings, soil vapor points, or monitoring wells.

Periodic monitoring for VOCs will be required during non-intrusive activities such as the collection of soil and sediment samples or the collection of groundwater samples from existing monitoring wells. Periodic monitoring during sample collection might reasonably consist of taking a reading upon arrival at a sample location, monitoring while opening a well cap or overturning soil, monitoring during well baling/purging, and taking a reading prior to leaving a sample location. In some instances, depending upon the proximity of potentially exposed individuals, continuous monitoring may be required during sampling activities. Examples of such situations include groundwater sampling at wells on the curb of a busy urban street, in the midst of a public park, or adjacent to a school or residence.

Meteorological monitoring including temperature, wind direction and speed will be conducted by the field personnel and the data will be logged in the field book on a daily basis. CAMP station(s) will be relocated based on the direction of the wind.

Special Requirements for Work Within 20 Feet of Potentially Exposed Individuals or Structures

When work areas are within 20 feet of potentially exposed populations or occupied structures, the continuous monitoring locations for VOCs and particulates will reflect the nearest potentially exposed individuals and the location of ventilation system intakes for nearby structures. The use of engineering controls such as vapor/dust barriers, temporary negative-pressure enclosures, or special ventilation devices will be considered to prevent exposures related to the work activities and to control dust and odors. Consideration will also be given to implementing the planned activities when potentially exposed populations are at a minimum, such as during weekends or evening hours in non-residential settings.

3.0 VOC MONITORING, RESPONSE LEVELS, AND ACTIONS

Volatile organic compounds (VOCs) must be monitored at the downwind and upwind perimeters of the immediate work area (i.e., the exclusion zone) on a continuous basis or as otherwise specified. Concentrations will be measured at the start of each workday and periodically thereafter to establish background conditions, particularly if wind direction changes. The monitoring work should be performed using equipment appropriate to measure the types of contaminants known or suspected to be present. The equipment should be calibrated at least daily for the contaminant(s) of concern or for an appropriate surrogate. The equipment should be capable of calculating 15-minute running average concentrations, which will be compared to the levels specified below.

- If the ambient air concentration of total organic vapors at the downwind perimeter of the work area or exclusion zone exceeds 5 parts per million (ppm) above background for the 15-minute average, work activities must be temporarily halted and monitoring continued. If the total organic vapor level readily decreases (per instantaneous readings) below 5 ppm over background, work activities can resume with continued monitoring.
- If total organic vapor levels at the downwind perimeter of the work area or exclusion zone persist at levels in excess of 5 ppm over background but less than 25 ppm, work activities must be halted, the source of vapors identified, corrective actions taken to abate emissions, and monitoring continued. After these steps, work activities can resume provided that the total organic vapor level 200 feet downwind of the exclusion zone or half the distance to the nearest potential receptor or residential/commercial structure, whichever is less - but in no case less than 20 feet, is below 5 ppm over background for the 15-minute average.
- If the organic vapor level is above 25 ppm at the perimeter of the work area, activities must be shutdown.
- All 15-minute readings must be recorded and be available for the NYSDEC and NYSDOH personnel to review. Instantaneous readings, if any, used for decision purposes should also be recorded.

SR-CAMP

- If total VOC concentrations opposite the walls of occupied structures or next to intake vents exceed 1 ppm, monitoring will occur within the occupied structure(s). Depending upon the nature of contamination, chemical-specific colorimetric tubes of sufficient sensitivity may be necessary for comparing the exposure point concentrations with appropriate pre-determined response levels (response actions will be pre-determined). Background readings in the occupied spaces will be taken prior to commencement of the planned work. Any unusual background readings will be discussed with NYSDOH prior to commencement of the work.

- If total particulate concentrations opposite the walls of occupied structures or next to intake vents exceed 150 mcg/m^3, work activities will be suspended until controls are implemented and are successful in reducing the total particulate concentration to150 mcg/m^3 or less at the monitoring point.
- Depending upon the nature of contamination and remedial activities, other parameters (e.g., explosivity, oxygen, hydrogen sulfide, carbon monoxide) may also need to be monitored. Response levels and actions will be pre-determined, as necessary.

4.0 PARTICULATE MONITORING, RESPONSE LEVELS, AND ACTIONS

Particulate concentrations should be monitored continuously at the upwind and downwind perimeters of the exclusion zone at temporary particulate monitoring stations (i.e.: DustTrak). The particulate monitoring should be performed using real-time monitoring equipment capable of measuring particulate matter less than 10 micrometers in size (PM-10) and capable of integrating over a period of 15 minutes (or less) for comparison to the airborne particulate action level. The equipment must be equipped with an audible alarm to indicate exceedance of the action level. In addition, fugitive dust migration should be visually assessed during all work activities.

- If the downwind PM-10 particulate level is 100 micrograms per cubic meter (mcg/m^3) greater than background (upwind perimeter) for the 15-minute period or if airborne dust is observed leaving the work area, then dust suppression techniques must be employed. Work may continue with dust suppression techniques provided that downwind PM-10 particulate levels do not exceed 150 mcg/m^3 above the upwind level and provided that no visible dust is migrating from the work area.
- If, after implementation of dust suppression techniques, downwind PM-10 particulate levels are greater than 150 mcg/m^3 above the upwind level, work must be stopped, and a re-evaluation of activities initiated. Work can resume provided that dust suppression measures and other controls are successful in reducing the downwind PM-10 particulate concentration to within 150 mcg/m^3 of the upwind level and in preventing visible dust migration.
- All readings must be recorded and be available for the NYSDEC and NYSDOH personnel to review.

Dust suppression will be achieved by applying water as needed.

APPENDIX A

ACTION LIMIT REPORT

CAMP
ACTION LIMIT REPORT

Project Location: 32-20 38th Avenue and 33-18 33rd Street, Queens, NY

Date: ______________________________ Time: ________________________

Name: ______________________________

Contaminant: _________________________ PM-10: __________ VOC: ________________________

Wind Speed: __________________________ Wind Direction: _______________

Temperature: _________________________ Barometric Pressure: _________

DOWNWIND DATA

Monitor ID #: ________________________ Location: _________ Level Reported: _______________

Monitor ID#: ________________________ Location: _________ Level Reported: _______________

UPWIND DATA

Monitor ID #: ________________________ Location: _________ Level Reported: _______________

Monitor ID#: ________________________ Location: _________ Level Reported: _______________

BACKGROUND CORRECTED LEVELS

Monitor ID #: Location: _______________ Level Reported: Level Reported: ___________________

ACTIONS TAKEN

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