NEWTOWN CREEK BUD SITE – NORTH BLOCK

2-21 MALT DRIVE, LONG ISLAND CITY
QUEENS, NEW YORK

Indoor Air Quality Work Plan

NYSDEC BCP Site No: C241248
AKRF Project Number: 200112

Prepared for:

Bud North LLC
387 Park Ave South, 7th Floor
New York, New York 10016

Prepared by:

AKRF, Inc.
440 Park Avenue South, 7th Floor
New York, New York 10016
(212) 696-0670

MAY 2024

TABLE OF CONTENTS

FIGURES

TABLES

APPENDIX

1.0 CERTIFICATION

I, Rebecca Kinal, P.E., certify that I am currently a New York State registered Professional Engineer as defined in 6 NYCRR Part 375 and that this Indoor Air Quality Work Plan was prepared in accordance with all applicable statutes and regulations and in substantial conformance with the DER Technical Guidance for Site Investigation and Remediation (DER-10).

Rebecca Kinal, P.E.		05/2/2024
Name	Signature	Date

REBECCA A. KINAL
082046-1

2.0 INTRODUCTION

This Indoor Air Quality (IAQ) Work Plan describes the procedures to be used during the pre-occupancy indoor air quality assessment, which will be performed at the Newtown Creek Bud Site (NCBS) – North Block project site, located at 2-21 Malt Drive in Long Island City, Queens, New York (hereinafter referred to as the "Site"). The Site, which is identified on the New York City Tax Map as Queens Borough Block 11, Lot 1, was remediated under the New York State Department of Environmental Conservation (NYSDEC) Brownfield Cleanup Program (BCP Site No. C241248).

This IAQ Work Plan describes the procedures to be used during the IAQ assessment, which will include collection of indoor and ambient air samples to confirm the effectiveness of the sub-slab depressurization system (SSDS) and soil vapor system (SVE) at preventing contaminated vapors from entering the Site building. The results of the assessment will be documented in an IAQ Report, which will evaluate Site-specific data in comparison to the New York State Department of Health (NYSDOH) Air Guidance Values (AGVs) and background conditions. All work will be completed in accordance with the Final Guidance for Evaluating Soil Vapor Intrusion in the State of New York (2006), with updates (SVI Guidance), this work plan, and the Quality Assurance Project Plan (QAPP) (Appendix A) and the Health and Safety Plan (HASP) (Appendix B), which were both included in the NYSDEC-approved Site Management Plan (SMP), dated December 27, 2023. Key project team members are summarized in Section 2.0 of the QAPP, and resumes of the project personnel are included in Attachment A of the QAPP.

3.0 SITE DESCRIPTION AND HISTORY

3.1 Site Description and Surrounding Land Use

The Site is bounded to the north by 54th Avenue, followed by various shipping and storage warehouses (including construction supplies, and iron and wireworks); to the west by 2nd Street, followed by a construction site; to the south by the NCBS – South Block site (currently under construction), followed by Newtown Creek; and to the east by a van and bus rental facility, followed by an air conditioning supplies and parts warehouse. The surrounding area is predominately mixed-use residential and commercial, with some industrial uses. The Site consists of a multi-story mixed-use commercial and residential building that is currently under construction. The Site is zoned residential with a commercial overlay and is part of the Special Southern Hunters Point District, allowing for additional development of high density residential mixed-use projects, a public park, and waterfront open space. The current Site occupants include construction workers and inspectors. Once the new building is complete, occupants will include residents, building staff and maintenance crews, and commercial tenants. The Site location is shown on Figure 1.

3.2 Site Geology, Hydrogeology, and Subsurface Characteristics

The surface topography in the area immediately surrounding the Site generally slopes south-southwest towards Newtown Creek and the East River. According to a topographic and boundary survey prepared by Fehringer Surveying, P.C., dated June 6, 2019 (revised April 23, 2021), the ground surface elevation in sidewalk-adjacent areas of the Site is between approximately 6 and 7 feet above the North American Vertical Datum of 1988 (NAVD88).

Based on the investigations conducted at the Site prior to redevelopment, subsurface conditions consisted of historic fill (generally sand with silt, gravel, concrete, brick, and trace amounts of asphalt) down to approximately 10 to 13 feet below grade surface (bgs), underlain by apparent native sand, gravel, and silt, with trace amounts of clay down to approximately 20 feet bgs (the maximum soil boring depth). Bedrock was not encountered during AKRF's previous investigation. As part of Site remediation, excavation was conducted to depths between 2 and 11 feet bgs across the Site. Following excavation, NYSDEC-approved fill material was imported and used as backfill to bring the Site grade to the slab elevation for the new building. Based pre-remedial investigations performed by AKRF, Inc. (AKRF), the groundwater elevation ranges between elevation (el.) 0.76 feet and el. 0.34 feet above the North American Vertical Datum of 1988 (NAVD88), based on measurements taken from six on-site permanent monitoring wells installed as part of the RI. Groundwater in this part of Queens is not used as a source of potable water.

3.3 Site History

AKRF's March 2019 Phase I Site Assessment indicated that the property that includes the Site was developed since at least the 1890s with industrial uses, including New York Sugar Refining Co., C. Hommel Stone Yard, The White Granite Co., and H.F. Burrough's Lumber Yard. Auto repair and garages with gasoline tanks were identified in the northern portion of the Site between 1915 and 1986. By 1970, Standard Folding Cartons Inc. occupied a warehouse in the central portion of the Site and continued to do so up until approximately 1991, when it was shown as a warehouse of unspecified use. Solvent tanks were identified in the southern-adjacent site (the South Block site) between 1977 and 1986. The northern portion of the Site was primarily occupied by parking and storage areas in the late 1980s through 2006.

The Site was remediated between March 2022 and October 2023 under an NYSDEC-approved Remedial Action Work Plan (RAWP). The RAWP included remedial excavation, groundwater treatment, and construction of Engineering Controls (ECs), including a site-wide cover system, and an SSDS and SVE system within the new building.

4.0 FIELD PROGRAM

The SMP requires IAQ sampling within the newly constructed building envelope prior to building occupancy to confirm that operation of the SSDS and SVE systems are effective in mitigating potential vapor intrusion within the new building. Indoor air sampling will be conducted within the building during two IAQ sampling events: one prior to building occupancy in spring/summer 2024, and one during the 2024 - 2025 heating season. Completion of the building envelope will be verified and documented. Prior to sampling, all windows, doors, and other openings will be sealed and airtight; the sampling areas will be free of active construction and associated materials; and the building's HVAC system will be operational. If these conditions are not met, the sampling will be postponed until such time as they are met.

Indoor air sampling will be conducted from eight locations. During both sampling rounds, one ambient (outdoor) air sample (AA-1) will be collected for Quality Assurance/Quality Control (QA/QC) purposes and to document background conditions. The indoor air and ambient air samples will be collected via 6-liter Summa Canisters over a required 24-hour period. Daily summary reports will be submitted to NYSDEC for each day of field work. The samples will be submitted to a NYSDOH Environmental Laboratory Program (ELAP)-certified laboratory for analysis of volatile organic compounds (VOCs) by Environmental Protection Agency (EPA) Method TO-15. The results of the indoor air sampling will be documented in an IAQ Report that will be submitted to NYSDEC and NYSDOH.

4.1 Indoor Air Sampling

Indoor air samples IA-01 through IA-08 will be collected from the breathing zone. The samples will be collected using batch-certified, 6-Liter SUMMA® canisters equipped with vacuum gauges and flow controllers calibrated to collect the samples over an approximately 24-hour period. Each SUMMA® canister will be placed at typical breathing zone height (approximately 3 to 4 feet above the floor) during collection. Immediately after opening the flow control valve, the initial SUMMA® canister vacuum (in. Hg) will be noted. Site conditions will be noted throughout the sampling period, including potential sources of VOCs in the vicinity of the sampling locations, which will be documented on a NYSDOH Indoor Air Quality Questionnaire and Building Inventory Form (Appendix C). Once the vacuum reading on the flow controller reads between approximately -8 in. Hg and -2 in. Hg (after approximately 24 hours), the flow controller valve will be closed, the final vacuum will be noted, and the SUMMA® canister will be placed in a shipping carton for delivery to the laboratory. The proposed sampling locations and rationale are summarized in Table 1 below:

Table 1 – Indoor Air Sampling Rationale

Sample ID	Sample Location	Sampling Rationale
IA-01	Incoming Water Room	Assess indoor air quality in the northwestern portion of building
IA-02	Back of House Vestibule	Assess indoor air quality in the southwestern portion of building
IA-03	Bike Room (west)	Assess indoor air quality in the north-central portion of building
IA-04	Parking Garage	Assess indoor air quality in the central portion of building
IA-05	Package Room	Assess indoor air quality in the south-central portion of building
IA-06	Bike Room (east)	Assess indoor air quality in the northeastern portion of building
IA-07	SVE Equipment Room	Assess indoor air quality in the eastern-central portion of building
IA-08	Service Vestibule No. 2	Assess indoor air quality in the southeastern portion of building

The indoor air quality sample locations were selected based on accessibility of spaces, and to maximize distribution throughout the first floor of the new building. Sampling locations are shown on Figure 2.

4.2 Ambient Air Sampling

One ambient (outdoor) air sample will be collected from an exterior location based on weather conditions and any work or other activities nearby. The ambient air sample will be collected concurrently with the indoor air samples using a batch-certified 6-Liter SUMMA® canister equipped with a vacuum gauge and flow controller calibrated to collect the sample over an approximately 24-hour period. The SUMMA® canister will be placed at typical breathing zone height (approximately 3 to 4 feet above the ground) during collection. Immediately after opening the flow control valve, the initial SUMMA® canister vacuum (in. Hg) will be noted. Conditions will be noted throughout the sampling period, including vacuum of the samples and potential sources of VOCs in the vicinity of the sampling locations. Once the vacuum reading on the flow controller reads between approximately -8 in. Hg and -2 in. Hg (after approximately 24 hours), the flow controller valve will be closed, the final vacuum will be noted, and the SUMMA® canister will be placed in a shipping carton for delivery to the laboratory. Sampling locations are shown on Figure 2.

4.3 Laboratory Analysis

Samples will be shipped to the laboratory with a chain of custody (COC). The indoor air and ambient air samples will be analyzed for VOCs by EPA Method TO-15 by a NYSDOH ELAP-certified laboratory with Category B deliverables and will be validated by a third-party prior to electronic data deliverable (EDD) submission to NYSDEC via EQuIS™.

5.0 REPORTING REQUIREMENTS

5.1 Indoor Air Quality Report

Upon completion of field work and receipt of laboratory analytical results, IAQ Reports will be prepared in compliance with Section 3.14 of DER-10 for each sampling event. The reports will include: a description of sampling methods; a presentation of the field and laboratory analytical results; field data sheets, the pre-sampling inspection form, and laboratory analytical reports as attachments; and an interpretation of the findings with regard to the operation of the SSDS and SVE system. The IAQ Reports will also include:

1. The NYSDOH Indoor Air Quality Questionnaire and Building Inventory Form, including a photo log of the completed rooms in which samples are collected, individual sampling locations, and any products present; and
2. A figure depicting sampling locations and results.

5.1.1 Description of Field Activities

The field activities section of the indoor air quality report will describe the field methods used, including sampling techniques and field screening equipment.

5.1.2 Indoor Air and Ambient Air Assessment

The report will include a section that presents field and laboratory data. Figures will be provided that illustrate the sampling locations. Field and laboratory analytical results will be presented in the body of the report, summarized in tables and figures, and the detected concentrations will be compared to the NYSDOH AGVs and background conditions established as part of the ambient air sampling. Sampling logs and laboratory analytical reports will be provided as attachments.

5.2 Proposed Schedule

The proposed schedule for implementation of the IAQWP is summarized in Table 2 below.

Table 2 – Proposed Schedule

Activity	Time To Complete
Submittal of Final IAQWP	3-May-24
NYSDEC approval of Final IAQWP	10-May-24
Implementation of Initial IAQ Sampling	20-May-24
Preparation of Initial IAQ Report	3-Jun-24
Submittal of Initial IAQ Report	21-Jun-24
First Building Occupancy	1-Jul-24
Implementation of Heating Season IAQ Sampling	15-Jan-25
Preparation of Heating Season IAQ Report	15-Feb-25
Submittal of Heating Season IAQ Report	1-Mar-25

FIGURES

Service Layer Credits: USGS The National Map: 3d Elevation Program 2020

440 Park Avenue South, New York, NY 10016

Newtown Creek Bud Site - North Block

2-10 54th Avenue - Long Island City, New York

BCP SITE LOCATION

DATE

11/29/2021

PROJECT NO.

200112

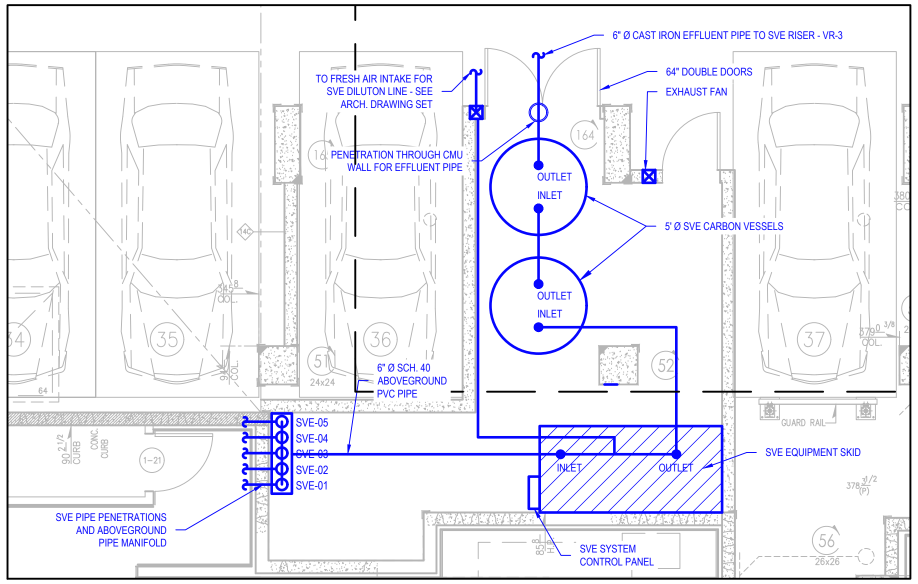
FIGURE

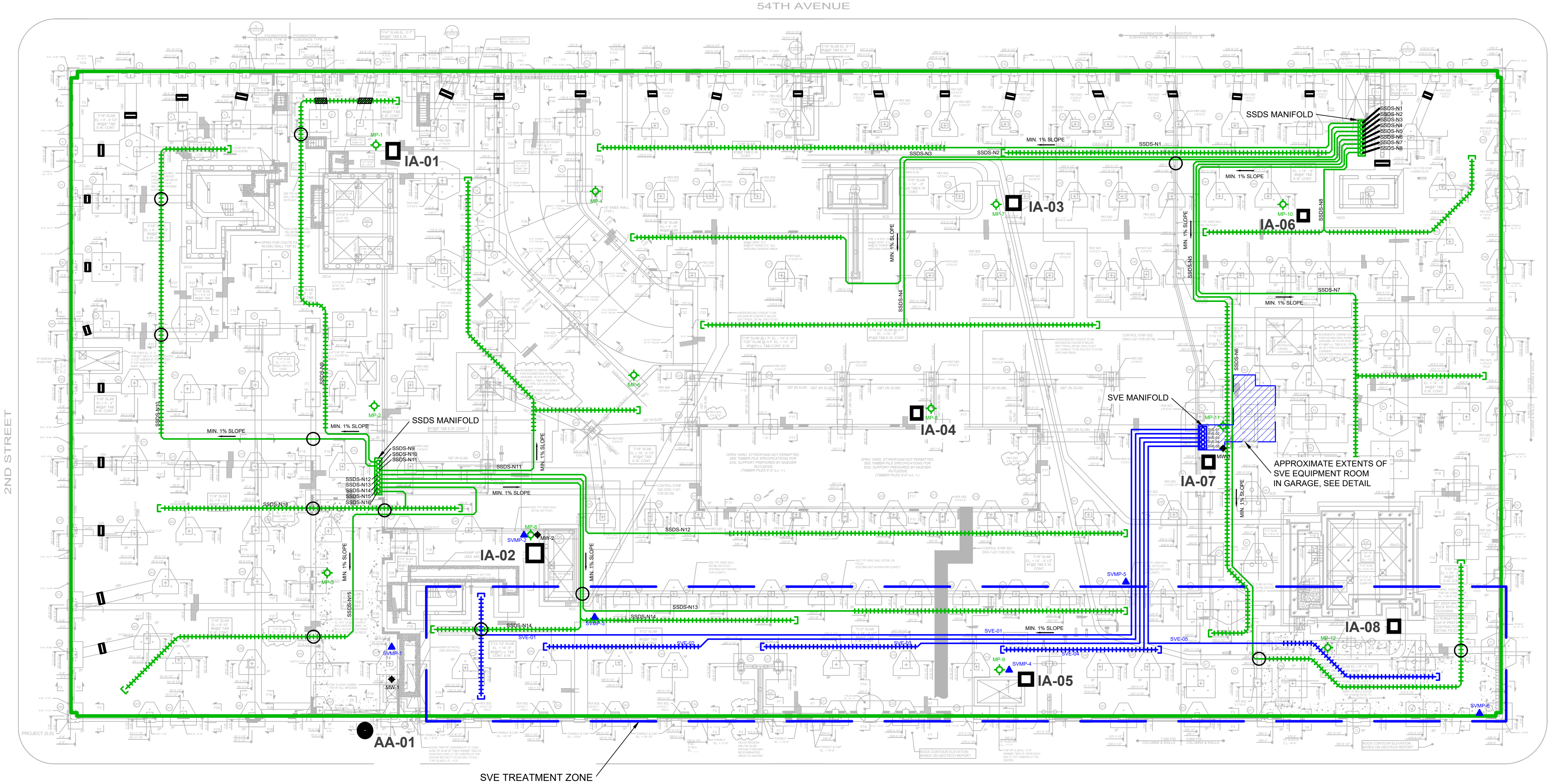
1

©2021 AKRF W:\Projects\200112 - BUD NORTH\Technical\GIS and Graphics\hazmat\200112 Fig 1 site location map.mxd8/25/2021 1:14:13 AM jszalus

SVE EQUIPMENT ROOM LAYOUT

0 5 10 20
SCALE IN FEET





LEGEND

🟩	SSDS TREATMENT ZONE (EXTENT OF WATERPROOFING/ VAPOR BARRIER/GAS-PERMEABLE AGGREGATE
[ ]	SVE TREATMENT ZONE
▬	SSDS COMMUNICATION SLEEVE THROUGH GRADE BEAM
▨	SSDS PIPE SLEEVE THROUGH GRADE BEAM
++++++]	SVE 4" Ø SLOTTED SCHEDULE 40 PVC PIPE WITH PVC END CAP
++++++]	SSDS 4" Ø SLOTTED SCHEDULE 40 PVC PIPE WITH PVC END CAP
—	SSDS/SVE 4" Ø SOLID SCHEDULE 40 PVC PIPE
—○—	SSDS PIPE ELEVATION CHANGE
○○○○○○○○	SSDS/SVE PIPING MANIFOLD
○ SVE-01/SSDS-N8	SSDS/SVE 4" Ø RISER SLAB PENETRATION
⌖ MP-1	SSDS VACUUM MONITORING POINT
▲ SVMP-1	SVE VACUUM MONITORING POINT
◆ MW-1	POST-REMEDIAL GROUNDWATER MONITORING WELL
■ IA-01	PROPOSED INDOOR AIR SAMPING LOCATION
● AA-01	PROPOSED AMBIENT AIR SAMPLING LOCATION

0 20 40 80
SCALE IN FEET

NOTE: PIPE SPACING NOT TO SCALE

AKRF
440 Park Avenue South, New York, NY 10016

Newtown Creek Bud Site - North Block
2-21 Malt Drive - Long Island City, New York

SVE, SSDS AND VAPOR BARRIER PLAN AND INDOOR AIR QUALITY SAMPLING LOCATIONS

DATE
2/27/2024
PROJECT NO.
200112
FIGURE
2

©2021 AKRF, Inc W:\Projects\200112 - BUD NORTH\Technical\Hazmat\RAWP\CAD\200112 Fig 14 SSDS SVE Layout.dwg last save: mveilleux 12/9/2021 4:17 PM

APPENDIX A
QAPP

NEWTOWN CREEK BUD SITE – NORTH BLOCK

2-10 54TH AVENUE

LONG ISLAND CITY, NEW YORK

Quality Assurance Project Plan

BCP Site No.: C241248

OER Project Number: 20TMP0962Q

AKRF Project Number: 200112

Prepared for:

New York State Department of Environmental Conservation
Division of Environmental Remediation, Remedial Bureau B
625 Broadway
Albany, New York 12233

On Behalf Of:

Bud North LLC
387 Park Avenue South
New York, NY 10016

Prepared by:

AKRF, Inc.
440 Park Avenue South, 7th Floor
New York, New York 10016
(212) 696-0670

DECEMBER 2023

TABLE OF CONTENTS

FIGURES

TABLES

ATTACHMENT

1.0 INTRODUCTION

This Quality Assurance Project Plan (QAPP) describes the protocols and procedures that will be followed during implementation of the Site Management Plan (SMP) and associated appendices at the Newtown Creek Bud Site – North Block site (hereinafter referred to as the Site). The Site is located at 2-10 54th Avenue in the Hunters Point South section of Long Island City, New York. The Site is also identified at the address 2-21 Malt Drive and as the New York City Tax Map as New York City Tax Block 11, Lot 1. The Site was remediated under the New York State Department of Environmental Conservation (NYSDEC) Brownfield Cleanup Program (BCP) (BCP Site No. C241248).

The objective of this QAPP is to provide for Quality Assurance (QA) and maintain Quality Control (QC) during sampling performed to evaluate the performance and effectiveness of the remedy to reduce or mitigate contamination at the Site. Adherence to the QAPP will ensure that defensible data will be obtained to confirm the successful operation and maintenance of remedial systems.

2.0 PROJECT TEAM

The project team will be drawn from AKRF professional and technical personnel and AKRF's subcontractors. All field personnel and subcontractors will have completed a 40-hour training course and updated 8-hour refresher course that meet the Occupational Safety and Health Administration (OSHA) requirements of 29 Code of Federal Regulation (CFR) Part 1910. The following sections describe the key project personnel and their responsibilities.

2.1 Remedial Engineer (RE)

Ms. Rebecca A. Kinal, P.E. will serve as the RE for the project throughout Site Management. Ms. Kinal served as the RE during Site remediation and oversaw the design of all Institutional Controls (ICs) and Engineering Controls (ECs) at the Site, and will oversee operation and maintenance (O&M) of ECs under the SMP. Ms. Kinal's resume is included in Attachment A.

2.2 Project Manager

Mr. Patrick Diggins will serve as the Project Manager throughout Site Management. The project manager will be responsible for directing and coordinating all elements of the SMP. The project manager will prepare reports and participate in meetings with the Site owner and/or NYSDEC. Mr. Diggins's resume is included in Attachment A.

2.3 Field Team Leader

The field team leader will be responsible for supervising the daily sampling and health and safety activities in the field and will ensure adherence to the SMP. The field team leader will report to the project manager on a regular basis regarding daily progress and any deviations from the SMP. The field team leader will be a qualified, responsible person able to act professionally and promptly during required activities. The field team leader will be established for each task; however, Mr. Michael Bates is expected to be the field team leader for much of the work under the SMP. Mr. Bates' resume is included in Attachment A.

2.4 Project Quality Assurance/Quality Control (QA/QC) Officer

Mr. Marc Godick will be the Project QA/QC Officer throughout Site Management. The QA/QC Officer will be responsible for adherence to this QAPP. The QA/QC officer will review the procedures with all personnel prior to commencing any fieldwork and will assess implementation of the required procedures. Mr. Godick's resume is included in Attachment A.

2.5 Laboratory Quality Assurance/Quality Control (QA/QC) Officer

The laboratory QA/QC officer will be responsible for QC procedures and checks in the laboratory and ensuring adherence to laboratory protocols. He/She will track the movement of samples from the time they are checked in at the laboratory to the time that analytical results are issued. The laboratory QA/QC officer will conduct a final check on the analytical calculations and sign off on the laboratory reports. The laboratory QA/QC officer will be determined upon selection of a contract laboratory(s) for the SMP.

3.0 DATA QUALITY USABILITY OBJECTIVES

3.1 Project Quality Objectives

The overall project objectives include:

- Documenting groundwater quality at the Site;
- Assessing Soil Vapor Extraction (SVE) system operation through collection of vapor samples;
- Assessing potential for vapor intrusion through collection of indoor air and soil vapor samples;
- Documenting the excavation of any residual contamination, as needed, during Site Management; and
- Documenting the environmental quality of any material imported to the Site, as needed, during Site Management.

In order to meet these objectives:

- Groundwater samples will be analyzed for volatile organic compounds (VOCs), Total Petroleum Hydrocarbons (TPH) – Diesel Range Organics (DRO), and TPH – Oil Range Organics (ORO)
- Indoor air, soil vapor, and vapor samples will be analyzed for VOCs.
- Soil import and/or endpoint samples will be analyzed for (VOCs, semivolatile organic compounds (SVOCs), metals, polychlorinated biphenyls (PCBs), pesticides, per- and polyfluoroalkyl substances (PFAS), and 1,4-dioxane.

Who will use the data?

The collected data will be used by NYSDEC, New York State Department of Health (NYSDOH), the Volunteer, and/or the RE.

What types of data are needed?

Groundwater samples will be collected from post-remedial monitoring wells and analyzed at an off-site laboratory for VOCs, TPH-DRO, and TPH-ORO. Indoor air, soil vapor, and/or vapor samples will be collected and analyzed at an off-site laboratory for VOCs. Soil samples will be collected from excavation areas on-site or from stockpiles at proposed import facilities, as needed, and analyzed at an off-site laboratory for VOCs, SVOCs, metals, pesticides, PCBs, PFAS, and 1,4-dioxane.

How “good” do the data need to be in order to support the environmental decision?

Data requirements and usability will be evaluated as presented in Section 3.2.

How much data are needed?

- Three groundwater samples will be collected from the post-remedial groundwater monitoring wells quarterly for a minimum of two years.
- The number of indoor air and soil vapor samples collected will be determined in collaboration with NYSDEC and NYSDOH.
- Three vapor samples will be collected from the SVE system (influent, intermediate, and effluent) during each periodic sampling event.
- Soil endpoint samples will be collected from the base of any excavation as needed, and analyzed for VOCs, SVOCs, metals, pesticides, PCBs, PFAS, and 1,4-dioxane.
- Material proposed for import will be tested as needed, and analyzed for VOCs, SVOCs, metals, pesticides, PCBs, PFAS, and 1,4-dioxane.

Where, when, and how should the data be collected/generated?

- Groundwater samples will be collected from the post-remedial groundwater monitoring wells.
- Indoor air samples will be collected from within the ground floor of the new building.
- Soil vapor samples will be collected immediately beneath the ground floor slab via monitoring points installed as part of the sub-slab depressurization system (SSDS)
- Vapor samples will be collected from sample collection valves within the SVE system.
- Soil samples will be recovered from the base and sidewalls (if accessible) of any excavation areas, or from stockpiled soil proposed for import to the Site.

Who will collect and generate the data?

AKRF will be responsible for collecting samples. All samples will be analyzed by Alpha Analytical Laboratories Inc. of Westborough, MA (Alpha; subcontracted to AKRF), a NYSDOH ELAP-certified laboratory. AKRF will be responsible for collecting, reviewing, assessing, and disseminating validated data. A qualified data validator will be selected for third party data validation.

How will the data be reported?

The data will be reported in Periodic Review Report(s) (PRRs).

How will the data be archived?

All hard-copy data will be maintained at AKRF offices for a minimum of one year and subsequently archived off-site. Field logbooks and forms will be scanned and all electronic data will be archived on the AKRF corporate server.

3.2 Usability Assessment

Summarize the usability assessment process and all procedures, including interim steps and any statistics, equations, and computer algorithms that will be used:

Data to be used in evaluating project technical objectives must be assessed to determine whether the data are of sufficient quality to allow their unrestricted use. It is the joint responsibility of the Project Manager, and QA/QC Officer to ensure that the data collected meets the requirements specified in this QAPP. After sampling is complete and the laboratory has submitted the final data package, a Third-Party Data Validator will validate the data and prepare the Data Validation and Usability Report (DUSR). This report will include limitations of the data and recommendations on the usability of the data for decision making. The Project Manager will review the report and, as needed, resolve any issues. The DUSR will be provided as an Appendix to the PRR.

Data will be evaluated relative to the criteria established in Section 5.3 (Table 1). The DUSR will also identify any non-conformances and explain any limitations on the use of the data. The following steps are taken in the data review/validation process:

- Verify that all collected samples were analyzed, using chain of custody (COC) records.
- Compare sample collection, extraction and analysis dates to applicable holding times.
- Review all calibration records against method and project criteria (MPC):
    - Verify frequency and criteria of initial calibrations.
    - GC/MS organics: verify frequency and criteria of tune performance analysis.
    - Verify frequency and criteria of continuing calibrations.
    - Recalculate one or more data points from raw data (RF/CF/%D).
- Review MDL study and compare to reported DLs.
- Verify frequency and criteria of method blanks.
- Organic analyses: compare surrogate recovery results to applicable criteria.
- GC/MS analyses: Review internal standard results for RT and area criteria.
- Precision and accuracy results are reviewed against applicable criteria:
    - Matrix duplicate or matrix spike/matrix spike duplicate (MS/MSD) results are compared to RPD criteria.
    - Matrix spike results are compared to % Recovery criteria.
    - Spiked blanked results (LCS) are evaluated against % Recovery criteria.
    - Review field duplicate results against MPC.
- Evaluate results of any trip and field blanks.
- Recalculate 25% of sample results from raw data, using unedited data.
- Assign Data Validation Qualifiers (DVQs) as needed.

Describe the evaluative procedures used to assess overall measurement error associated with the project:

Sample data that do not meet the measurement performance criteria established in this QAPP will be evaluated to determine whether they are usable for meeting project objectives. Data will be assigned a DVQ when the performance criteria are not met and will be considered as estimated values (DVQ = J or UJ) or will be rejected (DVQ = R) based on the degree and impact of the non-conformance. Non-conformances and the DVQ determination will be documented in the DUSR. Guidelines from the United States Environmental Protection Agency (EPA) Region 2 Data Validation SOPs, along with professional judgement, will be used to evaluate sample data and assign DVQs.

Trends in precision and accuracy over the project duration will be assessed by calulating average % recovery of all matrix spikes along with minimum and maximum values and the number of results that fall outside control limits. The range of precision values will be reported along with the number of any outliers. Field duplicate results will be evaluated for each matrix to proivde a measure of representativeness and matrix heterogenity. All results, decisions, and a discussion of the impact on project objectives will be included in the DUSR.

Identify the personnel responsible for performing the usability assessment:

The AKRF Project Manager and Third-Party Data Validator will be responsible for performing the usability assessment.

Describe the documentation that will be generated during the usability assessment and how the usability assessment results will be presented so that they identify trends, relationships (correlations), and anomalies:

Following data review and validation, the Third-Party Data Validator will prepare a DUSR. The report will include the following:

- Introduction: summarizes the purpose of the QA review and validation process and the samples reviewed.
- Data quality indicators: discusses of the measurements and calculations applied to the assessment of the data quality indicators (precision, accuracy, sensitivity, representativeness, comparability and completeness).
- Conclusions and data usability: provides a summary of the results of the QC measurements (averages, ranges, trends) and discusses any limitations in the use of the analytical data.
- QC Results: evaluates all QC measurements as per above (data review) and presents results by analytical parameter. Any non-conformances identified during the review process are discussed with respect to the impact on overall data quality and data usability. QC measurements are summarized and results provided in tabular form (average, range, applicable control limits, and number of results outside limits).

4.0 STANDARD OPERATING PROCEDURES (SOPS)

The following sections describe the SOPs for the monitoring activities included in the SMP. During these operations, all field personnel will wear appropriate personal protective equipment (PPE) and safety monitoring will be performed as described in the Site-specific Health and Safety Plan (HASP) provided as Appendix G of the SMP. SMP implementation will include sampling associated with the O&M of the sub-slab depressurization system (SSDS) and soil vapor extraction (SVE) system. The SMP also includes inspections of the SSDS, SVE system, and the Site composite cover system, and an Excavation Work Plan (EWP) and other provisions and appropriate actions to be taken in the event that future renovation or redevelopment of the Site requires the breaching of the composite cover system and excavation/removal of underlying soil/fill.

In all instances, any atypical or unexpected findings noted during inspections, sampling events, or SMP-governed field work will be communicated immediately to the environmental professional managing the Site work and, as necessary, to the NYSDEC project manager or NYSDEC’s successor agency.

4.1 Excavation and/or Site Composite Cover System Disturbance

The procedures for excavation and/or other invasive work that may disturb remaining contamination beneath the Site composite cover system will be as follows:

- Soil removal and/or other invasive activities will be completed as needed in accordance with the SMP and EWP.
- Following invasive work, the demarcation layer will be replaced to provide a visual reference to the top of the residual management zone (RMZ).

- The composite cover system will be replaced to restore the condition that existed prior to the excavation. In general, the restoration types must match or exceed the existing material and thickness conditions of the Site cover types presented in the SMP to maintain composite cover system integrity across the entire Site.
- Decontaminate all equipment used in composite cover system disturbance as described in Sections 3.2 and 3.3 of this QAPP.

4.2 Decontamination of Sampling Equipment

All sampling equipment (drilling rods and casing, macrocore samplers, probe rods, etc.) will be either dedicated or decontaminated between sampling locations. The decontamination procedure will be as follows:

1. Scrub using a tap water/Alconox™ mixture and bristle brush.
2. Rinse with tap water.
3. Scrub again with a tap water/Alconox™ mixture and bristle brush.
4. Rinse with distilled water.
5. Air-dry the equipment, if possible.

Decontamination will be conducted within 55-gallon drums or on plastic sheeting (or equivalent) that is bermed to prevent discharge to the ground or drains.

4.3 Decontamination for Emerging Contaminants

Prior to sampling for emerging contaminants the sampler must also:

1. Have selected clothes that do not contain perfluorinated compounds (PFCs) (such as GORE-TEX® or other waterproofed items) and laundered them multiple times using detergent that does not contain PFCs.
2. Must be wearing nitrile gloves.
3. Obtained pre-cleaned sample bottles with closures, coolers, ice, sample labels and a chain of custody form provided by the laboratory.
4. Ensured that all sampling equipment components and sample containers have not come in contact with aluminum foil, low density polyethylene (LDPE), glass or polytetrafluoroethylene (PTFE, a.k.a. TeflonTM) materials including sample bottle cap liners with a PTFE layer.
5. Rinse with PFC-free distilled water provided by the laboratory.
6. Air-dry the equipment, if possible.

4.4 Heavy Equipment Decontamination

Decontamination of chemically contaminated heavy equipment (e.g., augers, excavator buckets) will be accomplished using high-pressure steam or dry decontamination with brushes and shovels. Decontamination will take place on a decontamination pad and all liquids used in the decontamination procedure will be collected. Vehicles or equipment brought into an exclusion zone will be treated as contaminated and will be decontaminated prior to removal. All liquids used in the decontamination procedure will be collected, stored, and disposed of in accordance with federal, state, and local regulations. Personnel performing this task will wear the proper PPE as prescribed in the Site-specific HASP.

A decontamination area will be established around the planned excavation area, adjacent to the environmental enclosure. The floor of the decontamination area will be covered with 6-mil plastic sheeting, as necessary, and bermed to prevent spreading of decontamination fluids or potential discharge to the ground surface.

All equipment in direct contact with known or potentially contaminated material will be either dedicated or decontaminated prior to handling less contaminated material or removal from the Site. Decontamination of chemically contaminated heavy equipment will be accomplished using high-pressure steam or by dry decontamination with brushes and shovels. All liquids used in the decontamination procedure will be collected, stored, and disposed of in accordance with federal, state, and local regulations.

4.5 Management of Investigation-Derived Waste (IDW) and Remedial Operation and Maintenance (O&M) Waste

Any IDW and remedial O&M waste will be containerized in New York State Department of Transportation (NYSDOT)-approved 55-gallon drums or other appropriate containers. The drums will be sealed at the end of each workday and labeled with the date, the well or boring number(s), the type of waste (i.e., drill cuttings, development water or purge water), and the name of an AKRF point-of-contact. Drums will be staged in secure areas, away from public access, to the extent practicable.

Soil/fill samples collected from soil boring or excavation activities will be used for waste characterization of soil/fill, since such data would be biased towards areas which are expected to be most contaminated. Additional waste characterization soil or other samples may be collected, if requested by the disposal facility. All IDW and remedial waste will be disposed of or treated according to applicable local, state, and federal regulations.

5.0 SAMPLING AND LABORATORY PROCEDURES

5.1 Import Soil/Fill Sampling

Prior to importing soil/fill for use as backfill, the intended imported material will be evaluated using the following procedures:

- A segregated stockpile of the intended imported material will be made available for sampling at a frequency and for the required parameters as outlined in Section 5.4(e) 10 of NYSDEC DER-10.
- Soil/fill sample(s) will be collected from the segregated stockpile for analysis in accordance with NYSDEC requirements, and sampling results will be submitted to NYSDEC for approval.
- No material will be added to or removed from the segregated stockpile intended for import following the sample collection.
- Samples will be collected into laboratory-supplied containers.
- Samples will be kept in an ice-filled cooler or refrigerator, with the exception of any asbestos samples, until receipt by the laboratory.
- The clean soil/fill layer will be underlain by a demarcation layer such as orange snow fence to indicate the top of the original soil/fill.
- All sampling equipment will be decontaminated between sampling locations as described in Sections 3.2 and 3.3 of this QAPP.

5.2 Reuse Sampling

Prior to reuse as backfill, excavated material will be evaluated using the criteria below:

- Concrete or demolition debris that does not exhibit signs of contamination will be sampled for asbestos prior to reuse on-site.
- Soil/fill material proposed for reuse will be sampled at a frequency and for the required parameters as outlined in NYSDEC's DER-10, Table 5.4.
- Samples will be collected into laboratory-supplied containers.
- Samples will be kept in an ice-filled cooler or refrigerator, with the exception of any asbestos samples, until receipt by the laboratory.
- All sampling equipment will be decontaminated between sampling locations as described in Sections 3.2 and 3.3 of this QAPP.

5.3 Endpoint Soil Sampling

In the event that evidence of contamination [odors, staining, elevated photoionization detector (PID) readings, or analytical results of soil samples above NYSDEC Part 375 Restricted Residential Soil Cleanup Objectives (RRSCOs)] is identified during any breach to the composite cover system or excavation of soil/fill as part of the redevelopment or renovation of the Site, endpoint soil sampling activities will be performed in accordance with NYSDEC DER-10. Per NYSDEC DER-10 Section 5.4, sidewall samples will be collected at a minimum of one sample for every 30 linear feet and bottom samples will be collected at a frequency of one sample for every 900 square feet. Endpoint soil samples will be analyzed for NYSDEC Final Commissioner's Policy - Soil Cleanup Guidance (CP-51) volatile organic compounds (VOCs) by United States Environmental Protection Agency (EPA) Method 8260C, target compound list (TCL) semivolatile organic compounds/base-neutrals (SVOCs/BNs) by EPA Method 8270D, and Toxicity Characteristic Leaching Procedure (TCLP) metals by EPA Method 6010C.

Soil sampling will be conducted according to the following procedures:

- Characterize the sample according to the modified Burmister soil classification system.
- After selecting which samples will be analyzed in the laboratory, fill the required laboratory-supplied sample jars with the soil from the selected sampling location or labeled sealable plastic bags. Seal and label the sample jars as described in Section 4.8 of this QAPP and place in an ice-filled cooler.
- Decontaminate any reusable soil sampling equipment between sample locations as described in Section 3.2 of this QAPP.
- Record boring number, sample depth, and sample observations (evidence of contamination, PID readings, soil classification) in field logbook and boring log data sheet, if applicable.

5.4 Groundwater Sampling

Groundwater sampling will be conducted in accordance with the United States Environmental Protection Agency (EPA) low flow methodology. The monitoring well locations are presented in Figure 1. Groundwater sampling will be generally conducted as follows:

- Remove the well plug and immediately measure the vapor concentrations in the well headspace with a PID calibrated to the manufacturer's specifications.
- Measure the depth to water and total well depth, and check for the presence of non-aqueous phase liquid (NAPL) using an oil-water interface probe. Measure the thickness of NAPL, if

any, and record in field book and well log. If present, collect a sample of NAPL using a disposable plastic weighted bailer or similar collection device. Groundwater samples will not be collected from wells containing measurable NAPL.

- Connect dedicated tubing to either a submersible or bladder pump and lower the pump such that the intake of the pump is set at the midpoint of the water column within the screened interval of the well. Connect the discharge end of the tubing to the flow-through cell of a Horiba Quanta multi-parameter (or equivalent) meter. Connect tubing to the output of the cell and place the discharge end of the tubing in a five-gallon bucket.
- Activate the pump at the lowest flow rate setting of the pump.
- Measure the depth to water within the well. The pump flow rate may be increased such that the water level measurements do not change by more than 0.3 foot as compared to the initial static reading. The well-purging rate should be adjusted so as to produce a smooth, constant (laminar) flow rate and so as not to produce excessive turbulence in the well. The expected targeted purge rate will be approximately 0.5 liter and will be no greater than 3.8 liters per minute.
- Transfer discharged water from the 5-gallon buckets to 55-gallon drums designated for well-purge water.
- During purging, collect periodic samples and analyze for water quality indicators (e.g., turbidity, pH, temperature, dissolved oxygen, reduction-oxidation potential, and specific conductivity) with measurements collected approximately every five minutes.
- Continue purging the well until turbidity is less than 50 NTU and water quality indicators have stabilized to the extent practicable. The criteria for stabilization will be three successive readings for the following parameters and criteria:
    - Dissolved Oxygen - +/- 0.3 milligram per Liter (mg/L)
    - Turbidity - <50 nephthalometric turbidity units (NTU)
    - ORP/Eh - +/- 10 millivolts (mV)
    - Specific Conductance - +/- 3% millisievert per centimeter (mS/cm)
    - PH - +/- 0.1 pH units

If the water quality parameters do not stabilize and/or turbidity is greater than 50 NTU within two hours, purging may be discontinued. Efforts to stabilize the water quality for the well must be recorded in the field book, and samples may then be collected as described herein.

After purging, disconnect the tubing to the inlet of the flow-through cell. Collect groundwater samples directly from the discharge end of the tubing and place into the required sample containers. Label the containers as described in Section 4.9.1 of this QAPP and place in an ice-filled cooler for shipment to the laboratory. Groundwater samples will be analyzed for VOCs by EPA Method 624, and TPH –DRO and TPH –ORO by EPA Method 8015D.

Collect one final field sample and analyze for turbidity and water quality parameters (pH, temperature, dissolved oxygen, reduction-oxidation potential, and specific conductivity).

Record all measurements (depth to water, depth to NAPL, water quality parameters, turbidity), calculations (well volume), and observations in the project logbook and field data sheet, if applicable.

Once sampling is complete, remove the pump and tubing from the well. Dispose of the dedicated equipment and decontaminate reusable equipment, as described in Section. The purge water will be managed as described in Section 3.4 of this QAPP.

Sample collection for the emerging contaminants 1,4-Dioxane and/or PFAS is not planned. If required, samples will be collected and handled in accordance with the February 2018 and March 2019 NYSDEC-issued emerging contaminant sampling protocols with the exception that low-density polyethylene (LDPE) sampling bladders will be used if necessary. NYSDEC and EPA emerging contaminants sampling and laboratory procedures are detailed in Attachment B.

5.5 Collection of Groundwater Samples for PFAS from Monitoring Wells Sample Protocol

Samples collected using this protocol are intended to be analyzed for perfluorooctanoic acid (PFOA) and other perfluorinated compounds by EPA Method 537 Modified (Low Level). The sampling procedure used will be consistent with the NYSDEC March 1991 Sampling Guidelines and Protocols (Revision 1.2 August 9, 2018) with the following materials limitations.

At this time acceptable materials for sampling include: stainless steel, high density polyethylene (HDPE), and polypropylene. Additional materials may be acceptable if proven not to contain PFAS. It should be noted that Grundfos pumps and some bladder pumps are known to contain PFAS materials (e.g., Teflon™ washers for Grundfos pumps and LDPE bladders for bladder pumps) and should not be used for PFAS sampling.

All sampling equipment components and sample containers will not come in contact with aluminum foil, low density polyethylene (LDPE), glass, or polytetrafluoroethylene (PTFE, Teflon™) materials including sample bottle cap liners with a PTFE layer. Standard two-step decontamination using detergent and clean water rinse will be performed for equipment that does come in contact with PFAS materials. Clothing that contains PTFE material (including GORE-TEX®) or that have been waterproofed with PFAS materials will be avoided. Food and drink packaging materials and "plumbers thread seal tape," which contain PFAS, will be avoided during sampling. All clothing worn by sampling personnel will have been laundered multiple times. The sampler will wear nitrile gloves while filling and sealing the sample bottles.

Pre-cleaned sample bottles with closures, coolers, ice, sample labels and a chain of custody form will be provided by the laboratory, and the sampler will adhere to the following sampling protocol:

1. Fill two pre-cleaned 250 mL HDPE or polypropylene bottle with the sample.
2. Cap the bottles with an acceptable cap and liner closure system.
3. Label the sample bottles.
4. Fill out the chain of custody.
5. Place in a cooler maintained at 4 ± 2° Celsius.

One MS/MSD and one blind duplicate will be collected for every sample batch, not to exceed 20 samples, and at a frequency of one per day for equipment blanks. Category B electronic data deliverables will be requested from the laboratory.

5.6 Sub-Slab Depressurization System (SSDS) and Soil Vapor Extraction (SVE) System Operation and Maintenance (O&M) Sampling

Twelve SSDS vacuum monitoring points (VMPs) and six SVE vapor monitoring points (SVMPs) were installed during remedial action implementation at strategic locations to inspect induced vacuum conditions during the operation of the SSDS and SVE system, respectively. The VMP and SVMP locations will be monitored at regular intervals as designated in the SMP.

5.6.1 SSDS Vacuum Monitoring

The procedures for instantaneously screening the vacuum monitoring points are as follows:

- Remove the access manhole cover.
- Attach the analog vacuum gauge or digital manometer with male Quick-Connect fitting to the female quick connect fitting at the monitoring point well head and document reading.
- Detach vacuum gauge/manometer and confirm that Quick-Connect female fitting is closed.
- Replace the access manhole.

5.6.2 Indoor Air Sampling

Indoor air quality sampling may be conducted at the Site. If implemented, sampling will be conducted in accordance with the New York State Department of Health (NYSDOH) Vapor Intrusion Guidance Document. Indoor air quality sampling will be performed at the Site following system failure greater than 48 hours. The indoor air sampling is to be conducted following the completion of a pre-sampling inspection and chemical inventory of the Site building, in accordance with the following details:

- Place a labeled 6-Liter SUMMA® canister at the breathing zone level (3 to 4 feet above ground surface) in sampling locations established by NYSDEC and NYSDOH.
- Record the vacuum reading from the vacuum gauge on the canister at the beginning of the 24-hour sampling period.
- Open the valve of the canister and record the time in the field book. At the end of the 24-hour sampling period, close the valves, remove the flow-rate controllers and vacuum gauges, install caps on the canisters, and record the time.
- Place SUMMA canisters in shipping containers for transportation to the laboratory.
- Repeat these procedure for all of the sampling locations.

5.6.3 SVE Influent/Effluent Vapor Sampling

Confirmatory vapor sampling for the SVE system will be conducted following startup and 6 months of operation (and as determined by the SMP and NYSDEC thereafter) as part of a reassessment of VOC emissions calculations, according to the following procedures:

- Confirmatory sampling will comprise grab samples from the combined SVE influent, intermediate, and effluent samples, as appropriate.
- A 1-Liter Tedlar® bag will be filled with extracted vapors by attaching dedicated silicon-lined or silicon tubing from the sampling port to the inlet of the Tedlar® bag fill port. Both ports will be opened the 1-liter Tedlar® bag will be filled. The Tedlar® bag will be removed after its fill port has been closed.
- The Tedlar® bag will be properly labeled and enclosed in a zip-lock bag, which will be used as an added protection layer to ensure safety in transit to the laboratory.
- The silicone tubing will be replaced after each sample collected.

- Place Tedlar® bags in a shipping container for transportation to the laboratory (do not put the Tedlar® bags on ice).
- Samples will be analyzed for VOCs by EPA Method TO-15.
- Decontaminate all non-dedicated sampling equipment between sampling locations as described in Section 3.2 of this QAPP.

5.6.4 Carbon Sampling

Based on monitoring inspections performed during the operation of the SVE system, a representative grab sample of spent carbon may be collected and submitted for laboratory analysis prior to off-site disposal, according to the following procedures:

- Access the carbon treatment filter in accordance with manufacturer's specification and component manuals.
- Note any unusual or abnormal olfactory or visual field observations.
- Collect one aliquot of spent carbon material into a laboratory-supplied sampling container.
- Relinquish the sealed sampling container to a certified laboratory for analysis of VOCs by EPA Method 8260.

5.6.5 Condensate Water Sampling

Based on monitoring inspections performed during the operation of the SVE system, a representative sample of condensate water may be collected and submitted for laboratory analysis prior to off-site disposal, according to the following procedures:

- Slowly remove the lid of the 55-gallon drum containing the collected condensate water and immediately measure the vapor concentrations in the well with a PID calibrated to the manufacturer's specifications.
- Lightly stir the water in the drum with clean, dedicated sample collection equipment or tubing to homogenize the collected condensate water.
- Collect a representative sample directly from a dedicated bailer or tubing connected to a peristaltic pump and place into the required sample containers as described in Section 4.6 of this QAPP. Sample should be collected for VOCs and submitted to a certified laboratory.

5.7 Laboratory Methods

Table 1 summarizes the laboratory methods that will be used to analyze field samples as well as the sample container type, preservation, and applicable holding times. Other analytes may be added if required by the disposal facility. Alpha, a NYSDOH Environmental Laboratory Approval Program (ELAP)-certified laboratory, will be used for all chemical analyses in accordance with DER-10 2.1(b) and 2.1(f), including the NYSDEC July 2005 Analytical Services Protocol (ASP) Category B Deliverables. After sampling is complete and the laboratory has submitted the final data package, a Third-Party Data Validator will validate all data and prepare DUSRs.

Table 1
Laboratory Analytical Methods for Analysis Groups

Sample Type	Analysis	Method	Container Type	Preservative	Hold Time
Soil/Fill (Reuse/Backfill)	Target Compound List (TCL) Volatile Organic Compounds (VOCs)	8260C	3 EnCore® or TerraCore® samplers and 2 oz. plastic jar	≤ 6 ºC	48 hours to extract; 14 days to analyze
	TCL Semivolatile Organic Compounds (SVOCs)	8270D	8 oz. Glass Jar	≤ 6 ºC	14 days to extract; 40 days to analyze
	Total Analyte List (TAL) Metals, and Hexavalent Chromium	6000/7000 Series, 6010C, and 7196A	8 oz. Glass Jar	≤ 6 ºC	6 months holding time; Mercury 28 days holding time; Hexavalent chromium 30 days to extract, 7 days to analyze
	Total Polychlorinated Biphenyls (PCBs)	8260C	3 EnCore® or TerraCore® samplers and 2 oz. plastic jar	≤ 6 ºC	48 hours to extract; 14 days to analyze
	Pesticides	8081B	4 oz. clear glass jar	4 ºC	5 days to extract, 49 days to analyze
	1,4-Dioxane	8270D plus Selective Ion Monitoring (SIM); 0.35 µg/L RL	1-Liter Amber Jar	≤ 6 ºC	7 days to extract; 40 days to analyze
	Per- and Polyfluoroalkyl Substances (PFAS)	1633	3 x 250mL Polypropylene Bottles	≤ 6 ºC, Trizma	14 days to extract; 28 days to analyze
Soil/Fill (Endpoint Sampling)	CP-51 VOCs	8260	3 Encore samplers, 2 oz. plastic jar	4 ºC	48 hours
	TCL SVOCs/BNs	8270D	4 oz. clear glass jar	4 ºC	5 days to extract, 49 days to analyze
	TCLP Metals	6010C	4 oz. clear glass jar	4 ºC	14 days 26 days
Groundwater Sampling	TCL VOCs	624	3 x 40 mL Glass Vials	HCl to pH < 2 and ≤ 6 ºC	14 days to analyze if preserved
	TPH – DRO	8015D	2 x 1000 mL Glass Ambers	4 ºC	14 days to analyze if preserved
	TPH – ORO	8015D	2 x 1000 mL Glass Ambers	4 ºC	7 days to

Sample Type	Analysis	Method	Container Type	Preservative	Hold Time
Soil Vapor/ Indoor Air Sampling	VOCs	TO-15	6-Liter SUMMA® Canister	None	30 days
SVE System Total Influent, Intermediate, Effluent	TCL VOCs	TO-15	1-Liter Tedlar® Bags	None	14 days
Granular Activated Carbon	TCL and TCLP VOCs	8260C	EnCore sampler and 4 oz. clear glass jar	4 ºC	48 hours
Condensate Water	TCL VOCs	8260C	40 mL glass vial, septa top	4 ºC, HCL	14 days

5.8 QA/QC Sampling

In addition to the laboratory analysis of the investigative soil samples, additional analysis will be included for QA/QC measures, as required by the NYSDEC July 2005 ASP Category B sampling techniques. The QC samples will include field blanks, trip blanks, matrix spike/matrix spike duplicates (MS/MSD), and blind duplicate samples at a minimum frequency of one sample per 20 field samples collected or per sample delivery group (SDG). No additional QA/QC samples will be collected during waste classification sampling unless required by the disposal facility. Table 2 provides a summary of the field samples and QA/QC samples to be analyzed by the laboratory.

Table 2

Field Sample and QC Sample Quantities

Sample Type	Parameters	Analytical Method[1]	Field Samples	QC Samples			
				Field Blank	Trip Blank[2]	MS/MSD[3]	Duplicate[3]
Soil	VOCs	EPA 8260C	TBD	1/20 (TBD)	1 (Laboratory-Supplied)	1/20 (TBD)	1/20 (TBD)
	SVOCs, TAL Metals, Mercury, PCBs, Pesticides, 1,4-Dioxane, and PFAS	EPA 8270D, 6010C/7471, 8082A, 081B, 8270D SIM, and Mod. 537	TBD	1/20	NA	1/20	1/20
Groundwater	VOCs	EPA 8260C	TBD	1/20 (TBD)	1 (Laboratory-Supplied)	1/20 (TBD)	1/20 (TBD)
	TPH DRO and ORO	8015D	TBD	1/20	NA	1/20	1/20
SVES Total Influent, Intermediate, Effluent	TCL VOCs	TO-15	TBD	NA	NA	NA	NA

Notes:
TBD – sampling to be determined based on work activities
NA – not applicable
[1] – NYSDEC July 2005 ASP Category B deliverables
[2] – One trip blank per shipment with VOC analyses
[3] – One MS/MSD and duplicate sample per twenty field samples or sample shipment

5.9 Sample Handling

5.9.1 Sample Identification

All samples will be consistently identified in all field documentation, chain-of-custody (CoC) documents, and laboratory reports. All samples will be amended with the collection date at the end of the sample name in a year, month, day (YYYYMMDD) format. Blind duplicate sample nomenclature will consist of: the sample type, followed by an "X"; MS/MSD sample nomenclature will consist of the parent sample name only but triplicate sample volume will be collected and the CoC comment section will explain that the additional volume is for running the MS/MSD; and trip and field blanks will consist of "TB-" and "FB-", respectively, followed by a sequential number of the trip/field blanks collected within the SDG and the matrix (soil or groundwater). In accordance with NYSDEC Environmental Quality Information System (EQuIS™) protocol, special characters will not be used for sample nomenclature and sample IDs below 10 will be amended with a "0". Sample nomenclature examples are provided in Table 3.

Table 3

Examples of Sample Nomenclature

Sample Description	Sample Designation
Soil endpoint sample collected from 1 to 2 feet below grade at the north wall of an excavation	EP-N_1-2_ YYYYMMDD
Duplicate soil sample collected from 1 to 2 feet at the north wall of the excavation	EP-X_1-2_YYYYMMDD
Import soil sample collected from the first imported stockpile	ISP-1_YYYYMMDD
Reuse soil sample collected from the first on-site stockpile	SP-1_YYYYMMDD
Groundwater sample collected from a monitoring well	MW-01_YYYYMMDD
Soil vapor sample	SV-1_YYYMMDD
Ambient air sample	AA-1_YYYYMMD
Indoor air sample	IA-1_YYYYMMDD
SVES effluent sample collected from the carbon treatment system intermediate port	SVE-INT_YYYYMMDD
Granular activated carbon	GAC_YYYYMMDD
Condensate Water	COND_YYYYMMDD

5.9.2 Sample Labeling and Shipping

All sample containers will be provided with labels containing the following information:

- Project identification;
- Sample identification;
- Date and time of collection;
- Analysis(es) to be performed;
- Sample preservative, if any; and
- Sampler’s initials.

Once the samples are collected and labeled, they will be placed in chilled coolers and stored in a cool area away from direct sunlight to await shipment to the laboratory. All samples will be shipped to the laboratory at least twice per week. At the start and end of each workday, field personnel will add ice to the coolers as needed.

The samples will be prepared for shipment by placing each sample in a sealable plastic bag, then wrapping each container in bubble wrap to prevent breakage, adding freezer packs and/or fresh ice in sealable plastic bags, and including the CoC form. Tedlar® bags will be enclosed in a zip lock bag as an added protection prior to being placed in a cooler or shipment container without ice. SUMMA® canisters will also be placed into their appropriate shipment containers and do not require preservation with ice. All samples will be shipped overnight (e.g., Federal Express) or transported by a laboratory courier. All coolers and shipment containers shipped to the laboratory will be sealed with mailing tape and a CoC seal to ensure that they remain sealed during delivery.

5.9.3 Sample Custody

Field personnel will be responsible for maintaining the sample coolers in a secured location until they are picked up and/or sent to the laboratory. The record of possession of samples from the time they are obtained in the field to the time they are delivered to the laboratory or shipped off-site will be documented on CoC forms. The CoC forms will contain the following information: project name; names of sampling personnel; sample number; date and time of collection and matrix; signatures of individuals involved in sample transfer; and the dates and times of transfers. Laboratory personnel will note the condition of the custody seal and sample containers at sample check-in.

5.10 Field Instrumentation

Field personnel will be trained in the proper operation of all field instruments at the start of the field program. Instruction manuals for the equipment will be on file at the Site for referencing proper operation, maintenance, and calibration procedures. The equipment will be calibrated according to manufacturer specifications at the start of each day of fieldwork, if applicable. If an instrument fails calibration, the project manager or QA/QC officer will be contacted immediately to obtain a replacement instrument. A calibration log will be maintained to record the date of each calibration, any failure to calibrate, and corrective actions taken. The PID will be calibrated each day using 100 parts per million (ppm) isobutylene standard gas.

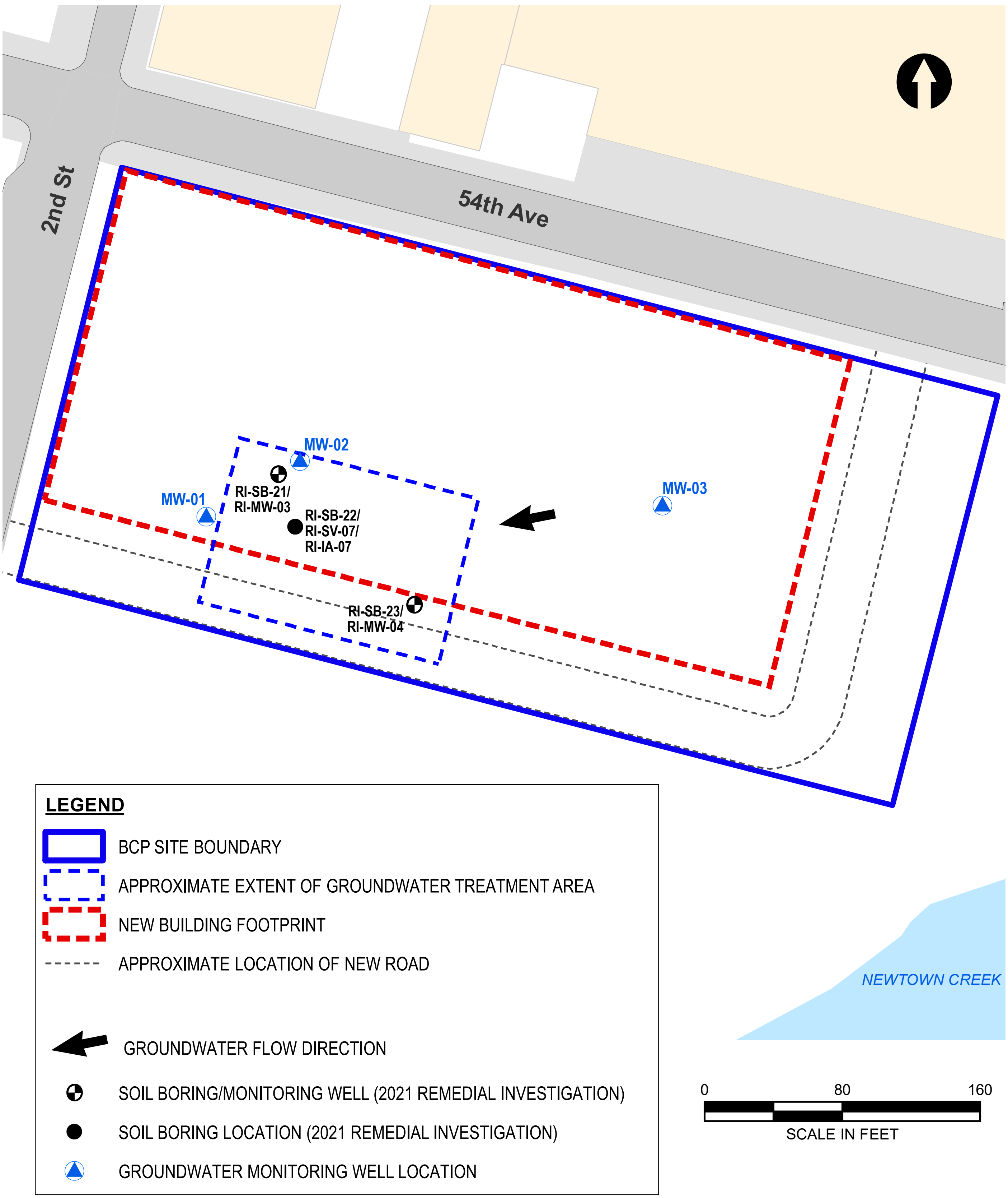
5.11 Data Review

In accordance with DER-10, each of the samples collected will undergo a third-party data review process to ensure the usability of the data collected. Data usability summary reports documenting any issues with QA/QC will be prepared and included in the Periodic Review Report (PRR). The resume for Lori Beyer of L.A.B. Validation Corp., the anticipated third-party data reviewer, is included in Attachment A.

5.12 Reporting of Data

All data generated during the monitoring activities will be submitted in the appropriate EQuIS™ Electronic Data Deliverable (EDD) format.

FIGURE



Note:
Groundwater Treatment included mechanical mixing of 2,500 pounds of Regenesis ORC Advanced and 4,000 pounds of PersulfOx within the approximately 12,500 square foot treatment area.

Map Source:
NYCDCP (NYC Dept. of City Planning) GIS database

AKRF
440 Park Avenue South, New York, NY 10016

Newtown Creek Bud Site - North Block
2-10 54th Avenue - Long Island City, New York

GROUNDWATER TREATMENT AREA AND MONITORING WELL NETWORK

DATE
6/27/2023

PROJECT NO.
200112

FIGURE
6

©2023 AKRF W:\Projects\200112 - BUD NORTH\Technical\GIS and Graphics\hazmat\SMP\200112 Fig 3 Groundwater Treatment Area.mxd6/27/2023 5:31:16 PM jszalus

ATTACHMENT A

RESUMES OF KEY PROJECT PERSONNEL

MARC S. GODICK, LEP

SR. VICE PRESIDENT

Marc S. Godick, a Senior Vice President of the firm, has over 27 years of experience in the environmental consulting industry. Mr. Godick has broad-based environmental experience includes expertise in brownfield redevelopment, site assessment, remedial investigation, design and implementation of remedial measures, compliance assessment, and litigation support.

Education

M.E., Engineering Science/Environmental Engineering, Pennsylvania State University, 1998

B.S., Chemical Engineering, Carnegie Mellon University, 1989

Licenses/Certifications

Licensed Environmental Professional (License # 396) – State of Connecticut – 2003 - Present

40 Hour HAZWOPER and Annual Refresher Training, 1990 - Present

Supervisors of Hazardous Waste Operations (8 Hour), 1990

Professional Memberships

Chairman, Village of Larchmont/Town of Mamaroneck Coastal Zone Management Commission, 1997 – Present

Member, Westchester County Stormwater Advisory Board, 2011 – Present

Chairman/Member, Westchester County Soil and Water Conservation District, 2005 - 2010

Board of Directors, Sheldrake Environmental Center, Larchmont, New York, 2006 - 2008

Member, NYSDEC Risk-Based Corrective Action (RBCA) Advisory Group for Petroleum-Impacted Sites, 1997

Community Leadership Alliance, Pace University School of Law, 2001

Years of Experience

Year started in company: 2002

Year started in industry: 1990

RELEVANT EXPERIENCE

New York City Department of Design and Construction, East Side Coastal Resiliency, Manhattan, NY

Mr. Godick leads the environmental investigation and related support for a multidisciplinary design team selected by the New York City agency partnership of DDC, DPR, and ORR for the Feasibility Study and Pre-Scoping Services for East Side Coastal Resiliency (ESCR) project. The AKRF Team is providing design services, for 100+ year storm protection with anticipated sea level rise along the east side of Lower Manhattan. The ESCR subsurface exploration program involved a review of available utility plans and environmental reports involving manufactured gas plant (MGP) and potential petroleum-related contamination along a 2.5 mile study area from Montgomery Street to East 25th Street to develop a Subsurface Investigation Work Plan, which was approved by the NYCDEP.

The program included both public and private utility mark-out services across vast areas of the project site containing critical infrastructure to enable the installation of numerous shallow and deep borings and groundwater wells. Mr. Godick supervised the implementation of the investigation, which was completed in two phases. He was also responsible for the interpreting the wide-range of chemical parameters to evaluate critical cost and environmental impacts for the City and design team, and to prepare technical reports for submission and approval by the NYCDEP to satisfy for City Environmental Quality Review (CEQR) requirements. In addition, he continues to support the design and environmental review team, including preparation of the Hazardous Materials chapter for the Environmental Impact Statement, estimating cost impacts to the project for design and cost recovery purposes, and developing a Soil Management Plan. Mr. Godick also managed a hydrogeologic modeling study to evaluate potential hydraulic and contaminant migration impacts associated with construction of the proposed flood control structure. Mr. Godick continues to coordinate with the NYC team, NYSDEC, and Con Edison to ensure that the design incorporates appropriate remedial measures to be implemented prior to and/or in conjunction with construction.

Remedial Design, Gowanus Canal First Street Turning Basin, New York City Department of Design and Construction (DDC)

Mr. Godick is managing the remedial design for restoration of the filled-in former First Street Turning Basin in Brooklyn, New York. The remediation is being conducted as part of an Order of Consent between the City of New York and EPA for the Gowanus Canal Superfund Site. The remedial design will include removal of fill and sediment within the fill-in basing in an approximately 475-foot by 50-foot area. The restored basin will provide enhanced waterfront access to the community and a boat launch for canoes and kayaks. Design considerations include geotechnical concerns related to adjacent buildings and new and existing bulkheads; soil and water management; landscape design; and access/construction logistics. The design in anticipated to be completed in late 2017.

Remediation & Litigation Support, 3200 Jerome Avenue, Bronx, NY (Former PS 151)

Mr. Godick managed the investigation and remediation of a former public school in the Bronx under the New York State Department of Environmental Conservation (NYSDEC) Brownfields Cleanup Program (BCP). The site was contaminated with trichloroethylene (TCE) from historic operations at the property prior to use as a school. The remedial investigation included soil, groundwater, and vapor intrusion assessment both on-site and off-site. The remedial design included excavation of the source area, in-situ chemical oxidation of groundwater, and installation of a sub-slab depressurization system (SSDS) to address to potential vapor intrusion. Implementation of the remedy was complete in late 2014. The completed remediation allows for future multi-family residential, educational, childcare, and/or medical uses. Mr. Godick also provided litigation support in connection with a cost recovery claim against the former operator of the site.

Remediation & Litigation Support, Queens West Project, Avalon Bay Communities, Queens, NY

For over 20 years, AKRF has played a key role in advancing the Queens West development, which promises to transform an underused industrial waterfront property into one of largest and most vibrant mixed-use communities just across the East River from the United Nations. AKRF prepared an Environmental Impact Statement (EIS) that examines issues pertaining to air quality, land use and community character, economic impacts, historic and archaeological resources, and infrastructure. As part of this project, Mr. Godick managed one of the largest remediation projects completed under the NYSDEC BCP at the time that was contaminated by coal tar and petroleum. The remedy included the installation of a hydraulic barrier (sheet pile cut off wall), excavation of contaminated soil under a temporary structure to control odors during remediation, a vapor mitigation system below the buildings, and implementation of institution controls. The investigation, remediation design, and remedy implementation, and final sign-off (issuance of Certificate of Completion) were completed in two years. Total remediation costs were in excess of $13 million. Following completion of the remediation, Mr. Godick developed a cost allocation model and provided litigation support for a cost recovery action against a former operator of the site, including participation in a deposition as a fact witness prior to settlement between the parties.

On-Call Environmental Consulting Services (Various Locations), New York City Mayor's Office of Environmental Remediation (OER) (administered by NYCEDC)

Mr. Godick is managing an on-call contract with the OER for brownfields environmental assessment and remediation. The work has included conducting Phase I environmental site assessments (ESAs) and multi-media sampling of soil, groundwater, and soil vapor for various sites funded by EPA grants. The work plans and investigation reports were completed in accordance with OER and EPA requirements. AKRF also developed a remedial plan for a former gas station site in the Bronx and implemented a remedial plan for capping a park site in Staten Island. In addition, Mr. Godick is providing support to OER and an affordable housing developer to expedite an application for entry into the New York State Department of Environmental Conservation

(NYSDEC) Brownfield Cleanup Program (BCP), as well as preparation and implementation of the remedial investigation and remedial plan.

On-Call Environmental Consulting (Various Locations), New York City School Construction Authority

Mr. Godick is managing an on-call contract with the SCA for environmental assessment, remedial design, and plumbing disinfection. For new school sites, initial due diligence involves conducting Phase I environmental site assessments (ESAs) and multi-media sampling of soil, groundwater, and soil vapor to determine the suitability of a site for development as a school and remediation requirements and associated costs. Once design for a school is underway, AKRF would prepare remediation plans and construction specifications and oversee the construction activities. For existing school sites, the work can involve conducting Phase I ESAs and indoor air quality testing, preparation of specifications, supervision of storage tank removals, investigation and remediation of spills, and development of remediation cost estimates. AKRF also oversees plumbing disinfection work, which is required prior to new plumbing being placed into service. The assignments involve reviewing and commenting on disinfection plans, supervision of the disinfection and confirmation testing, and preparation of a report documenting the work was conducted in accordance with the specifications and applicable requirements. Due to the sensitivity of school sites, work under this contract is often conducted on short notice and during non-school hours. Mr. Godick also manages AKRF's potable water sampling (for lead) work for SCA, including providing recommendations for mitigating exceedances.

Remediation, Former Industrial Laundry/Dry Cleaning Plant, 2350 Fifth Avenue. New York, NY

Mr. Godick managed the assessment, cleanup and post-remedial operations, maintenance and monitoring of the only NYSDEC listed inactive hazardous waste (State Superfund) site in Manhattan, a former laundry/dry cleaning plant in Harlem. Remedial investigation included evaluation of soil, groundwater, soil vapor, indoor air, and building materials. Interim remediation included the removal of contaminated building materials and operation of a sub-slab vapor extraction system retrofitted into the existing building. Mr. Godick coordinated with the regulatory agencies, site owner and occupants; and managed the investigation, remedial design, and remedial implementation activities. Phase 1 of the Remedial Action Work Plan consisted of further removal of contaminated building materials. Phase 2 of the remediation included a sub-slab depressurization system (SSDS) retrofitted into the existing building, soil vapor extraction (SVE) system, and chemical oxidation injection. Remedial action work was completed in 2014 and documented in a Final Engineering Report. NYSDEC issued Certificate of Completion in January 2015 and the site has been reclassified to a "Class 4" site (site properly closed – requires continued management). Mr. Godick continues to manage the project, including operations, maintenance and monitoring of the SSDS and SVE system under the NYSDEC-approved Site Management Plan.

606 West 57th Street, New York, NY, TF Cornerstone

AKRF has been retained by TF Cornerstone to provide environmental services for the proposed redevelopment of a portion of the block bounded by Eleventh and Twelfth Avenues and West 56th and 57th Streets. The proposed actions included a zoning map amendment, zoning text amendments, a special permit, and an authorization to facilitate development of approximately 1.2 million square feet of residential and retail space. AKRF prepared an Environmental Impact Statement (EIS) for the New York City Department of City Planning (DCP) to analyze the effects of the proposed actions and development of the proposed building. The EIS addressed the full range of environmental impacts associated with the proposed development.

Mr. Godick was responsible for the elements of the EIS pertaining to hazardous materials, including coordination of a Phase I ESA and summarizing pertinent site information for the hazardous materials and construction chapters. Mr. Godick provided pre-acquisition support to TF Cornerstone, which included development of a remedial cost estimate report to outline remediation cost during site development. Mr. Godick also managed work related to the subsurface investigation, localized remediation (chemical injection and limited excavation beneath the building basement) and regulatory closure of a petroleum spill on a portion of the project site to satisfy NYSDEC requirements. After EIS certification, Mr. Godick coordinated approvals with NYCOER, the regulatory agency overseeing remedial measures related to the redevelopment of the site. The Site has an (E) Designation and is participating in the New York City Voluntary Cleanup Program. Mr. Godick managed the preparation of a Phase II Investigation Work Plan, Remedial Investigation Report, Remedial Action Work Plan (RAWP), and contractor specifications for soil management and tank and hydraulic lift removal. Mr. Godick managed implementation of the remediation in accordance with the RAWP.

164 Kent Avenue, Brooklyn, NY (AKA Northside Piers and 1 North 4th Place), RD Management, L&M Development, Toll Brothers, and Douglaston Development

The project was a multi-phase development consisting of a large waterfront block in the Williamsburg Rezoning Area. The project site has been developed with a mixed-use residential-commercial high rise towers with an esplanade and a pier along the East River. AKRF provided acquisition and development support, including performing Phase I and II environmental site assessments and development of remedial cost estimates for development, and preparation of Remedial Action Plans (RAPs) and Construction Health and Safety Plan (CHASPs) for approval by DEP and OER. AKRF provided assistance with construction oversight during soil handling activities and managing the Community Air Monitoring Plan (CAMP) activities. Closure reports were prepared and the project is fully built-out and occupied.

Site Investigation–Over 20 Facilities, Con Edison, New York, NY

Mr. Godick managed site investigations associated with petroleum, dielectric fluid, and PCB releases at over 20 Con Edison facilities including service centers, substations, generating stations, and underground transmission and distribution systems. Site investigations have included due diligence site reviews, soil boring installation, monitoring well installation, hydrogeologic testing, and water quality sampling. Risk-based closures were proposed for several sites.

Underground Storage Tank Closure and Site Remediation–Program Management, Con Edison, New York, NY

Mr. Godick provided technical assistance to Con Edison in developing technical submittals and budgets associated with tank closures at over 50 facilities. Technical summaries were prepared for submittal of contractor-prepared closure reports to the NYSDEC. The summaries included a review of historic pre-closure assessments, tank closure data, and provided recommendations for additional assessment, remediation or closure. Subsequently, a three-year program budget was developed for implementation of the UST investigation/remedial program, which Con Edison utilized for internal budgeting purposes.

Site Investigation–7 World Trade Center Substation, Con Edison, New York, NY

Mr. Godick managed the site investigation at the former 7 World Trade Center Substation in an effort to delineate and recover approximately 140,000 gallons of transformer and feeder oil following the collapse of the building. The project involved coordination with several crews, Con Edison, and other site personnel.

Site Investigation–Former Manufactured Gas Plant (MGP) Facilities, Con Edison, New York, NY

Mr. Godick managed site investigations at four former manufactured gas plant (MGP) facilities. The investigations were completed at Con Edison substations, a flush pit facility, and a service center to support remedial design and expansion at select locations. The findings from these characterizations were used by Con Edison to make appropriate changes to the design specifications and to plan for appropriate handling of impacted materials and health and safety protocols during future construction activities.

National Grid – Halesite Manufactured Gas Plant Site Remediation, Town of Huntington, NY

Mr. Godick managed the remedial design and engineering work associated with remediation of National Grid's former MGP located in the Town of Huntington. The site is situated in a sensitive location along the waterfront, surrounded by commercial and residential properties, and half the property where the remediation was conducted was a steep slope. The remedy consisted of soil removal, oxygen injection, and non-aqueous phase liquid recovery. Mr. Godick was responsible for the development of the remedial work plans, design/construction documents, landscape architecture, confirmatory sampling, air monitoring, supervision, and preparation of close-out documentation in accordance with NYSDEC requirements.

Verizon, Investigation & Remediation, Various Locations, NY, PA and DE

Mr. Godick managed over 50 environmental investigations and remediation projects related to petroleum releases at various facilities. Responsibilities included annual budgeting, day-to-day project management, development and implementation of soil and ground water investigation workplans, ground water modeling, risk evaluation, remedial action work plans, remedial design, system installation, waste disposal, well abandonment, and operation and maintenance. Many of the assessment and remedial projects followed a risk-based approach. Remedial technologies implemented included air sparging, soil vapor extraction, bioremediation, pump and treat, soil excavation, and natural attenuation.

Storage Tank Management, Verizon, Various Locations, NY, PA, DE, and MA

Mr. Godick managed the removal and replacement of underground and aboveground storage tank systems for Verizon in New York, Pennsylvania, Delaware, and Massachusetts. Responsibilities included the management of design, preparation of specifications, contractor bidding, construction oversight, project budget, and documentation. For selected AST sites, managed the development of Spill Control, Contingency and Countermeasures (SPCC) plans.

Litigation Support, Cost Recovery Action, Gowanus Superfund Site, New York

Mr. Godick provided technical support to one of the 40+ potential responsible parties (PRPs) associated with a Federal Superfund site in New York State, which included conducting a liability assessment for the various parties and development of a cost allocation model.

Litigation Support, Cost Recovery Action, New York State Superfund Site

Mr. Godick provided technical support for the former owner of a New York State Superfund site in upstate New York. The owner of the property brought a cost recovery action against our client as a PRP. Mr. Godick completed a technical review of the draft Remedial Investigation/Feasibility Study prepared by the opposing party's consultant to develop a more cost effective remedial strategy and to better position the client for liability allocation as part of future settlement negotiations. Mr. Godick also developed a cost allocation report that included a model for settlement negotiations, as well as participated in mediation.

Litigation Support & Remediation, Former Service Station, Brooklyn, New York

Mr. Godick took over management of remediation of an inactive service station (formerly conducted by another firm). His approach outlined additional characterization and remediation efforts which resulted in successful closure of the spill by NYSDEC within two years. Mr. Godick testified as an expert witness at a hearing in the New York State Supreme Court of Kings County to determine the adequacy of the remediation efforts.

Litigation Support, Cost Recovery Action, Town of Carmel, New York

Mr. Godick served as an expert witness representing the owner of a property in a landlord-tenant dispute, which was used as a gasoline station and oil change facility. Mr. Godick prepared exhibits, testified, and participated in meetings with NYSDEC to support the landlord's claim that the oil change tenant's practices were poor and were adversely affecting the environment and the overall facility systems at the site.

Litigation Support, Cost Recovery Action, New York State Petroleum Spill Site, New York, NY

Mr. Godick provided technical support for the former owner of a New York City multi-unit residential apartment building. The State of New York brought a cost recovery action against our client as a result of a previous spill from a former underground storage tank. Mr. Godick reviewed invoices and project documentation to dispute work performed by the NYSDEC, which provided the basis for settlement at a fraction of the initial claim.

Litigation Support, Class Action Lawsuit, Confidential Client, NJ

Mr. Godick provided technical support for a class action suit involving a petroleum-impacted community water supply in southern New Jersey. The technical assistance included analysis of expert testimony and coordination with legal counsel in preparing for cross-examination of the opposing party's lead expert witness.

Cost Analysis, Environmental Insurance Claims, Various Locations

Mr. Godick provided technical support for cost analyses completed for a large national insurance company related to several former MGP and other industrial sites. Responsibilities included evaluation and development of cost-effective remedial strategies, as well as compilation of detailed costs for remedial action implementation and closure.

REBECCA KINAL, P.E.

VICE PRESIDENT

Rebecca Kinal has over 20 years of experience in the assessment and remediation of soil and groundwater contamination and other hazardous/non-hazardous waste problems. Ms. Kinal's experience includes environmental due diligence, soil and groundwater investigations, leaking underground storage tank studies, soil gas/vapor intrusion surveys, and oversight of small- and large-scale remediation programs, including design of groundwater remediation systems and vapor mitigation systems. She has directed numerous Phase I and Phase II investigations and remediation programs, many of them in conjunction with commercial/residential developers, law firms, lending institutions, and public agencies. She is experienced in the cleanup of contaminated properties under New York State Brownfield Cleanup Program (BCP) regulations and the New York City "E-designation" program. As a part of this work, her duties have included technical and report review, proposal writing, scheduling, budgeting, and acting as liaison between clients and regulatory agencies, and project coordination with federal, state, and local authorities.

BACKGROUND

Education

M.S., Hydrogeology, Rensselaer Polytechnic Institute, 1995

B.S., Civil Engineering, Lafayette College, 1992

Licenses/Certifications

State of New York, P.E. Registration No. 082046, 2004

Years of Experience

Year started in company: 2000

Year started in industry: 1996

RELEVANT EXPERIENCE

White Plains Mall/Hamilton Green

Ms. Kinal managed environmental due diligence and remediation planning for the project, which included Phase I and II environmental assessments, a petroleum Spill investigation, preparation of remediation cost estimates, and application to the NYSDEC BCP.

New York City School Construction Authority On-Call Contracts for Environmental Consulting Services, Various Sites, NY

Ms. Kinal serves as the project manager for AKRF's on-call hazardous materials consulting contract with the New York City School Construction Authority for over 8 years. For potential new school sites, assignments include initial due diligence, Phase I environmental site assessments, (ESAs) and subsurface investigation of soil, groundwater, and soil vapor to determine the suitability of a site for development as a school, likely remediation requirements, and associated costs. For sites undergoing design and development, assignments include preparation of remediation plan, contract specifications, and design drawings. The work has also included conducting indoor air quality testing, vapor intrusion assessments, preparation of specifications, supervision of storage tank removals, and investigation and remediation of spills for existing schools. Due to the sensitivity of school sites, work under this contract is often conducted on short notice and during non-school hours.

USTA National Tennis Center, Queens, NY

AKRF prepared an EIS for the New York City Departments of City Planning (DCP) and Environmental Protection (DEP) as co-lead agencies to analyze the expansion of the National Tennis Center, which includes multiple improvements and construction projects at the USTA campus over several years. As part of the EIS requirements, AKRF prepared a Remedial Action Plan for implementation during the proposed project's construction. In accordance with the RAP, vapor mitigation systems were incorporated into the design for several of the proposed structures at the facility, including two new stadiums, a new transportation center, and several practice court facilities. Ms. Kinal prepared the specifications and design drawings for the vapor mitigation and is providing on-going construction support to review contractor submittals and inspect the vapor barrier and sub-slab depressurization system installations.

Montefiore Medical Center, Various Locations, NY

Ms. Kinal provides due diligence assistance to Montefiore Medical Center (MMC) for the ongoing expansion of their facilities, primarily in the Bronx and Westchester County. She conducts and manages environmental due diligence tasks related to their property transactions, including Phase I Environmental Site Assessments (ESAs), Phase II investigations, and geophysical surveys. She also assists MMC in making decisions with respect to environmental risk issues.

Queens West Development Project, Long Island City, NY

For over 20 years, AKRF has played a key role in advancing the Queens West development, which promises to transform an underused industrial waterfront property into one of largest and most vibrant mixed-use communities just across the East River from the United Nations. AKRF has prepared an Environmental Impact Statement that examines issues pertaining to air quality, land use and community character, economic impacts, historic and archaeological resources, and infrastructure. As part of the project, AKRF also undertook the largest remediation ventures completed to date under the NYSDEC Brownfields Cleanup Program (BCP). Ms. Kinal helped prepare the Remedial Work Plan (RWP) and oversaw the remediation of Parcel 9, a 1.8-acre former industrial site. Remediation includes installation of a sheet pile containment wall, excavation of coal tar- and petroleum-contaminated soil under a temporary structure to control odors during remediation, vapor mitigation for the future buildings, and institutional controls. Upon completion of the remediation activities, Ms. Kinal managed the preparation of a Final Engineering Report (FER) to document the clean-up activities. The NYSDEC issued a Certificate of Completion (COC) for the Parcel 9 site in December 2006. Ms. Kinal continues to oversee post-remediation monitoring and site management activities to ensure that the remedy remains in-place and effective.

Roosevelt Union Free School District, Roosevelt, NY

Ms. Kinal managed environmental investigation and remediation activities for the sites of three new elementary schools and a new middle school in Roosevelt, New York. Remediation activities include removal/closure of contaminated dry wells and underground petroleum storage tanks, and excavation and off-site disposal of petroleum- and pesticide-contaminated soil. Remediation of the new middle school site, which also included a sub-slab depressurization system, was conducted through coordination with the NYSDEC, NYSDOH, New York State Education Department (NYSED), and the local school district. Upon completion of the remediation and school construction, Ms. Kinal managed confirmatory indoor air testing and preparation of a Final Engineering Report to document the site clean-up. The NYSDEC issued a Certificate of Completion and the school was open for the Fall 2008 semester as planned.

Proposed NYC Public School Campus, Bronx, NY

Ms. Kinal provided environmental consulting services to the selected environmental remediation contractor for this former manufactured gas plant in the Mott Haven neighborhood of the Bronx, which was remediated under the NYSDEC BCP. These services included: preparation of an in situ sampling plan and excavation plan for waste characterization and disposal; supervision of waste characterization sampling activities; development and implementation of a community air monitoring program during all remediation activities; and daily reporting to the NYC School Construction Authority.

National Grid – Halesite Manufactured Gas Plant Site, Town of Huntington, NY

Ms. Kinal served as the project manager for the remedial design and engineering work associated with remediation of National Grid's former manufactured gas plant (MGP) located in the Town of Huntington. The site is situated in a sensitive location along the waterfront, surround by commercial and residential properties, and half the property where the remediation was conducted is a steep slope. The remedy consisted of soil removal, oxygen injection, and non-aqueous phase liquid recovery. Ms. Kinal developed the remedial work plans, design/construction documents, and managed environmental oversight of the remedial work, including waste characterization and tracking, confirmatory endpoint sampling, air monitoring, and reporting to the NYSDEC. After the remediation work was completed, Ms. Kinal prepared appropriate close-out documentation in accordance with NYSDEC requirements.

Shell Service Station, Millwood, NY

Ms. Kinal planned and oversaw a Phase I Environmental Site Assessment and Phase II Subsurface Investigation of this active gasoline station in northern Westchester County. The Phase I/Phase II investigations were performed for the potential buyer of the property who wished to redevelop it with a more modern service station and convenience store. Ms. Kinal also prepared a conceptual remediation plan to address several areas of petroleum contamination identified during the Phase II. The plan, which was approved by NYSDEC, will be implemented in conjunction with the site redevelopment activities to achieve closure for several spills reported at the site.

Pelham Plaza Shopping Center Site Investigation & Remediation, Pelham Manor, NY

Ms. Kinal managed a Site Investigation at Pelham Plaza, an approximately ten-acre site that formerly contained a manufactured gas plant. The site was investigated under a voluntary clean-up agreement entered into with the NYSDEC by the site owner. The site investigation included advancing over 100 soil borings with continuous soil sampling to bedrock, installing monitoring and recovery wells, and conducting test pitting both indoor and outdoor locations to collect soil and groundwater samples and determine the extent of Non-Aqueous Phase Liquid (NAPL). The investigation also included: soil gas sampling to determine contaminant concentrations in the vapors beneath the foundation of an on-site retail store; sediment sampling in an adjacent creek to identify off-site impacts; and a tidal survey to determine tidal influence on groundwater levels at the site. Ms. Kinal also oversaw interim remedial measures, which include biweekly pumping of recovery wells to remove dense NAPL (DNAPL) from the site subsurface.

Shaws Supermarket Redevelopment Project, New Fairfield, CT

Ms. Kinal managed the Remedial Investigation (RI) for an approximately nine-acre shopping center site that was contaminated by releases from former dry cleaning operations. The site was being redeveloped with a new supermarket and separate retail stores. The investigation included the installation of monitoring wells in the intermediate overburden aquifer and bedrock aquifer, sampling of existing and newly installed wells, geophysical logging in bedrock wells, and pump testing in intermediate and bedrock wells. Ms. Kinal prepared a Remedial Action Work Plan (RAWP) based on results from the RI, which included a groundwater pump and treat system to contain a plume of perchlorethylene (PCE)-contaminated groundwater, and excavation and disposal of contaminated soil in the presumed source area. Following CTDEP approval of the RAWP, Ms. Kinal prepared bid specifications for soil excavation and remediation system installation, and oversaw their implementation. Ms. Kinal also prepared NPDES permit applications for discharges from construction dewatering and the groundwater remediation system, and conducted associated discharge monitoring.

Yankee Stadium, Bronx, NY

Ms. Kinal performed the hazardous materials analysis for the Draft Environmental Impact Statement for the proposed new Yankee Stadium. The analysis included a Phase I Environmental Site Assessment of the entire project area and Subsurface (Phase II) Investigation in areas where environmental conditions were identified. The Phase II investigation included geophysical surveys to search for potential underground storage tanks; and soil, soil gas, and groundwater sampling at over 40 locations to determine potential environmental impacts during and after the proposed construction. Ms. Kinal also developed an extensive community air monitoring plan and oversaw its implementation during deconstruction of the old Yankee Stadium.

Avalon on the Sound, New Rochelle, NY

Ms. Kinal oversaw environmental investigation and soil remediation during the construction of two luxury high-rise apartment buildings and an associated parking garage. Investigation activities included an electromagnetic survey to search for possible underground storage tanks, and subsurface sampling to characterize soil and groundwater. Remediation activities included removing underground storage tanks, excavating and disposing of soil contaminated with volatile and semi-volatile organic compounds, and collecting end-of-excavation confirmation samples.

Davids Island Environmental Audit, New Rochelle, NY

Ms. Kinal managed the hazardous materials portion of the audit of this undeveloped island site, including a Phase I Environmental Site Assessment (ESA) and Subsurface (Phase II) Investigation in areas where environmental conditions were identified. The Phase II investigation included collecting soil samples from more than 100 locations and analyzing them for targeted compounds, including volatile organic compounds, semi-volatile compounds, metals, pesticides, and polychlorinated biphenyls (PCBs). Ms. Kinal also oversaw an electromagnetic (EM) survey conducted to identify the location of suspected underground storage tanks on the island. Based on soil sample results, Ms. Kinal estimated the volume of contaminated soil requiring remediation and prepared cost estimates for soil excavation and for transportation and disposal of contaminated soil and hazardous materials.

Outlet City Site Investigation, Queens, NY

Ms. Kinal prepared a work plan for remedial investigation of the Outlet City site, a property in Long Island City that was formerly occupied by a manufacturer of industrial cleaners and pharmaceuticals. The site is being investigated and remediated under the NYSDEC voluntary clean-up program. In preparing the work plan, Ms. Kinal evaluated results from several previous investigations and conducted a limited groundwater sampling program to determine future data needs for designing remediation of creosote-contaminated soil and groundwater. The work plan included additional soil and groundwater sampling, a tidal survey to determine tidal influence on groundwater levels, and pilot free product recovery testing. Ms. Kinal also helped design a venting system for an on-site basement and performed exposure calculations for the vented vapors.

Yonkers Waterfront Redevelopment Project, Yonkers, NY

For this redevelopment along Yonkers' Hudson River waterfront, Ms. Kinal supervised the remediation of Parcels H and I that were contaminated with hazardous soil. During the remediation process, she reviewed the subcontractor health and safety plans, delineated the areas of excavation, and oversaw field activities to ensure compliance with the specifications and appropriate regulations. This property was remediated under the NYSDEC Environmental Restoration Program (ERP).

J. PATRICK DIGGINS, P.G.

Senior Technical Director

J. Patrick Diggins has 13 years of environmental consulting experience primarily in environmental investigations, and remediation planning and oversight. His experience includes implementing due diligence assessments and investigations [Phase I Environmental Site Assessments (ESAs) and Subsurface (Phase II) Investigations], completing regulatory environmental investigations and reporting, developing and implementing remedial action programs, and assisting clients with long-term post-remediation site management. His New York City (NYC) projects are currently working their way through or have been successfully remediated under either the New York State Department of Environmental Conservation (NYSDEC) Brownfield Cleanup Program (BCP) or NYC Office of Environmental Remediation (OER) E Designation program or Voluntary Cleanup Program (VCP). Prior to his work in New York City, he gained experience in the New England region implementing large-scale environmental investigation and groundwater remediation projects.

BACKGROUND

Education

M.S. Hydrogeology, University of Massachusetts - Amherst, 2009
B.S Geology, Beloit College, 2005

Years of Experience

Date started at AKRF: January 2016
Prior industry experience: Langan Engineering and Environmental Services – Oct. 2011 to Dec. 2015 (4 years)
Environmental Resources Management – September 2008 to October 2011 (3 years)

Work History

AKRF: 01/2016 – Present
Langan Engineering and Environmental Services – 10/2011 - 12/2015
Environmental Resources Management – 09/2008 to 10/2011

Office Number:

914.922.2784

Certifications

New York State Certified Professional Geologist (August 2017)

RELEVANT EXPERIENCE

Newtown Creek Bud Site – North Block, Long Island City, NY

The property is a future mixed-use residential building with ground floor commercial spaces, and AKRF has assisted the client with entering the proposed site redevelopment project into the NYSDEC BCP. AKRF has provided ongoing environmental consulting services for this project, including completion of due diligence investigations (Phase I ESA and a Phase II Investigation), completion of a groundwater elevation and tidal study, submission of the BCP Application and associated NYSDEC coordination, completion of the Remedial Investigation, and submission of the Remedial Investigation Report (RIR) and Remedial Action Work Plan (RAWP). Mr. Diggins has acted as project manager, overseeing field personnel implementing the due diligence and regulatory reports and work plans. Remedial construction is slated to being in early 2022, and AKRF will be providing field oversight and regulatory coordination and reporting throughout redevelopment.

Newtown Creek Bud Site – South Block, Long Island City, NY

The property is a future mixed-use residential building with ground floor commercial spaces and is enrolled in the OER E-Designation program. AKRF has provided ongoing environmental consulting services for this project, including completion of due diligence investigations (Phase I ESA and a Phase II Investigation), completion of a groundwater elevation and tidal study, and completion of the Remedial Investigation, and submission of the RIR and RAWP to OER. Mr. Diggins has acted as project manager, overseeing field personnel implementing the due diligence and regulatory reports and work plans. Remedial construction is slated to being in early 2022, and AKRF will be providing field oversight and regulatory coordination and reporting throughout redevelopment.

272 4th Avenue, Brooklyn

The property is a future mixed-use residential building with ground floor commercial spaces, and AKRF has assisted the client with entering the proposed site redevelopment project into the NYSDEC BCP. AKRF has provided ongoing environmental consulting services for this project, including completion of due diligence investigations (Phase I ESA and a Phase II Investigation), submission of the BCP Application, completion of the Remedial Investigation, and submission of the RIR. Mr. Diggins acted as project manager, overseeing field personnel implementing the due diligence and regulatory reports. Remedial construction is slated to being in early 2022, and AKRF will be submitting the RAWP, and providing field oversight and regulatory coordination and reporting throughout redevelopment.

Queens Animal Shelter, Ridgewood, Queens, New York

The property is a future animal shelter, and AKRF has assisted the client with entering the proposed site redevelopment project into the NYSDEC BCP. AKRF has provided ongoing environmental consulting services for this project, including completion of due diligence investigations (Phase I ESA and a Phase II Investigation), submission of the BCP Application, completion of the Remedial Investigation, and submission of the RIR. AKRF is currently overseeing the implementation of remedial actions, which began in late 2019. For this project, Mr. Diggins is acting as project manager, overseeing field personnel and reviewing daily reports.

Gantry Plaza State Park, Long Island City, NY

Gantry Plaza State Park (GPSP) is situated along the waterfront in the Hunter's Point South section of Long Island City. Hunter's Point South, including GPSP, was constructed in the mid-2000s under a patchwork of state regulatory programs, including the BCP and the now defunct State Voluntary Cleanup Program (VCP). AKRF drafted an environmental Site Management Plan (SMP) for the New York State Office of Parks, Recreation, and Historic Preservation (OPRHP) in 2017, and has provided ongoing environmental site management support and consulting services. Mr. Diggins has acted a project manager for this project, coordinating with OPRHP and their subcontractors to characterize and properly manage soil during park upgrades, and has complete the necessary regulatory coordination and reporting.

Marsha P Johnson State Park, Brooklyn, NY

Marsha P Johnson State Park (MPJSP) is situated along the waterfront in the Williamsburg neighborhood of Brooklyn. The Park was constructed in 2007. AKRF is providing environmental site management support and consulting services for this project. Mr. Diggins has acted a project manager, coordinating with OPRHP and their subcontractors to characterize and properly manage soil during park upgrades.

110-10 Astoria Boulevard (419Q), Queens, NY

The property is a future public school and is enrolled in the OER E-Designation program. AKRF is representing the New York City School Construction Authority (NYC SCA) completed the remedial investigation, developed and submitted the OER RIR and RAWP, and is currently overseeing the implementation of remedial actions. For this project, Mr. Diggins is acting as project manager, overseeing field personnel and reviewing daily reports.

1325 Jerome Avenue, Bronx, NY

The property is a charter school, which was enrolled in the OER E-Designation program and opened to students in 2021. AKRF provided environmental consulting services for this project, including completion of due diligence investigations (Phase I ESA and a Phase II Investigation), and completion of the Remedial Investigation, and submission of the RIR and RAWP to OER. Mr. Diggins acted as project manager, overseeing field personnel implementing the due diligence and regulatory reports and work plans.

11 Greene Street, New York, NY

The property is a New York City Mayor's Office of Environmental Remediation (NYC OER) Voluntary Cleanup Program (VCP) site. AKRF performed the remedial investigation; developed remedial work plans for approval by the NYC OER, and oversaw the successful implementation of remedial actions during redevelopment. For this project, Mr. Diggins acted as project manager, overseeing field personnel, reviewing daily reports, coordinating with property owner and NYC OER. The remedial actions are complete, and the building opened in 2020.

29-39 East Fordham Road, Bronx, NY

The property has undergone remediation of a petroleum spill that originated in the facility basement. AKRF performed the spill investigation, developed remedial work plans for approval by the New York State Department of Environmental Conservation (NYSDEC), and oversaw the implementation of remedial actions. For this project, Mr. Diggins acted as project manager overseeing field personnel and guiding the client over the regulatory hurdles.

East Side Coastal Resiliency, East River Waterfront/Lower Manhattan, New York

Mr. Diggins prepared cost estimates for construction of coastal resiliency structures in potentially contaminated areas of the East River waterfront, on behalf of NYC Department of Design and Construction (DDC). He evaluated field and laboratory data to assist the project manager in the report preparation, and represented AKRF at meetings with city officials.

MICHAEL BATES

GEOLOGIST – SITE ASSESSMENT AND REMEDIATION

Michael Bates is a Geologist/Environmental Professional II in AKRF's Site Assessment and Remediation group, with experience in environmental sampling and monitoring during site remediation, subsurface and vapor intrusion investigations, remediation system operation and maintenance, and technical reporting.

BACKGROUND

Role in Project
Junior Environmental Scientist

EDUCATION

B.A. Geology, SUNY Geneseo, May 2017

CERTIFICATIONS

OSHA 40-hour Hazardous Waste Operations and Emergency Response Training
OSHA 30-hour Construction Safety Training
EPA Lead Risk Assessor
NY Certified Asbestos Inspector

YEARS OF EXPERIENCE

2 years in the industry

6 months with AKRF

RELEVANT EXPERIENCE

New York City School Construction Authority On-Call Contracts for Environmental Consulting Services, Various Sites, NY

AKRF has undertaken various assignments under five consecutive hazardous materials on-call contracts, including environmental assessment, remedial design, construction support, plumbing disinfection, and potable water (lead) sampling consulting tasks. For potential new school sites, assignments include initial due diligence, Phase I environmental site assessments, and subsurface investigation of soil, groundwater, and soil vapor to determine the suitability of a site for development as a school, likely remediation requirements, and associated costs. For sites undergoing design and development, assignments include preparation of remediation plans, design of sub-slab depressurization systems and contract specifications, and construction oversight. The work also includes conducting indoor air quality testing, vapor intrusion assessments, preparation of specifications and construction management for petroleum storage tank removals, and investigation and remediation of spills for existing schools. Under the most recent contract, Michael Bates has completed waste characterization sampling for planned improvements at an existing school facility (K597) and conducted environmental oversight and community air monitoring during construction of a new school facility (X468).

Phipps Houses, Atlantic Chestnut, Brooklyn, NY

AKRF was retained to provide environmental consulting services in connection with the purchase and redevelopment of former burned manufacturing buildings encompassing an entire city block in Brooklyn, New York. AKRF conducted due diligence prior to acquisition, and facilitated entry into the New York State Brownfield Cleanup Program (NYSBCP) to delineate contamination in soil, groundwater, and soil vapor; and remediate the lots during redevelopment. AKRF designed and implemented several rounds of investigations and remedies. The first phase of the project received NYSDEC sign off in 2022 and the second phase of the project is currently being remediated and redeveloped. The remedies include groundwater injections and treatment, fuel oil recovery and tank closure, management of soil disposal, excavation and disposal of hazardous and non-hazardous waste streams, installation and operation of soil vapor extraction systems and sub-slab depressurization systems, and long-term groundwater and vapor monitoring and reporting to ensure compliance with the NYSBCP. Michael Bates served as an on-site environmental during the complex beginning stages of the second phase of remediation, and completed hazardous waste delineation sampling.

Newtown Creek Bud Site - North Block, Queens, NY

AKRF is providing environmental planning and site assessment/remediation services for a 575-unit, 34-story apartment building at 55-01 Second Street and an 812-unit, 39-story building at 2-10 54th Avenue in Long Island City. The buildings will total 1.43 million square feet. The site was investigated and is being remediated under the NYS Brownfield Cleanup Program. Michael Bates served as an on-site environmental monitor during construction to ensure compliance with the Remedial Action Work Plan. His duties included community and work zone air monitoring, soil disposal and import tracking, inspection of the sub-slab depressurization system installation, and associated reporting.

1100 Myrtle Avenue, Brooklyn, NY

AKRF prepared a Remedial Investigation Work Plan (RIWP) for New York City Mayor's Office of Environmental Remediation (OER) and performed the associated Remedial Investigation. Following, the site was accepted into the New York State Department of Environmental Conservation (NYSDEC) Brownfield Cleanup Program (BCP), after which AKRF conducted additional investigation and prepared a Remedial Action Work Plan (RAWP). Michael Bates conducted inspections during start-up of the sub-slab depressurization system and soil vapor extraction system, which were installed under the new building in accordance with the RAWP and associated design documents.

221 Glenmore Avenue, Brooklyn, New York

AKRF is conducting a large-scale Remedial Investigation at a former lighting company facility in support of a NYSDEC Brownfield Cleanup Program application and anticipated remediation. Michael Bates performed groundwater sampling of newly installed and existing monitoring wells at the Site in accordance with EPA low-flow sampling protocols and preformed soil vapor sampling from nested vapor points to determine the vertical distribution of chlorinated solvent contamination in the subsurface.

BESS, Astoria, Queens, New York

AKRF prepared and is implementing a Construction Health and Safety Plan (CHASP, approved by the New York Power Authority) during construction of a stand-alone new battery energy storage system at a Con Edison facility in Astoria Queens. Michael Bates served as an on-site environmental monitor during construction to ensure compliance with the CHASP. His duties included community and work zone air monitoring during utility clearance and waste characterization sampling.

PREVIOUS EXPERIENCE

As a Staff Geologist at two previous environmental consulting firms, Michael Bates conducted subsurface investigations, low-flow groundwater sampling, and soil vapor sampling, and prepared associated technical reports. He also conducted routine O&M and monitoring of large groundwater and soil vapor treatment systems and sub-slab depressurization systems, and oversaw installation/rehabilitation of recovery wells for system upgrades.

Qualifications Summary

- Over 30 years of experience in the environmental field and over 40 years in analytical laboratories
- Extensive experience involving management of environmental laboratory operations.
- Involvement with NELAC since its inception and member of "Accreditation Committee"
- ASTM committee member on D-34 "Waste Characterization and Disposal"
- Co-founder of Matrix Analytical, Inc.
- Diverse experience in laboratory from medical, industrial and environmental
- Lab Design for wastewater, water treatment, analytical & environmental facilities for existing & new labs, including equipment selection, casework, hood selection.
  Linear process flow for expansion considerations

James C. Todaro

Quality Assurance Officer

Professional Affiliations

National Environmental Laboratory Accreditation Conference (NELAC)
American Chemical Society (ACS)
American Society for the Testing of Materials (ASTM)
Independent Testing Laboratory Association (ITLA)
Society of American Military Engineers (SAME)

Fields of Expertise

Laboratory Management – Environmental, Analytical, Medical
Marketing and Sales
Laboratory Design

Higher Education

B.A., Biology – Ricker College (1970)
M.T. A.S.C.P. – Norwood Hospital (1971)

Employment History

2007-Present	Alpha Analytical Labs – Quality Assurance Officer,
2005-2007	Alpha Analytical Labs – Laboratory Director - Mansfield
2000-2005	Alpha Analytical Labs – Laboratory Director - Westboro
1983-2000	Matrix Analytical Laboratory – Owner/Laboratory Director
1979-1983	NE Medical Laboratory – Laboratory Director
1976-1979	Corning Medical Diagnostics – Quality Assurance Officer
1974-1976	NE Deaconess Hospital – Emergency Lab Technologist
1971-1974	NE Medical Laboratory – Automated Chem Supervisor

Professional Training/Committees

NELAC/TNI Expert PT Committee

DoD Technical Advisory Group

MassDEP Laboratory Advisory Committee

NJDEP Environmental Laboratory Advisory Committee

ASTM D-34 Waste Management Committee

Certified Instructor 4 hr LEP and LSP CEU courses for: "Interpretation of Analytical Data", "Selection of Organic Methods".

Qualifications Summary

- Over 30 years of experience in the environmental field and over 40 years in analytical laboratories
- Extensive experience involving management of environmental laboratory operations.
- Involvement with NELAC since its inception and member of "Accreditation Committee"
- ASTM committee member on D-34 "Waste Characterization and Disposal"
- Co-founder of Matrix Analytical, Inc.
- Diverse experience in laboratory from medical, industrial and environmental
- Lab Design for wastewater, water treatment, analytical & environmental facilities for existing & new labs, including equipment selection, casework, hood selection.
  Linear process flow for expansion considerations

James C. Todaro

Quality Assurance Officer

Professional Affiliations

National Environmental Laboratory Accreditation Conference (NELAC)
American Chemical Society (ACS)
American Society for the Testing of Materials (ASTM)
Independent Testing Laboratory Association (ITLA)
Society of American Military Engineers (SAME)

Fields of Expertise

Laboratory Management – Environmental, Analytical, Medical
Marketing and Sales
Laboratory Design

Higher Education

B.A., Biology – Ricker College (1970)
M.T. A.S.C.P. – Norwood Hospital (1971)

Employment History

2007-Present	Alpha Analytical Labs – Quality Assurance Officer,
2005-2007	Alpha Analytical Labs – Laboratory Director - Mansfield
2000-2005	Alpha Analytical Labs – Laboratory Director - Westboro
1983-2000	Matrix Analytical Laboratory – Owner/Laboratory Director
1979-1983	NE Medical Laboratory – Laboratory Director
1976-1979	Corning Medical Diagnostics – Quality Assurance Officer
1974-1976	NE Deaconess Hospital – Emergency Lab Technologist
1971-1974	NE Medical Laboratory – Automated Chem Supervisor

Professional Training/Committees

NELAC/TNI Expert PT Committee

DoD Technical Advisory Group

MassDEP Laboratory Advisory Committee

NJDEP Environmental Laboratory Advisory Committee

ASTM D-34 Waste Management Committee

Certified Instructor 4 hr LEP and LSP CEU courses for: "Interpretation of Analytical Data", "Selection of Organic Methods".

Lori A. Beyer

SUMMARY: General Manager/Laboratory Director with a solid technical background combined with Management experience in environmental testing industry. Outstanding organizational, leadership, communication and technical skills. Customer focused, quality oriented professional with consistently high marks in customer/employee satisfaction.

EXPERIENCE:

1998-Present L.A.B. Validation Corporation, 14 West Point Drive, East Northport, NY
President

- Perform Data Validation activities relating to laboratory generated Organic and Inorganic Environmental Data.

1998-Present American Analytical Laboratories, LLC. 56 Toledo Street, Farmingdale, NY
Laboratory Director/Technical Director

- Plan, direct and control the operation, development and implementation of programs for the entire laboratory in order to meet AAL's financial and operational performance standards.
- Ensures that all operations are in compliance with AAL's QA manual and other appropriate regulatory requirements.
- Actively maintains a safe and healthy working environmental that is demanded by local laws/regulations.
- Monitors and manages group's performance with respect to data quality, on time delivery, safety, analyst development/goal achievement and any other key performance indices.
- Reviews work for accuracy and completeness prior to release of results to customers.

1996-1998 Nytest Environmental, Inc. (NEI) Port Washington, New York
General Manager

- Responsible for controlling the operation of an 18,000 square foot facility to meet NEI's financial and operational performance standards.
- Management of 65 FTEs including Sales and Operations
- Ensure that all operations are in compliance with NEI's QA procedures
- Ensures that productivity indicators, staffing levels and other cost factors are held within established guidelines
- Maintains a quantified model of laboratory's capacity and uses this model as the basis for controlling the flow of work into and through the lab so as to ensure that customer requirements and lab's revenue and contribution targets are achieved.

1994-1996 Nytest Environmental, Inc. (NEI) Port Washington, New York
Technical Project Manager

- Responsible for the coordination and implementation of environmental testing programs requirements between NEI and their customers
- Supervise Customer Service Department
- Assist in the development of major proposals
- Complete management of all Federal and State Contracts and assigned commercial contracts
- Provide technical assistance to the customer, including data validation and interpretation
- Review and implement Project specific QAPP's.

1995-1996 Nytest Environmental, Inc. (NEI) Port Washington, New York
Corporate QA/QC Officer

- Responsible for the implementation of QA practices as required in the NJDEP and EPA Contracts
- Primary contact for NJDEP QA/QC issues including SOP preparation, review and approval
- Responsible for review, verification and adherence to the Contract requirements and NEI QA Plan

1992-1994 Nytest Environmental, Inc. (NEI) Port Washington, New York
Data Review Manager

- Responsible for the accurate compilation, review and delivery of analytical data to the company's customers. Directly and effectively supervised a department of 22 personnel.
- Managed activities of the data processing software including method development, form creation, and production
- Implement new protocol requirements for report and data management formats
- Maintained control of data storage/archival areas as EPA/CLP document control officer

1987-1991 Nytest Environmental, Inc. (NEI) Port Washington, New York
Data Review Specialist

- Responsible for the review of GC, GC/MS, Metals and Wet Chemistry data in accordance with regulatory requirements
- Proficient with USEPA, NYSDEC, NJDEP and NEESA requirements
- Review data generated in accordance with SW846, NYSDEC ASP, EPA/CLP and 40 CFR Methodologies

1986-1987 Nytest Environmental, Inc (NEI) Port Washington, New York
GC/MS VOA Analyst

EDUCATION:

1982-1985 State University of New York at Stony Brook, New York; BS Biology/Biochemistry
1981-1982 University of Delaware; Biology/Chemistry
5/91 Rutgers University; Mass Spectral Data Interpretation Course, GC/MS Training
8/92 Westchester Community College; Organic Data Validation Course
9/93 Westchester Community College; Inorganic Data Validation Course

Form **W-9**
(Rev. December 2011)
Department of the Treasury
Internal Revenue Service

Request for Taxpayer Identification Number and Certification

Give Form to the requester. Do not send to the IRS.

Print or type
See **Specific Instructions** on page 2.

Name (as shown on your income tax return)
L.A.B VALIDATION CORP

Business name/disregarded entity name, if different from above

Check appropriate box for federal tax classification:
☐ Individual/sole proprietor ☐ C Corporation ☒ S Corporation ☐ Partnership ☐ Trust/estate

☐ Limited liability company. Enter the tax classification (C=C corporation, S=S corporation, P=partnership) ▶

☐ Other (see instructions) ▶

☐ Exempt payee

Address (number, street, and apt. or suite no.)
14 WEST POINT DRIVE

City, state, and ZIP code
EAST NORTHPORT, New York 11731

Requester's name and address (optional)

List account number(s) here (optional)

Part I Taxpayer Identification Number (TIN)

Enter your TIN in the appropriate box. The TIN provided must match the name given on the "Name" line to avoid backup withholding. For individuals, this is your social security number (SSN). However, for a resident alien, sole proprietor, or disregarded entity, see the Part I instructions on page 3. For other entities, it is your employer identification number (EIN). If you do not have a number, see *How to get a TIN* on page 3.

Note. If the account is in more than one name, see the chart on page 4 for guidelines on whose number to enter.

Social security number
☐☐☐ - ☐☐ - ☐☐☐☐

Employer identification number
58 - 2381714

Part II Certification

Under penalties of perjury, I certify that:

1. The number shown on this form is my correct taxpayer identification number (or I am waiting for a number to be issued to me), and
2. I am not subject to backup withholding because: (a) I am exempt from backup withholding, or (b) I have not been notified by the Internal Revenue Service (IRS) that I am subject to backup withholding as a result of a failure to report all interest or dividends, or (c) the IRS has notified me that I am no longer subject to backup withholding, and
3. I am a U.S. citizen or other U.S. person (defined below).

Certification instructions. You must cross out item 2 above if you have been notified by the IRS that you are currently subject to backup withholding because you have failed to report all interest and dividends on your tax return. For real estate transactions, item 2 does not apply. For mortgage interest paid, acquisition or abandonment of secured property, cancellation of debt, contributions to an individual retirement arrangement (IRA), and generally, payments other than interest and dividends, you are not required to sign the certification, but you must provide your correct TIN. See the instructions on page 4.

Sign Here Signature of U.S. person ▶ Date ▶ 01/18/13

General Instructions

Section references are to the Internal Revenue Code unless otherwise noted.

Purpose of Form

A person who is required to file an information return with the IRS must obtain your correct taxpayer identification number (TIN) to report, for example, income paid to you, real estate transactions, mortgage interest you paid, acquisition or abandonment of secured property, cancellation of debt, or contributions you made to an IRA.

Use Form W-9 only if you are a U.S. person (including a resident alien), to provide your correct TIN to the person requesting it (the requester) and, when applicable, to:

1. Certify that the TIN you are giving is correct (or you are waiting for a number to be issued),
2. Certify that you are not subject to backup withholding, or
3. Claim exemption from backup withholding if you are a U.S. exempt payee. If applicable, you are also certifying that as a U.S. person, your allocable share of any partnership income from a U.S. trade or business is not subject to the withholding tax on foreign partners' share of effectively connected income.

Note. If a requester gives you a form other than Form W-9 to request your TIN, you must use the requester's form if it is substantially similar to this Form W-9.

Definition of a U.S. person. For federal tax purposes, you are considered a U.S. person if you are:

- An individual who is a U.S. citizen or U.S. resident alien,
- A partnership, corporation, company, or association created or organized in the United States or under the laws of the United States,
- An estate (other than a foreign estate), or
- A domestic trust (as defined in Regulations section 301.7701-7).

Special rules for partnerships. Partnerships that conduct a trade or business in the United States are generally required to pay a withholding tax on any foreign partners' share of income from such business. Further, in certain cases where a Form W-9 has not been received, a partnership is required to presume that a partner is a foreign person, and pay the withholding tax. Therefore, if you are a U.S. person that is a partner in a partnership conducting a trade or business in the United States, provide Form W-9 to the partnership to establish your U.S. status and avoid withholding on your share of partnership income.

Westchester Community College
Professional Development Center

Awards this Certificate of Achievement To

LORI BEYER

for Successfully Completing

ORGANIC DATA VALIDATION COURSE (35 HOURS)

Dr. John Samuelian

Date AUGUST 1992

Assistant Dean
Professional Development Center

President

The Professional
Development Center

SUNY
WESTCHESTER COMMUNITY COLLEGE
Valhalla, New York 10595

Westchester Community College
Professional Development Center

Awards this Certificate of Achievement To

LORI BEYER

for Successfully Completing

INORGANIC DATA VALIDATION

Instructor: Dale Boshart

Date MARCH 1993

Assistant Dean
Professional Development Center

President

The Professional
Development Center

SUNY
WESTCHESTER COMMUNITY COLLEGE
Valhalla, New York 10595

New York State Department of Environmental Conservation
50 Wolf Road, Albany, New York 12233

Thomas C. Jorling
Commissioner

July 8, 1992

Ms. Elaine Sall
Program Coordinator
Westchester Community College
Valhalla, NY 10595-1698

Dear Elaine,

Thank you for your letter of June 29, 1992. I have reviewed the course outline for organic data validation, qualifications for teachers and qualifications for students. The course that you propose to offer would be deemed equivalent to that which is offered by EPA. The individuals who successfully complete the course and pass the final written exam would be acceptable to perform the task of organic data validation for the Department of Environmental Conservation, Division of Hazardous Waste Remediation.

As we have discussed in our conversation of July 7, 1992, you will forward to me prior to the August course deadline, the differences between the EPA SOW/90 and the NYSDEC ASP 12/91. You stated these differences will be compiled by Mr. John Samulian.

I strongly encourage you to offer an inorganic data validation course. I anticipate the same list of candidates would be interested in an inorganic validation course as well, since most of the data to be validated consists of both organic and inorganic data.

Thank you for you efforts and please contact me if I can be of any further assistance.

Sincerely,

Maureen P. Serafini

Maureen P. Serafini
Environmental Chemist II
Division of Hazardous Waste
Remediation

The Professional Development Center
AT
WESTCHESTER COMMUNITY COLLEGE

914 285-6619

October 2, 1992

Ms. Lori Beyer
3 sparkill Drive
East Northport, NY 11731

Dear Ms. Beyer:

Congratulations upon successful completion of the Organic Data Validation course held August 17 - 21, 1992, through Westchester Community College, Professional Development Center. This course has been deemed by New York State Department of Environmental Conservation as equivalent to EPA's Organic Data Validation Course.

Enclosed is your Certificate. Holders of this Certificate are deemed competent to perform organic data validation for the New York State DEC Division of Hazardous Waste Remediation.

The Professional Development Center at Westchester Community College plans to continue to offer courses and seminars which will be valuable to environmental engineers, chemists and related personnel. Current plans include a TCLP seminar on November 17th and a conference on Environmental Monitoring Regulations on November 18th.

We look forward to seeing you again soon at another environmental program or event. Again, congratulations.

Very truly yours,

Passing Grade is 70%
Your Grade is 99%

Elaine Sall
Program Coordinator

ES/bf

SUNY
WESTCHESTER COMMUNITY COLLEGE
Valhalla, New York 10595

The Professional
Development Center
AT
WESTCHESTER COMMUNITY COLLEGE

914 285-6619

June 21, 1993

Dear Ms. Beyer:

Enclosed is your graded final examination in the Inorganic Data Validation course you completed this past March. A score of 70% was required in order to receive a certificate of satisfactory completion. Persons holding this certificate are deemed acceptable to perform Inorganic Data Validation for the New York State Department of Environmental Conservation, Division of Hazardous Waste Remediation.

I am also enclosing a course evaluation for you to complete if you have not already done so. The information you provide will greatly aid us in structuring further courses. We wish to make these course offerings as relevant, targeted and comprehensive as possible. Your evaluation is vital to that end.

Congratulations on your achievement. I look forward to seeing you again at another professional conference or course. We will be co-sponsoring an environmental monitoring conference on October 21, 1993 with the New York Water Pollution Control Association, Lower Hudson Chapter, at IBM's Yorktown Heights, NY site. Information regarding this event will be going out in August.

Very truly yours,

Elaine Sall

Elaine Sall
Program Coordinator

ES/bf

Enclosures

SUNY
WESTCHESTER COMMUNITY COLLEGE
Valhalla, New York 10595

ATTACHMENT B

NYSDEC- AND- EPA-ISSUED EMERGING CONTAMINANT SAMPLING PROTOCOLS

February 2019

Laboratory Guidance for Analysis of Per- and Polyfluoroalkyl Substances (PFAS) in Non-Potable Water and Solids

---

The Division of Environmental Remediation (DER) developed the following guidance for laboratories submitting PFAS data to DER. If laboratories cannot comply with any of the following requirements, they must contact Dana Maikels at dana.maikels@dec.ny.gov prior to analysis of samples.

1. Standards containing both branched and linear isomers must be used when standards are commercially available. Currently, quantitative standards are available for PFHxS, PFOS, NMeFOSAA, and NEtFOSAA. All isomer peaks present in the standard must be integrated and the areas summed. Samples must be integrated in the same manner as the standards.

   Since a quantitative standard does not exist for branched isomers of PFOA, the instrument must be calibrated using just the linear isomer and a technical (qualitative) PFOA standard must be used to identify the retention time of the branched PFOA isomers in the sample. The total response of PFOA branched and linear isomers must be integrated in the samples and quantitated using the calibration curve of the linear standard.

2. Quantifier and qualifier ions must be monitored for all target analytes (PFPeA and PFBA are an exception). The ratio of quantifier ion response to qualifier ion response must be calculated for each target analyte and the ratio compared to standards. Lab derived criteria can be used to determine if the ratios are acceptable.

3. The ion transitions below must be used for the following PFASs:

PFOA	413 > 369
PFOS	499 > 80
PFHxS	399 > 80
PFBS	299 > 80
6:2 FTS	427 > 407
8:2 FTS	527 > 507
NEtFOSAA	584 > 419
NMeFOSAA	570 > 419

4. For all target analyte ions used for quantification, signal to noise ratio must be 3:1 or greater.

5. For water samples, the entire sample bottle must be extracted, and the sample bottle rinsed with appropriate solvent to remove any residual PFAS.

6. Detections below the reporting limit should be reported and qualified with a J qualifier.

March 2019

Sampling for 1,4-Dioxane and Per- and Polyfluoroalkyl Substances (PFAS) Under DEC's Part 375 Remedial Programs

Objective

The Department of Environmental Conservation (DEC) is requiring sampling of all environmental media and subsequent analysis for the emerging contaminants 1,4-Dioxane and PFAS as part of all remedial programs implemented under 6 NYCRR Part 375, as further described in the guidance below.

Sample Planning

The number of samples required for emerging contaminant analyses is to be the same number of samples where "full TAL/TCL sampling" would typically be required in an investigation or remedial action compliance program.

Sampling of all media for ECs is required at all sites coming into or already in an investigative phase of any DER program. In other words, if the sampling outlined in the guidance hasn't already been done or isn't part of an existing work plan to be sampled for in the future, it will be necessary to go back out and perform the sampling prior to approving a SC report or issuing a decision document.

PFAS and 1,4-dioxane shall be incorporated into the investigation of potentially affected media, including soil, groundwater, surface water, and sediment as an addition to the standard "full TAL/TCL sampling." Biota sampling may be necessary based upon the potential for biota to be affected as determined pursuant to a Fish and Wildlife Impact analysis. Soil vapor sampling for PFAS and 1,4-dioxane is not required.

Upon an emerging contaminant being identified as a contaminant of concern (COC) for a site, those compounds must be assessed as part of the remedy selection process in accordance with Part 375 and DER-10 and included as part of the monitoring program upon entering the site management phase.

Soil imported to a site for use in a soil cap, soil cover, or as backfill must be sampled for 1,4-dioxane and PFAS contamination in general conformance with DER-10, section 5.4(e). Assessment of the soil data will be made on a site-specific basis to determine appropriateness for use.

The work plan should explicitly describe analysis and reporting requirements, including laboratory analytical procedures for modified methods discussed below.

Analysis and Reporting

Labs should provide a full category B deliverable, and a DUSR should be prepared by an independent 3rd party data validator. QA/QC samples should be collected as required in DER-10, Section 2.3(c). The electronic data submission should meet the requirements provided at: https://www.dec.ny.gov/chemical/62440.html.

PFAS analysis and reporting: DEC has developed a *PFAS Analyte List* (below) for remedial programs. 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 compounds, the DEC project manager, in consultation with the DEC remedial program chemist, will make case-by-case decisions as to whether certain analytes may be temporarily or permanently discontinued from analysis at each site.

Currently, ELAP does not offer certification for PFAS compounds in matrices other than finished drinking water. However, laboratories analyzing environmental samples (e.g., soil, sediments, and groundwater) are required by DER to hold ELAP certification for PFOA and PFOS in drinking water by EPA Method 537 or ISO 25101. Labs must also adhere to the requirements and criteria set forth in the Laboratory Guidance for Analysis of PFAS in Non-Potable Water and Solids.

Modified EPA Method 537 is the preferred method to use for environmental samples due to its ability to achieve very low detection limits. Reporting limits for PFAS in groundwater and soil are to be 2 ng/L (ppt) and 1 ug/kg (ppb), respectively. If contract labs or work plans submitted by responsible parties indicate that they are not able to achieve these reporting limits for the entire list of 21 PFAS, site-specific decisions will need to be made by the DEC project manager in consultation with the DEC remedial program chemist. Note: Reporting limits for PFOA and PFOS in groundwater should not exceed 2 ng/L.

Additional laboratory methods for analysis of PFAS may be warranted at a site. These methods include Synthetic Precipitation Leaching Procedure (SPLP) by EPA Method 1312 and Total Oxidizable Precursor Assay (TOP Assay).

SPLP is a technique for determining the potential for chemicals in soil to leach to groundwater and may be helpful in determining the need for addressing PFAS-containing soils or other solid material as part of the remedy. SPLP sampling need not be considered if there are no elevated PFAS levels in groundwater. If elevated levels of PFAS are detected in water, and PFAS are also seen in soil, then an SPLP test should be considered to better understand the relationship between the PFAS in the two media.

The TOP Assay can assist in determining the potential PFAS risk at a site. For example, some polyfluoroalkyl substances may transform to form perfluoroalkyl substances, resulting in an increase in perfluoroalkyl substance concentrations as contaminated groundwater moves away from the site. To conceptualize the amount and type of oxidizable perfluoroalkyl substances which could be liberated in the environment, a “TOP Assay” analysis can be performed, which approximates the maximum concentration of perfluoroalkyl substances that could be generated if all polyfluoroalkyl substances were oxidized.

PFAS-containing materials can be made up of per- and polyfluoroalkyl substances that are not analyzable by routine analytical methodology (LC-MS/MS). The TOP assay converts, through oxidation, polyfluoroalkyl substances (precursors) into perfluoroalkyl substances that can be detected by current analytical methodology. Please note that analysis of highly contaminated samples, such as those from an AFFF site, can result in incomplete oxidation of the samples and an underestimation of the total perfluoroalkyl substances. Please consult with a DEC remedial program chemist for assistance interpreting the results.

1,4-Dioxane analysis and reporting: The reporting limit for 1,4-dioxane in groundwater should be no higher than 0.35 µg/L (ppb) and no higher than 0.1 mg/kg (ppm) in soil. Although ELAP offers certification for both EPA Method 8260 SIM and EPA Method 8270 SIM in waters, DER is advising the use of Method 8270 SIM because it provides a more robust extraction procedure, uses a larger sample volume, and is less vulnerable to interference from chlorinated solvents. The analysis currently performed for SVOCs in soil is adequate for evaluation of 1,4-dioxane in soil, which already has an established SCO.

Refinement of sample analyses

As with other contaminants that are analyzed for at a site, the emerging contaminant analyte list may be refined for future sampling events based on investigative findings. Initially, however, sampling using this PFAS Analyte List and 1,4-dioxane is needed to understand the nature of contamination.

PFAS Analyte List

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

Groundwater Sampling for Emerging Contaminants

February 2018

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

Implementation

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

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

Analysis and Reporting

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

The work plan should explicitly describe analysis and reporting requirements.

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

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

Some sampling using this full PFAS target analyte list is needed to understand the nature of contamination. It may also be critical to differentiate PFAS compounds associated with a site from other sources of these chemicals. Like routine refinements to parameter lists based on investigative findings, the full PFAS target analyte list may not be needed for all sampling intended to define the extent of contamination. Project managers may approve a shorter analyte list (e.g., just the UCMR3 list) for some reporting on a case by case basis.

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

Full PFAS Target Analyte List

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

Bold entries depict the 6 original UCMR3 chemicals

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

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

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

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

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

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

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

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

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

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

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

EPA Document #: EPA/600/R-20/006

METHOD 537.1 DETERMINATION OF SELECTED PER- AND POLYFLUORINATED ALKYL SUBSTANCES IN DRINKING WATER BY SOLID PHASE EXTRACTION AND LIQUID CHROMATOGRAPHY/TANDEM MASS SPECTROMETRY (LC/MS/MS)

Version 2.0
March 2020

J.A. Shoemaker and D.R. Tettenhorst, Office of Research and Development

J.A. Shoemaker and D.R. Tettenhorst, Office of Research and Development, Method 537.1, Rev 1.0 (2018)

J.A. Shoemaker (Office of Research and Development), P.E. Grimmett (Office of Research and Development), B.K. Boutin (National Council on Aging), Method 537, Rev 1.1 (2009)

CENTER FOR ENVIRONMENTAL SOLUTIONS & EMERGENCY RESPONSE
OFFICE OF RESEARCH AND DEVELOPMENT
U. S. ENVIRONMENTAL PROTECTION AGENCY
CINCINNATI, OHIO 45268

METHOD 537.1

DETERMINATION OF SELECTED PER- AND POLYFLUORINATED ALKYL SUBSTANCES IN DRINKING WATER BY SOLID PHASE EXTRACTION AND LIQUID CHROMATOGRAPHY/TANDEM MASS SPECTROMETRY (LC/MS/MS)

1. SCOPE AND APPLICATION

1.1. This is a solid phase extraction (SPE) liquid chromatography/tandem mass spectrometry (LC/MS/MS) method for the determination of selected per- and polyfluorinated alkyl substances (PFAS) in drinking water. Accuracy and precision data have been generated in reagent water and drinking water for the compounds listed in the table below.

Analyte[a]	Acronym	Chemical Abstract Services Registry Number (CASRN)
Hexafluoropropylene oxide dimer acid	HFPO-DA	13252-13-6[b]
N-ethyl perfluorooctanesulfonamidoacetic acid	NEtFOSAA	2991-50-6
N-methyl perfluorooctanesulfonamidoacetic acid	NMeFOSAA	2355-31-9
Perfluorobutanesulfonic acid	PFBS	375-73-5
Perfluorodecanoic acid	PFDA	335-76-2
Perfluorododecanoic acid	PFDoA	307-55-1
Perfluoroheptanoic acid	PFHpA	375-85-9
Perfluorohexanesulfonic acid	PFHxS	355-46-4
Perfluorohexanoic acid	PFHxA	307-24-4
Perfluorononanoic acid	PFNA	375-95-1
Perfluorooctanesulfonic acid	PFOS	1763-23-1
Perfluorooctanoic acid	PFOA	335-67-1
Perfluorotetradecanoic acid	PFTA	376-06-7
Perfluorotridecanoic acid	PFTrDA	72629-94-8
Perfluoroundecanoic acid	PFUnA	2058-94-8
11-chloroeicosafluoro-3-oxaundecane-1-sulfonic acid	11Cl-PF3OUdS	763051-92-9[c]
9-chlorohexadecafluoro-3-oxanonane-1-sulfonic acid	9Cl-PF3ONS	756426-58-1[d]
4,8-dioxa-3H-perfluorononanoic acid	ADONA	919005-14-4[e]

---

[a] Some PFAS are commercially available as ammonium, sodium and potassium salts. This method measures all forms of the analytes as anions while the counterion is inconsequential. Analytes may be purchased as acids or as any of the corresponding salts (see Section 7.2.3 regarding correcting the analyte concentration for the salt content).

[b] HFPO-DA and the ammonium salt of HFPO-DA are components of the GenX processing aid technology and both are measured as the anion of HFPO-DA by this method.

[c] 11Cl-PF3OUdS is available in salt form (e.g. CASRN of potassium salt is 83329-89-9).

[d] 9Cl-PF3ONS analyte is available in salt form (e.g. CASRN of potassium salt is 73606-19-6)

[e] ADONA is available as the sodium salt (no CASRN) and the ammonium salt (CASRN is 958445-44-8).

1.2. Minimum Reporting Level (MRL) is the lowest analyte concentration that meets Data Quality Objectives (DQOs) that are developed based on the intended use of this method. The single laboratory lowest concentration MRL (LCMRL) is the lowest true concentration for which the future recovery is predicted to fall, with high confidence (99%), between 50 and 150% recovery. Single laboratory LCMRLs for analytes in this method range from 0.53-6.3 ng/L and are listed in Table 5. The procedure used to determine the LCMRL is described elsewhere.[1]

1.3. Laboratories using this method will not be required to determine the LCMRL for this method, but will need to demonstrate that their laboratory MRL for this method meets requirements described in Section 9.2.6.

1.4. Determining the Detection Limit (DL) for analytes in this method is optional (Sect. 9.2.8). Detection limit is defined as the statistically calculated minimum concentration that can be measured with 99% confidence that the reported value is greater than zero.[2] The DL is compound dependent and is dependent on extraction efficiency, sample matrix, fortification concentration, and instrument performance.

1.5. This method is intended for use by analysts skilled in solid phase extractions, the operation of LC/MS/MS instruments, and the interpretation of the associated data.

1.6. METHOD FLEXIBILITY – In recognition of technological advances in analytical systems and techniques, the laboratory is permitted to modify the evaporation technique, separation technique, LC column, mobile phase composition, LC conditions and MS and MS/MS conditions (Sect. 6.12, 9.1.1, 10.2, and 12.1). **Changes may not be made to sample collection and preservation (Sect. 8), the sample extraction steps (Sect. 11.4), or to the quality control requirements (Sect. 9).** Method modifications should be considered only to improve method performance. Modifications that are introduced in the interest of reducing cost or sample processing time, but result in poorer method performance, should not be used. Analytes must be adequately resolved chromatographically to permit the mass spectrometer to dwell on a minimum number of compounds eluting within a retention time window. Instrumental sensitivity (or signal-to-noise) will decrease if too many compounds are permitted to elute within a retention time window. In all cases where method modifications are proposed, the analyst must perform the procedures outlined in the initial demonstration of capability (IDC, Sect. 9.2), verify that all Quality Control (QC) acceptance criteria in this method (Sect. 9) are met, and that acceptable method performance can be verified in a real sample matrix (Sect. 9.3.6).

NOTE: The above method flexibility Section is intended as an abbreviated summation of method flexibility. Sections 4-12 provide detailed information of specific portions of the method that may be modified. If there is any perceived conflict between the general method flexibility statement in Section 1.6 and specific information in Sections 4-12, Sections 4-12 supersede Section 1.6.

2. SUMMARY OF METHOD

A 250-mL water sample is fortified with surrogates and passed through an SPE cartridge containing polystyrenedivinylbenzene (SDVB) to extract the method analytes and surrogates. The compounds are eluted from the solid phase sorbent with a small amount of methanol. The extract is concentrated to dryness with nitrogen in a heated water bath, and then adjusted to a 1-mL volume with 96:4% (vol/vol) methanol:water and addition of the internal standards. A 10-µL injection is made into an LC equipped with a C18 column that is interfaced to an MS/MS. The analytes are separated and identified by comparing the acquired mass spectra and retention times to reference spectra and retention times for calibration standards acquired under identical LC/MS/MS conditions. The concentration of each analyte is determined by using the internal standard technique. Surrogate analytes are added to all Field and QC Samples to monitor the extraction efficiency of the method analytes.

3. DEFINITIONS

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

3.2. CALIBRATION STANDARD (CAL) – A solution prepared from the primary dilution standard solution and/or stock standard solution, internal standard(s), and the surrogate(s). The CAL solutions are used to calibrate the instrument response with respect to analyte concentration.

3.3. COLLISIONALLY ACTIVATED DISSOCIATION (CAD) – The process of converting the precursor ion's translational energy into internal energy by collisions with neutral gas molecules to bring about dissociation into product ions.

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

3.5. DETECTION LIMIT (DL) – The minimum concentration of an analyte that can be identified, measured, and reported with 99% confidence that the analyte concentration is greater than zero. This is a statistical determination of precision (Sect. 9.2.8), and accurate quantitation is not expected at this level.2

3.6. EXTRACTION BATCH – A set of up to 20 Field Samples (not including QC samples) extracted together by the same person(s) during a work day using the same lot of SPE devices, solvents, surrogate, internal standard and fortifying solutions. Required QC samples include Laboratory Reagent Blank, Laboratory Fortified Blank, Laboratory Fortified Sample Matrix, and either a Field Duplicate or Laboratory Fortified Sample Matrix Duplicate.

3.7. FIELD DUPLICATES (FD1 and FD2) – Two separate samples collected at the same time and place under identical circumstances and treated exactly the same throughout field and laboratory procedures. Analyses of FD1 and FD2 give a measure of the precision associated with sample collection, preservation, and storage, as well as laboratory procedures.

3.8. FIELD REAGENT BLANK (FRB) – 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 FRB is to determine if method analytes or other interferences are present in the field environment.

3.9. INTERNAL STANDARD (IS) – A pure chemical added to an extract or standard solution in a known amount(s) and used to measure the relative response of other method analytes and surrogates that are components of the same solution. The internal standard must be a chemical that is structurally similar to the method analytes, has no potential to be present in water samples, and is not a method analyte.

3.10. LABORATORY FORTIFIED BLANK (LFB) – A volume of reagent water or other blank matrix to which known quantities of the method analytes and all the preservation compounds are added in the laboratory. The LFB is analyzed exactly like a sample, and its purpose is to determine whether the methodology is in control, and whether the laboratory is capable of making accurate and precise measurements.

3.11. LABORATORY FORTIFIED SAMPLE MATRIX (LFSM) – A preserved field sample to which known quantities of the method analytes are added in the laboratory. The LFSM is processed and analyzed exactly like a sample, and its purpose is to determine whether the sample matrix contributes bias to the analytical results. The background concentrations of the analytes in the sample matrix must be determined in a separate sample extraction and the measured values in the LFSM corrected for background concentrations.

3.12. LABORATORY FORTIFIED SAMPLE MATRIX DUPLICATE (LFSMD) – A duplicate of the Field Sample used to prepare the LFSM. The LFSMD is fortified, extracted, and analyzed identically to the LFSM. The LFSMD is used instead of the Field Duplicate to assess method precision when the occurrence of method analytes is low.

3.13. LABORATORY REAGENT BLANK (LRB) – An aliquot of reagent water or other blank matrix that is treated exactly as a sample including exposure to all glassware, equipment, solvents and reagents, sample preservatives, internal standard, and surrogates that are used in the analysis batch. The LRB is used to determine if method analytes or other interferences are present in the laboratory environment, the reagents, or the apparatus.

3.14. LOWEST CONCENTRATION MINIMUM REPORTING LEVEL (LCMRL) – The single laboratory LCMRL is the lowest true concentration for which a future recovery is expected, with 99% confidence, to be between 50 and 150% recovery.1

3.15. MINIMUM REPORTING LEVEL (MRL) – The minimum concentration that can be reported as a quantitated value for a method analyte in a sample following analysis. This defined concentration can be no lower than the concentration of the lowest calibration standard for that analyte and can only be used if acceptable QC criteria for this standard are met. A procedure for verifying a laboratory's MRL is provided in Section 9.2.6.

3.16. PRECURSOR ION – For the purpose of this method, the precursor ion is the deprotonated molecule ([M-H]-) of the method analyte. In MS/MS, the precursor ion is mass selected and fragmented by collisionally activated dissociation to produce distinctive product ions of smaller m/z.

3.17. 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.

3.18. 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.

3.19. QUALITATIVE STANDARD – A qualitative standard is a standard for which either the concentration is estimated or method analyte impurities exist at a concentration >1/3 of the MRL in the highest concentration calibration standard. For the purposes of this method, qualitative standards are used to identify retention times of branched isomers of method analytes and are not used for quantitation purposes.

3.20. QUALITY CONTROL SAMPLE (QCS) – A solution of method analytes of known concentrations that is obtained from a source external to the laboratory and different from the source of calibration standards. The second source SSS is used to fortify the QCS at a known concentration. The QCS is used to check calibration standard integrity.

3.21. QUANTITATIVE STANDARD – A quantitative standard is a standard of known concentration and purity. The quantitative standard must not contain any of the method analytes as impurities at concentrations >1/3 of the MRL in the highest concentration calibration standard.

3.22. SAFETY DATA SHEET (SDS) – Written information provided by vendors concerning a chemical's toxicity, health hazards, physical properties, fire, and reactivity data including storage, spill, and handling precautions.

3.23. STOCK STANDARD SOLUTION (SSS) – A concentrated solution containing one or more method analytes prepared in the laboratory using assayed reference materials or purchased from a reputable commercial source.

3.24. SURROGATE ANALYTE (SUR) – A pure chemical which chemically resembles method analytes and is extremely unlikely to be found in any sample. This chemical is added to a sample aliquot in known amount(s) before processing and is measured with the same procedures used to measure other method analytes. The purpose of the SUR is to monitor method performance with each sample.

4. INTERFERENCES

4.1. All glassware must be meticulously cleaned. Wash glassware with detergent and tap water, rinse with tap water, followed by a reagent water rinse. Non-volumetric glassware can be heated in a muffle furnace at 400 °C for 2 h or solvent rinsed. Volumetric glassware should be solvent rinsed and not be heated in an oven above 120 °C. Store clean glassware inverted or capped. **Do not cover with aluminum foil because PFAS can be potentially transferred from the aluminum foil to the glassware.**

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

4.2. Method interferences may be caused by contaminants in solvents, reagents (including reagent water), sample bottles and caps, and other sample processing hardware that lead to discrete artifacts and/or elevated baselines in the chromatograms. The analytes in this method can also be found in many common laboratory supplies and equipment, such as PTFE (polytetrafluoroethylene) products, LC solvent lines, methanol, aluminum foil, SPE sample transfer lines, etc.[3] All items such as these must be routinely demonstrated to be free from interferences (less than 1/3 the MRL for each method analyte) under the conditions of the analysis by analyzing laboratory reagent blanks as described in Section 9.3.1. **Subtracting blank values from sample results is not permitted.**

4.3. Matrix interferences may be caused by contaminants that are co-extracted from the sample. The extent of matrix interferences will vary considerably from source to source, depending upon the nature of the water. Humic and/or fulvic material can be co-extracted during SPE and high levels can cause enhancement and/or suppression in the electrospray ionization source or low recoveries on the SPE sorbent.[4-5] Total organic carbon (TOC) is a good indicator of humic content of the sample. Under the LC conditions used during method development, matrix effects due to total organic carbon (TOC) were not observed.

4.4. Relatively large quantities of the preservative (Sect. 8.1.2) are added to sample bottles. The potential exists for trace-level organic contaminants in these reagents. Interferences from these sources should be monitored by analysis of laboratory reagent blanks (Sect. 9.3.1), particularly when new lots of reagents are acquired.

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

5. SAFETY

5.1. The toxicity or carcinogenicity of each reagent used in this method has not been precisely defined. Each chemical should be treated as a potential health hazard, and exposure to these chemicals should be minimized. Each laboratory is responsible for maintaining an awareness of OSHA regulations regarding safe handling of chemicals used in this method. A reference file of SDSs should be made available to all personnel involved in the chemical analysis. Additional references to laboratory safety are available.[6-8]

5.2. PFOA has been described as likely to be carcinogenic to humans.[9] Pure standard materials and stock standard solutions of these method analytes should be handled with suitable protection to skin and eyes, and care should be taken not to breathe the vapors or ingest the materials.

6. EQUIPMENT AND SUPPLIES

(Brand names and/or catalog numbers are included for illustration only, and do not imply endorsement of the product.) Due to potential adsorption of analytes onto glass, polypropylene containers were used for all standard, sample and extraction preparations. Other plastic materials (e.g., polyethylene) which meet the QC requirements of Section 9 may be substituted.

6.1. SAMPLE CONTAINERS – 250-mL polypropylene bottles fitted with polypropylene screw caps.

6.2. POLYPROPYLENE BOTTLES – 4-mL narrow-mouth polypropylene bottles (VWR Cat. No.: 16066-960 or equivalent).

6.3. CENTRIFUGE TUBES – 15-mL conical polypropylene tubes with polypropylene screw caps for storing standard solutions and for collection of the extracts (Thomas Scientific Cat. No.: 2602A10 or equivalent).

6.4. AUTOSAMPLER VIALS – Polypropylene 0.4-mL autosampler vials (ThermoFisher Cat. No.: C4000-11) with polypropylene caps (ThermoFisher Cat. No.: C5000-50 or equivalent).

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

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

6.6. MICRO SYRINGES – Suggested sizes include 5, 10, 25, 50, 100, 250, 500 and 1000-µL syringes.

6.7. PLASTIC PIPETS – Polypropylene or polyethylene disposable pipets (Fisher Cat. No.: 13-711-7 or equivalent).

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

6.9. SOLID PHASE EXTRACTION (SPE) APPARATUS FOR USING CARTRIDGES

6.9.1. SPE CARTRIDGES – 0.5 g, 6-mL SPE cartridges containing styrenedivinylbenzene (SDVB) polymeric sorbent phase (Agilent Cat. No.: 1225-5021 or equivalent). The sorbent may not be modified with monomers other than SDVB.

6.9.2. VACUUM EXTRACTION MANIFOLD – A manual vacuum manifold with Visiprep™ large volume sampler (Supelco Cat. No. 57030 and 57275 or equivalent) for cartridge extractions, or an automatic/robotic sample preparation system designed for use with SPE cartridges, may be used if all QC requirements discussed in Section 9 are met. Extraction and/or elution steps may not be changed or omitted to accommodate the use of an automated system. Care must be taken with automated SPE systems to ensure the PTFE commonly used in these systems does not contribute to unacceptable analyte concentrations in the LRB (Sect. 9.3.1).

6.9.3. SAMPLE DELIVERY SYSTEM – Use of a polypropylene transfer tube system, which transfers the sample directly from the sample container to the SPE cartridge, is recommended, but not mandatory. Standard extraction manifolds come equipped with PTFE transfer tube systems. These can be replaced with 1/8" O.D. x 1/16" I.D. polypropylene or polyethylene tubing (Hudson Extrusions LLDPE or equivalent) cut to an appropriate length to ensure no sample contamination from the sample transfer lines. Other types of non-PTFE tubing may be used provided it meets the LRB (Sect. 9.3.1) and LFB (Sect. 9.3.3) QC requirements. The PTFE transfer tubes may be used, but an LRB must be run on each PTFE transfer tube and the QC requirements in Section 9.3.1 must be met. In the case of automated SPE, the removal of PTFE lines may not be feasible; therefore, LRBs will need to be rotated among the ports and must meet the QC requirements of Sections 9.2.2 and 9.3.1.

6.10. EXTRACT CONCENTRATION SYSTEM – Extracts are concentrated by evaporation with nitrogen using a water bath set no higher than 65 °C (Meyer N-Evap, Model 111, Organomation Associates, Inc. or equivalent).

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

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

6.12.1. LC SYSTEM – Instrument capable of reproducibly injecting up to 10-µL aliquots and performing binary linear gradients at a constant flow rate near the flow rate used for development of this method (0.3 mL/min). The usage of a column heater is optional.

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

6.12.2. LC/TANDEM MASS SPECTROMETER – The LC/MS/MS must be capable of negative ion electrospray ionization (ESI) near the suggested LC flow rate of 0.3 mL/min. The system must be capable of performing MS/MS to produce unique product ions (Sect. 3.18) for the method analytes within specified retention time segments. A minimum of 10 scans across the chromatographic peak is required to ensure adequate precision. Data are demonstrated in Tables 5-9 using a triple quadrupole mass spectrometer (Waters XEVO TQMS). See the Note in Sect. 10.2.3 pertaining to potential limitations of some MS/MS instrumentation in achieving the required MS/MS transitions.

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

6.12.4. ANALYTICAL COLUMN – An LC C18 column (2.1 x 150 mm) packed with 5 µm dp C18 solid phase particles (Waters #: 186001301 or equivalent) was used. Any column that provides adequate resolution, peak shape, capacity, accuracy, and precision (Sect. 9) may be used.

7. REAGENTS AND STANDARDS

7.1. GASES, REAGENTS, AND SOLVENTS – Reagent grade or better chemicals should be used. Unless otherwise indicated, it is intended that all reagents shall conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available. Other grades may be used, provided it is first determined that the reagent is of sufficiently high purity to permit its use without lessening the quality of the determination.

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

7.1.2. METHANOL (CH3OH, CAS#: 67-56-1) – High purity, demonstrated to be free of analytes and interferences (Fisher LC/MS grade or equivalent).

7.1.3. AMMONIUM ACETATE (NH4C2H3O2, CAS#: 631-61-8) – High purity, demonstrated to be free of analytes and interferences (Sigma-Aldrich ACS grade or equivalent).

7.1.4. 20 mM AMMONIUM ACETATE/REAGENT WATER – To prepare 1 L, add 1.54 g ammonium acetate to 1 L of reagent water. This solution is volatile and must be replaced at least once a week. More frequent replacement may be necessary if unexplained loss in sensitivity or retention time shifts are encountered and attributed to loss of the ammonium acetate.

7.1.5. TRIZMA® PRESET CRYSTALS, pH 7.0 (Sigma cat# T-7193 or equivalent) – Reagent grade. A premixed blend of Tris [Tris(hydroxymethyl)aminomethane] and Tris HCL [Tris(hydroxymethyl)aminomethane hydrochloride]. Alternatively, a mix of the two components with a weight ratio of 15.5/1 Tris HCL/Tris may be used. This blend is targeted to produce a pH near 7.0 at 25 °C in reagent water. Trizma® functions as a buffer and removes free chlorine in chlorinated finished waters (Sect. 8.1.2).

7.1.6. NITROGEN – Used for the following purposes:

7.1.6.1. Nitrogen aids in aerosol generation of the ESI liquid spray and is used as collision gas in some MS/MS instruments. The nitrogen used should meet or exceed instrument manufacturer's specifications.

7.1.6.2. Nitrogen is used to concentrate sample extracts (Ultra High Purity or equivalent).

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

7.2. STANDARD SOLUTIONS – When a compound purity is assayed to be 96% or greater, the weight can be used without correction to calculate the concentration of the stock standard. PFAS analyte, IS and SUR standards commercially purchased in glass ampoules are acceptable; however, all subsequent transfers or dilutions performed by the analyst must be prepared and stored in polypropylene containers. Solution concentrations listed in this Section were used to develop this method and are included as an example. Alternate concentrations may be used as necessary depending on instrument sensitivity and the calibration range used. Standards for sample fortification generally should be prepared in the smallest volume that can be accurately measured to minimize the addition of excess organic solvent to aqueous samples. PDS and calibration standards were found to be stable for, at least, one month during method development. Laboratories should use standard QC practices to determine when standards need to be replaced. The target analyte manufacturer's guidelines may be helpful when making the determination.

NOTE: Stock standards (Sect. 7.2.1.1, 7.2.2.1 and 7.2.3.1) were stored at ≤4 °C. Primary dilution standards (Sect.7.2.1.2, 7.2.2.2 and 7.2.3.2) were stored at room temperature to prevent adsorption of the method analytes onto the container surfaces that may occur when refrigerated. Storing the standards at room temperature will also minimize daily imprecision due to the potential of inadequate room temperature stabilization. However, standards may be stored cold provided the standards are allowed to come to room temperature and vortexed well prior to use.

7.2.1. INTERNAL (IS) STOCK STANDARD SOLUTIONS – This method uses three IS compounds listed in the table below. These isotopically labeled IS(s) were carefully chosen during method development because they encompass all the functional groups of the method analytes. Although alternate IS standards may be used provided they are isotopically labeled compounds with similar functional groups as the method analytes, the analyst must have documented reasons for using alternate IS(s). Alternate IS(s) must meet the QC requirements in Section 9.3.4. Note that different isotopic labels of the same IS(s) are acceptable (e.g., $^{13}C_2$-PFOA and $^{13}C_4$-PFOA) but will require modification of the MS/MS precursor and product ions.

Internal Standards	**Acronym**
Perfluoro-[1,2-$^{13}C_2$]octanoic acid	$^{13}C_2$-PFOA
Sodium perfluoro-1-[1,2,3,4-$^{13}C_4$]octanesulfonate	$^{13}C_4$-PFOS
N-deuteriomethylperfluoro-1-octanesulfonamidoacetic acid	d_3-NMeFOSAA

7.2.1.1. IS STOCK STANDARD SOLUTIONS (IS SSS) – These IS stocks can be obtained as individual certified stock standard solutions. The ISs can also be purchased as PDSs, making the preparation of individual SSSs unnecessary. Analysis of the IS(s) is less complicated if the IS(s) purchased contains only the linear isomer.

7.2.1.2. INTERNAL STANDARD PRIMARY DILUTION (IS PDS) STANDARD (1-4 ng/µL) – Prepare, or purchase commercially, the IS PDS at a suggested concentration of 1-4 ng/µL. The IS PDS (in methanol with 4 molar equivalents of sodium hydroxide) was purchased from Wellington Labs. Alternatively, the IS PDS can be prepared in methanol containing 4% reagent water. Use 10 µL of this 1-4 ng/µL solution to fortify the final 1-mL extracts (Sect. 11.5). This will yield a concentration of 10-40 ng/mL of each IS in the 1-mL extracts.

IS	**Final Conc. of IS PDS (ng/µL)**
$^{13}C_2$-PFOA	1.0
$^{13}C_4$-PFOS	3.0
d_3-NMeFOSAA	4.0

7.2.2. SURROGATE (SUR) STANDARD SOLUTIONS – The four SUR(s) listed in the table below were purchased from Wellington Labs as linear only isomers. These isotopically labeled SUR standards were carefully chosen during method development because they encompass most of the functional groups, as well as the water solubility range of the method analytes. Although alternate SUR standards may be used provided they are isotopically labeled compounds with similar functional groups as the method analytes, the analyst must have documented reasons for using alternate SUR standards. The alternate SUR standards chosen must still span the water solubility range of the method analytes. In addition, alternate SUR standards must meet the QC requirements in Section 9.3.5.

Surrogates	**Acronym**
Perfluoro-n-[1,2-$^{13}C_2$]hexanoic acid	$^{13}C_2$-PFHxA
Perfluoro-n-[1,2-$^{13}C_2$]decanoic acid	$^{13}C_2$-PFDA
N-deuterioethylperfluoro-1-octanesulfonamidoacetic acid	d_5-NEtFOSAA
Tetrafluoro-2-heptafluoropropoxy-$^{13}C_3$-propanoic acid	$^{13}C_3$-HFPO-DA

7.2.2.1. SUR STOCK STANDARD SOLUTIONS (SUR SSS) – These SUR stocks can be obtained as individual certified stock standard solutions. The SURs can also be purchased as PDSs, making the preparation of individual SSSs unnecessary. Analysis of the SUR(s) is less complicated if the SUR(s) purchased contains only the linear isomer.

7.2.2.2. SURROGATE PRIMARY DILUTION STANDARD (SUR PDS) (1-4 ng/µL) – Prepare, or purchase commercially, the SUR PDS at a suggested concentration of 1-4 ng/µL. The SUR PDS (in methanol with 4 molar equivalents of sodium hydroxide) was purchased from Wellington Labs. Alternatively, the SUR PDS can be prepared in methanol containing 4% reagent water. Use 10 µL of this 1-4 ng/µL solution to fortify all QC and Field Samples. (Sect. 11.5). This will yield SUR concentrations of 40-160 ng/L in the 250 mL aqueous samples.

SUR	Final Conc. of SUR PDS (ng/µL)
$^{13}C_2$-PFHxA	1.0
$^{13}C_2$-PFDA	1.0
d_5-NEtFOSAA	4.0
$^{13}C_3$-HFPO-DA	1.0

7.2.3. ANALYTE STANDARD SOLUTIONS – Analyte standards may be purchased commercially as ampoulized solutions or prepared from neat materials. If commercially available, the method analytes must be purchased as technical grade (linear and branched isomers) standards or neat materials. Standards or neat materials that contain only the linear isomer can be substituted only if technical grade (linear and branched isomers) standards or neat material cannot be purchased as quantitative standards (see note below regarding PFOA). At the time of this method development, PFHxS, PFOS, NEtFOSAA and NMeFOSAA are available as technical grade (containing branched and linear isomers) and therefore must be purchased as technical grade.

A qualitative standard (Sect. 3.19) is available for PFOA that contains the linear and branched isomers (Wellington Labs, Cat. No. T-PFOA, or equivalent). This qualitative PFOA standard must be purchased and used to identify the retention times of the branched PFOA isomers, but the linear only PFOA standard must be used for quantitation (Sect. 12.2) until a quantitative PFOA standard containing the branched and linear isomers becomes commercially available.

PFHxS, PFOS, ADONA, 9Cl-PF3ONS and 11Cl-PF3OUdS may not be available as the acids listed in Section 1.1, but rather as their corresponding salts, such as NH_4^+, Na^+ and K^+. These salts are acceptable starting materials for the stock standards provided the measured mass is corrected for the salt content according to the equation below. Prepare the Analyte Stock and Primary Dilutions Standards as described below.

$$Mass_{acid} = MeasuredMass_{salt} \times \frac{MW_{acid}}{MW_{salt}}$$

where:

MW_{acid} = the molecular weight of PFAS
MW_{salt} = the molecular weight of purchased salt

7.2.3.1. ANALYTE STOCK STANDARD SOLUTION (SSS) – Analyte standards may be purchased commercially as ampoulized solutions prepared from neat materials. Commercially prepared SSSs are available for all method analytes. During method development, mixes or individual stocks were obtained from Accustandard, Absolute, Wellington Labs and Synquest. When using these stock standards to prepare a PDS, care must be taken to ensure that these standards are at room temperature and adequately vortexed.

7.2.3.2. ANALYTE PRIMARY DILUTION STANDARD (PDS) SOLUTION (0.5-2.5 ng/µL) – The analyte PDS contains all the method analytes of interest at various concentrations in methanol containing 4% water (or in methanol containing 4 molar equivalents of sodium hydroxide). The ESI and MS/MS response varies by compound; therefore, a mix of concentrations may be needed in the analyte PDS. See Tables 5-9 in Section 17 for suggested concentrations for each analyte. During method development, the analyte PDS was prepared such that approximately the same instrument response was obtained for all the analytes. The analyte PDS is prepared by dilution of the combined Analyte Stock Standard Solutions and is used to prepare the CAL standards, and fortify the LFBs, LFSMs, and LFSMDs with the method analytes. If the PDS is stored cold, care must be taken to ensure that these standards are at room temperature and adequately vortexed before usage.

7.2.4. CALIBRATION STANDARDS (CAL) – At least five calibration concentrations are required to prepare the initial calibration curve spanning a 20-fold concentration range (Sect. 10.2). Larger concentration ranges will require more calibration points. Prepare the CAL standards over the concentration range of interest from dilutions of the analyte PDS in methanol containing 4% reagent water. The suggested analyte concentrations found in Tables 5-9 can be used as a starting point for determining the calibration range. The IS and SUR are added to the CAL standards at a constant concentration. During method development, the concentrations of the SUR(s) were 10-40 pg/µL in the standard (40-160 ng/L in the sample) and the IS(s) were 10-40 ng/mL. The lowest concentration CAL standard must be at or below the MRL, which may depend on system sensitivity. The CAL standards may also be used as CCCs (Sect. 9.3.2).

8. SAMPLE COLLECTION, PRESERVATION, AND STORAGE

8.1. SAMPLE BOTTLE PREPARATION

8.1.1. Samples must be collected in a 250-mL polypropylene bottle fitted with a polypropylene screw-cap.

8.1.2. The preservation reagent, listed in the table below, is added to each sample bottle as a solid prior to shipment to the field (or prior to sample collection).

Compound	**Amount**	**Purpose**
Trizma® (Sect. 7.1.5)	5.0 g/L	buffering reagent and removes free chlorine

8.2. SAMPLE COLLECTION

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

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

8.2.2. Fill sample bottles, taking care not to flush out the sample preservation reagent. Samples do not need to be collected headspace free.

8.2.3. After collecting the sample, cap the bottle and agitate by hand until preservative is dissolved. Keep the sample sealed from time of collection until extraction.

8.3. FIELD REAGENT BLANKS (FRB)

8.3.1. An FRB must be handled along with each sample set. The sample set is composed of samples collected from the same sample site and at the same time. At the laboratory, fill the field blank sample bottle with reagent water, then seal, and ship to the sampling site along with the sample bottles. For each FRB shipped, a second FRB bottle containing only the preservative must also be shipped. At the sampling site, the sampler must open the shipped FRB and pour the preserved reagent water into the empty shipped sample bottle, seal and label this bottle as the FRB. The FRB is shipped back to the laboratory along with the samples and analyzed to ensure that PFAS were not introduced into the sample during sample collection/handling.

8.3.2. The same batch of preservative must be used for the FRBs as for the field samples.

8.3.3. The reagent water used for the FRBs must be initially analyzed for method analytes as a LRB (using the same lot of sample bottles as the field samples) and must meet the LRB criteria in Section 9.3.1 prior to use. This requirement will ensure samples are not being discarded due to contaminated reagent water or sample bottles rather than contamination during sampling.

8.4. SAMPLE SHIPMENT AND STORAGE – Samples must be chilled during shipment and must not exceed 10 °C during the first 48 hours after collection. Sample temperature must be confirmed to be at or below 10 °C when the samples are received at the laboratory. Samples stored in the lab must be held at or below 6 °C until extraction but must not be frozen.

NOTE: Samples that are significantly above 10° C, at the time of collection, may need to be iced or refrigerated for a period of time, in order to chill them prior to shipping. This will allow them to be shipped with sufficient ice to meet the above requirements.

8.5. SAMPLE AND EXTRACT HOLDING TIMES – Results of the sample storage stability study (Table 10) indicated that all compounds listed in this method have adequate stability for 14 days when collected, preserved, shipped and stored as described in Sections 8.1, 8.2, and 8.4. Therefore, water samples should be extracted as soon as possible but must be extracted within 14 days. Extracts must be stored at room temperature and analyzed within 28 days after extraction. The extract storage stability study data are presented in Table 11.

9. QUALITY CONTROL

9.1. QC requirements include the Initial Demonstration of Capability (IDC) and ongoing QC requirements that must be met when preparing and analyzing Field Samples. This Section describes the QC parameters, their required frequencies, and the performance criteria that must be met in order to meet EPA quality objectives. The QC criteria discussed in the following sections are summarized in Table 12 and Table 13. These QC requirements are considered the minimum acceptable QC criteria. Laboratories are encouraged to institute additional QC practices to meet their specific needs.

9.1.1. METHOD MODIFICATIONS – The analyst is permitted to modify LC columns, LC conditions, evaporation techniques, internal standards or surrogate standards, and MS and MS/MS conditions. Each time such method modifications are made, the analyst must repeat the procedures of the IDC. **Modifications to LC conditions should still produce conditions such that co-elution of the method analytes is minimized to reduce the probability of suppression/enhancement effects.**

9.2. INITIAL DEMONSTRATION OF CAPABILITY – The IDC must be successfully performed prior to analyzing any Field Samples. Prior to conducting the IDC, the analyst must first generate an acceptable Initial Calibration following the procedure outlined in Section 10.2.

9.2.1. INITIAL DEMONSTRATION OF BRANCHED vs LINEAR ISOMER PROFILE for PFOA IN A QUALITATIVE STANDARD – Prepare and analyze a qualitative standard used for identifying retention times of branch isomers of PFOA. Identify the retention times of branched isomers of PFOA in the purchased technical grade PFOA standard. This qualitative PFOA standard is not used for quantitation (see Section 12.2). This branched isomer identification check must be repeated any time changes occur that affect the analyte retention times.

9.2.2. INITIAL DEMONSTRATION OF LOW SYSTEM BACKGROUND – Any time a new lot of SPE cartridges, solvents, centrifuge tubes, disposable pipets, and autosampler vials are used, it must be demonstrated that an LRB is reasonably free of contamination and that the criteria in Section 9.3.1 are met. If an automated extraction system is used, an LRB should be extracted on each port to ensure that all the valves and tubing are free from potential PFAS contamination.

9.2.3. INITIAL DEMONSTRATION OF PRECISION (IDP) – Prepare, extract, and analyze four to seven replicate LFBs fortified near the midrange of the initial calibration curve according to the procedure described in Section 11.4. Sample preservatives as described in Section 8.1.2 must be added to these samples. The relative standard deviation (RSD) of the results of the replicate analyses must be less than 20%.

9.2.4. INITIAL DEMONSTRATION OF ACCURACY (IDA) – Using the same set of replicate data generated for Section 9.2.3, calculate average recovery. The average recovery of the replicate values must be within ± 30% of the true value.

9.2.5. INITIAL DEMONSTRATION OF PEAK ASYMMETRY FACTOR – Peak asymmetry factors must be calculated using the equation in Section 9.3.9 for the first two eluting peaks (if only two analytes are being analyzed, both must be evaluated) in a mid-level CAL standard. The peak asymmetry factors must fall in the range of 0.8 to 1.5. See guidance in Section 10.2.4.1 if the calculated peak asymmetry factors do not meet the criteria.

9.2.6. MINIMUM REPORTING LEVEL (MRL) CONFIRMATION – Establish a target concentration for the MRL based on the intended use of the method. The MRL may be established by a laboratory for their specific purpose or may be set by a regulatory agency. Establish an Initial Calibration following the procedure outlined in Section 10.2. The lowest CAL standard used to establish the Initial Calibration (as well as the low-level CCC, Section 10.3) must be at or below the concentration of the MRL. Establishing the MRL concentration too low may cause repeated failure of ongoing QC requirements. Confirm the MRL following the procedure outlined below.

9.2.6.1. Fortify, extract, and analyze seven replicate LFBs at the proposed MRL concentration. These LFBs must contain all method preservatives described in Section 8.1.2. Calculate the mean measured concentration (*Mean*) and standard deviation for these replicates. Determine the Half Range for the prediction interval of results (HR_{PIR}) using the equation below

$$HR_{PIR} = 3.963s$$

where

s = the standard deviation
3.963 = a constant value for seven replicates.[1]

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

The Upper PIR Limit must be ≤150% recovery.

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

The Lower PIR Limit must be ≥ 50% recovery.

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

9.2.6.3. The MRL is validated if both the Upper and Lower PIR Limits meet the criteria described above (Sect. 9.2.6.2). If these criteria are not met, the MRL has been set too low and must be determined again at a higher concentration.

9.2.7. CALIBRATION CONFIRMATION – Analyze a QCS as described in Section 9.3.10 to confirm the accuracy of the standards/calibration curve.

9.2.8. DETECTION LIMIT DETERMINATION *(optional) – While DL determination is not a specific requirement of this method, it may be required by various regulatory bodies associated with compliance monitoring. It is the responsibility of the laboratory to determine if DL determination is required based upon the intended use of the data.*

9.2.8.1. Replicate analyses for this procedure should be done over at least three days (i.e., both the sample extraction and the LC/MS/MS analyses should be done over at least three days). Prepare at least seven replicate LFBs at a concentration estimated to be near the DL. This concentration may be estimated by selecting a concentration at 2-5 times the noise level. The DLs in Table 5 were calculated from LFBs fortified at various concentrations as indicated in the table. The appropriate fortification concentrations will be dependent upon the sensitivity of the LC/MS/MS system used. All preservation reagents listed in Section 8.1.2 must also be added to these samples. Analyze the seven replicates through all steps of Section 11.

NOTE: If an MRL confirmation data set meets these requirements, a DL may be calculated from the MRL confirmation data, and no additional analyses are necessary.

Calculate the *DL* using the following equation

$$DL = s \times t_{(n-1, 1-\alpha=0.99)}$$

where

s = standard deviation of replicate analyses
$t_{(n-1,\, 1-\alpha=0.99)}$ = Student's t value for the 99% confidence level with n-1 degrees of freedom
n = number of replicates.

NOTE: Do not subtract blank values when performing DL calculations. The DL is a statistical determination of precision only.[2] If the DL replicates are fortified at a low enough concentration, it is likely that they will not meet the precision and accuracy criteria for CCCs. Therefore, no precision and accuracy criteria are specified.

9.2.8.2. If a laboratory is establishing their own MRL, the calculated DLs should not be used as the MRL for analytes that commonly occur as background contaminants. Method analytes that are seen in the background should be reported as present in Field Samples, only after careful evaluation of the background levels. It is recommended that a MRL be established at the mean LRB concentrations + 3σ or 3 times the mean LRB concentration, whichever is greater. This value should be calculated over a period of time, to reflect variability in the blank measurements. It is recommended that this value be used as an MRL in order to avoid reporting false positive results.

9.3. ONGOING QC REQUIREMENTS – This Section summarizes the ongoing QC criteria that must be followed when processing and analyzing Field Samples.

9.3.1. LABORATORY REAGENT BLANK (LRB) – An LRB is required with each extraction batch (Sect. 3.6) to confirm that potential background contaminants are not interfering with the identification or quantitation of method analytes. If more than 20 Field Samples are included in a batch, analyze an LRB for every 20 samples. If the LRB produces a peak within the retention time window of any analyte that would prevent the determination of that analyte, determine the source of contamination and eliminate the interference before processing samples. Background contamination must be reduced to an acceptable level before proceeding. Background from method analytes or other contaminants that interfere with the measurement of method analytes must be below 1/3 of the MRL. Blank contamination is estimated by extrapolation, if the concentration is below the lowest CAL standard. This extrapolation procedure is not allowed for sample results as it may not meet data quality objectives. If the method analytes are detected in the LRB at concentrations equal to or greater than this level, then all data for the problem analyte(s) must be considered invalid for all samples in the extraction batch. Because background contamination is a significant problem for several method analytes, maintaining a historical record of LRB data is highly recommended.

9.3.2. CONTINUING CALIBRATION CHECK (CCC) – CCC Standards are analyzed at the beginning of each analysis batch, after every 10 Field Samples, and at the end of the analysis batch. See Section 10.3 for concentration requirements and acceptance criteria.

9.3.3. LABORATORY FORTIFIED BLANK (LFB) – An LFB is required with each extraction batch (Sect. 3.6). The fortified concentration of the LFB must be rotated between low, medium, and high concentrations from batch to batch. The low concentration LFB must be as near as practical to, but no more than two times, the MRL. Similarly, the high concentration LFB should be near the high end of the calibration range established during the initial calibration (Sect. 10.2). Results of the low-level LFB analyses must be 50-150% of the true value. Results of the medium and high-level LFB analyses must be 70-130% of the true value. If the LFB results do not meet these criteria for method analytes, then all data for the problem analyte(s) must be considered invalid for all samples in the extraction batch.

9.3.4. INTERNAL STANDARDS (IS) – The analyst must monitor the peak areas of the IS(s) in all injections during each analysis day. The IS responses (peak areas) in any chromatographic run must be within 70-140% of the response in the most recent CCC and must not deviate by more than 50% from the average area measured during initial analyte calibration. If the IS areas in a chromatographic run do not meet these criteria, inject a second aliquot of that extract aliquotted into a new capped autosampler vial. Random evaporation losses have been observed with the polypropylene caps causing high IS(s) areas.

9.3.4.1. If the reinjected aliquot produces an acceptable IS response, report results for that aliquot.

9.3.4.2. If the reinjected extract fails again, the analyst should check the calibration by reanalyzing the most recently acceptable CAL standard. If the CAL standard fails the criteria of Section 10.3, recalibration is in order per Section 10.2. If the CAL standard is acceptable, extraction of the sample may need to be repeated provided the sample is still within the holding time.

Otherwise, report results obtained from the reinjected extract, but annotate as suspect. Alternatively, collect a new sample and re-analyze.

9.3.5. SURROGATE RECOVERY – The SUR standard is fortified into all samples, CCCs, LRBs, LFBs, LFSMs, LFSMDs, FD, and FRB prior to extraction. It is also added to the CAL standards. The SUR is a means of assessing method performance from extraction to final chromatographic measurement. Calculate the recovery (%R) for the SUR using the following equation

$$\%R = \left(\frac{A}{B}\right) \times 100$$

where

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

9.3.5.1. SUR recovery must be in the range of 70-130%. When SUR recovery from a sample, blank, or CCC is less than 70% or greater than 130%, check 1) calculations to locate possible errors, 2) standard solutions for degradation, 3) contamination, and 4) instrument performance. Correct the problem and reanalyze the extract.

9.3.5.2. If the extract reanalysis meets the SUR recovery criterion, report only data for the reanalyzed extract.

9.3.5.3. If the extract reanalysis fails the 70-130% recovery criterion, the analyst should check the calibration by injecting the last CAL standard that passed. If the CAL standard fails the criteria of Section 10.3, recalibration is in order per Section 10.2. If the CAL standard is acceptable, extraction of the sample should be repeated provided the sample is still within the holding time. If the re-extracted sample also fails the recovery criterion, report all data for that sample as suspect/SUR recovery to inform the data user that the results are suspect due to SUR recovery. Alternatively, collect a new sample and re-analyze.

9.3.6. LABORATORY FORTIFIED SAMPLE MATRIX (LFSM) – Analysis of an LFSM is required in each extraction batch and is used to determine that the sample matrix does not adversely affect method accuracy. Assessment of method precision is accomplished by analysis of a Field Duplicate (FD) (Sect. 9.3.7); however, infrequent occurrence of method analytes would hinder this assessment. If the occurrence of method analytes in the samples is infrequent, or if historical trends are unavailable, a second LFSM, or LFSMD, must be prepared, extracted, and analyzed from a duplicate of the Field Sample. Extraction batches that contain LFSMDs will not require the extraction of a FD. If a variety of different sample matrices are analyzed regularly, for example, drinking water from groundwater and surface water sources, method performance should be established for each. Over time, LFSM data should be documented by the laboratory for all routine sample sources.

9.3.6.1. Within each extraction batch (Sect. 3.6), a minimum of one Field Sample is fortified as an LFSM for every 20 Field Samples analyzed. The LFSM is prepared by spiking a sample with an appropriate amount of the Analyte PDS (Sect. 7.2.3.2). Select a spiking concentration that is greater than or equal to the matrix background concentration, if known. Use historical data and rotate through the low, mid and high concentrations when selecting a fortifying concentration.

9.3.6.2. Calculate the percent recovery (%*R*) for each analyte using the equation

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

where

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

9.3.6.3. Analyte recoveries may exhibit matrix bias. For samples fortified at or above their native concentration, recoveries should range between 70-130%, except for low-level fortification near or at the MRL (within a factor of 2-times the MRL concentration) where 50-150% recoveries are acceptable. If the accuracy of any analyte falls outside the designated range, and the laboratory performance for that analyte is shown to be in control in the CCCs, the recovery is judged to be matrix biased. The result for that analyte in the unfortified sample is labeled suspect/matrix to inform the data user that the results are suspect due to matrix effects.

9.3.7. FIELD DUPLICATE OR LABORATORY FORTIFIED SAMPLE MATRIX DUPLICATE (FD or LFSMD) – Within each extraction batch (not to exceed 20 Field Samples, Sect. 3.6), a minimum of one FD or LFSMD must be analyzed. Duplicates check the precision associated with sample collection, preservation, storage, and laboratory procedures. If method analytes are not routinely observed in Field Samples, an LFSMD should be analyzed rather than an FD.

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

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

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

9.3.7.3. If an LFSMD is analyzed instead of a FD, calculate the relative percent difference (RPD) for duplicate LFSMs (LFSM and LFSMD) using the equation

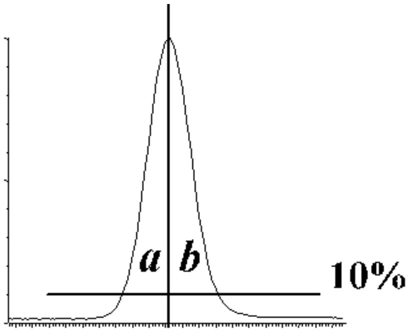
$$RPD = \frac{\left|LFSM - LFSMD\right|}{\left(LFSM + LFSMD\right)/2} \times 100$$

9.3.7.4. RPDs for duplicate LFSMs must be ≤30% for samples fortified at or above their native concentration. Greater variability may be observed when LFSMs are fortified at analyte concentrations that are within a factor of 2 of the MRL. LFSMs fortified at these concentrations must have RPDs that are ≤50% for samples fortified at or above their native concentration. If the RPD of any analyte falls outside the designated range, and the laboratory performance for that analyte is shown to be in control in the CCC, the recovery is judged to be matrix biased. The result for that analyte in the unfortified sample is labeled suspect/matrix to inform the data user that the results are suspect due to matrix effects.

9.3.8. FIELD REAGENT BLANK (FRB) – The purpose of the FRB is to ensure that PFAS measured in the Field Samples were not inadvertently introduced into the sample during sample collection/handling. Analysis of the FRB is required only if a Field Sample contains a method analyte or analytes at or above the MRL. The FRB is processed, extracted and analyzed in exactly the same manner as a Field Sample. If the method analyte(s) found in the Field Sample is present in the FRB at a concentration greater than 1/3 the MRL, then all samples collected with that FRB are invalid and must be recollected and reanalyzed.

9.3.9. PEAK ASYMMETRY FACTOR – A peak asymmetry factor must be calculated using the equation below during the IDC and every time chromatographic changes are made that may affect peak shape. The peak asymmetry factor for the first two eluting peaks in a mid-level CAL standard (if only two analytes are being analyzed, both must be evaluated) must fall in the range of 0.8 to 1.5. Modifying the standard or extract composition to more aqueous content to prevent poor shape is not permitted. See guidance in Section 10.2.4.1 if the calculated peak asymmetry factors do not meet the criteria.

$$A_s = \frac{b}{a}$$



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

9.3.10. QUALITY CONTROL SAMPLES (QCS) – As part of the IDC (Sect. 9.2), each time a new Analyte PDS (Sect. 7.2.3.2) is prepared, and at least quarterly, analyze a QCS sample from a source different from the source of the CAL standards. If a second vendor is not available, then a different lot of the standard should be used. The QCS should be prepared at a mid-level concentration and analyzed just like a CCC. Acceptance criteria for the QCS are identical to the CCCs; the calculated amount for each analyte must be ± 30% of the expected value. If measured analyte concentrations are not of acceptable accuracy, check the entire analytical procedure to locate and correct the problem.

10. CALIBRATION AND STANDARDIZATION

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

10.2. INITIAL CALIBRATION

10.2.1. ESI-MS/MS TUNE

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

10.2.1.2. Optimize the $[M\text{-}H]^-$ or $[M\text{-}CO_2]^-$ for each method analyte by infusing approximately 0.5-1.0 µg/mL of each analyte (prepared in the initial mobile phase conditions) directly into the MS at the chosen LC mobile phase flow rate (approximately 0.3 mL/min). This tune can be done on a mix of the method analytes. The MS parameters (voltages, temperatures, gas flows, etc.) are varied until optimal analyte responses are determined. The method analytes may have different optima requiring some compromise between the optima. See Table 2 for ESI-MS conditions used in method development.

10.2.1.3. Optimize the product ion (Sect. 3.18) for each analyte by infusing approximately 0.5-1.0 µg/mL of each analyte (prepared in the initial mobile phase conditions) directly into the MS at the chosen LC mobile phase flow rate (approximately 0.3 mL/min). This tune can be done on a mix of the method analytes. The MS/MS parameters (collision gas pressure, collision energy, etc.) are varied until optimal analyte responses are determined. Typically, the carboxylic acids have very similar MS/MS conditions and the sulfonic acids have similar MS/MS conditions. See Table 4 for MS/MS conditions used in method development.

10.2.2. Establish LC operating parameters that optimize resolution and peak shape. Suggested LC conditions can be found in Table 1. The LC conditions listed in Table 1 may not be optimum for all LC systems and may need to be optimized by the analyst (See Sect. 10.2.4.1). Modifying the standard or extract composition to more aqueous content to prevent poor shape is not permitted.

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

Mobile phase modifiers other than 20 mM ammonium acetate may be used at the discretion of the analyst, provided that the retention time stability criteria in Sect. 11.7.2 can be met over a period of two weeks. During method development, retention times shifted to shorter and shorter times as days progressed when mobile phases with less than 20 mM ammonium acetate were used.

10.2.3. Inject a mid-level CAL standard under LC/MS conditions to obtain the retention times of each method analyte. Divide the chromatogram into retention time windows each of which contains one or more chromatographic peaks. During MS/MS analysis, fragment a small number of selected precursor ions ($[M-H]^-$; Sect. 3.16) for the analytes in each window and choose the most abundant product ion. The product ions (also the quantitation ions) chosen during method development are in Table 4, although these will be instrument dependent. For maximum sensitivity, small mass windows of ±0.5 daltons around the product ion mass were used for quantitation.

NOTE: There have been reports[10] that not all product ions in the linear PFOS are produced in all branched PFOS isomers. (This phenomenon may exist for many of the PFAS.) Thus, to reduce PFOS, PFBS and PFHxS bias, it is required that the precursor *m/z* → *m/z* 80 transition be used as the quantitation transition. Some MS/MS instruments, may not be able to scan a product ion with such a wide mass difference from the precursor ion; therefore, if the MS/MS cannot measure the precursor *m/z* → *m/z* 80 transition they may not be used for this method if PFOS, PFBS, or PFHxS analysis is to be conducted.

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

NOTE: Ensure that the retention time window used to collect data for each analyte is sufficient to detect earlier eluting branched isomers.

10.2.4.1. If broad, split or fronting peaks are observed for the first two eluting chromatographic peaks (if only two analytes are being analyzed, both must be evaluated), change the initial mobile phase conditions to higher aqueous content until the peak asymmetry ratio for each peak is 0.8 – 1.5. The peak asymmetry factor is calculated as described in Section 9.3.9 on a mid-level CAL standard. The peak asymmetry factor must meet the above criteria for the first two eluting peaks during the IDC and every time a new calibration curve is generated. Modifying the standard or extract composition to more aqueous content to prevent poor shape is not permitted.

10.2.4.2. Most PFAS are produced by two different processes. One process gives rise to linear PFAS only while the other process produces both linear and branched isomers. Thus, both branched and linear PFAS can potentially be found in the environment. Refer to Section 12.2 for guidance on integration and quantitation of PFAS.

10.2.5. Prepare a set of at least five CAL standards as described in Section 7.2.4. The lowest concentration CAL standard must be at or below the MRL, which may depend on system sensitivity. It is recommended that at least four of the CAL standards are at a concentration greater than or equal to the MRL.

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

10.2.7. CALIBRATION ACCEPTANCE CRITERIA – Validate the initial calibration by calculating the concentration of each analyte as an unknown against its regression equation. For calibration levels that are ≤ MRL, the result for each analyte must be within ± 50% of the true value. All other calibration points must calculate to be within ± 30% of their true value. If these criteria cannot be met, the analyst will have difficulty meeting ongoing QC criteria. It is recommended that corrective action is taken to reanalyze the CAL standards, restrict the range of calibration, or select an alternate method of calibration (forcing the curve through zero is still required).

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

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

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

10.3.2. Determine that the absolute areas of the quantitation ions of the IS(s) are within 70-140% of the areas measured in the most recent continuing calibration check, and within 50-150% from the average areas measured during initial calibration. If any of the IS areas has changed by more than these amounts, adjustments must be made to restore system sensitivity. These adjustments may include cleaning of the MS ion source, or other maintenance as indicated in Section 10.3.4. Major instrument maintenance requires recalibration (Sect. 10.2) and verification of sensitivity by analyzing a CCC at or below the MRL (Sect. 10.3). Control charts are useful aids in documenting system sensitivity changes.

10.3.3. Calculate the concentration of each analyte and SUR in the CCC. The calculated amount for each analyte and SUR for medium and high level CCCs must be within ± 30% of the true value. The calculated amount for the lowest calibration point for each analyte must be within ± 50% and the SUR must be within ± 30% of the true value. If these conditions do not exist, then all data for the problem analyte must be considered invalid, and remedial action should be taken (Sect. 10.3.4) which may require recalibration. Any Field or QC Samples that have been analyzed since the last acceptable calibration verification that are still within holding time must be reanalyzed after adequate calibration has been restored, with the following exception. **If the CCC fails because the calculated concentration is greater than 130% (150% for the low-level CCC) for a particular method analyte, and Field Sample extracts show no detection for that method analyte, non-detects may be reported without re-analysis.**

10.3.4. REMEDIAL ACTION – Failure to meet CCC QC performance criteria may require remedial action. Major maintenance, such as cleaning the electrospray probe, atmospheric pressure ionization source, cleaning the mass analyzer, replacing the LC column, etc., requires recalibration (Sect. 10.2) and verification of sensitivity by analyzing a CCC at or below the MRL (Sect. 10.3)

11. PROCEDURE

11.1. This procedure may be performed manually or in an automated mode using a robotic or automatic sample preparation device. The data presented in Tables 5-11 demonstrate data collected by manual extraction. If an automated system is used to prepare samples, follow the manufacturer's operating instructions, but all extraction and elution steps must be the same as in the manual procedure. Extraction and/or elution steps may not be changed or omitted to accommodate the use of an automated system. If an automated system is used, the LRBs should be rotated among the ports to ensure that all the valves and tubing meet the LRB requirements (Sect. 9.3.1).

11.2. Some of the PFAS adsorb to surfaces, including polypropylene. Therefore, the aqueous sample bottles must be rinsed with the elution solvent (Sect. 11.4.4) whether extractions are performed manually or by automation. The bottle rinse is passed through the cartridge to elute the method analytes and is then collected (Sect. 11.4.4).

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

11.3. SAMPLE PREPARATION

11.3.1. Samples are preserved, collected and stored as presented in Section 8. All Field and QC Samples, including the LRB, LFB and FRB, must contain the dechlorinating agent listed in Section 8.1.2. Before extraction, verify that the sample pH is 7 ± 0.5. Determine sample volume. An indirect measurement may be done in one of two ways: by marking the level of the sample on the bottle or by weighing the sample and bottle to the nearest 1 g. After extraction, proceed to Section 11.6 for final volume determination. Some of the PFAS adsorb to surfaces, thus the sample volume may **NOT** be transferred to a graduated cylinder for volume measurement. The LRB, LFB and FRB may be prepared by measuring 250 mL of reagent water with a polypropylene graduated cylinder or filling a 250-mL sample bottle to near the top.

11.3.2. Add an aliquot of the SUR PDS (Sect. 7.2.2.2) to each sample, cap and invert to mix. During method development, a 10-µL aliquot of the 1-4 ng/µL SUR PDS (Sect. 7.2.2.2) was added to 250 mL of sample for a final concentration of 40 ng/L for $^{13}C_2$-PFHxA, $^{13}C_3$-HFPO-DA, and $^{13}C_2$-PFDA and 160 ng/L for d_5-NEtFOSAA.

11.3.3. In addition to the SUR(s) and dechlorination agent, if the sample is an LFB, LFSM, or LFSMD, add the necessary amount of analyte PDS (Sect. 7.2.3.2). Cap and invert each sample to mix.

11.4. CARTRIDGE SPE PROCEDURE

11.4.1. CARTRIDGE CLEAN-UP AND CONDITIONING – DO NOT allow cartridge packing material to go dry during any of the conditioning steps. Rinse each cartridge with 15 mL of methanol. Next, rinse each cartridge with 18 mL of reagent water, without allowing the water to drop below the top edge of the packing. If the cartridge goes dry during the conditioning phase, the conditioning must be started over. Add 2-3 mL of reagent water to each cartridge, attach the sample transfer tubes (Sect. 6.9.3), turn on the vacuum, and begin adding sample to the cartridge.

NOTE: If low recoveries are observed for PFBS and PFHxA during the IDC, recoveries may be improved by allowing a one- or two-minute soak time after each addition of the methanol and water used in the clean-up and conditioning step.

11.4.2. SAMPLE EXTRACTON – Adjust the vacuum so that the approximate flow rate is 10-15 mL/min. Do not allow the cartridge to go dry before all the sample has passed through.

11.4.3. SAMPLE BOTTLE AND CARTRIDGE RINSE – After the entire sample has passed through the cartridge, rinse the sample bottles with two 7.5-mL aliquots of reagent water and draw each aliquot through the sample transfer tubes and the cartridges. Draw air or nitrogen through the cartridge for 5 min at high vacuum (10-15 in. Hg).

NOTE: If empty plastic reservoirs are used in place of the sample transfer tubes to pass the samples through the cartridges, these reservoirs

must be treated like the transfer tubes. After the entire sample has passed through the cartridge, the reservoirs must be rinsed to waste with reagent water.

11.4.4. SAMPLE BOTTLE AND CARTRIDGE ELUTION – Turn off and release the vacuum. Lift the extraction manifold top and insert a rack with collection tubes into the extraction tank to collect the extracts as they are eluted from the cartridges. Rinse the sample bottles with 4 mL of methanol and elute the analytes from the cartridges by pulling the 4 mL of methanol through the sample transfer tubes and the cartridges. Use a low vacuum such that the solvent exits the cartridge in a dropwise fashion. Repeat sample bottle rinse and cartridge elution with a second 4-mL aliquot of methanol.

NOTE: If low recoveries are observed for PFBS and PFHxA during the IDC, recoveries may be improved by allowing a one or two-minute soak time after each four mL addition of the methanol and water used in the clean-up and conditioning step.

NOTE: If empty plastic reservoirs are used in place of the sample transfer tubes to pass the samples through the cartridges, these reservoirs must be treated like the transfer tubes. After the reservoirs have been rinsed in Section 11.4.3, the elution solvent used to rinse the sample bottles must be swirled down the sides of the reservoirs while eluting the cartridge to ensure that any method analytes on the surface of the reservoirs are transferred to the extract.

11.5. EXTRACT CONCENTRATION – Concentrate the extract to dryness under a gentle stream of nitrogen in a heated water bath (60-65 °C) to remove all the water/methanol mix. Add the appropriate amount of 96:4% (vol/vol) methanol:water solution and the IS PDS (Sect. 7.2.1.2) to the collection vial to bring the volume to 1 mL and vortex. (10 µL of the 1-4 ng/µL IS PDS for extract concentrations of 10-40 ng/mL were used for method development). Transfer a small aliquot with a plastic pipet (Sect. 6.7) to a polypropylene autosampler vial.

NOTE: It is recommended that the entire 1-mL aliquot not be transferred to the autosampler vial because the polypropylene autosampler caps do not reseal after injection. Therefore, do not store the extracts in the autosampler vials as evaporation losses occur in these autosampler vials. Extracts can be stored in 15-mL centrifuge tubes (Sect. 6.3).

11.6. SAMPLE VOLUME DETERMINATION – If the level of the sample was marked on the sample bottle, use a graduated cylinder to measure the volume of water required to fill the original sample bottle to the mark made prior to extraction. Determine to the nearest 2 mL. If using weight to determine volume, weigh the empty bottle to the nearest 1 g and determine the sample weight by subtraction of the empty bottle weight from the original sample weight (Sect. 11.3.1). Assume a sample density of 1.0 g/mL.

In either case, the sample volume will be used in the final calculations of the analyte concentration (Sect. 12.3).

11.7. EXTRACT ANALYSIS

11.7.1. Establish operating conditions equivalent to those summarized in Tables 1-4 of Section 17. Instrument conditions and columns should be optimized prior to the initiation of the IDC.

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

11.7.3. Calibrate the system by either the analysis of a calibration curve (Sect. 10.2) or by confirming the initial calibration is still valid by analyzing a CCC as described in Section 10.3. If establishing an initial calibration for the first time, complete the IDC as described in Section 9.2.

11.7.4. Begin analyzing Field Samples, including QC samples, at their appropriate frequency by injecting the same size aliquots (10 µL was used in method development), under the same conditions used to analyze the CAL standards.

11.7.5. At the conclusion of data acquisition, use the same software that was used in the calibration procedure to identify peaks of interest in predetermined retention time windows. Use the data system software to examine the ion abundances of the peaks in the chromatogram. Identify an analyte by comparison of its retention time with that of the corresponding method analyte peak in a reference standard. Comparison of the MS/MS mass spectra is not particularly useful given the limited ±0.5 dalton mass range around a single product ion for each method analyte.

11.7.6. The analyst must not extrapolate beyond the established calibration range. If an analyte peak area exceeds the range of the initial calibration curve, the extract may be diluted with 96%:4% (vol/vol) methanol:water solution and the appropriate amount of IS added to match the original concentration. Re-inject the diluted extract. Incorporate the dilution factor into the final concentration calculations. Acceptable SUR performance (Sect. 9.3.5.1) should be determined from the undiluted sample extract. The resulting data must be documented as a dilution and MRLs adjusted accordingly.

12. DATA ANALYSIS AND CALCULATION

12.1. Complete chromatographic resolution is not necessary for accurate and precise measurements of analyte concentrations using MS/MS. In validating this method, concentrations were calculated by measuring the product ions listed in Table 4. Other ions may be selected at the discretion of the analyst.

12.2. Because environmental samples may contain both branched and linear isomers for method analytes, but quantitative standards that contain the linear and branched isomers do not exist for all method analytes, integration and quantitation of the PFAS is dependent on type of standard available for each PFAS. It is recognized that some of the procedures described below for integration of standards, QC samples and Field Samples may cause a small amount of unavoidable bias in the quantitation of the method analytes due to the current state of the commercially available standards.

12.2.1. During method development, multiple chromatographic peaks were observed for standards of PFHxS, PFOS, NMeFOSAA, and NEtFOSAA using the LC conditions in Table 1 due to chromatographic resolution of the linear and branched isomers of these compounds. For PFHxS, PFOS, NMeFOSAA and NEtFOSAA, all the chromatographic peaks observed in the standard must be integrated and the areas summed. Chromatographic peaks in all Field Samples and QC samples must be integrated in the same way as the CAL standard for analytes with quantitative standards containing the branched and linear isomers.

12.2.2. For PFOA, identify the branched isomers by analyzing a qualitative standard that includes both linear and branched isomers and compare retention times and tandem mass spectrometry transitions. Quantitate Field Samples and QC samples by integrating the total response (i.e., accounting for peaks that are identified as linear and branched isomers) and relying on the initial calibration with a linear-isomer quantitative PFOA standard.

12.2.3. If standards containing the branched and linear isomers cannot be purchased (i.e., only linear isomer is available), only the linear isomer can be identified and quantitated in Field Samples and QC samples using the linear standard because the retention time of the branched isomers cannot be confirmed.

12.3. Calculate analyte and SUR concentrations using the multipoint calibration as described in Section 10.2. Do not use daily calibration verification data to quantitate analytes in samples. Adjust final analyte concentrations to reflect the actual sample volume determined in Section 11.6.

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

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

NOTE: Some data in Section 17 of this method are reported with more than two significant figures. This is done to better illustrate the method performance.

13. METHOD PERFORMANCE

13.1. PRECISION, ACCURACY, AND MINIMUM REPORTING LEVELS – Tables for these data are presented in Section 17. LCMRLs and DLs for each method analyte are presented in Table 5. Precision and accuracy are presented for four water matrices: reagent water (Table 6); chlorinated (finished) ground water (Table 7); chlorinated (finished) surface water (Table 8); and private well water (Table 9).

13.2. SAMPLE STORAGE STABILITY STUDIES – An analyte storage stability study was conducted by fortifying the analytes into chlorinated surface water samples that were collected, preserved, and stored as described in Section 8. The precision and mean recovery (n=4) of analyses, conducted on Days 0, 8, and 14 are presented in Table 10.

13.3. EXTRACT STORAGE STABILITY STUDIES – Extract storage stability studies were conducted on extracts obtained from a chlorinated surface water fortified with the method analytes. The precision and mean recovery (n=4) of injections conducted on Days 0, 8, 14, 22, and 28 are reported in Table 11.

13.4. MULTI-LABORATORY DEMONSTRATION – The performance of this method was demonstrated by multiple laboratories, with results similar to those reported in Section 17. The authors wish to acknowledge the work of 1) EPA Region 2 in Edison, NJ., 2) Eurofins Eaton Analytical, LLC in Monrovia, CA, and 3) New Jersey Department of Health in Ewing, NJ.

14. POLLUTION PREVENTION

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

14.2. For information about pollution prevention that may be applicable to laboratory operations, consult "Less is Better: Laboratory Chemical Management for Waste Reduction" available from the American Chemical Society's Department of Government Relations and Science Policy, 1155 16th Street N.W., Washington, D.C., 20036 or on-line at http://membership.acs.org/c/ccs/pub_9.htm (accessed August 2008).

15. WASTE MANAGEMENT

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

16. REFERENCES

1. Winslow, S.D., Pepich, B.V., Martin, J.J., Hallberg, G.R., Munch, D.J., Frebis, C.P., Hedrick, E.J., Krop, R.A. “Statistical Procedures for Determination and Verification of Minimum Reporting Levels for Drinking water Methods.” Environ. Sci. Technol. 2004, 40, 281-288.

2. Glaser, J.A., D.L. Foerst, G.D. McKee, S.A. Quave, W.L. Budde, "Trace Analyses for Wastewaters.” Environ. Sci. Technol. 1981, 15, 1426-1435.

3. Martin, J.W., Kannan, K., Berger, U., De Voogt, P., Field, J., Franklin, J, Giesy, J.P., Harner, T., Muir, D.C., Scott, B., Kaiser, M., Järnberg, U., Jones, K.C., Mabury, S.A., Schroeder, H., Simcik, M., Sottani, C., van Bavel, B., Kärrman, A., Lindström, G., van Leeuwen, S. “Analytical Challenges Hamper Perfluoroalkyl Research.” Environ. Sci. Technol. 2004, 38, 248A-255A.

4. Leenheer, J.A., Rostad, C.E., Gates, P.M., Furlong, E.T., Ferrer, I. “Molecular Resolution and Fragmentation of Fulvic Acid by Electrospray Ionization/Multistage Tandem Mass Spectrometry.” Anal. Chem. 2001, 73, 1461-1471.

5. Cahill, J.D., Furlong E.T., Burkhardt, M.R., Kolpin, D., Anderson, L.G. “Determination of Pharmaceutical Compounds in Surface- and Ground-Water Samples by Solid-Phase Extraction and High-Performance Liquid Chromatography Electrospray Ionization Mass Spectrometry.” J. Chromatogr. A 2004, 1041, 171-180.

6. “OSHA Safety and Health Standards, General Industry," (29CRF1910). Occupational Safety and Health Administration, OSHA 2206, (Revised, July 1, 2001).

7. “Carcinogens-Working with Carcinogens,” Publication No. 77-206, Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute of Occupational Safety and Health, Atlanta, Georgia, August 1977.

8. "Safety in Academic Chemistry Laboratories,” American Chemical Society Publication, Committee on Chemical Safety, 8th Edition. Information on obtaining a copy is available at

https://www.acs.org/content/dam/acsorg/about/governance/committees/chemicalsafety/publications/safety-in-academic-chemistry-laboratories-students.pdf (accessed October 2018).

9. "SAB Review of EPA's Draft Risk Assessment of Potential Human Health Effects Associated with PFOA and Its Salts." Document available at http://yosemite.epa.gov/sab/SABPRODUCT.NSF/A3C83648E77252828525717F004B9099/$File/sab_06_006.pdf (accessed October 2018).

10. Langlois, I. and Oehme, M. "Structural Identification of Isomers Present In Technical Perfluorooctane Sulfonate By Tandem Mass Spectrometry." Rapid Commun. Mass Spectrom. 2006, 20, 844-850.

17. TABLES, DIAGRAMS, FLOWCHARTS AND VALIDATION DATA

Table 1. LC Method Conditions

Time (min)	% 20 mM ammonium acetate	% Methanol
Initial	60.0	40.0
1.0	60.0	40.0
25.0	10.0	90.0
32.0	10.0	90.0
32.1	60.0	40.0
37.0	60.0	40.0
Waters Atlantis® dC_{18} 2.1 x 150 mm packed with 5.0 µm C_{18} stationary phase Flow rate of 0.3 mL/min 10 µL injection into a 50 µL loop		

Table 2. ESI-MS Method Conditions

ESI Conditions	
Polarity	Negative ion
Capillary needle voltage	-3 kV
Cone gas flow	50 L/hr
Nitrogen desolvation gas	800 L/hr
Desolvation gas temp.	350°C

Table 3. Method Analytes, Retention Times (RT) and Suggested IS References

Analyte	Peak # (Fig. 1)	RT (min)	IS# Ref
PFBS	1	7.62	2
PFHxA	2	10.42	1
HFPO-DA	4	11.38	1
PFHpA	6	13.40	1
PFHxS	7	13.58	2
ADONA	8	13.73	1
PFOA	9	15.85	1
PFOS	11	17.91	2
PFNA	13	17.92	1
9Cl-PF3ONS	14	18.91	2
PFDA	15	19.69	1
NMeFOSAA	17	20.50	3
PFUnA	19	21.21	1
NEtFOSAA	20	21.26	3
11Cl-PF3OUdS	22	21.84	2
PFDoA	23	22.52	1
PFTrDA	24	23.66	1
PFTA	25	24.64	1
$^{13}C_2$-PFHxA	3	10.42	1
$^{13}C_3$-HFPO-DA	5	11.40	1
$^{13}C_2$-PFDA	16	19.69	1
d_5-NEtFOSAA	21	21.24	3
$^{13}C_2$-PFOA– IS#1	10	15.85	-
$^{13}C_4$-PFOS– IS#2	12	17.91	-
d_3-NMeFOSAA–IS#3	18	20.49	-

Table 4. MS/MS Method Conditions[a]

Segment[b]	Analyte	Precursor Ion [c] (*m/z*)	Product Ion[c,d] (*m/z*)	Cone Voltage (v)	Collision Energy[e] (v)
1	PFBS[g]	299	80	42	30
1	PFHxA	313	269	14	10
1	HFPO-DA	285[f]	169	12	8
2	PFHpA	363	319	12	10
2	PFHxS[g,h]	399	80	46	32
2	ADONA	377	251	14	12
3	PFOA	413	369	14	10
3	PFOS[g,h]	499	80	52	42
3	PFNA	463	419	16	12
4	9Cl-PF3ONS	531	351	34	24
4	PFDA	513	469	14	10
4	NMeFOSAA[g]	570	419	30	20
4	PFUnA	563	519	12	10
4	NEtFOSAA[g]	584	419	30	20
4	11Cl-PF3OUdS	631	451	40	24
4	PFDoA	613	569	18	10
5	PFTrDA	663	619	14	14
5	PFTA	713	669	14	12
1	$^{13}C_2$-PFHxA	315	270	16	10
1	$^{13}C_3$-HFPO-DA	287	169	10	6
4	$^{13}C_2$-PFDA	515	470	18	10
4	d_5-NEtFOSAA	589	419	28	22
3	$^{13}C_2$-PFOA	415	370	16	10
3	$^{13}C_4$-PFOS	503	80	58	42
4	d_3-NMeFOSAA	573	419	28	14

[a] An LC/MS/MS chromatogram of the analytes is shown in Figure 1.

[b] Segments are time durations in which single or multiple scan events occur.

[c] Precursor and product ions listed in this table are nominal masses. During MS and MS/MS optimization, the analyst should determine precursor and product ion masses to one decimal place by locating the apex of the mass spectral peak place (e.g., *m/z* 498.9→79.9 for PFOS). These precursor and product ion masses (with at least one decimal place) should be used in the MS/MS method for all analyses.

[d] Ions used for quantitation purposes.

[e] Argon used as collision gas at a flow rate of 0.15 mL/min.

[f] HFPO-DA is not stable in the ESI source and the $[M-H]^-$ is not observed under typical ESI conditions. The precursor ion used during method development was $[M-CO_2]^-$.

[g] Analyte has multiple resolved chromatographic peaks due to linear and branched isomers. All peaks summed for quantitation purposes.

[h] To reduce bias regarding detection of branch and linear isomers, the *m/z* 80 product ion must be used for this analyte.

Table 5. DLs and LCMRLs in Reagent Water

Analyte	Fortified Conc. (ng/L)[a]	DL[b] (ng/L)	LCMRL[c] (ng/L)
PFBS	4.0	1.8	6.3
PFHxA	4.0	1.0	1.7
HFPO-DA	4.0	1.9	4.3
PFHpA	4.0	0.71	0.63
PFHxS	4.0	1.4	2.4
ADONA	4.0	0.88	0.55
PFOA	4.0	0.53	0.82
PFOS	4.0	1.1	2.7
PFNA	4.0	0.70	0.83
9Cl-PF3ONS	4.0	1.4	1.8
PFDA	4.0	1.6	3.3
NMeFOSAA	4.0	2.4	4.3
PFUnA	4.0	1.6	5.2
NEtFOSAA	4.0	2.8	4.8
11Cl-PF3OUdS	4.0	1.5	1.5
PFDoA	4.0	1.2	1.3
PFTrDA	4.0	0.72	0.53
PFTA	4.0	1.1	1.2

[a] Spiking concentration used to determine DL.

[b] Detection limits were determined by analyzing seven replicates over three days according to Section 9.2.8.

[c] LCMRLs were calculated according to the procedure in reference 1.

Table 6. Precision and Accuracy (n=8) of PFAS in Fortified Reagent Water

18. Analyte	Fortified Conc. (ng/L)	Mean % Recovery	% RSD	Fortified Conc. (ng/L)	Mean % Recovery	% RSD
PFBS	16.0	90.8	6.8	80.0	85.1	6.7
PFHxA	16.0	101	8.0	80.0	96.5	4.6
HFPO-DA	16.0	97.8	1.8	80.0	96.8	5.1
PFHpA	16.0	105	3.3	80.0	104	2.7
PFHxS	16.0	109	6.7	80.0	107	4.4
ADONA	16.0	108	1.3	80.0	106	3.6
PFOA	16.0	106	1.8	80.0	104	3.1
PFOS	16.0	111	4.7	80.0	107	4.8
PFNA	16.0	110	2.6	80.0	104	3.6
9Cl-PF3ONS	16.0	108	8.8	80.0	101	3.8
PFDA	16.0	111	2.4	80.0	107	3.6
NMeFOSAA	16.0	104	5.2	80.0	102	5.4
PFUnA	16.0	107	2.8	80.0	101	1.3
NEtFOSAA	16.0	97.7	6.8	80.0	101	2.5
11Cl-PF3OUdS	16.0	109	3.4	80.0	103	6.1
PFDoA	16.0	101	7.2	80.0	107	3.7
PFTrDA	16.0	108	2.6	80.0	99.1	3.6
PFTA	16.0	110	0.9	80.0	97.2	3.6
$^{13}C_2$-PFHxA	40.0	88.5	6.4	40.0	97.0	4.9
$^{13}C_3$-HFPO-DA	40.0	94.5	3.2	40.0	101	9.9
$^{13}C_2$-PFDA	40.0	99.1	3.4	40.0	106	2.7
d_5-NEtFOSAA	160	90.0	2.6	160	99.5	4.8

Table 7. Precision and Accuracy (n=4) of PFAS in Tap Water[a] from a Ground Water Source

19. Analyte	Fortified Conc. (ng/L)	Mean % Recovery	% RSD	Fortified Conc. (ng/L)	Mean % Recovery	% RSD
PFBS	16.0	104	3.1	80.0	90.2	2.1
PFHxA	16.0	105	3.5	80.0	91.6	3.9
HFPO-DA	16.0	99.6	4.0	80.0	90.6	2.9
PFHpA	16.0	101	3.4	80.0	91.2	4.2
PFHxS	16.0	110.0	3.3	80.0	93.5	4.8
ADONA	16.0	104	3.9	80.0	92.2	4.7
PFOA	16.0	105	2.7	80.0	91.1	4.8
PFOS	16.0	108	3.3	80.0	93.9	3.8
PFNA	16.0	105	2.4	80.0	92.4	6.9
9Cl-PF3ONS	16.0	101	8.1	80.0	92.4	4.9
PFDA	16.0	102	4.5	80.0	92.5	7.7
NMeFOSAA	16.0	92.6	7.4	80.0	87.1	9.4
PFUnA	16.0	104	4.8	80.0	92.8	5.6
NEtFOSAA	16.0	108	18.4	80.0	94.1	6.7
11Cl-PF3OUdS	16.0	103	3.4	80.0	95.4	5.4
PFDoA	16.0	99.4	4.6	80.0	92.0	5.0
PFTrDA	16.0	98.8	4.1	80.0	93.1	5.9
PFTA	16.0	102	3.7	80.0	93.9	5.0
$^{13}C_2$-PFHxA	40.0	97.7	3.4	40.0	87.0	6.2
$^{13}C_3$-HFPO-DA	40.0	97.2	3.9	40.0	88.8	6.2
$^{13}C_2$-PFDA	40.0	97.5	5.3	40.0	86.0	10
d_5-NEtFOSAA	160	94.7	8.8	160	80.8	10

[a] TOC = 0.53 mg/L and hardness = 377 mg/L measured as calcium carbonate.

Table 8. Precision and Accuracy (n=4) Of PFAS in Tap Water[a] from a Surface Water Source

20. Analyte	Fortified Conc. (ng/L)	Mean % Recovery	% RSD	Fortified Conc. (ng/L)	Mean % Recovery	% RSD
PFBS	16.0	91.6	3.8	80.0	91.9	7.1
PFHxA	16.0	92.0	5.5	80.0	99.3	4.0
HFPO-DA	16.0	88.6	1.3	80.0	102	2.2
PFHpA	16.0	95.5	3.6	80.0	101	3.3
PFHxS	16.0	99.1	2.5	80.0	102	0.9
ADONA	16.0	95.5	2.9	80.0	102	3.5
PFOA	16.0	97.9	5.2	80.0	98.8	3.9
PFOS	16.0	93.5	5.9	80.0	101	2.4
PFNA	16.0	96.4	3.4	80.0	101	2.8
9Cl-PF3ONS	16.0	93.1	4.6	80.0	102	3.3
PFDA	16.0	95.3	1.7	80.0	99.2	3.3
NMeFOSAA	16.0	99.3	7.2	80.0	94.9	4.5
PFUnA	16.0	99.8	1.7	80.0	100	4.1
NEtFOSAA	16.0	93.3	8.0	80.0	90.5	3.9
11Cl-PF3OUdS	16.0	97.6	6.7	80.0	97.5	3.1
PFDoA	16.0	88.0	1.8	80.0	97.0	2.7
PFTrDA	16.0	94.7	2.5	80.0	95.5	1.8
PFTA	16.0	94.1	5.9	80.0	97.8	3.3
$^{13}C_2$-PFHxA	40.0	86.3	2.8	40.0	90.6	4.1
$^{13}C_3$-HFPO-DA	40.0	92.9	2.4	40.0	101	1.8
$^{13}C_2$-PFDA	40.0	89.3	4.3	40.0	95.8	2.2
d_5-NEtFOSAA	160	86.5	5.4	160	83.1	4.4

[a] TOC = 2.4 mg/L and hardness = 103 mg/L measured as calcium carbonate.

Table 9. Precision and Accuracy (n=4) Of PFAS in Tap Water[a] from a Private Well

21. Analyte	Fortified Conc. (ng/L)	Mean % Recovery	% RSD
PFBS	80.0	99.7	3.1
PFHxA	80.0	96.3	2.7
HFPO-DA	80.0	94.2	4.3
PFHpA	80.0	97.4	1.9
PFHxS	80.0	99.4	4.0
ADONA	80.0	98.7	2.8
PFOA	80.0	97.2	1.5
PFOS	80.0	100	1.9
PFNA	80.0	99.4	1.3
9Cl-PF3ONS	80.0	101	2.2
PFDA	80.0	98.7	2.3
NMeFOSAA	80.0	93.2	4.6
PFUnA	80.0	98.8	1.7
NEtFOSAA	80.0	94.4	0.6
11Cl-PF3OUdS	80.0	99.8	2.5
PFDoA	80.0	99.3	1.9
PFTrDA	80.0	96.2	1.3
PFTA	80.0	97.9	1.2
$^{13}C_2$-PFHxA	40.0	89.9	2.7
$^{13}C_3$-HFPO-DA	40.0	95.7	5.3
$^{13}C_2$-PFDA	40.0	92.3	1.8
d_5-NEtFOSAA	160	86.3	4.5

[a] TOC = 0.56 mg/L and hardness = 394 mg/L measured as calcium carbonate.

Table 10. Aqueous Sample Holding Time Data for Tap Water Samples from a Surface Water Source[a], Fortified with Method Analytes and Preserved and Stored According to Section 8 (n=4)

Analyte	Fortified Conc. (ng/L)	Day 0 Mean % Recovery	Day 0 % RSD	Day 8 Mean % Recovery	Day 8 % RSD	Day 14 Mean % Recovery	Day 14 % RSD
PFBS	80.0	91.9	7.1	99.4	4.2	93.4	11
PFHxA	80.0	99.3	4.0	101	5.4	93.4	7.9
HFPO-DA	80.0	102	2.2	101	5.3	100	11
PFHpA	80.0	101	3.3	99.2	2.2	101	3.6
PFHxS	80.0	102	0.9	103	4.0	107	4.5
ADONA	80.0	102	3.5	102	4.7	101	4.4
PFOA	80.0	98.8	3.9	99.8	0.63	100	3.5
PFOS	80.0	101	2.4	101	3.6	106	6.8
PFNA	80.0	101	2.8	101	0.87	105	4.8
9Cl-PF3ONS	80.0	102	3.3	100	2.2	102	4.4
PFDA	80.0	99.2	3.3	99.6	1.6	102	5.5
NMeFOSAA	80.0	94.9	4.5	98.0	3.5	95.4	7.3
PFUnA	80.0	100	4.1	101	4.4	100	6.2
NEtFOSAA	80.0	90.5	3.9	102	5.3	96.5	7.7
11Cl-PF3OUdS	80.0	97.5	3.1	101	4.5	102	5.5
PFDoA	80.0	97.0	2.7	98.4	3.5	103	3.8
PFTrDA	80.0	95.5	1.8	99.5	3.2	99.4	3.8
PFTA	80.0	97.8	3.3	102	3.2	96.2	2.1
$^{13}C_2$-PFHxA	40.0	90.6	4.1	93.6	5.5	93.0	8.8
$^{13}C_3$-HFPO-DA	40.0	101	1.8	101	3.1	91.5	12
$^{13}C_2$-PFDA	40.0	95.8	2.2	92.6	6.8	104	2.8
d_5-NEtFOSAA	160	83.1	4.4	87.6	2.6	95.2	4.3

[a] TOC = 2.4 mg/L and hardness = 103 mg/L measured as calcium carbonate.

Table 11. Extract Holding Time Data for Tap Water Samples from a Surface Water Source, Fortified with Method Analytes and Preserved and Stored According to Section 8 (n=4)

Analyte	Fortified Conc. (ng/L)	Day 0 Mean % Recovery	Day 0 % RSD	Day 8 Mean % Recovery	Day 8 % RSD	Day 14 Mean % Recovery	Day 14 % RSD	Day 28 Mean % Recovery	Day 28 % RSD
PFBS	80.0	91.9	7.1	96.9	5.1	90.6	10	99.4	5.3
PFHxA	80.0	99.3	4.0	10	1.3	94.1	2.9	105	2.6
HFPO-DA	80.0	102	2.2	103	1.4	98.7	2.6	103	1.1
PFHpA	80.0	101	3.3	102	2.9	98.3	1.0	104	3.5
PFHxS	80.0	102	0.9	105	2.9	99.7	1.8	107	2.5
ADONA	80.0	102	3.5	104	3.7	98.6	2.5	106	2.5
PFOA	80.0	98.8	3.9	106	3.7	101	1.8	106	2.8
PFOS	80.0	101	2.4	102	1.1	103	1.8	109	2.2
PFNA	80.0	101	2.8	105	1.8	103	2.3	107	2.4
9Cl-PF3ONS	80.0	102	3.3	99.4	3.1	97.6	2.9	107	2.2
PFDA	80.0	99.2	3.3	104	1.9	101.2	0.9	107	3.4
NMeFOSAA	80.0	94.9	4.5	101	3.9	90.5	5.2	105	6.8
PFUnA	80.0	100	4.1	104	5.5	102	4.2	106	3.0
NEtFOSAA	80.0	90.5	3.9	104	3.1	93.6	7.7	102	2.9
11Cl-PF3OUdS	80.0	97.5	3.1	103	1.9	97.3	1.6	108	2.7
PFDoA	80.0	97.0	2.7	102	3.7	99.8	3.3	106	2.6
PFTrDA	80.0	95.5	1.8	102	3.0	97.2	1.6	104	3.1
PFTA	80.0	97.8	3.3	105	4.2	98.8	2.1	108	2.5
$^{13}C_2$-PFHxA	40.0	90.6	4.1	101	1.2	101	2.6	114	2.1
$^{13}C_3$-HFPO-DA	40.0	101	1.8	95.5	3.2	96.5	2.7	111	2.5
$^{13}C_2$-PFDA	40.0	95.8	2.2	100	2.7	109	1.9	124	4.4
d_5-NEtFOSAA	160	83.1	4.4	94.7	1.6	91.4	4.8	113	9.1

Table 12. Initial Demonstration of Capability Quality Control Requirements

Method Reference	Requirement	Specification and Frequency	Acceptance Criteria
Sect. 9.2.2	Initial Demonstration of Low System Background	Analyze LRB prior to any other IDC steps.	Demonstrate that all method analytes are below 1/3 the MRL and that possible interferences from extraction media do not prevent the identification and quantification of method analytes.
Sect. 9.2.3	Initial Demonstration of Precision (IDP)	Analyze four to seven replicate LFBs fortified near the midrange calibration concentration.	%RSD must be <20%
Sect. 9.2.4	Initial Demonstration of Accuracy (IDA)	Calculate average recovery for replicates used in IDP.	Mean recovery ± 30% of true value
Sect. 9.2.5	Initial Demonstration of Peak Asymmetry Factor	Calculate the peak asymmetry factor using the equation in Section 9.3.9 for the first two eluting chromatographic peaks in a mid-level CAL standard.	Peak asymmetry factor of 0.8 - 1.5
Sect. 9.2.6	Minimum Reporting Limit (MRL) Confirmation	Fortify, extract and analyze seven replicate LFBs at the proposed MRL concentration. Calculate the Mean and the Half Range (HR). Confirm that the upper and lower limits for the Prediction Interval of Result (Upper PIR, and Lower PIR, Sect. 9.2.6.2) meet the recovery criteria.	Upper PIR ≤ 150% Lower PIR ≥ 50%
Sect. 9.2.7 and 9.3.10	Quality Control Sample (QCS)	Analyze a standard from a second source, as part of IDC.	Results must be within 70-130% of true value.
Sect. 9.2.8	Detection Limit (DL) Determination (optional)	Over a period of three days, prepare a minimum of seven replicate LFBs fortified at a concentration estimated to be near the DL. Analyze the replicates through all steps of the analysis. Calculate the DL using the equation in Sect. 9.2.8.1.	Data from DL replicates are <u>not required</u> to meet method precision and accuracy criteria. If the DL replicates are fortified at a low enough concentration, it is likely that they will not meet precision and accuracy criteria.

NOTE: Table 12 is intended as an abbreviated summary of QC requirements provided as a convenience to the method user. Because the information has been abbreviated to fit the table format, there may be issues that need additional clarification, or areas where important additional information from the method text is needed. In all cases, the full text of the QC in Section 9 supersedes any missing or conflicting information in this table.

Table 13. Ongoing Quality Control Requirements (Summary)

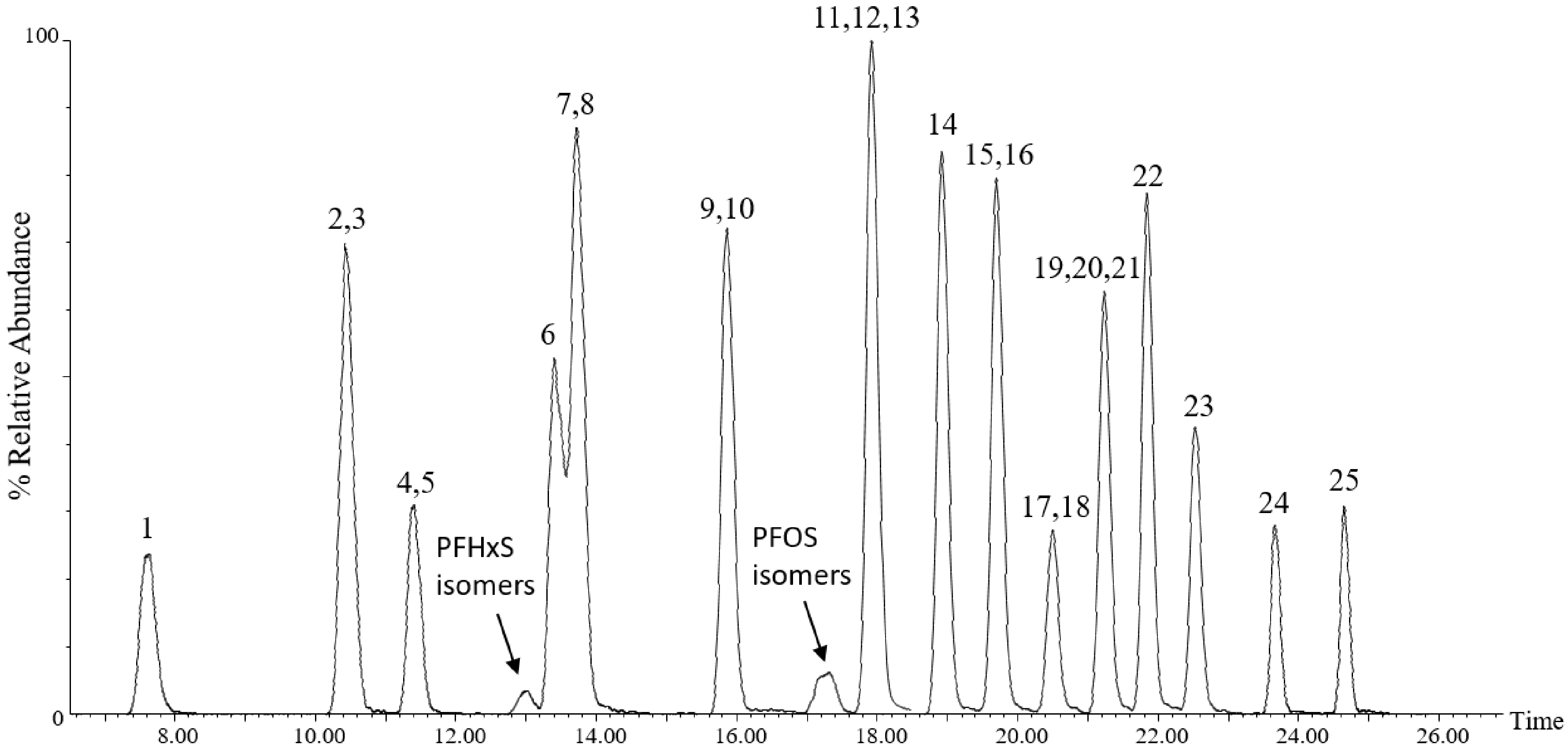
Method Reference	Requirement	Specification and Frequency	Acceptance Criteria
Sect. 8.1 - Sect. 8.5	Sample Holding Time	14 days with appropriate preservation and storage as described in Sections 8.1-8.5.	Sample results are valid only if samples are extracted within the sample holding time.
Sect. 8.5	Extract Holding Time	28 days when stored at room temperature in polypropylene centrifuge tubes.	Extract results are valid only if extracts are analyzed within the extract holding time.
Sect. 9.3.1	Laboratory Reagent Blank (LRB)	One LRB with each extraction batch of up to 20 samples.	Demonstrate that all method analytes are below 1/3 the MRL and confirm that possible interferences do not prevent quantification of method analytes. If targets exceed 1/3 the MRL or if interferences are present, results for these subject analytes in the extraction batch are invalid.
Sect. 9.3.3	Laboratory Fortified Blank (LFB)	One LFB is required for each extraction batch of up to 20 Field Samples. Rotate the fortified concentrations between low, medium and high amounts.	Results of LFB analyses must be 70-130% of the true value for each method analyte for all fortified concentrations except the lowest CAL point. Results of the LFBs corresponding to the lowest CAL point for each method analyte must be 50-150% of the true value.
Sect. 9.3.4	Internal Standard (IS)	Internal standards, $^{13}C_2$-PFOA (IS#1), $^{13}C_4$-PFOS (IS#2), and d_3-NMeFOSAA (IS#3), are added to all standards and sample extracts, including QC samples. Compare IS areas to the average IS area in the initial calibration and to the most recent CCC.	Peak area counts for all ISs in all injections must be within ± 50% of the average peak area calculated during the initial calibration and 70-140% from the most recent CCC. If ISs do not meet this criterion, corresponding target results are invalid.
Sect. 9.3.5	Surrogate Standards (SUR)	Surrogate standards, $^{13}C_2$-PFHxA, $^{13}C_3$-HFPO-DA, $^{13}C_2$-PFDA, and d_5-NEtFOSAA, are added to all CAL standards and samples, including QC samples. Calculate SUR recoveries.	SUR recoveries must be 70-130% of the true value. If a SUR fails this criterion, report all results for sample as suspect/SUR recovery.

Table 13. (Continued)

Method Reference	Requirement	Specification and Frequency	Acceptance Criteria
Sect. 9.3.6	Laboratory Fortified Sample Matrix (LFSM)	Analyze one LFSM per extraction batch (20 samples or less) fortified with method analytes at a concentration close to but greater than the native concentration, if known. Calculate LFSM recoveries.	Recoveries at mid and high levels must be within 70-130% and within 50-150% at the low-level fortified amount (near the MRL). If these criteria are not met, results are labeled suspect due to matrix effects.
Sect. 9.3.7	Laboratory Fortified Sample Matrix Duplicate (LFSMD) or Field Duplicates (FD)	Extract and analyze at least one FD or LFSMD with each extraction batch (20 samples or less). A LFSMD may be substituted for a FD when the frequency of detects are low. Calculate RPDs.	Method analyte RPDs for the LFMD or FD must be ≤30% at mid and high levels of fortification and ≤50% near the MRL. If these criteria are not met, results are labeled suspect due to matrix effects.
Sect. 9.3.8	Field Reagent Blank (FRB)	Analysis of the FRB is required only if a Field Sample contains a method analyte or analytes at or above the MRL. The FRB is processed, extracted and analyzed in exactly the same manner as a Field Sample.	If the method analyte(s) found in the Field Sample is present in the FRB at a concentration greater than 1/3 the MRL, then all samples collected with that FRB are invalid and must be recollected and reanalyzed.
Sect. 9.3.9	Peak Asymmetry Factor	Calculate the peak asymmetry factor for the first two eluting chromatographic peaks in a mid-level CAL standard during IDC and when chromatographic changes are made that affect peak shape.	Peak asymmetry factor of 0.8 - 1.5
Sect. 9.3.10	Quality Control Sample (QCS)	Analyze at least quarterly or when preparing new standards, as well as during the IDC.	Results must be within 70-130% of true value.
Sect. 10.2 and Sect. 9.3.2	Initial Calibration	Use IS calibration technique to generate a first or second order calibration curve forced through zero. Use at least five standard concentrations. Check the calibration curve as described in Sect. 10.2.4.4.	When each CAL standard is calculated as an unknown using the calibration curve, the analyte and SUR results must be 70-130% of the true value for all except the lowest standard, which must be 50-150% of the true value. Recalibration is recommended if these criteria are not met.
Sect. 9.3.2 and Sect. 10.3	Continuing Calibration Check (CCC)	Verify initial calibration by analyzing a low level (at the MRL or below) CCC prior to analyzing samples. CCCs are then injected after every 10 samples and after the last sample, rotating concentrations to cover the calibrated range of the instrument.	Recovery for each analyte and SUR must be within 70-130% of the true value for all but the lowest level of calibration. Recovery for each analyte in the lowest CAL level CCC must be within 50-150% of the true value and the SUR must be within 70-130% of the true value.

NOTE: Table 13 is intended as an abbreviated summary of QC requirements provided as a convenience to the method user. Because the information has been abbreviated to fit the table format, there may be issues that need additional clarification, or areas where important additional information from the method text is needed. In all cases, the full text of the QC in Sections 8-10 supersedes any missing or conflicting information in this table.

Figure 1. Example Chromatogram for Reagent Water Fortified with Method 537.1 Analytes at 80 ng/L. Numbered Peaks are Identified in Table 3



APPENDIX B
HASP

NEWTOWN CREEK BUD SITE – NORTH BLOCK

2-10 54TH AVENUE

LONG ISLAND CITY, NEW YORK

Health and Safety Plan

BCP Site No.: C241248

OER Project Number: 20TMP0962Q

AKRF Project Number: 200112

Prepared for:

New York State Department of Environmental Conservation
Division of Environmental Remediation, Remedial Bureau B
625 Broadway, 12th Floor
Albany, New York 12233

On Behalf of:

Bud North LLC
387 Park Avenue South
New York, NY 10016

Prepared by:

AKRF

AKRF, Inc.
440 Park Avenue South, 7th Floor
New York, New York 10016
(212) 696-0670

NOVEMBER 2023

TABLE OF CONTENTS

FIGURES

TABLES

APPENDIX B TABLES

APPENDICES

1.0 INTRODUCTION

1.1 Purpose

This Health and Safety Plan (HASP) was prepared by AKRF, Inc. (AKRF) on behalf of Bud North LLC (the Volunteer) for the Newtown Creek Bud Site (NCBS) – North Block property located at 2-10 54th Avenue in the Hunters Point South section of Long Island City, Queens, New York (hereafter referred to as the Site). Currently, the Site is also referred to as New York City Tax Block 11, Lot 1, and at the address 2-21 Malt Drive. The Site was remediated under the New York State Department of Environmental Conservation (NYSDEC) Brownfield Cleanup Program (BCP) (BCP Site No. C241248). The Site location is shown on Figure 1.

The Site was remediated to Track 4 NYSDEC Part 375 Restricted Residential Soil Cleanup Objectives (RRSCOs) and/or Protection of Groundwater Soil Cleanup Objectives (PGWSCOs) in general accordance with the January 2022 NYSDEC-approved Remedial Action Work Plan (RAWP) and Decision Document (DD). A Site Management Plan (SMP) was prepared to manage remaining contamination at the Site, as required by the Environmental Easement (EE). The EE is an Institutional Control (IC) restricting the type of use at the Site after completion of the remedial program under the RAWP. Details on the Site environmental history and remedial activities performed under the RAWP are provided in the SMP.

Engineering Controls (ECs) have been incorporated into the Site remedy to control exposure to remaining contamination during the use of the Site to ensure protection of public health and the environment. The following ECs were installed at the Site: (1) a composite cover system; (2) an active sub-slab depressurization system (SSDS); and (3) a soil vapor extraction (SVE) system. An EE granted to NYSDEC and recorded with the Queens County Clerk requires compliance with the SMP, and all ECs and ICs placed on the Site.

The ICs place restrictions on Site use and mandate operation, maintenance, monitoring, and reporting measures for all ECs and ICs. The SMP specifies the methods necessary to ensure compliance with all ECs and ICs required by the EE for contamination that may remain at the Site. The SMP has been approved by NYSDEC, and compliance with the plan is required by the grantor of the EE and the grantor’s successors and assigns. The SMP may be revised only with the approval of NYSDEC.

This HASP, which is an appendix to the SMP, details the procedures required to manage known or potential residual contamination following completion of the remedial action (RA) at the Site. The purpose of this HASP is to assign responsibilities, establish personnel protection standards and mandatory safety practices and procedures, and provide contingency plans for situations that may arise during Site management inspections, operation and maintenance (O&M), periodic sampling activities, and any soil/fill disturbance activities conducted at the Site. This HASP takes into account the specific hazards inherent to the Site, and presents procedures to be followed by AKRF and contractors to avoid, and if necessary protect against, health and/or safety hazards. Application of this HASP should be considered on a task-by-task basis, as not all measures are applicable or necessary for all activities on-site. On-site work activities should comply with applicable parts of the United States Occupational Safety and Health Administration (OSHA) Regulations, primarily 29 Code of Federal Regulations (CFR) Parts 1910 and 1926. A copy of this HASP will be maintained on-site during all work performed under the SMP.

All workers who participate in remediation-related activities at the Site that are under the direction of AKRF and/or the Site owner are required to comply with the provisions specified in this HASP. All Site visitors who enter designated work zones must also comply with this HASP. Refusal or failure to comply with this HASP or violation of any safety procedures by field personnel and/or subcontractors performing work covered by this HASP may result in immediate removal from the Site following consultation with the Site owner's representative. No personnel are permitted to enter permit confined spaces under this HASP.

1.2 Scope

This HASP has been developed to address health and safety concerns during Site O&M, monitoring, and inspections after completion of the Site remedy, under the direction of AKRF and any of AKRF's subcontractor(s), as specified in the SMP. On-site work anticipated under the SMP includes the following tasks:

- Assessing achievement of the remedial performance criteria (e.g., inspections of the SSDS, SVE system, and the composite cover system);
- Sampling and analysis of appropriate media (e.g., groundwater, soil vapor, and/or indoor air); and
- O&M of the ECs (SSDS, SVE system, and composite cover system), which may include disturbance and handling of Site soil/fill.

1.3 Application

This HASP applies to all personnel involved in the above tasks under the direction of the Site owner or AKRF, or those who wish to gain access to active intrusive work areas, including:

- Owner's representatives, contractors, and subcontractors performing tasks under the direction of AKRF, the owner, and/or the owner's representative;
- Federal, state, or local representatives;
- AKRF personnel; and
- AKRF subcontractors' and their employees.

2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

This section specifies the project team's project organization.

2.1 Remedial Engineer (RE)

Ms. Rebecca A. Kinal, P.E. will serve as the RE under the SMP. As the RE, Ms. Kinal will oversee O&M of ECs under the SMP.

2.2 Project Director (PD)

The project director is Mr. Marc Godick of AKRF. Mr. Godick's responsibilities include the following:

- Plan, schedule, and manage implementation of remediation activities;
- Coordinate with the Site Manager (SM), Site Supervisor (SS), and Project Environmental Safety Manager (PESM) to ensure that health and safety requirements are met;
- Ensure that field work is scheduled with adequate personnel and equipment resources to complete the job safely and enforce Site health and safety rules;
- Conduct periodic inspections;
- Participate in incident investigations;
- Ensure this HASP has all of the required approvals before any Site work is conducted;
- Ensure that the SM is informed of project changes that require modifications to this HASP; and
- Assume overall responsibility for project health and safety.

2.3 Site Manager (SM)

The SM is Mr. Michael Bates of AKRF. The SM's responsibilities include the following:

- Manage day-to-day implementation of the Site safety measures specified in this HASP;
- Ensure that adequate communication between field crews, health and safety monitoring personnel, and emergency response personnel is maintained;
- Confirm that the Site's field personnel are adequately trained and qualified to work at the Site and that proper personal protective equipment (PPE) is utilized by field teams;
- Investigate and report all accidents/incidents to the RE, PD, and PESM;
- Conduct and document periodic safety briefings;
- Stop work if necessary based on health and safety monitoring;
- Act as the primary point of contact for Site-related activities and coordinate with project personnel;
- Identify operational changes that require potential modifications to health and safety procedures and Site safety plans, and reports such changes to the RE, PD, and PESM;
- Conduct health and safety monitoring activities;
- Determine upgrades or downgrades of PPE based on Site conditions and/or real-time monitoring results;
- Ensure that monitoring instruments are calibrated; and

- Report summaries of field operations and progress to the project director and PESM.

2.4 Project Environmental and Safety Manager (PESM)

The PESM is a qualified health and safety professional with experience in hazardous waste Site remediation activities. The PESM is Mr. Patrick Diggins of AKRF. The PESM's responsibilities include the following:

- Provide for the development and approval of the HASP;
- Serve as the primary contact to review health and safety matters that may arise;
- Approve revised or new safety protocols for field operations;
- Coordinate revisions of this HASP with field personnel;
- Coordinate upgrading or downgrading of PPE with the SM;
- Assist in the investigation of all accidents/incidents; and
- Enforce work stoppage following reporting of on-site activities from the RE, PD, and SM.

2.5 Site Supervisor (SS)

The SS will be appointed by the owner's contractor. If work is being performed solely by AKRF, the SS tasks would be performed by the SM (Section 2.3). The SS responsibilities include the following:

- Provide for the necessary training of field crews in accordance with OSHA regulations and provide proof of training to the SM prior to entering the Site;
- Conduct routine safety inspections of their work areas;
- Conduct incident investigations and, together with the SM, prepare appropriate reports;
- Enforce health and safety rules and compliance with this HASP; and
- Plan field work using appropriate safe procedures and equipment.

2.6 Site Personnel

The Site Personnel responsibilities include the following:

- Report any unsafe or potentially hazardous conditions to the SM;
- Maintain knowledge of the information, instructions, and emergency response actions contained in the HASP;
- Comply with the rules, regulations, and procedures set forth in this HASP and any revisions;
- Prevent unauthorized personnel from entering work sites; and
- Inspect all tools and equipment, including PPE, prior to use.

3.0 SITE HISTORY AND BACKGROUND

Historical records including Sanborn maps identified current and historical commercial, industrial, and automobile-related uses on the Site, including New York Sugar Refining Co., Standard Folding Cartons Inc., News Syndicate Co. Inc., Port Distributing Corp., and an Anheuser-Busch beer distribution facility. Auto repair and garages with gasoline tanks were identified in the northern portion of the Site between 1915 and 1986. The Site was also listed on the NYSDEC Petroleum Bulk Storage (PBS) database (PBS Facility No. 2-034568) with several closed-removed diesel, waste oil, and lube oil underground storage tanks (USTs) and aboveground storage tanks (ASTs). The Site now consists of a multi-story mixed use commercial and residential building, parking areas, a courtyard, a private roadway, walkways, and landscaped areas.

Between March 2021 and January 2022, the Site was remediated in accordance with the NYSDEC-approved RAWP. The remedial elements performed consisted of the following:

1. Soil/fill was excavated and removed from the Site to achieve a Track 4 remedy, including:
    a. Approximately 3,800 tons (2,530 cubic yards) of source material associated with NYSDEC Spill No. 2100710 [identified as Area of Concern (AOC)-1] down to approximately 2 feet below the water table (between 7 and 11 feet below existing grade surface), where petroleum-related volatile organic compound (VOC), polycyclic aromatic hydrocarbon (PAH), and metal concentrations exceeded the 6 New York Codes, Rules, and Regulations (NYCRR) Part 375 Protection of Groundwater Soil Cleanup Objectives (PGWSCOs) and Restricted Residential Soil Cleanup Objectives (RRSCOs);

    b. Approximately 45 tons of source material associated with AOC-2, down to approximately 8 feet below grade, to remove impacted soils found when two USTs and associated tank grave were uncovered during construction activities; and

    c. The top 2 feet of material across the Site to facilitate installation of a site-wide cover system and other ECs. An additional approximately 21,200 tons (14,130 cubic yards) of material was excavated and properly disposed of off-site as part of Site redevelopment.
2. A groundwater treatment program was performed, which consisted of surface application of approximately 4,000 pounds of Regenesis Oxygen Release Compound® (ORC) and 2,500 pounds of PersulfOx® within the groundwater treatment area to enhance natural biodegradation of the residual petroleum contamination. Following groundwater treatment, three permanent 2-inch-diameter polyvinyl chloride (PVC) groundwater monitoring wells were installed at the Site to monitor benzene, toluene, ethylbenzene, and xylene (BTEX) concentrations. Four rounds of groundwater sample collection will be implemented at the Site within the first year following remediation (one round per quarter).
3. An SVE system was installed in the southern portion of the site to address elevated levels of Freon 12 identified in soil vapor.
4. A vapor mitigation system consisting of an active SSDS and a 0.20-mil vapor barrier was installed beneath the new building to prevent vapor intrusion.
5. A Community Air Monitoring Plan (CAMP) was implemented during all intrusive Site activities to monitor levels of VOCs and airborne particulates within the active work zones and around the perimeter of the Site.
6. Waste disposal facilities will be selected based on the data collected to date and additional waste classification sampling. Based on the requirements of the selected facilities, additional soil/fill waste characterization samples may be collected and analyzed to obtain approval for soil/fill disposal.

7. Appropriate off-site disposal of all material removed from the Site was performed in accordance with all federal, state, and local rules and regulations for handling, transport, and disposal.
8. All responsibilities associated with the RA, including permitting requirements and pretreatment requirements, were addressed in accordance with all applicable federal, state, and local rules and regulations.
9. Clean fill that met the requirements of 6 NYCRR Part 375-6.7(d) was imported to replace soil/fill excavated as part of the RA to bring the excavated areas back to grade surface or as required for redevelopment. All materials imported and/or reused at the Site were approved by NYSDEC prior to use.
10. One hundred and fifty-one (151) documentation samples were collected across the Site and analyzed to evaluate the performance of the remedy with respect to attainment of Track 4 RRSCOs. Documentation sampling included 110 confirmatory documentation samples at the base of the 2-foot remedial cut, and 41 sidewall and bottom samples following removal of soil from two source areas.
11. A composite cover system was constructed across the Site consists of: (1) minimum 6-inch-thick concrete building slabs; (2) asphalt and/or concrete pavement for roadways, sidewalks, and walkways; and (3) a minimum of 2 feet of imported or reused clean backfill material across exterior landscaped areas.
12. An EE was recorded with the New York City Office of the Registrar. The EE: requires the remedial parties/Site owners to complete and submit a periodic certification of ICs and ECs to NYSDEC in accordance with NYCRR Part 375-1.8 (h)(3); allows for the future redevelopment and use of the Site for restricted residential use as defined by Part 375-1.8(g), although land use is subject to local zoning laws; prohibits the use of groundwater as a source of potable or process water without necessary water quality treatment, as determined by the New York State Department of Health (NYSDOH); and requires compliance with a Site-specific NYSDEC-approved SMP.
13. An SMP was prepared for long-term management of residual contamination, as required by the EE. The SMP includes plans for: (1) ECs and ICs, (2) monitoring, (3) operation and maintenance, and (4) reporting. The SMP also includes a Soil Management Plan and Excavation Work Plan (EWP).

4.0 POTENTIAL HAZARDS AT THE SITE

This section presents an assessment of the chemical, biological, and physical hazards that may be encountered at the Site.

4.1 Hazard Potential

The remediation has been completed; however, some residual contamination remains in the Site subsurface. Exposure to residual contamination is being prevented by the Site-wide composite cover system, which is designed to remain intact long term. Disturbance of the concrete slabs, SSDS, and/or SVE system without prior NYSDEC approval is prohibited by the EE. In the unlikely event of an unanticipated, accidental, or required disturbance of the composite cover system, or if any cracks or openings in the floor occur, they shall be properly sealed immediately and NYSDEC or its successor agency shall be notified.

4.2 Properties of Chemical Contamination

4.2.1 Chemical Hazards in Soil/Fill, Groundwater, and/or Soil Vapor

Potential chemical pathways that may be encountered include: dermal contact, inhalation, and/or ingestion hazards associated with contaminated soil/fill and/or soil vapor.

The potential health effects from on-site contamination are summarized in Table 1 and detailed in the United States Department of Health and Human Services Agency for Toxic Substances and Disease Registry (ATSDR) fact sheets attached in Appendix A.

Table 1
Potential Health Effects from Remaining On-Site Contamination

Chemicals	REL/PEL/STEL	Health Hazards
Acetone	REL = TWA 250ppm PEL = TWA 1000ppm	Irritation eyes, nose, throat; headache, dizziness, central nervous system depression; dermatitis
Arsenic	REL = 0.002 mg/m^3 PEL = TWA 0.010 mg/m^3	Ulceration of nasal septum, dermatitis, gastrointestinal disturbances, peripheral neuropathy, resp irritation, hyperpigmentation of skin, potential occupational carcinogen
Barium	PEL = 0.5 mg/m^3 REL = 0.5 mg/m^3	Irritation eyes, skin, upper respiratory system; skin burns; gastroenteritis; muscle spasm; slow pulse, extrasystoles; hypokalemia.
Benzene	REL = TWA 0.1 ppm PEL = TWA 1 ppm	Irritation eyes, skin, nose, respiratory system; dizziness; headache, nausea, staggered gait; anorexia, lassitude (weakness, exhaustion); dermatitis; bone marrow depression.
Copper	REL = 1 mg/m^3 PEL = 1 mg/m^3	Irritation eyes, nose, pharynx; nasal septum perforation; metallic taste; dermatitis; in animals: lung, liver, kidney damage; anemia
Dichlorofluoromethane	REL = TWA 1000 ppm (4950 mg/m^3) PEL = TWA 1000 ppm (4950 mg/m^3)	dizziness, tremor, asphyxia, unconsciousness, cardiac arrhythmias, cardiac arrest; liquid: frostbite
Ethyl Benzene	REL = TWA 100 ppm PEL = TWA 100 ppm	Irritation eyes, skin, mucous membrane; headache; dermatitis; narcosis, coma.
Lead	REL = 0.05 mg/m^3 PEL = 0.05 mg/m^3	Lassitude (weakness, exhaustion), insomnia; facial pallor; anorexia, weight loss, malnutrition; constipation, abdominal pain, colic; anemia; gingival lead line; tremor; paralysis wrist, ankles; encephalopathy; kidney disease; irritation eyes; hypertension.

Table 1
Potential Health Effects from Remaining On-Site Contamination

Chemicals	REL/PEL/STEL	Health Hazards
Manganese	REL = 1 mg/m^3 PEL = 0.2 mg/m^3	Manganism; asthenia, insomnia, mental confusion; metal fume fever: dry throat, cough, chest tightness, dyspnea (breathing difficulty), rales, flu-like fever; low-back pain; vomiting; malaise (vague feeling of discomfort); lassitude (weakness, exhaustion); kidney damage.
Methylene Chloride	PEL = TWA 25 ppm	Irritation eyes, skin; lassitude (weakness, exhaustion), drowsiness, dizziness; numb, tingle limbs; nausea.
Mercury	REL = 0.1 mg/m^3 PEL = 0.05 mg/m^3	Irritation eyes, skin; cough, chest pain, dyspnea (breathing difficulty), bronchitis, pneumonitis; tremor, insomnia, irritability, indecision, headache, lassitude (weakness, exhaustion); stomatitis, salivation; gastrointestinal disturbance, anorexia, weight loss; proteinuria.
Polychlorinated Biphenyls (PCBs)	REL = 0.001 mg/m^3 PEL = 0.5 mg/m^3 (skin)	Irritation eyes, chloracne; liver damage; reproductive effects; [potential occupational carcinogen].
Polycyclic Aromatic Hydrocarbons (PAHs)	PEL = 5 mg/m^3	Harmful effects to skin, bodily fluids, and ability to fight disease, reproductive problems; potential carcinogen.
Toluene	PEL = TWA 200 ppm (750 mg/m^3)	Central nervous system depression, causing fatigue, headache, confusion, paresthesia, dizziness, and muscular incoordination, irritation of the eyes, mucous membranes, and upper respiratory tract.
Xylenes	REL = TWA 435 mg/m^3 PEL = TWA 435 mg/m^3	Irritation eyes, skin, nose, throat; dizziness, excitement, drowsiness, incoordination, staggering gait; corneal vacuolization; anorexia, nausea, vomiting, abdominal pain; dermatitis

Comments:
REL = National Institute for Occupational Safety and Health (NIOSH) Recommended Exposure Limit
PEL = OSHA Permissible Exposure Limit
STEL = OSHA Short Term Exposure Limit

4.2.2 Other Chemical Hazards

Although not anticipated, chemicals not identified in this HASP may be used or encountered during Site work. Prior to the initiation of site management tasks, ATSDR Fact Sheets will be obtained for each of the chemicals to be used and all Site workers and visitors who may potentially be exposed will be made aware of the hazards.

4.3 Physical Hazards

Physical hazards will be addressed as necessary. More detailed safety procedures are provided as appendices to this HASP, where applicable.

4.3.1 Cold Stress

At certain times of the year, workers may be exposed to the hazards of working in cold environments. Potential hazards in cold environments include frostbite, trench/immersion foot, and hypothermia, as well as slippery surfaces and brittle equipment. A Cold Stress Program is provided as Appendix B.

4.3.2 Heat Stress

Heat stress is a significant potential hazard, which is greatly exacerbated with the use of PPE in hot environments. The potential hazards of working in hot environments include dehydration, cramps, heat rash, heat exhaustion, and heat stroke. A heat stress prevention program will be implemented when ambient temperatures exceed 70 ºF for personnel wearing impermeable clothing. A Heath Stress Program is provided as Appendix C.

4.3.3 Noise

Noise is a potential hazard associated with the operation of heavy equipment, power tools, pumps, and generators. Operations that require the use of hearing protection include operation of heavy equipment, generators, jackhammers, chain saws, sheetpile drivers, dewatering equipment, and pressure washers. Site workers who will perform suspected high noise tasks and operations will be provided with earplugs. Workers not performing those tasks but working in close proximity to that equipment will also be required to wear hearing protection. If deemed necessary by the SM, the PESM will be consulted on the need for additional hearing protection and the need to monitor sound levels for Site activities.

4.3.4 Hand and Power Tools

To complete the various tasks for the proposed scope of work, personnel may be required to use hand and/or power tools. The use of hand and power tools can present a variety of hazards, including physical harm from being struck by flying objects, being cut or struck by the tool, fire, and electrocution. Work gloves, safety glasses, and hard hats will be worn by the operating personnel at all times when using hand and power tools, and ground fault interrupter (GFI)-equipped circuits will be used for all power tools.

4.3.5 Slips, Trips, and Falls

Working in and around the Site will pose slip, trip, and fall hazards due to slippery surfaces that may be oil covered, or from surfaces that are wet from rain or ice. Excavation at the Site will cause uneven footing in the trenches and around the spoil piles. Care should be exercised when walking at the Site, especially when carrying equipment.

4.3.6 Fire and Explosion

The use of cutting/grinding tools, which may spark in the vicinity of flammable building materials, or use of gasoline- or diesel-powered instruments could present the possibility of encountering fire and explosion hazards. Care should be exercised and fire extinguishers available during any work that presents a fire or explosion hazard.

4.3.7 Manual Lifting

Manual lifting of heavy objects, such as sections of pipe or blower supplies, may be required. Failure to follow proper lifting technique can result in back injuries and strains. Site workers will be instructed to use power equipment to lift heavy loads whenever possible and to evaluate loads before trying to lift them (i.e., they should be able to easily tip the load and then return it to its original position). Heavy loads should be carried with a buddy and the following proper lifting techniques will be stressed: 1) make sure footing is solid, 2) make back straight with no curving or slouching, 3) center body over feet, 4) grasp the object firmly and as close to your body as possible, 5) lift with legs, and 6) turn with your feet, don't twist. Back injuries are a serious concern as they are the most common workplace injury, often resulting in lost or restricted work time, and long treatment and recovery periods.

4.3.8 Utilities (Electrocution and Fire Hazards)

Underground utilities at the Site pose fire, explosion, and electrocution hazards. Potential adverse effects of electrical hazards include burns and electrocution, which could result in death. Underground utilities, facilities, equipment, and structures will be located prior to the start of any intrusive activities. The Underground Utilities Call Center will be notified a minimum of three days before any subsurface disturbance. Care shall be exercised to avoid damage to utilities beneath the surface slab. As-builts will be consulted and a geophysical survey shall be completed, if needed.

4.4 Task Hazard Analysis

The scope of work described in Section 1.2 will be accomplished with the following tasks:

1. Mobilization/Demobilization: mobilize equipment and establish Site security, work zones, and staging areas.
2. Site Preparation: locate utilities, construct decontamination pad, and construct negative pressure environmental enclosure around excavation area, if required.
3. Sampling: use appropriate PPE (e.g., nitrile gloves, safety glasses, ear plugs, hard hats).
4. Soil/Fill Excavation and Loading: in the event that soil/fill removal is necessary, remove floor slab in designated area, excavate material and segregate dissimilar materials, load dump trucks or drums, decontaminate heavy equipment, and backfill excavations.
5. Site Restoration Activities: restore flooring in excavation area and any damaged adjacent floors/walls to original condition.

All of these tasks include the potential for chemical and physical hazards, and care should be taken within the work zone to avoid these hazards, as described above. There is a higher potential for chemical hazards to occur during activities that involve the removal and handling of contaminated material; however, exposure to vapors may occur to a lesser degree as soon as the top concrete slab is removed. All tasks should be conducted using the appropriate PPE for the associated exposure, as described in Section 6.0.

5.0 PROCESS SAFETY MANAGEMENT

Process safety management is a systematic way of identifying the potential health and safety hazards associated with major phases of work on a project, and the methods to avoid, control, and mitigate those hazards. Process safety management guidelines will be developed for all activities as necessary, prior to start-up. Process safety management will be used to train work crews in proper safety procedures during phase preparatory meetings.

6.0 PERSONAL PROTECTIVE EQUIPMENT (PPE)

The PPE required for various remediation tasks is based on 29 CFR 1910.120, Hazardous Waste Operations and Emergency Response (HAZWOPER), Appendix B, "General Description and Discussion of the Levels of Protection and Protective Gear." All on-site personnel shall wear, at a minimum, Level D PPE when performing site management tasks. The protection will be based on the air monitoring described in Section 7.0. Table 2 lists the required PPE for the anticipated site management tasks:

Table 2
Personal Protection Equipment (PPE) Selection

Level of Protection and PPE Required		Work Conditions
Level D (x) Steel Toe Boots (x) Hard Hat (as needed) (x) Work Gloves (as needed) (x) Reflective Vest (as needed)	(x) Safety Glasses or Face Shield (x) Ear Plugs (as needed) (x) Latex or nitrile Gloves (as needed)	• All activities except those noted under Levels D modified and C
Level D – Modified ***(in addition to Level D)*** (x) Nitrile Gloves (x) Overboots	(x) Tyvek Coveralls (as needed) -or- (x) Saranex/Polyethylene-coated Tyvek Coveralls (as needed)	• Activities with potential for contact with grossly contaminated material
Level C – ***(in addition to Level D – Modified)*** (x) Half-Face Respirator ( ) Full Face Respirator ( ) Full-Face PAPR	( ) Particulate Cartridge (P100) ( ) Organic Cartridge (x) Dual Organic/Particulate Cartridge	• If PID > 10 ppm and/or • If $PM_{10} > 5.0$ mg/m^3
Level C - Modified ***(in addition to Level D – Modified)*** ( ) Half-Face Respirator (x) Full Face Respirator ( ) Full-Face PAPR	( ) Particulate Cartridge (P100) ( ) Organic Cartridge (x) Dual Organic/Particulate Cartridge	• If PID >50 ppm; or • Eye irritation occurs
Note: Vapor (PID) and particulate (PM_{10}) measurements are work zone action levels sustained for 15 minutes or greater.		

The PPE specified in Table 2 reflects the hazard analysis presented in Section 4.0 and PPE selection required by 29 CFR 1910.132. For the purposes of PPE selection, the PESM and SM are considered competent persons. The signatures in this HASP constitute certification of the hazard assessment. For any activities not covered by Table 2, the SM will conduct the hazard assessment and select the appropriate required PPE in consultation with the PESM.

6.1 OSHA Requirements for PPE

All PPE used must meet the OSHA standards presented in Table 3.

Table 3
PPE OSHA Standards

Type of Protection	Regulation	Source
Eye and Face	29 CFR 1910.133	ANSI Z87.1 1968
Respiratory	29 CFR 1910.134	ANSI Z88.1 1980
Head	29 CFR 1910.135	ANSI Z89.1 1969
Foot	29 CFR 1910.136	ANSI Z41.1 1967
Note: ANSI - American National Standards Institute		

7.0 AIR MONITORING

Environmental health and safety monitoring will be performed during all soil disturbance activities in accordance with the CAMP, which is also included in Appendix G of the SMP.

8.0 ZONES, PROTECTION, AND COMMUNICATION

8.1 Site Control

Site zones are intended to control the potential spread of contamination and to assure that only authorized individuals are permitted into potentially hazardous areas. A three-zone approach will be utilized and will include: an Exclusion Zone (EZ), a Contamination Reduction Zone (CRZ), and a Support Zone (SZ). These zones will be established prior to beginning work for each task requiring such delineation (i.e., intrusive work beneath the Site cover or handling of contaminated materials). For larger scale subgrade work, the work zones will be sketched out and maps delineating the various work zones will be available at the Site and used during initial Site-specific training.

All work will be conducted under the requirements of 29 CFR 1910.120, and any personnel working in an area where the potential for exposure to Site contaminants exists will only be allowed access after proper training and medical documentation is provided to the SM. These records will be maintained by the SM and copies should be provided to the SM prior to mobilization for project activities.

The following will be used for guidance in revising these preliminary zone designations, if necessary:

- The SZ is an uncontaminated area that will be the field support area for most operations. The SZ provides for field team communications and staging for emergency response. Appropriate sanitary facilities and safety equipment will be located in this zone. Potentially contaminated personnel/materials are not allowed in this zone. The only exception will be appropriately packaged/decontaminated and labeled samples.
- The CRZ is established between the EZ and the SZ. The CRZ contains the contamination reduction corridor and provides an area for decontamination of personnel and portable hand-held equipment, tools, and heavy equipment. A personnel decontamination area will be prepared at each exclusion zone. The CRZ will be used for Exclusion Zone entry and egress in addition to access for heavy equipment and emergency support services.
- An EZ includes any area that may involve exposure to Site contaminants and hazardous materials and/or conditions. These zones will be clearly delineated by cones, tape, or other means. The SM may establish more than one EZ where different levels of protection may be employed or different hazards exist. The size of the EZ shall be determined by the Site SM, allowing adequate space for field members, emergency equipment, and the activity to be completed.

8.2 Contamination Control

8.2.1 Personnel Decontamination Station

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

8.2.2 Minimization of Contact with Contaminants

During completion of all Site activities, personnel should attempt to minimize the degree of contact with contaminated materials. This involves a conscientious effort to keep “clean” during Site activities. All personnel should minimize physical contact with contamination to ultimately minimize the degree of decontamination required and the generation of waste materials from Site operations.

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

8.2.3 Personnel Decontamination Sequence

Consideration will be given to prevailing wind directions so that the decontamination line, the SZ, and the CRZ exit are upwind from the EZ. Decontamination will be performed by removing all PPE used in the EZ and placing it in drums/trash cans within the CRZ. Baby wipes will be available for washing hands and face after PPE removal. In addition, brushes will be available for removing soil/fill from boots.

8.2.4 Emergency Decontamination

If circumstances dictate that contaminated clothing cannot be readily removed, then remove gross contamination and wrap injured personnel with clean garments/blankets to avoid contaminating other personnel or transporting equipment.

If the injured person can be moved, he/she will be moved to the EZ boundary and decontaminated by Site personnel, as previously described, before emergency responders handle the victim. If the person cannot be moved because of the extent of the injury (a back or neck injury), provisions shall be made to ensure that emergency response personnel will be able to respond to the victim without being exposed to potentially hazardous atmospheric conditions. If the potential for inhalation hazards exists, such as with an open excavation, this area will be covered with poly sheeting to eliminate any potential inhalation hazards. All emergency personnel are to be immediately informed of the injured person’s condition and potential contaminants and provided with all pertinent chemical data.

8.2.5 Heavy Equipment Decontamination

Decontamination of chemically contaminated heavy equipment will be accomplished using high-pressure steam or dry decontamination with brushes and shovels. Decontamination shall take place on a decontamination pad and all liquids used in the decontamination procedure will be collected. Vehicles or equipment brought into an EZ will be treated as contaminated and will be decontaminated prior to removal. All liquids used in the decontamination procedure will be collected, stored, and disposed of in accordance with federal, state, and local regulations. Personnel performing these tasks will wear the proper PPE, as described in Table 2.

8.3 Communications

The following communications equipment shall be specified as appropriate:

- Telephones - A cellular telephone will be located in the SZ for communication with emergency support services/facilities and the home office. Personnel in the EZ can carry cellular telephones for communication as well if Level D PPE has been determined to be appropriate.
- Hand Signals - Hand signals shall be used by field teams along with the buddy system. They shall be known by the entire field team before operations commence and their use covered during Site-specific training. Typical hand signals are described in Table 4.

Table 4
Hand Signals

Signal	Meaning
Hand gripping throat	Out of air, can’t breathe
Grip on a partner’s wrist or placement of both hands around a partner’s waist	Leave area immediately/no debate
Hands on top of head	Need assistance
Thumbs up	Okay/I’m all right/I understand
Thumbs down	No/negative

9.0 MEDICAL SURVEILLANCE PROCEDURES

All personnel performing field work at the Site where potential exposure to contaminants exists are required to have passed a complete medical surveillance examination in accordance with 29 CFR 1910.120(f) and, where applicable, expanded health standards.

9.1 Medical Surveillance Requirements

A physician's medical release for work will be confirmed by the SM before a worker can enter the EZ. The medical release shall consider the type of work to be performed and the required PPE. The examination will be conducted annually at a minimum. Additional medical testing may be required by the PESM in consultation with the SM if an over-exposure or accident occurs, if an employee exhibits symptoms of exposure, or if other Site conditions warrant further medical surveillance.

10.0 SAFETY CONSIDERATIONS

10.1 Excavation and Trenching

The safety requirements for each excavation must be determined by a competent person who is capable of identifying existing and predictable hazards and work conditions that are unsanitary, hazardous, or dangerous to employees. The competent person must also have the authorization to take prompt corrective measures to eliminate unsatisfactory conditions.

The following are general requirements for work activities in and around excavations:

- Prior to initiation of any excavation activity, the location of underground utilities, obstructions, etc. will be determined. The New York State One-Call Center will be contacted by the excavation subcontractor a minimum of 72 hours prior to excavation activities.
- All excavations will be inspected daily and after each period of rain by the competent person prior to commencement of work activities. Evidence of cave-ins, slides, sloughing, or surface cracks or excavations will be cause for work to cease until necessary precautions are taken to safeguard employees.
- Excavated and other materials or equipment that could fall or roll into the excavation shall be placed at least 5 feet from the edge of the excavation.
- Each employee in an excavation shall be protected from cave-ins by an adequate protective system designed in accordance with CFR 1926.652 (b) or (c), except when excavations are less than 5 feet in depth and examination of the ground by a competent person provides no indication of a potential cave-in or excavation is made entirely in stable rock.
- Ladders will be positioned no further than 25 feet from any individual working in the trench.

11.0 DISPOSAL PROCEDURES

All discarded materials, waste materials, or other objects shall be handled in such a way as to preclude the potential for spreading contamination, creating a sanitary hazard, or causing litter to be left on-site. All potentially contaminated materials (e.g., clothing, gloves, etc.) will be bagged or drummed as necessary, labeled, and segregated for disposal. All non-contaminated materials shall be collected and bagged for appropriate disposal. The waste management procedures will be conducted in accordance with applicable local, state, and federal regulations.

12.0 EMERGENCY RESPONSE/CONTINGENCY PLAN

This section establishes procedures and provides information for use during a project emergency. Emergencies happen unexpectedly and quickly, and require an immediate response; therefore, contingency planning and advanced training of staff are essential. Specific elements of emergency support procedures addressed in the following subsections include communications, local emergency support units, preparation for medical emergencies, first aid for injuries incurred on-site, record keeping, and emergency Site evacuation procedures.

12.1 Responsibilities

12.1.1 Project Environmental and Safety Manager (PESM)

The PESM is responsible for overseeing and approving the Emergency Response/Contingency Plan, and performing audits to determine that the plan is in effect and that all pre-emergency requirements are met. The PESM acts as a liaison to applicable regulatory agencies and notifies OSHA of reportable accidents.

12.1.2 Site Manager (SM)

The SM is responsible for ensuring that all personnel are evacuated safely and that machinery and processes are shut down or stabilized in the event of a stop work order or evacuation. The SM is required to immediately notify the PM and PESM of any fatalities or catastrophes (three or more workers injured and hospitalized) so that the PESM can notify OSHA within the required time frame. The PESM will be notified of all OSHA recordable injuries, fires, spills, releases, or equipment damage in excess of $500 within 24 hours. The SM also serves as the Alternate Emergency Coordinator.

12.1.3 Emergency Coordinator

In the event of an emergency, the Emergency Coordinator shall make contact with local emergency response personnel. In these contacts, the Emergency Coordinator will inform response personnel about the nature of work on the Site, the type of contaminants and associated health or safety effects, and the nature of the emergency, particularly if it is related to exposure to contaminants.

The Emergency Coordinator shall review this plan and verify emergency phone numbers and identify hospital routes prior to beginning work on-site. The Emergency Coordinator shall make necessary arrangements to be prepared for any emergencies that could occur.

The Emergency Coordinator shall implement the Emergency Response/Contingency Plan whenever conditions at the Site warrant such action.

12.1.4 Site Personnel

Site personnel are responsible for knowing the Emergency Response/Contingency Plan and the procedures contained herein. Personnel are expected to notify the Emergency Coordinator of situations that could constitute a Site emergency.

12.2 Communications

A variety of communication systems may be utilized during emergency situations. These are discussed in the following sections.

The primary form of communication during an emergency between field groups in the EZ and the Emergency Coordinator will be verbal communications. During an emergency situation, communication lines will be kept clear so that instructions can be received by all field teams.

12.2.1 Telephone Communications

A cellular telephone will be available on-site.

12.2.2 Hand Signals

Hand signals will be employed by downrange field teams where necessary for communication during emergency situations. Hand signals are presented in Table 4 in Section 8.3.

12.3 Pre-Emergency Planning

Before emergency field activities begin, local emergency response personnel may be notified by the Site owner's representative or contractor of the schedule for field activities and about the materials that are thought to exist on the Site so that they will be able to respond quickly and effectively in the event of a fire, explosion, or other emergency.

To be able to deal with any emergency that might occur during remedial activities at the Site, emergency telephone numbers will be readily available in the SM vehicle or the Site office. These telephone numbers are presented Section 12.16. The emergency phone numbers listed are preliminary and will be updated as needed prior to the start of work. Immediately prior to mobilization, the SM shall verify all numbers and document any changes in the Site logbook. Hospital route maps will also be readily available in the SM vehicle and/or Site office.

12.4 Emergency Medical Treatment

The procedures and rules in this HASP are designed to prevent employee injury. However, should an injury occur, no matter how slight, it will be reported to the SM immediately. First aid equipment such as a first aid kit and disposable eye washes will be available on-site.

During the Site safety briefing, project personnel will be informed of the location of the first aid station(s) that have been set up. In the case of a medical emergency, the SM will determine the nature of the emergency and he/she will have someone call for an ambulance, if needed. If the nature of the injury is not serious, i.e., the person can be moved without expert emergency medical personnel, he/she should be driven to a hospital by on-site personnel. Directions to the hospital with a hospital route map are provided in Section 12.15/Table 6. Unless they are in immediate danger, severely injured persons will not be moved until paramedics can attend to them. Some injuries, such as severe cuts and lacerations or burns, may require immediate treatment. Any first aid instructions that can be obtained from doctors or paramedics before an emergency-response squad arrives at the Site or before the injured person can be transported to the hospital will be followed closely.

12.5 Emergency Site Evacuation Routes and Procedures

In the event of a Site emergency that would require the evacuation of personnel, the Emergency Coordinator will immediately contact the Site owner or owner's representative (this person may or may not be on-site). All project personnel will be instructed on proper emergency response procedures and locations of emergency telephone numbers during the initial Site safety meeting. If an emergency occurs at the work area, including but not limited to fire, explosion, or significant release of toxic gas into the atmosphere, immediate evacuation of all personnel is necessary due to an immediate or impending danger. The following evacuation procedures will be used:

- The SM will initiate evacuation procedures by signaling to leave the Site or EZ. The signal for Site evacuation will consist of three long blasts on an air horn.

- All heavy equipment will be shut down and all personnel will evacuate the work areas and assemble at a pre-determined meeting location. The designated meeting location for the Site will be at the sidewalk along Malt Drive near the new building loading dock.
- All personnel suspected to be in or near the work area should be accounted for and the whereabouts of missing persons determined immediately.
- The SM will then give further instruction.

If any task covered under this HASP has the potential for significant hazards, evacuation drills will be performed as deemed necessary by the SM and PESM.

12.6 Fire Prevention and Protection

In the event of a fire or explosion, the work area will be evacuated immediately and the Emergency Coordinator will notify the local fire and police departments. No personnel will fight a fire beyond the stage where it can be put out with a portable extinguisher (incipient stage).

Fires will be prevented by adhering to the following precautions:

- Good housekeeping and storage of materials;
- Storage of flammable liquids and gases in nonflammable storage cabinets when not in use, away from oxidizers;
- Storage of oxygen at least 25 feet away from acetylene cylinders when not in use. Oxygen and acetylene may not be stored on welding carts;
- No smoking in the EZ or any work area;
- No hot work without a properly executed hot work permit;
- Shutting off engines to refuel;
- Grounding and bonding metal containers during transfer of flammable liquids;
- Use of UL approved non-flammable storage cans;
- Fire extinguishers rated at least 10 pounds Class A, B, and C located on all heavy equipment, in all trailers, and near all hot work activities; and
- Monthly inspection of all fire extinguishers.

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

12.7 Overt Chemical Exposure

The following are standard procedures to treat chemical exposures. Other specific procedures detailed on the ATSDR Fact Sheets will be followed as necessary. If first aid or emergency medical treatment is necessary, the Emergency Coordinator will contact the appropriate emergency facilities. All chemical exposure incidents must be reported in writing to the PESM. If a member of the field crew demonstrates symptoms of chemical exposure, another team member (buddy) should remove the individual from the immediate area of contamination. The buddy should communicate to the SM (via voice and hand signals) of the chemical exposure. The SM should contact the appropriate emergency response agency. The procedures outlined in Table 5 should be followed.

Table 5
Chemical Exposure Treatment Procedures

Exposure Pathway	Treatment Procedure
Skin and Eye Contact	Use copious amounts of soap and water. Wash/rinse affected areas thoroughly, and then provide appropriate medical attention. Eyes should be rinsed for 15 minutes upon chemical contamination. Skin should also be rinsed for 15 minutes if contact with caustics, acids, or hydrogen peroxide occurs.
Inhalation	Move to fresh air. Decontaminate and transport to hospital or local medical provider.
Ingestion	Decontaminate and transport to emergency medical facility.
Puncture Wound or Laceration	Decontaminate and transport to emergency medical facility.

12.8 Personal Injury

In case of personal injury at the Site, the following procedures should be followed:

- Another team member (buddy) should signal to the SM that an injury has occurred.
- A field team member trained in first aid can administer treatment to an injured worker.
- If deemed necessary, the victim should then be transported to the nearest hospital or medical center. If necessary, an ambulance should be called to transport the victim.
- The SM or PESM should make certain that an Incident Report Form (provided as Appendix D) is completed. This form is to be submitted to the AKRF PESM and health and safety officer (HSO). Follow-up action should be taken to correct the situation that caused the accident.
- Any incident (near miss, property damage, first aid, medical treatment, etc.) must be reported.
- A first aid kit and an eye wash will be kept on-site during the field activities.

12.9 Decontamination During Medical Emergencies

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

12.10 Accident/Incident Reporting

Written confirmation of verbal reports of injuries or other emergencies are to be submitted to the PESM within 24 hours. The Incident Report Form is provided as Appendix D.

In addition to the incident reporting procedures and actions described in this HASP, the SM will coordinate with the owner's representative for reporting and notification for all environmental, safety, and other incidents.

If necessary, a Site safety briefing will be held to discuss accidents/incidents and any findings from the investigation of the incident. This HASP will be modified if deemed necessary by the PESM.

12.11 Spill Control and Response

All small hazardous spills/environmental releases shall be contained as close to the source as possible. Whenever possible, the ATSDR Fact Sheets will be consulted to assist in determining the best means of containment and cleanup. For small spills, absorbent materials such as sand, sawdust or commercial sorbents should be placed directly on the substance to contain the spill and aid recovery. Any acid spills should be diluted or neutralized carefully prior to attempting recovery. Berms of earthen or sorbent materials can be used to contain the leading edge of the spills. Drains or drainage areas should be blocked. All spill containment materials will be properly disposed. An EZ of 50-100 feet around the spill area should be established depending on the size and type of the spill.

The following steps should be taken by the Emergency Coordinator:

1. Determine the nature, identity, and amounts of major spill components;
2. Make sure all unnecessary persons are removed from the spill area;
3. Notify appropriate response teams and authorities;
4. Use proper PPE in consultation with the SM;
5. If a flammable liquid, gas, or vapor is involved, remove all ignition sources and use non-sparking and/or explosive proof equipment to contain or clean up the spill (diesel only vehicles, air operated pumps, etc.);
6. If possible, try to stop the leak with appropriate material;
7. Remove all surrounding materials that can react or compound with the spill; and
8. Notify the Site owner and determine who will report the spill to the NYSDEC Spills Hotline, as applicable.

12.12 Emergency Equipment

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

- Industrial first aid kit;
- Portable eye washes;
- Fire extinguishers (one per vehicle and heavy equipment); and
- Absorbent material.

12.13 Postings

The following information shall be posted or be readily visible and available at conspicuous locations throughout the Site:

- Emergency telephone numbers; and
- Hospital Route Map (Figure 2).

12.14 Restoration and Salvage

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

- Refilling fire extinguishers;
- Refilling medical supplies;
- Recharging eyewashes and/or showers;
- Replenishing spill control supplies; and
- Replacing used air horns.

12.15 Hospital Directions

The address and directions to the nearest hospital to the Site are provided in Table 6:

Table 6
Hospital Directions

Hospital Name:	NYU Langone Health Emergency Department
Phone Number:	212-263-5550
Address:	570 1st Avenue, New York, NY 10016
Directions:	1. Turn RIGHT onto 54th Avenue towards Vernon Boulevard. 2. Turn LEFT onto Vernon Boulevard. 3. Turn RIGHT onto 53rd Avenue. 4. Turn LEFT onto 11th Street. 5. Turn RIGHT onto Borden Avenue. 6. Turn LEFT onto the ramp entrance and merge onto the I-495 WEST. 7. Take the Queens Midtown Tunnel to East 37th Street and use the RIGHT lane to take the Downtown Exit. 8. Turn RIGHT onto East 37th Street. 9. Turn RIGHT onto 2nd Avenue. 10. Turn LEFT onto East 30th Street. 11. Turn LEFT onto 1st Avenue. 12. The entrance to the Emergency Room will be on the RIGHT.

A map showing the Site evacuation meeting point and driving route to the hospital is provided as Figure 2.

12.16 Emergency Contacts

Table 7
Emergency Contacts

Company	Individual Name	Title	Contact Number
AKRF	Rebecca A. Kinal	Project Engineer	(914) 922-2362 (office)
	Marc Godick	Project Director	(914) 922-2356 (office)
	Patrick Diggins	PESM	(603) 494-7090 (cell)
	Mike Bates	Site Manager	(914) 335-0693(cell)
Bud North LLC	Bruce M. Weill	Client Representative	212-672-1000 (office)
NYSDEC	Christopher Allen	BCP Project Manager	716-901-5774
Ambulance, Fire Department & Police Department	-	-	911
NYSDEC Spill Hotline	-	-	(800) 457-7362

The emergency contact list will be updated as needed.

13.0 TRAINING

13.1 General Health and Safety Training

In accordance with 29 CFR 1910.120, hazardous waste Site workers shall, at the time of job assignment, have received a minimum of 40 hours of initial health and safety training for hazardous waste Site operations, unless otherwise noted in the standard referenced above. At a minimum, the training will have consisted of instruction in the topics outlined in the standard referenced above. Personnel who have not met the requirements for initial training shall not be allowed to work in any Site activities during which they may be exposed to hazards (chemical or physical). Proof of training shall be submitted to the SM prior to the start of field activities. Other personnel involved in ancillary or support activities, including transportation of material for disposal, shall have the proper training as required by federal, state, and local regulations.

13.2 Annual Eight-Hour Refresher Training

Annual eight-hour refresher training will be required of hazardous waste Site field personnel working in the work zone to maintain their qualifications for fieldwork. The training will cover a review of 29 CFR 1910.120 requirements and related company programs and procedures.

13.3 Supervisor Training

Personnel acting in a supervisory capacity shall have received 8 hours of instruction in addition to the initial 40-hour training.

13.4 Site-Specific Training

Prior to commencement of field activities, all field personnel assigned to the project will have completed training that will specifically address the activities, procedures, monitoring, and equipment used in the Site operations. The training will cover Site and facility layout, hazards and emergency services, and all provisions contained within this HASP. This training will also allow field workers to clarify anything they do not understand and reinforce their responsibilities regarding safety and operations for their particular activity. The training should include the following topics:

- General requirements of this HASP;
- Review of the scope of work;
- Names of personnel responsible for Site safety and health;
- Potential hazards and acute effects of compounds present at the Site;
- Air monitoring procedures;
- Proper use of PPE;
- Safe use of ECs and equipment on the Site;
- Decontamination procedures; and
- Work practices by which the employee can minimize risk from hazards. This may include a specific review of heavy equipment safety, safety during inclement weather, changes in the escape rendezvous point, Site security measures, or other Site-specific issues that need to be addressed before work begins.

Personnel that have not received Site-specific training will not be allowed in the work zone.

13.5 On-Site Safety Briefings

Project personnel working in designated work zones on-site will be given health and safety briefings periodically by the SM to assist in safely conducting their work activities. The briefings will include information on new operations to be conducted, changes in work practices or changes in the Site's environmental conditions, and periodic reinforcement of previously discussed topics. The briefings will also provide a forum to facilitate conformance with safety requirements and to identify performance deficiencies related to safety during daily activities or as a result of safety inspections. The meetings will also be an opportunity to periodically update the crews on monitoring results.

14.0 LOGS, REPORTS, AND RECORD KEEPING

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

14.1 Medical and Training Records

Copies or verification of training (40-hour, 8-hour, supervisor, and Site-specific training) and medical clearance for hazardous waste Site work and respirator use will be maintained by the SM.

14.2 On-Site Log

A log of personnel on-site each day will be kept by the SM in a field logbook.

14.3 Exposure Records

The SM will periodically notify the PESM of exposure monitoring results that require workers to upgrade to Level C. All personal monitoring results, laboratory reports, calculations, and air sampling data sheets will be maintained by the SM during Site work.

14.4 Accident/Incident Reports

Incident reporting and investigation during Site work will be completed using an Incident Report Form, provided as Appendix D.

14.5 Hazard Communication Program/Agency for Toxic Substances and Disease Registry (ATSDR)

ATSDR Fact Sheets will be obtained for applicable substances and included in the Site hazard communication file. The hazard communication program will be maintained on-site in accordance with 29 CFR 1910.1200.

14.6 Work Permits

All work permits, including lockout/tagout, sidewalk permits, and debris container permits (if necessary), will be maintained in the project files. Copies of the work permits shall also be provided to the SM and the Site owner's representative.

15.0 FIELD PERSONNEL REVIEW

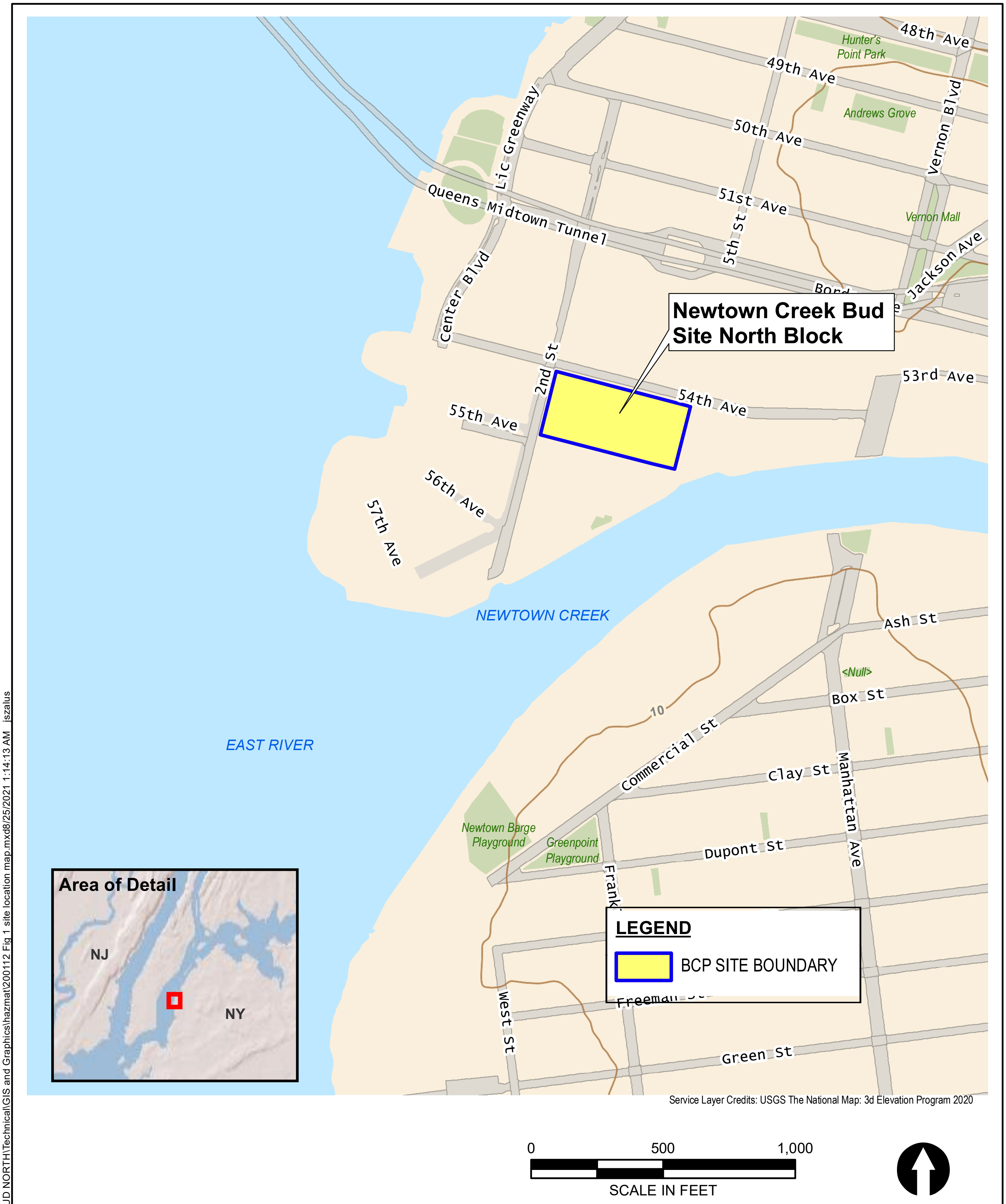
This form serves as documentation that field personnel have read, been informed of, and understand the provisions of this HASP for the Site at 2-10 54th Avenue, Long Island City, New York 11101. It will be maintained on-site by the SM as a project record. Each field team member shall sign this section after training in the contents of this HASP has been completed. Site workers must sign this form after Site-specific training is completed and before being permitted to work on-site.

AFFIDAVIT

I have read, or have been informed of, this Health and Safety Plan and understand the information presented. I have also completed Site-specific training for the work detailed in the project specifications. I will comply with the provisions contained therein.

Name (Print and Sign) and Company	Date

FIGURES



Service Layer Credits: USGS The National Map: 3d Elevation Program 2020

AKRF

440 Park Avenue South, New York, NY 10016

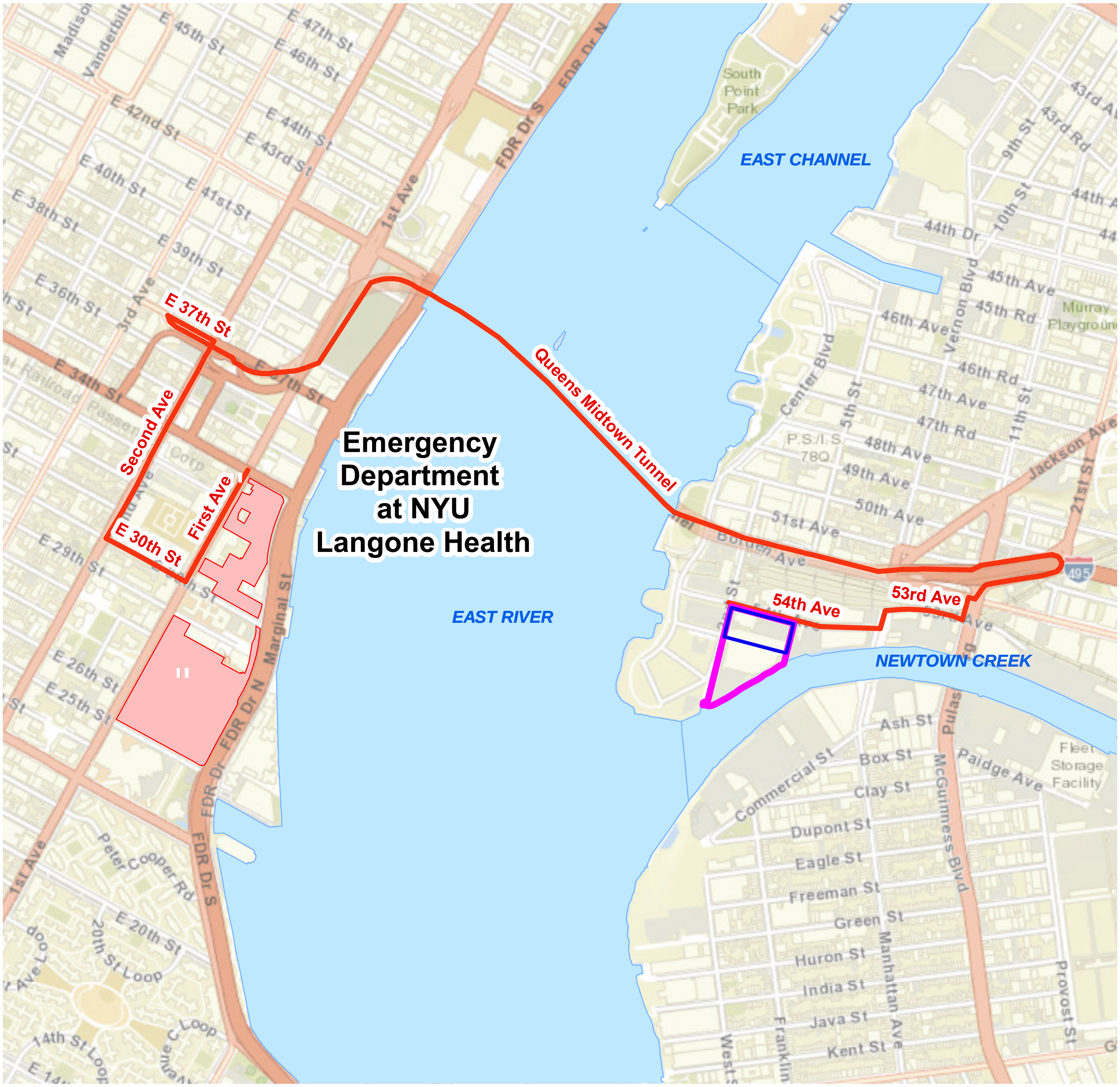
Newtown Creek Bud Site - North Block

2-10 54th Avenue - Long Island City, New York

BCP SITE LOCATION

DATE	11/29/2021
PROJECT NO.	200112
FIGURE	1

©2021 AKRF W:\Projects\200112 - BUD NORTH\Technical\GIS and Graphics\hazmat\200112 Fig 1 site location map.mxd8/25/2021 1:14:13 AM jszalus



Service Layer Credits: ESRI World Street Map 2020

LEGEND

🟦 BCP SITE BOUNDARY

🟪 PROPERTY BOUNDARY

━ ROUTE TO HOSPITAL

HOSPITAL LOCATION

NYU Langone Health
570 1^{st} Avenue,
New York, NY 10016
(Emergency Department on 1^{st} Ave)

0 0.25 0.5
Miles

AKRF
440 Park Avenue South, New York, NY 10016

Newtown Creek Bud Site North Block
2-21 Malt Drive - Long Island City, New York

HOSPITAL ROUTE MAP

DATE	8/19/2021
PROJECT NO.	200112
FIGURE	2

©2021 AKRF W:\Projects\200112 - BUD NORTH\Technical\GIS and Graphics\hazmat\200112 Figure 1 Hospital Route Map.mxd2/8/2021 2:08:20 PM jszalus

APPENDIX A

ATSDR FACT SHEETS

Benzene - ToxFAQs™

CAS # 71-43-2

This fact sheet answers the most frequently asked health questions (FAQs) about benzene. For more information, call the CDC Information Center at 1-800-232-4636. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It is important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHTLIGHTS: Benzene is a widely used chemical formed from both natural processes and human activities. Breathing benzene can cause drowsiness, dizziness, and unconsciousness; long-term benzene exposure causes effects on the bone marrow and can cause anemia and leukemia. Benzene has been found in at least 1,000 of the 1,684 National Priority List (NPL) sites identified by the Environmental Protection Agency (EPA).

What is benzene?

Benzene is a colorless liquid with a sweet odor. It evaporates into the air very quickly and dissolves slightly in water. It is highly flammable and is formed from both natural processes and human activities.

Benzene is widely used in the United States; it ranks in the top 20 chemicals for production volume. Some industries use benzene to make other chemicals which are used to make plastics, resins, and nylon and other synthetic fibers. Benzene is also used to make some types of rubbers, lubricants, dyes, detergents, drugs, and pesticides. Natural sources of benzene include emissions from volcanoes and forest fires. Benzene is also a natural part of crude oil, gasoline, and cigarette smoke.

What happens to benzene when it enters the environment?

- Industrial processes are the main source of benzene in the environment.
- Benzene can pass into the air from water and soil.
- It reacts with other chemicals in the air and breaks down within a few days.
- Benzene in the air can attach to rain or snow and be carried back down to the ground.
- It breaks down more slowly in water and soil, and can pass through the soil into underground water.
- Benzene does not build up in plants or animals.

How might I be exposed to benzene?

- Outdoor air contains low levels of benzene from tobacco smoke, automobile service stations, exhaust from motor vehicles, and industrial emissions.
- Vapors (or gases) from products that contain benzene, such as glues, paints, furniture wax, and detergents, can also be a source of exposure.
- Air around hazardous waste sites or gas stations will contain higher levels of benzene.
- Working in industries that make or use benzene.

How can benzene affect my health?

Breathing very high levels of benzene can result in death, while high levels can cause drowsiness, dizziness, rapid heart rate, headaches, tremors, confusion, and unconsciousness. Eating or drinking foods containing high levels of benzene can cause vomiting, irritation of the stomach, dizziness, sleepiness, convulsions, rapid heart rate, and death.

The major effect of benzene from long-term exposure is on the blood. Benzene causes harmful effects on the bone marrow and can cause a decrease in red blood cells leading to anemia. It can also cause excessive bleeding and can affect the immune system, increasing the chance for infection. Some women who breathed high levels of benzene for many months had irregular menstrual periods and a decrease in the size of their ovaries, but we do not know for certain that benzene caused the effects. It is not known whether benzene will affect fertility in men.

Benzene

CAS # 71-43-2

How likely is benzene to cause cancer?

Long-term exposure to high levels of benzene in the air can cause leukemia, particularly acute myelogenous leukemia, often referred to as AML. This is a cancer of the bloodforming organs. The Department of Health and Human Services (DHHS) has determined that benzene is a known carcinogen. The International Agency for Research on Cancer (IARC) and the EPA have determined that benzene is carcinogenic to humans.

How can benzene affect children?

Children can be affected by benzene exposure in the same ways as adults. It is not known if children are more susceptible to benzene poisoning than adults.

Benzene can pass from the mother's blood to a fetus. Animal studies have shown low birth weights, delayed bone formation, and bone marrow damage when pregnant animals breathed benzene.

How can families reduce the risks of exposure to benzene?

Benzene exposure can be reduced by limiting contact with gasoline and cigarette smoke. Families are encouraged not to smoke in their house, in enclosed environments, or near their children.

Is there a medical test to determine whether I've been exposed to benzene?

Several tests can show if you have been exposed to benzene. There is a test for measuring benzene in the breath; this test must be done shortly after exposure. Benzene can also be measured in the blood; however, since benzene disappears rapidly from the blood, this test is only useful for recent exposures.

In the body, benzene is converted to products called metabolites. Certain metabolites can be measured in the urine. The metabolite S-phenylmercapturic acid in urine is a sensitive indicator of benzene exposure. However, this test must be done shortly after exposure and is not a reliable indicator of how much benzene you have been exposed to, since the metabolites may be present in urine from other sources.

Has the federal government made recommendations to protect human health?

The EPA has set the maximum permissible level of benzene in drinking water at 5 parts benzene per billion parts of water (5 ppb).

The Occupational Safety and Health Administration (OSHA) has set limits of 1 part benzene per million parts of workplace air (1 ppm) for 8 hour shifts and 40 hour work weeks.

References

Agency for Toxic Substances and Disease Registry (ATSDR) 2007. Toxicological Profile for Benzene (Update). Atlanta, GA: U.S. Department of Public Health and Human Services, Public Health Service.

Where can I get more information?

For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology and Human Health Sciences, 1600 Clifton Road NE, Mailstop F-57, Atlanta, GA 30329-4027.

Phone: 1-800-232-4636

ToxFAQs^{TM} Internet address via WWW is http://www.atsdr.cdc.gov/toxfaqs/index.asp.

ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

Toluene - ToxFAQs™

What is toluene?

Toluene is a clear, colorless liquid with a distinctive smell. It occurs naturally in crude oil and in the tolú tree. Toluene is produced in the process of making gasoline and other fuels from crude oil and in making coke from coal.

Toluene is a good solvent (a substance that can dissolve other substances). It is used in making paints, paint thinners, fingernail polish, lacquers, adhesives, and rubber and in some printing and leather tanning processes. Toluene is also used in the manufacture of other chemicals, nylon, and plastics. It is also added to gasoline along with benzene and xylene to improve octane ratings.

What happens to toluene in the environment?

Toluene can enter the air from car exhaust or when materials that contain it (such as paints or fingernail polish) are used. It can get into surface waters (like lakes and streams), groundwater, or soil if solvents or petroleum products are accidently spilled, or from leaking underground storage tanks at gasoline stations and other facilities. When toluene-containing products are placed in landfills or waste disposal sites, toluene can enter the soil or water near the waste site.

Toluene does not usually stay in the environment long. In surface water or soil, it will readily evaporate into the air or be degraded by bacteria. In the air, toluene rapidly breaks down by reacting with other chemicals or oxygen in the air. Below the surface, microorganisms will break down toluene.

How can I be exposed to toluene?

You may be exposed to toluene by breathing contaminated air or touching products that contain this chemical. Car exhaust contains toluene; therefore, if you spend time in or near vehicles or traffic, you may be exposed to this chemical. People who work with gasoline, paint, or dyes may be exposed to higher levels of toluene than most people.

Toluene is not frequently detected in drinking water or food. People that abuse (inhale) certain products such as glue or paint thinner can be exposed to toluene.

How can toluene affect my health?

Toluene may affect the nervous system. Low to moderate levels can cause headaches, dizziness, tiredness, confusion, weakness, drunken-type actions, memory loss, nausea, and loss of appetite. These symptoms usually disappear when exposure stops.

Toluene can be found in gasoline products, paints, stain removers, and fingernail polish. Breathing toluene can cause headaches, dizziness, and nausea.

Long-term daily exposure to toluene in the workplace may cause some hearing and color vision loss. Repeatedly breathing toluene from glue or paint thinners may permanently damage the brain.

Exposure to high levels of toluene during pregnancy, such as those associated with solvent abuse, may lead to developmental effects, such as reduced mental abilities and growth in children.

In animal studies, the effects of toluene were similar to those seen in humans. In addition, it was found that animals that drank toluene also had decreased immune responses.

Toluene

Can toluene cause cancer?

Studies in workers and animals exposed to toluene generally show that toluene does not cause cancer.

The U.S. Department of Health and Human Services (DHHS) has not evaluated the carcinogenicity (ability to cause cancer) of toluene.

The U.S. Environmental Protection Agency (EPA) has determined that there is inadequate information to assess the carcinogenicity of toluene.

The International Agency for Research on Cancer (IARC) has determined that toluene is not classifiable as to its carcinogenicity in humans.

Can I get a medical test to check for toluene?

Toluene and its breakdown products can be measured in blood and urine. These tests are only useful if done within several days after exposure. These tests cannot predict whether you will have health problem from exposure to toluene.

How can I protect myself and my family from toluene?

To reduce exposure to toluene, you should use products that contain it (such as paints, nail polish, glues, inks, and stain removers) in well-ventilated areas. When not in use, these products should be tightly covered to prevent evaporation into the air and, if possible, stored in a shed or an outside location. Always store household chemicals in their original labeled containers.

Have your tap water tested if you are concerned it may have toluene and, if necessary, take steps to protect yourself. Keep children from eating or playing in the dirt if you live near a waste site.

Sometimes, older children sniff household chemicals in an attempt to get high. Talk with children about the dangers of sniffing chemicals.

For more information:

Call **CDC-INFO** at 1-800-232-4636, or submit your question online at https://wwwn.cdc.gov/dcs/ContactUs/Form

Go to ATSDR's Toxicological Profile for Toluene: https://wwwn.cdc.gov/TSP/ToxProfiles/ToxProfiles.aspx?id=161&tid=29

Go to ATSDR's Toxic Substances Portal: https://wwwn.cdc.gov/TSP/index.aspx

Find & contact your ATSDR Regional Representative at http://www.atsdr.cdc.gov/DRO/dro_org.html

ATSDR
AGENCY FOR TOXIC SUBSTANCES
AND DISEASE REGISTRY

XYLENE

CAS # 1330-20-7

Division of Toxicology and Environmental Medicine ToxFAQs™ August 2007

This fact sheet answers the most frequently asked health questions (FAQs) about xylene. For more information, call the ATSDR Information Center at 1-800-232-4636. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It is important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Exposure to xylene occurs in the workplace and when you use paint, gasoline, paint thinners and other products that contain it. People who breathe high levels may have dizziness, confusion, and a change in their sense of balance. Xylene has been found in at least 840 of the 1,684 National Priority List sites identified by the Environmental Protection Agency (EPA).

What is xylene?

There are three forms of xylene in which the methyl groups vary on the benzene ring: *meta*-xylene, *ortho*-xylene, and *para*-xylene (*m*-, *o*-, and *p*-xylene). These different forms are referred to as isomers.

Xylene is a colorless, sweet-smelling liquid that catches on fire easily. It occurs naturally in petroleum and coal tar. Chemical industries produce xylene from petroleum. It is one of the top 30 chemicals produced in the United States in terms of volume.

Xylene is used as a solvent and in the printing, rubber, and leather industries. It is also used as a cleaning agent, a thinner for paint, and in paints and varnishes. It is found in small amounts in airplane fuel and gasoline.

What happens to xylene when it enters the environment?

❏ Xylene evaporates quickly from the soil and surface water into the air.
❏ In the air, it is broken down by sunlight into other less harmful chemicals in a couple of days.
❏ It is broken down by microorganisms in soil and water.
❏ Only a small amount of it builds up in fish, shellfish, plants, and other animals living in xylene-contaminated water.

How might I be exposed to xylene?

❏ Using a variety of consumer products including gasoline, paint varnish, shellac, rust preventatives, and cigarette smoke. Xylene can be absorbed through the respiratory tract and through the skin.
❏ Ingesting xylene-contaminated food or water, although these levels are likely to be very low.
❏ Working in a job that involves the use of xylene such as painters, paint industry workers, biomedical laboratory workers, automobile garage workers, metal workers, and furniture refinishers.

How can xylene affect my health?

No health effects have been noted at the background levels that people are exposed to on a daily basis.

High levels of exposure for short or long periods can cause headaches, lack of muscle coordination, dizziness, confusion, and changes in one’s sense of balance. Exposure of people to high levels of xylene for short periods can also cause irritation of the skin, eyes, nose, and throat; difficulty in breathing; problems with the lungs; delayed reaction time; memory difficulties; stomach discomfort; and possibly changes in the liver and kidneys. It can cause unconsciousness and even death at very high levels.

How likely is xylene to cause cancer?

Both the International Agency for Research on Cancer (IARC) and the EPA have found that there is insufficient information to determine whether or not xylene is carcinogenic.

How can xylene affect children?

The effects of xylene have not been studied in children, but it is likely that they would be similar to those seen in exposed adults. Although there is no direct evidence, children may be more sensitive to acute inhalation exposure than adults because their narrower airways would be more sensitive to swelling effects.

Studies of unborn animals indicate that high concentrations of xylene may cause increased numbers of deaths, and delayed growth and development. In many instances, these same concentrations also cause damage to the mothers. We do not know if xylene harms the unborn child if the mother is exposed to low levels of xylene during pregnancy

How can families reduce the risks of exposure to xylene?

❏ Exposure to xylene as solvents (in paints or gasoline) can be reduced if the products are used with adequate ventilation and if they are stored in tightly closed containers out of the reach of small children.

❏ Sometimes older children sniff household chemicals in attempt to get high. Talk with your children about the dangers of sniffing xylene.

❏ If products containing xylene are spilled on the skin, then the excess should be wiped off and the area cleaned with soap and water.

Is there a medical test to determine whether I've been exposed to xylene?

Laboratory tests can detect xylene or its breakdown products in exhaled air, blood, or urine. There is a high degree of agreement between the levels of exposure to xylene and the levels of xylene breakdown products in the urine. However, a urine sample must be provided very soon after exposure ends because xylene quickly leaves the body. These tests are not routinely available at your doctor's office because they require special equipment.

Has the federal government made recommendations to protect human health?

The EPA set a limit of 10 parts xylene per million parts drinking water (10 ppm).

The Occupational Safety and Health Administration (OSHA) has set limits of 100 parts xylene per million parts of workplace air (100 ppm) for 8 hour shifts and 40 hour work weeks.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 2007. Toxicological Profile for Xylene (Update). Atlanta, GA: U.S. Department of Public Health and Human Services, Public Health Service.

Where can I get more information? For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology and Environmental Medicine, 1600 Clifton Road NE, Mailstop F-32, Atlanta, GA 30333. Phone: 1-800-232-4636, FAX: 770-488-4178. ToxFAQs Internet address via WWW is http://www.atsdr.cdc.gov/toxfaq.html. ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

Ethylbenzene- ToxFAQs™

CAS # 100-41-4

This fact sheet answers the most frequently asked health questions (FAQs) about ethylbenzene. For more information, call the CDC Information Center at 1-800-232-4636. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It is important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Ethylbenzene is a colorless liquid found in a number of products including gasoline and paints. Breathing very high levels can cause dizziness and throat and eye irritation. Breathing lower levels has resulted in hearing effects and kidney damage in animals. Ethylbenzene has been found in at least 829 of 1,699 National Priorities List (NPL) sites identified by the Environmental Protection Agency (EPA).

What is ethylbenzene?

Ethylbenzene is a colorless, flammable liquid that smells like gasoline.

It is naturally found in coal tar and petroleum and is also found in manufactured products such as inks, pesticides, and paints.

Ethylbenzene is used primarily to make another chemical, styrene. Other uses include as a solvent, in fuels, and to make other chemicals.

What happens to ethylbenzene when it enters the environment?

- Ethylbenzene moves easily into the air from water and soil.
- It takes about 3 days for ethylbenzene to be broken down in air into other chemicals.
- In surface water, ethylbenzene breaks down by reacting with other chemicals found naturally in water.
- Ethylbenzene can move through soil into groundwater.
- In soil, it is broken down by bacteria.

How might I be exposed to ethylbenzene?

- If you live in a city or near many factories or heavily traveled highways, you may be exposed to ethylbenzene in air.
- Releases of ethylbenzene into the air occur from burning oil, gas, and coal and from industries using ethylbenzene.
- Ethylbenzene is not often found in drinking water. Higher levels may be found in residential drinking water wells near landfills, waste sites, or leaking underground fuel storage tanks.
- Exposure can occur if you work in an industry where ethylbenzene is used or made.
- Exposure can occur if you use products containing it, such as gasoline, carpet glues, varnishes, and paints.

How can ethylbenzene affect my health?

Exposure to high levels of ethylbenzene in air for short periods can cause eye and throat irritation. Exposure to higher levels can result in dizziness.

Irreversible damage to the inner ear and hearing has been observed in animals exposed to relatively low concentrations of ethylbenzene for several days to weeks.

Exposure to relatively low concentrations of ethylbenzene in air for several months to years causes kidney damage in animals.

How likely is ethylbenzene to cause cancer?

The International Agency for Research on Cancer (IARC) has determined that ethylbenzene is a possible human carcinogen.

CAS # 100-41-4

How does ethylbenzene affect children?

There are no studies evaluating the effects of ethylbenzene exposure on children or immature animals. It is likely that children would have the same health effects as adults. We do not know whether children would be more sensitive than adults to the effects of ethylbenzene.

We do not know if ethylbenzene will cause birth defects in humans. Minor birth defects and low birth weight have occurred in newborn animals whose mothers were exposed to ethylbenzene in air during pregnancy.

How can families reduce the risk of exposure to ethylbenzene?

- Use adequate ventilation to reduce exposure to ethylbenzene vapors from consumer products such as gasoline, pesticides, varnishes and paints, and newly installed carpeting.
- Sometimes older children sniff household chemicals, including ethylbenzene, in an attempt to get high. Talk with your children about the dangers of sniffing chemicals.
- Household chemicals should be stored out of reach of children to prevent accidental poisoning. Always store household chemicals in their original containers; never store them in containers that children would find attractive to eat or drink from, such as old soda bottles. Gasoline should be stored in a gasoline can with a locked cap.

Is there a medical test to show whether I've been exposed to ethylbenzene?

Ethylbenzene is found in the blood, urine, breath, and some body tissues of exposed people. The most common way to test for ethylbenzene is in the urine. This test measures substances formed by the breakdown of ethylbenzene. Because these substances leave the body very quickly, this test needs to be done within a few hours after exposure occurs.

These tests can show you were exposed to ethylbenzene, but cannot predict the kind of health effects that might occur.

Has the federal government made recommendations to protect human health?

The EPA has determined that exposure to ethylbenzene in drinking water at concentrations of 30 mg/L for 1 day or 3 mg/L for 10 days is not expected to cause any adverse effects in a child.

The EPA has determined that lifetime exposure to 0.7 mg/L ethylbenzene is not expected to cause any adverse effects.

The Occupational Health and Safety Administration (OSHA) has limited workers' exposure to an average of 100 ppm for an 8-hour workday, 40-hour workweek.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 2010. Toxicological Profile for Ethylbenzene. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Where can I get more information?

For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology and Human Health Sciences, 1600 Clifton Road NE, Mailstop F-57, Atlanta, GA 30329-4027.

Phone: 1-800-232-4636

ToxFAQs™ Internet address via WWW is http://www.atsdr.cdc.gov/toxfaqs/index.asp.

ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

Acetone - ToxFAQs™

What is acetone?

Acetone is a man-made chemical that can also be found naturally in the environment. It is a colorless liquid with a distinct smell and taste. It evaporates easily in air, is flammable, and dissolves in water. Acetone is used by humans to dissolve other substances and produce plastics, paints and coatings, cleaning products, and personal care products. Other man-made sources of acetone are vehicle exhaust, tobacco smoke, and landfills. Acetone is also released naturally by plants, trees, insects, microbes (germs), volcanic erruptions, and forest fires, and can be found naturally in many fruits and vegetables. Low levels of acetone are produced naturally by the human body, and some health conditions can cause these levels to increase.

What happens to acetone in the environment?

- Most acetone in the environment exists as vapor in the air, and it can travel long distances this way.
- About half of the total acetone in air is broken down by sunlight or other chemicals within 22 days.
- Acetone moves from the air into water and soil by rain and snow, and moves quickly from water and soil back into the air. It does not bind to soil or build up in animals.
- Acetone can enter surface water as manufacturing waste and seep into groundwater from landfills.
- Acetone is broken down by microbes or chemicals in water and soil.

A strong scent of acetone and irritation in your eyes, nose, and throat are warning signs of moderate exposure. Noticing these signals can help you avoid exposure to damaging levels of acetone.

How can I be exposed to acetone?

- Low levels of acetone are in the air, so most people are exposed to very small amounts through breathing, but these are rarely at levels that are harmful to your health.
- Workers in certain industries, such as commercial painting, plastic manufacturing, household cleaning, and beauty salons, may be exposed by breathing air with higher levels of acetone in the workplace.
- You may be exposed by drinking water or eating food that is contaminated with acetone.
- Exposure may occur by smoking tobacco products or breathing in secondhand tobacco smoke.
- You may be exposed to acetone by using products that contain acetone (such as nail polish remover) or being in enclosed environments where these products are used.

How can acetone affect my health?

If you are exposed to acetone, it enters your blood, which carries it to all organs in the body. When there is only a small amount, your liver breaks it down into harmless chemicals. Breathing or swallowing high amounts of acetone over a short period of time can cause headaches, confusion, nausea, racing pulse, changes in the size and amount of blood cells, unconsciousness (passing out), or coma. Breathing a moderate to high amount of acetone can also cause nose, throat, lung, and eye irritation. Skin contact with acetone can cause your skin to become dry, irritated, and cracked. The effects of long-term acetone exposure have been mostly studied in animals, and include kidney, liver, and nerve damage; birth defects; and male infertilty. It is not known if long-term exposure to acetone affects people in these ways.

Can acetone cause cancer?

The U.S. Environmental Protection Agency (EPA) has concluded that there is not sufficient evidence to assess whether acetone is carcinogenic (causing cancer) to humans.

The International Agency for Research on Cancer (IARC) and National Toxicology Program (NTP) have not classified acetone for carcinogenicity.

Can I get a medical test to check for acetone?

There are tests available to measure the amount of acetone in your breath, blood, and urine. While these tests can tell you how much acetone is in your body, it's important to remember that the amount of acetone that occurs naturally in the body varies from person to person. These tests cannot predict whether you will experience any health problems as a result of the exposure.

Tests for acetone exposure must be performed within 2–3 days after you have been exposed, because acetone leaves your body within a few days of entering it. These tests are usually not performed at your doctor's office; your doctor takes blood or urine samples and sends them to a testing laboratory.

How can I protect my family from acetone exposure?

Always follow directions on the label when using and storing products that contain acetone.

- Do not use products that contain acetone near open flames or hot surfaces.
- Store products that contain acetone in a cool, well-ventilated place, away from direct heat.
- If you spill a product that contains acetone, open a window to make sure you get proper ventilation and fresh air as the acetone evaporates.

Always supervise children and when using consumer products that contain acetone.

- Never allow children to drink a product that contains acetone. Keep these products away from children.

If you or a member of your household smokes cigarettes, ensure proper ventilation in your home.

- Avoid smoking tobacco products inside if possible.
- Open windows when possible to reduce the concentration of acetone in the air in your home.

For more information:

Call **CDC-INFO** at 1-800-232-4636, or submit your question online at https://wwwn.cdc.gov/dcs/ContactUs/Form

Go to ATSDR's Toxicological Profile for Acetone: https://wwwn.cdc.gov/TSP/ToxProfiles/ToxProfiles.aspx?id=5&tid=1

Go to ATSDR's Toxic Substances Portal: https://wwwn.cdc.gov/TSP/index.aspx

Find & contact your ATSDR Regional Representative at http://www.atsdr.cdc.gov/DRO/dro_org.html

Polychlorinated Biphenyls - ToxFAQs™

This fact sheet answers the most frequently asked health questions (FAQs) about polychlorinated biphenyls. For more information, call the CDC Information Center at 1-800-232-4636. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It's important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Polychlorinated biphenyls (PCBs) are a mixture of individual chemicals which are no longer produced in the United States, but are still found in the environment. Health effects that have been associated with exposure to PCBs include acne-like skin conditions in adults and neurobehavioral and immunological changes in children. PCBs are known to cause cancer in animals. PCBs have been found in at least 500 of the 1,598 National Priorities List (NPL) sites identified by the Environmental Protection Agency (EPA).

What are polychlorinated biphenyls?

Polychlorinated biphenyls are mixtures of up to 209 individual chlorinated compounds (known as congeners). There are no known natural sources of PCBs. PCBs are either oily liquids or solids that are colorless to light yellow. Some PCBs can exist as a vapor in air. PCBs have no known smell or taste. Many commercial PCB mixtures are known in the U.S. by the trade name Aroclor.

PCBs have been used as coolants and lubricants in transformers, capacitors, and other electrical equipment because they don't burn easily and are good insulators. The manufacture of PCBs was stopped in the U.S. in 1977 because of evidence they build up in the environment and can cause harmful health effects. Products made before 1977 that may contain PCBs include old fluorescent lighting fixtures and electrical devices containing PCB capacitors, and old microscope and hydraulic oils.

What happens to PCBs when they enter the environment?

- PCBs entered the air, water, and soil during their manufacture, use, and disposal; from accidental spills and leaks during their transport; and from leaks or fires in products containing PCBs.
- PCBs can still be released to the environment from hazardous waste sites; illegal or improper disposal of industrial wastes and consumer products; leaks from old electrical transformers containing PCBs; and burning of some wastes in incinerators.
- PCBs do not readily break down in the environment and thus may remain there for very long periods of time. PCBs can travel long distances in the air and be deposited in areas far away from where they were released. In water, a small amount of PCBs may remain dissolved, but most stick to organic particles and bottom sediments. PCBs also bind strongly to soil.
- PCBs are taken up by small organisms and fish in water. They are also taken up by other animals that eat these aquatic animals as food. PCBs accumulate in fish and marine mammals, reaching levels that may be many thousands of times higher than in water.

How might I be exposed to PCBs?

- Using old fluorescent lighting fixtures and electrical devices and appliances, such as television sets and refrigerators, that were made 30 or more years ago. These items may leak small amounts of PCBs into the air when they get hot during operation, and could be a source of skin exposure.
- Eating contaminated food. The main dietary sources of PCBs are fish (especially sportfish caught in contaminated lakes or rivers), meat, and dairy products.
- Breathing air near hazardous waste sites and drinking contaminated well water.
- In the workplace during repair and maintenance of PCB transformers; accidents, fires or spills involving transformers, fluorescent lights, and other old electrical devices; and disposal of PCB materials.

How can PCBs affect my health?

The most commonly observed health effects in people exposed to large amounts of PCBs are skin conditions such as acne and rashes. Studies in exposed workers have shown changes in blood and urine that may indicate liver damage. PCB exposures in the general population are not likely to result in skin and liver effects. Most of the studies of health effects of PCBs in the general population examined children of mothers who were exposed to PCBs.

Animals that ate food containing large amounts of PCBs for short periods of time had mild liver damage and some died. Animals that ate smaller amounts of PCBs in food over several weeks or months developed various kinds of health effects, including anemia; acne-like skin conditions; and liver, stomach, and thyroid gland injuries. Other effects of PCBs in animals include changes in the immune system, behavioral alterations, and impaired reproduction. PCBs are not known to cause birth defects.

How likely are PCBs to cause cancer?

Few studies of workers indicate that PCBs were associated with certain kinds of cancer in humans, such as cancer of the liver and biliary tract. Rats that ate food containing high levels of PCBs for two years developed liver cancer. The Department of Health and Human Services (DHHS) has concluded that PCBs may reasonably be anticipated to be carcinogens. PCBs have been classified as probably carcinogenic, and carcinogenic to humans (group 1) by the Environmental Protection Agency (EPA) and International Agency for Research on Cancer (IARC), respectively.

How can PCBs affect children?

Women who were exposed to relatively high levels of PCBs in the workplace or ate large amounts of fish contaminated with PCBs had babies that weighed slightly less than babies from women who did not have these exposures. Babies born to women who ate PCB-contaminated fish also showed abnormal responses in tests of infant behavior. Some of these behaviors, such as problems with motor skills and a decrease in short-term memory, lasted for several years. Other studies suggest that the immune system was affected in children born to and nursed by mothers exposed to increased levels of PCBs. There are no reports of structural birth defects caused by exposure to PCBs or of health effects of PCBs in older children. The most likely way infants will be exposed to PCBs is from breast milk. Transplacental transfers of PCBs were also reported In most cases, the benefits of breast-feeding outweigh any risks from exposure to PCBs in mother's milk.

How can families reduce the risks of exposure to PCBs?

- You and your children may be exposed to PCBs by eating fish or wildlife caught from contaminated locations. Certain states, Native American tribes, and U.S. territories have issued advisories to warn people about PCB-contaminated fish and fish-eating wildlife. You can reduce your family's exposure to PCBs by obeying these advisories.
- Children should be told not play with old appliances, electrical equipment, or transformers, since they may contain PCBs.
- Children should be discouraged from playing in the dirt near hazardous waste sites and in areas where there was a transformer fire. Children should also be discouraged from eating dirt and putting dirty hands, toys or other objects in their mouths, and should wash hands frequently.
- If you are exposed to PCBs in the workplace it is possible to carry them home on your clothes, body, or tools. If this is the case, you should shower and change clothing before leaving work, and your work clothes should be kept separate from other clothes and laundered separately.

Is there a medical test to show whether I've been exposed to PCBs?

Tests exist to measure levels of PCBs in your blood, body fat, and breast milk, but these are not routinely conducted. Most people normally have low levels of PCBs in their body because nearly everyone has been environmentally exposed to PCBs. The tests can show if your PCB levels are elevated, which would indicate past exposure to above-normal levels of PCBs, but cannot determine when or how long you were exposed or whether you will develop health effects.

Has the federal government made recommendations to protect human health?

The EPA has set a limit of 0.0005 milligrams of PCBs per liter of drinking water (0.0005 mg/L). Discharges, spills or accidental releases of 1 pound or more of PCBs into the environment must be reported to the EPA. The Food and Drug Administration (FDA) requires that infant foods, eggs, milk and other dairy products, fish and shellfish, poultry and red meat contain no more than 0.2-3 parts of PCBs per million parts (0.2-3 ppm) of food. Many states have established fish and wildlife consumption advisories for PCBs.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 2000. Toxicological profile for polychlorinated biphenyls (PCBs). Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Where can I get more information?

For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology and Human Health Sciences, 1600 Clifton Road NE, Mailstop F-57, Atlanta, GA 30329-4027.

Phone: 1-800-232-4636.

ToxFAQs™ Internet address via WWW is http://www.atsdr.cdc.gov/toxfaqs/index.asp.

ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

Arsenic - ToxFAQs™

CAS # 7440-38-2

This fact sheet answers the most frequently asked health questions (FAQs) about arsenic. For more information, call the CDC Information Center at 1-800-232-4636. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It is important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Exposure to higher than average levels of arsenic occur mostly in the workplace, near hazardous waste sites, or in areas with high natural levels. At high levels, inorganic arsenic can cause death. Exposure to lower levels for a long time can cause a discoloration of the skin and the appearance of small corns or warts. Arsenic has been found in at least 1,149 of the 1,684 National Priority List (NPL) sites identified by the Environmental Protection Agency (EPA).

What is arsenic?

Arsenic is a naturally occurring element widely distributed in the earth's crust. In the environment, arsenic is combined with oxygen, chlorine, and sulfur to form inorganic arsenic compounds. Arsenic in animals and plants combines with carbon and hydrogen to form organic arsenic compounds.

Inorganic arsenic compounds are mainly used to preserve wood. Copper chromated arsenate (CCA) is used to make "pressure-treated" lumber. CCA is no longer used in the U.S. for residential uses; it is still used in industrial applications. Organic arsenic compounds are used as pesticides, primarily on cotton fields and orchards.

What happens to arsenic when it enters the environment?

- Arsenic occurs naturally in soil and minerals and may enter the air, water, and land from wind-blown dust and may get into water from runoff and leaching.
- Arsenic cannot be destroyed in the environment. It can only change its form.
- Rain and snow remove arsenic dust particles from the air.
- Many common arsenic compounds can dissolve in water. Most of the arsenic in water will ultimately end up in soil or sediment.
- Fish and shellfish can accumulate arsenic; most of this arsenic is in an organic form called arsenobetaine that is much less harmful.

How might I be exposed to arsenic?

- Ingesting small amounts present in your food and water or breathing air containing arsenic.
- Breathing sawdust or burning smoke from wood treated with arsenic.
- Living in areas with unusually high natural levels of arsenic in rock.
- Working in a job that involves arsenic production or use, such as copper or lead smelting, wood treating, or pesticide application.

How can arsenic affect my health?

Breathing high levels of inorganic arsenic can give you a sore throat or irritated lungs.

Ingesting very high levels of arsenic can result in death. Exposure to lower levels can cause nausea and vomiting, decreased production of red and white blood cells, abnormal heart rhythm, damage to blood vessels, and a sensation of "pins and needles" in hands and feet.

Ingesting or breathing low levels of inorganic arsenic for a long time can cause a darkening of the skin and the appearance of small "corns" or "warts" on the palms, soles, and torso.

Skin contact with inorganic arsenic may cause redness and swelling.

Almost nothing is known regarding health effects of organic arsenic compounds in humans. Studies in animals show that some simple organic arsenic compounds are less toxic than inorganic forms. Ingestion of methyl and dimethyl compounds can cause diarrhea and damage to the kidneys.

How likely is arsenic to cause cancer?

Several studies have shown that ingestion of inorganic arsenic can increase the risk of skin cancer and cancer in the liver, bladder, and lungs. Inhalation of inorganic arsenic can cause increased risk of lung cancer. The Department of Health and Human Services (DHHS) and the EPA have determined that inorganic arsenic is a known human carcinogen. The International Agency for Research on Cancer (IARC) has determined that inorganic arsenic is carcinogenic to humans.

How can arsenic affect children?

There is some evidence that long-term exposure to arsenic in children may result in lower IQ scores. There is also some evidence that exposure to arsenic in the womb and early childhood may increase mortality in young adults.

There is some evidence that inhaled or ingested arsenic can injure pregnant women or their unborn babies, although the studies are not definitive. Studies in animals show that large doses of arsenic that cause illness in pregnant females, can also cause low birth weight, fetal malformations, and even fetal death. Arsenic can cross the placenta and has been found in fetal tissues. Arsenic is found at low levels in breast milk.

How can families reduce the risks of exposure to arsenic?

- If you use arsenic-treated wood in home projects, you should wear dust masks, gloves, and protective clothing to decrease exposure to sawdust.
- If you live in an area with high levels of arsenic in water or soil, you should use cleaner sources of water and limit contact with soil.
- If you work in a job that may expose you to arsenic, be aware that you may carry arsenic home on your clothing, skin, hair, or tools. Be sure to shower and change clothes before going home.

Is there a medical test to determine whether I've been exposed to arsenic?

There are tests available to measure arsenic in your blood, urine, hair, and fingernails. The urine test is the most reliable test for arsenic exposure within the last few days. Tests on hair and fingernails can measure exposure to high levels of arsenic over the past 6-12 months. These tests can determine if you have been exposed to above-average levels of arsenic. They cannot predict whether the arsenic levels in your body will affect your health.

Has the federal government made recommendations to protect human health?

The EPA has set limits on the amount of arsenic that industrial sources can release to the environment and has restricted or cancelled many of the uses of arsenic in pesticides. EPA has set a limit of 0.01 parts per million (ppm) for arsenic in drinking water.

The Occupational Safety and Health Administration (OSHA) has set a permissible exposure limit (PEL) of 10 micrograms of arsenic per cubic meter of workplace air ($10\ \mu g/m^3$) for 8 hour shifts and 40 hour work weeks.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 2007. Toxicological Profile for Arsenic (Update). Atlanta, GA: U.S. Department of Health and Human Services. Public Health Service.

Where can I get more information?

For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology and Human Health Sciences, 1600 Clifton Road NE, Mailstop F-57, Atlanta, GA 30329-4027.

Phone: 1-800-232-4636

ToxFAQs™ Internet address via WWW is http://www.atsdr.cdc.gov/toxfaqs/index.asp.

ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

ATSDR
AGENCY FOR TOXIC SUBSTANCES
AND DISEASE REGISTRY

BARIUM

CAS # 7440-39-3

Division of Toxicology and Human Health Sciences ToxFAQs™ **June 2013**

This fact sheet answers the most frequently asked health questions (FAQs) about barium and barium compounds. For more information, call the ATSDR Information Center at 1-800-232-4636. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It is important you understand this information because these substances may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Exposure to barium occurs mostly in the workplace or from drinking contaminated water. Ingesting drinking water containing levels of barium above the EPA drinking water guidelines for relatively short periods of time can cause gastrointestinal disturbances and muscle weakness. Ingesting high levels for a long time can damage the kidneys. Barium and barium compounds have been found in at least 798 of the 1,684 National Priority List sites identified by the Environmental Protection Agency (EPA).

What is barium?

Barium is a silvery-white metal which exists in nature only in ores containing mixtures of elements. It combines with other chemicals such as sulfur or carbon and oxygen to form barium compounds.

Barium compounds are used by the oil and gas industries to make drilling muds. Drilling muds make it easier to drill through rock by keeping the drill bit lubricated. They are also used to make paint, bricks, ceramics, glass, and rubber.

Barium sulfate is sometimes used by doctors to perform medical tests and to take x-rays of the gastrointestinal tract.

What happens to barium when it enters the environment?

□ Barium gets into the air during the mining, refining, and production of barium compounds, and from the burning of coal and oil.
□ The length of time that barium will last in air, land, water, or sediments depends on the form of barium released.
□ Barium compounds, such as barium sulfate and barium carbonate, which do not dissolve well in water, can last a long time in the environment.
□ Barium compounds, such as barium chloride, barium nitrate, or barium hydroxide, that dissolve easily in water usually do not last in these forms for a long time in the environment. The barium in these compounds that is dissolved in water quickly combines with sulfate or carbonate that are naturally found in water and become the longer lasting forms (barium sulfate and barium carbonate).
□ Fish and aquatic organisms can accumulate barium.

How might I be exposed to barium?

□ Ingesting small amounts present in your food and water or breathing air containing very low levels of barium.
□ Living in areas with unusually high natural levels of barium in the drinking water.
□ Working in a job that involves barium production or use.
□ Living or working near waste sites where barium has been disposed of.

How can barium affect my health?

The health effects of the different barium compounds depend on how well the compound dissolves in water or in the stomach contents. Barium compounds that do not dissolve well, such as barium sulfate, are not generally harmful.

Barium has been found to potentially cause gastrointestinal disturbances and muscular weakness when people are exposed to it at levels above the EPA drinking water standards for relatively short periods of time. Some people who eat or drink amounts of barium above background levels found in food and water for a short period may experience vomiting, abdominal cramps, diarrhea, difficulties in breathing, increased or decreased blood pressure, numbness around the face, and muscle weakness. Eating or drinking very large amounts of barium compounds that easily dissolve can cause changes in heart rhythm or paralysis and possibly death. Animals that drank barium over long periods had damage to the kidneys, decreases in body weight, and some died.

How likely is barium to cause cancer?

The Department of Health and Human Services (DHHS) and the International Agency for Research on Cancer (IARC) have not classified barium as to its carcinogenicity. The EPA has determined that barium is not likely to be carcinogenic to humans following ingestion and that there is insufficient information to determine whether it will be carcinogenic to humans following inhalation exposure.

How can barium affect children?

We do not know whether children will be more or less sensitive than adults to barium toxicity. A study in rats that swallowed barium found a decrease in newborn body weight; we do not know if a similar effect would be seen in humans.

How can families reduce the risk of exposure to barium?

□ The greatest potential source of barium exposure is through food and drinking water. However, the amount of barium in foods and drinking water are typically too low to be of concern.

Is there a medical test to determine whether I've been exposed to barium?

There is no routine medical test to determine whether you have been exposed to barium. Doctors can measure barium in body tissues and fluids, such as bones, blood, urine, and feces, using very complex instruments. These tests cannot be used to predict the extent of the exposure or potential health effects.

The geometric mean barium level measured in the U.S. general population aged 6 and older is reported by the Centers for Disease Control and Prevention (CDC) as 1.56 µg/g creatinine (measured in urine).

Has the federal government made recommendations to protect human health?

The EPA has set a limit of 2.0 milligrams of barium per liter of drinking water (2.0 mg/L), which is the same as 2 ppm.

The Occupational Safety and Health Administration (OSHA) has set Permissible Exposure Limits (PELs) of 0.5 milligrams of soluble barium compounds per cubic meter of workplace air (0.5 mg/m^3) for 8 hour shifts and 40 hour work weeks. The OSHA limits for barium sulfate dust are 15 mg/m^3 of total dust and 5 mg/m^3 for respirable fraction.

The National Institute for Occupational Safety and Health (NIOSH) has set Recommended Exposure Limits (RELs) of 0.5 mg/m^3 for soluble barium compounds. The NIOSH has set RELs of 10 mg/m^3 (total dust) for barium sulfate and 5 mg/m^3 (respirable fraction).

References

Agency for Toxic Substances and Disease Registry (ATSDR). 2007. Toxicological Profile for Barium and Compounds (*Update*). Atlanta, GA: U.S. Department of Public Health and Human Services, Public Health Service.

http://www.cdc.gov/exposurereport/pdf/FourthReport_UpdatedTables_Sep2012.pdf

Where can I get more information? For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology and Human Health Sciences, 1600 Clifton Road NE, Mailstop F-57, Atlanta, GA 30333. Phone: 1-800-232-4636, FAX: 770-488-4178. ToxFAQs Internet address via WWW is http://www.atsdr.cdc.gov/toxfaqs/index.asp. ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

ATSDR
AGENCY FOR TOXIC SUBSTANCES
AND DISEASE REGISTRY

COPPER

CAS # 7440-50-8

Division of Toxicology ToxFAQs™ **September 2004**

This fact sheet answers the most frequently asked health questions (FAQs) about copper. For more information, call the ATSDR Information Center at 1-888-422-8737. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It is important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Copper is a metal that occurs naturally in the environment, and also in plants and animals. Low levels of copper are essential for maintaining good health. High levels can cause harmful effects such as irritation of the nose, mouth and eyes, vomiting, diarrhea, stomach cramps, nausea, and even death. Copper has been found in at least 906 of the 1,647 National Priority Sites identified by the Environmental Protection Agency (EPA).

What is copper?

Copper is a metal that occurs naturally throughout the environment, in rocks, soil, water, and air. Copper is an essential element in plants and animals (including humans), which means it is necessary for us to live. Therefore, plants and animals must absorb some copper from eating, drinking, and breathing.

Copper is used to make many different kinds of products like wire, plumbing pipes, and sheet metal. U.S. pennies made before 1982 are made of copper, while those made after 1982 are only coated with copper. Copper is also combined with other metals to make brass and bronze pipes and faucets.

Copper compounds are commonly used in agriculture to treat plant diseases like mildew, for water treatment and, as preservatives for wood, leather, and fabrics.

What happens to copper when it enters the environment?

- ❑ Copper is released into the environment by mining, farming, and manufacturing operations and through waste water releases into rivers and lakes. Copper is also released from natural sources, like volcanoes, windblown dusts, decaying vegetation, and forest fires.
- ❑ Copper released into the environment usually attaches to particles made of organic matter, clay, soil, or sand.
- ❑ Copper does not break down in the environment. Copper compounds can break down and release free copper into the air, water, and foods.

How might I be exposed to copper?

- ❑ You may be exposed to copper from breathing air, drinking water, eating foods, or having skin contact with copper, particulates attached to copper, or copper-containing compounds.
- ❑ Drinking water may have high levels of copper if your house has copper pipes and acidic water.
- ❑ Lakes and rivers that have been treated with copper compounds to control algae, or that receive cooling water from power plants, can have high levels of copper. Soils can also contain high levels of copper, especially if they are near copper smelting plants.
- ❑ You may be exposed to copper by ingesting copper-containing fungicides, or if you live near a copper mine or where copper is processed into bronze or brass.
- ❑ You may be exposed to copper if you work in copper mines or if you grind metals containing copper.

How can copper affect my health?

Everyone must absorb small amounts of copper every day because copper is essential for good health. High levels of copper can be harmful. Breathing high levels of copper can cause irritation of your nose and throat. Ingesting high levels of copper can cause nausea, vomiting, and diarrhea. Very-high doses of copper can cause damage to your liver and kidneys, and can even cause death.

How likely is copper to cause cancer?

We do not know whether copper can cause cancer in humans. The EPA has determined that copper is not classifiable as to human carcinogenicity.

How can copper affect children?

Exposure to high levels of copper will result in the same type of effects in children and adults. We do not know if these effects would occur at the same dose level in children and adults. Studies in animals suggest that the young children may have more severe effects than adults, but we don't know if this would also be true in humans. There is a very small percentage of infants and children who are unusually sensitive to copper.

We do not know if copper can cause birth defects or other developmental effects in humans. Studies in animals suggest that high levels of copper may cause a decrease in fetal growth.

How can families reduce the risk of exposure to copper?

The most likely place to be exposed to copper is through drinking water, especially if your water is corrosive and you have copper pipes in your house. The best way to lower the level of copper in your drinking water is to let the water run for at least 15 seconds first thing in the morning before drinking or using it. This reduces the levels of copper in tap water dramatically.

If you work with copper, wear the necessary protective clothing and equipment, and always follow safety procedures. Shower and change your clothes before going home each day.

Is there a medical test to show whether I've been exposed to copper?

Copper is found throughout the body; in hair, nails, blood, urine, and other tissues. High levels of copper in these samples can show that you have been exposed to higher-than normal levels of copper. These tests cannot tell whether you will experience harmful effects. Tests to measure copper levels in the body are not usually available at a doctor's office because they require special equipment, but the doctor can send samples to a specialty laboratory.

Has the federal government made recommendations to protect human health?

The EPA requires that levels of copper in drinking water be less than 1.3 mg of copper per one liter of drinking water (1.3 mg/L).

The U.S. Department of Agriculture has set the recommended daily allowance for copper at 900 micrograms of copper per day (µg/day) for people older than eight years old.

The Occupational Safety and Health Administration (OSHA) requires that levels of copper in the air in workplaces not exceed 0.1 mg of copper fumes per cubic meter of air (0.1 mg/m^3) and 1.0 mg/m^3 for copper dusts.

Reference

Agency for Toxic Substances and Disease Registry (ATSDR). 2004. Toxicological Profile for Copper. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Where can I get more information? For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology, 1600 Clifton Road NE, Mailstop F-32, Atlanta, GA 30333. Phone: 1-888-422-8737, FAX: 770-488-4178. ToxFAQs Internet address via WWW is http://www.atsdr.cdc.gov/toxfaq.html. ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

Lead – ToxFAQs™

CAS # 7439-92-1

This fact sheet answers the most frequently asked health questions (FAQs) about lead. For more information, call the CDC Information Center at 1-800-232-4636. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It is important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Exposure to lead can happen from breathing workplace air or dust, eating contaminated foods, or drinking contaminated water. Children can be exposed from eating lead-based paint chips or playing in contaminated soil. Lead can damage the nervous system, kidneys, and reproductive system. Lead has been found in at least 1,272 of the 1,684 National Priority List (NPL) sites identified by the Environmental Protection Agency (EPA).

What is lead?

Lead is a naturally occurring bluish-gray metal found in small amounts in the earth's crust. Lead can be found in all parts of our environment. Much of it comes from human activities including burning fossil fuels, mining, and manufacturing.

Lead has many different uses. It is used in the production of batteries, ammunition, metal products (solder and pipes), and devices to shield X-rays. Because of health concerns, lead from paints and ceramic products, caulking, and pipe solder has been dramatically reduced in recent years. The use of lead as an additive to gasoline was banned in 1996 in the United States.

What happens to lead when it enters the environment?

- Lead itself does not break down, but lead compounds are changed by sunlight, air, and water.
- When lead is released to the air, it may travel long distances before settling to the ground.
- Once lead falls onto soil, it usually sticks to soil particles.
- Movement of lead from soil into groundwater will depend on the type of lead compound and the characteristics of the soil.

How might I be exposed to lead?

- Eating food or drinking water that contains lead. Water pipes in some older homes may contain lead solder. Lead can leach out into the water.
- Spending time in areas where lead-based paints have been used and are deteriorating. Deteriorating lead paint can contribute to lead dust.
- Working in a job where lead is used or engaging in certain hobbies in which lead is used, such as making stained glass.
- Using health-care products or folk remedies that contain lead.

How can lead affect my health?

The effects of lead are the same whether it enters the body through breathing or swallowing. Lead can affect almost every organ and system in your body. The main target for lead toxicity is the nervous system, both in adults and children. Long-term exposure of adults can result in decreased performance in some tests that measure functions of the nervous system. It may also cause weakness in fingers, wrists, or ankles. Lead exposure also causes small increases in blood pressure, particularly in middle-aged and older people and can cause anemia. Exposure to high lead levels can severely damage the brain and kidneys in adults or children and ultimately cause death. In pregnant women, high-levels of exposure to lead may cause miscarriage. High-level exposure in men can damage the organs responsible for sperm production.

How likely is lead to cause cancer?

We have no conclusive proof that lead causes cancer in humans. Kidney tumors have developed in rats and mice that had been given large doses of some kind of lead compounds. The Department of Health and Human Services (DHHS) has determined that lead and lead compounds are reasonably anticipated to be human carcinogens and the EPA has determined that lead is a probable human carcinogen. The International Agency for Research on Cancer (IARC) has determined that inorganic lead is probably carcinogenic to humans and that there is insufficient information to determine whether organic lead compounds will cause cancer in humans.

How can lead affect children?

Small children can be exposed by eating lead-based paint chips, chewing on objects painted with lead-based paint, or swallowing house dust or soil that contains lead.

Children are more vulnerable to lead poisoning than adults. A child who swallows large amounts of lead may develop blood anemia, severe stomachache, muscle weakness, and brain damage. If a child swallows smaller amounts of lead, much less severe effects on blood and brain function may occur. Even at much lower levels of exposure, lead can affect a child's mental and physical growth.

Exposure to lead is more dangerous for young and unborn children. Unborn children can be exposed to lead through their mothers. Harmful effects include premature births, smaller babies, decreased mental ability in the infant, learning difficulties, and reduced growth in young children. These effects are more common if the mother or baby was exposed to high levels of lead. Some of these effects may persist beyond childhood.

How can families reduce the risks of exposure to lead?

- Avoid exposure to sources of lead.
- Do not allow children to chew or mouth surfaces that may have been painted with lead-based paint.
- If you have a water lead problem, run or flush water that has been standing overnight before drinking or cooking with it.
- Some types of paints and pigments that are used as make-up or hair coloring contain lead. Keep these kinds of products away from children.
- If your home contains lead-based paint or you live in an area contaminated with lead, wash children's hands and faces often to remove lead dusts and soil, and regularly clean the house of dust and tracked in soil.

Is there a medical test to determine whether I've been exposed to lead?

A blood test is available to measure the amount of lead in your blood and to estimate the amount of your recent exposure to lead. Blood tests are commonly used to screen children for lead poisoning. Lead in teeth or bones can be measured by X-ray techniques, but these methods are not widely available. Exposure to lead also can be evaluated by measuring erythrocyte protoporphyrin (EP) in blood samples. EP is a part of red blood cells known to increase when the amount of lead in the blood is high. However, the EP level is not sensitive enough to identify children with elevated blood lead levels below about 25 micrograms per deciliter (µg/dL). These tests usually require special analytical equipment that is not available in a doctor's office. However, your doctor can draw blood samples and send them to appropriate laboratories for analysis.

Has the federal government made recommendations to protect human health?

The Centers for Disease Control and Prevention (CDC) recommends that states test children at ages 1 and 2 years. Children should be tested at ages 3–6 years if they have never been tested for lead, if they receive services from public assistance programs for the poor such as Medicaid or the Supplemental Food Program for Women, Infants, and Children, if they live in a building or frequently visit a house built before 1950; if they visit a home (house or apartment) built before 1978 that has been recently remodeled; and/or if they have a brother, sister, or playmate who has had lead poisoning. CDC has updated its recommendations on children's blood lead levels. Experts now use an upper reference level value of 97.5% of the population distribution for children's blood lead. In 2012-2015, the value to identify children with blood lead levels that are much higher than most children have, is 5 micrograms per deciliter (µg/dL). EPA limits lead in drinking water to 15 µg per liter.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 2007. Toxicological Profile for lead (Update). Atlanta, GA: U.S. Department of Public Health and Human Services, Public Health Service.

Where can I get more information?

For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology and Human Health Sciences, 1600 Clifton Road NE, Mailstop F-57, Atlanta, GA 30329-4027.

Phone: 1-800-232-4636.

ToxFAQs™ Internet address via WWW is http://www.atsdr.cdc.gov/toxfaqs/index.asp.

ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

Manganese - ToxFAQs™

CAS # 7439-96-5

This fact sheet answers the most frequently asked health questions (FAQs) about manganese. For more information, call the CDC Information Center at 1-800-232-4636. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It is important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Manganese is a trace element and eating a small amount from food or water is needed to stay healthy. Exposure to excess levels of manganese may occur from breathing air, particularly where manganese is used in manufacturing, and from drinking water and eating food. At high levels, it can cause damage to the brain. Manganese has been found in at least 869 of the 1,669 National Priorities List (NPL) sites identified by the Environmental Protection Agency (EPA).

What is manganese?

Manganese is a naturally occurring metal that is found in many types of rocks. Pure manganese is silver-colored, but does not occur naturally. It combines with other substances such as oxygen, sulfur, or chlorine. Manganese occurs naturally in most foods and may be added to some foods.

Manganese is used principally in steel production to improve hardness, stiffness, and strength. It may also be used as an additive in gasoline to improve the octane rating of the gas.

What happens to manganese when it enters the environment?

- Manganese can be released to the air, soil, and water from the manufacture, use, and disposal of manganese-based products.
- Manganese cannot break down in the environment. It can only change its form or become attached to or separated from particles.
- In water, manganese tends to attach to particles in the water or settle into the sediment.
- The chemical state of manganese and the type of soil determine how fast it moves through the soil and how much is retained in the soil.
- The manganese-containing gasoline additive may degrade in the environment quickly when exposed to sunlight, releasing manganese.

How might I be exposed to manganese?

- The primary way you can be exposed to manganese is by eating food or manganese-containing nutritional supplements. Vegetarians, who consume foods rich in manganese such as grains, beans and nuts, as well as heavy tea drinkers, may have a higher intake of manganese than the average person.
- Certain occupations like welding or working in a factory where steel is made may increase your chances of being exposed to high levels of manganese.
- Manganese is routinely contained in groundwater, drinking water, and soil at low levels. Drinking water containing manganese or swimming or bathing in water containing manganese may expose you to low levels of this chemical.

How can manganese affect my health?

Manganese is an essential nutrient, and eating a small amount of it each day is important to stay healthy.

The most common health problems in workers exposed to high levels of manganese involve the nervous system. These health effects include behavioral changes and other nervous system effects, which include movements that may become slow and clumsy. This combination of symptoms when sufficiently severe is referred to as "manganism". Other less severe nervous system effects such as slowed hand movements have been observed in some workers exposed to lower concentrations in the work place.

Manganese

CAS # 7439-96-5

Exposure to high levels of manganese in air can cause lung irritation and reproductive effects.

Nervous system and reproductive effects have been observed in animals after high oral doses of manganese.

How likely is manganese to cause cancer?

The EPA concluded that existing scientific information cannot determine whether or not excess manganese can cause cancer.

How can manganese affect children?

Studies in children have suggested that extremely high levels of manganese exposure may produce undesirable effects on brain development, including changes in behavior and decreases in the ability to learn and remember. We do not know for certain that these changes were caused by manganese alone. We do not know if these changes are temporary or permanent. We do not know whether children are more sensitive than adults to the effects of manganese, but there is some indication from experiments in laboratory animals that they may be.

Studies of manganese workers have not found increases in birth defects or low birth weight in their offspring. No birth defects were observed in animals exposed to manganese.

How can families reduce the risk of exposure to manganese?

- Children are not likely to be exposed to harmful amounts of manganese in the diet. However, higher-than-usual amounts of manganese may be absorbed if their diet is low in iron. It is important to provide your child with a well-balanced diet.
- Workers exposed to high levels of airborne manganese in certain occupational settings may accumulate manganese dust on their work clothes. Manganese-contaminated work clothing should be removed before getting into your car or entering your home to help reduce the exposure hazard for yourself and your family.

Is there a medical test to determine whether I've been exposed to manganese?

Several tests are available to measure manganese in blood, urine, hair, or feces. Because manganese is normally present in our body, some is always found in tissues or fluids.

Because excess manganese is usually removed from the body within a few days, past exposures are difficult to measure with common laboratory tests.

Has the federal government made recommendations to protect human health?

The EPA has determined that exposure to manganese in drinking water at concentrations of 1 mg/L for up to 10 days is not expected to cause any adverse effects in a child.

The EPA has established that lifetime exposure to 0.3 mg/L manganese is not expected to cause any adverse effects.

The Food and Drug Administration (FDA) has determined that the manganese concentration in bottled drinking water should not exceed 0.05 mg/L.

The Occupational Health and Safety Administration (OSHA) has established a ceiling limit (concentration that should not be exceeded at any time during exposure) of 5 mg/m^3 for manganese in workplace air.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 2012. Toxicological Profile for Manganese. Atlanta, GA: U.S. Department of Public Health and Human Services, Public Health Service.

Where can I get more information?

For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology and Human Health Sciences, 1600 Clifton Road NE, Mailstop F-57, Atlanta, GA 30329-4027.

Phone: 1-800-232-4636.

ToxFAQs™ Internet address via WWW is http://www.atsdr.cdc.gov/toxfaqs/index.asp.

ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

ATSDR
AGENCY FOR TOXIC SUBSTANCES
AND DISEASE REGISTRY

METHYLENE CHLORIDE

CAS # 75-09-2

Division of Toxicology ToxFAQs™ **February 2001**

This fact sheet answers the most frequently asked health questions (FAQs) about methylene chloride. For more information, call the ATSDR Information Center at 1-888-422-8737. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It's important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Exposure to methylene chloride occurs mostly from breathing contaminated air, but may also occur through skin contact or by drinking contaminated water. Breathing in large amounts of methylene chloride can damage the central nervous system. Contact of eyes or skin with methylene chloride can result in burns. Methylene chloride has been found in at least 882 of 1,569 National Priorities List sites identified by the Environmental Protection Agency (EPA).

What is methylene chloride?

Methylene chloride is a colorless liquid with a mild, sweet odor. Another name for it is dichloromethane. Methylene chloride does not occur naturally in the environment.

Methylene chloride is used as an industrial solvent and as a paint stripper. It may also be found in some aerosol and pesticide products and is used in the manufacture of photographic film.

What happens to methylene chloride when it enters the environment?

❏ Methylene chloride is mainly released to the environment in air. About half of the methylene chloride in air disappears in 53 to 127 days.

❏ Methylene chloride does not easily dissolve in water, but small amounts may be found in drinking water.

❏ We do not expect methylene chloride to build up in plants or animals.

How might I be exposed to methylene chloride?

❏ The most likely way to be exposed to methylene chloride is by breathing contaminated air.

❏ Breathing the vapors given off by products containing methylene chloride. Exposure to high levels of methylene chloride is likely if methylene chloride or a product containing it is used in a room with inadequate ventilation.

How can methylene chloride affect my health?

If you breathe in large amounts of methylene chloride you may feel unsteady, dizzy, and have nausea and a tingling or numbness of your finger and toes. A person breathing smaller amounts of methylene chloride may become less attentive and less accurate in tasks requiring hand-eye coordination. Skin contact with methylene chloride causes burning and redness of the skin.

How likely is methylene chloride to cause cancer?

We do not know if methylene chloride can cause cancer in humans. An increased cancer risk was seen in mice

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES, Public Health Service
Agency for Toxic Substances and Disease Registry

breathing large amounts of methylene chloride for a long time.

The World Health Organization (WHO) has determined that methylene chloride may cause cancer in humans.

The Department of Health and Human Services (DHHS) has determined that methylene chloride can be reasonably anticipated to be a cancer-causing chemical.

The EPA has determined that methylene chloride is a probable cancer-causing agent in humans.

How can methylene chloride affect children?

It is likely that health effects seen in children exposed to high amounts of methylene chloride will be similar to the effects seen in adults. We do not know if methylene chloride can affect the ability of people to have children or if it causes birth defects. Some birth defects have been seen in animals inhaling very high levels of methylene chloride.

How can families reduce the risk of exposure to methylene chloride?

❏ Families may be exposed to methylene chloride while using products such as paint removers. Such products should always be used in well-ventilated areas and skin contact should be avoided.
❏ Children should not be allowed to remain near indoor paint removal activities.

Is there a medical test to show whether I've been exposed to methylene chloride?

❏ Several tests can measure exposure to methylene chloride. These tests are not routinely available in your doctor's office.
❏ Methylene chloride can be detected in the air you breathe out and in your blood. These tests are only useful for detecting exposures that have occurred within a few days.
❏ It is also possible to measure carboxyhemoglobin (a chemical formed in the blood as methylene chloride breaks down in the body) in the blood or formic acid (a breakdown product of methylene chloride) in the urine. These tests are not specific for methylene chloride.

Has the federal government made recommendations to protect human health?

❏ The EPA requires that releases of methylene chloride of 1,000 pounds or more be reported to the federal government.
❏ The EPA recommends that exposure of children to methylene chloride be limited to less than 10 milligrams per liter of drinking water (10 mg/L) for 1 day or 2 mg/L for 10 days.
❏ The Food and Drug Administration (FDA) has established limits on the amounts of methylene chloride that can remain after processing of spices, hops extract, and decaffeinated coffee.
❏ The Occupational Safety and Health Administration (OSHA) has set limits of 25 parts methylene chloride per million parts of workplace air (25 ppm) for 8-hour shifts and 40-hour work weeks.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 2000. Toxicological Profile for methylene chloride. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Where can I get more information? For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology, 1600 Clifton Road NE, Mailstop F-32, Atlanta, GA 30333. Phone: 1-888-422-8737, FAX: 770-488-4178. ToxFAQs™ Internet address is http://www.atsdr.cdc.gov/toxfaq.html . ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

Mercury - ToxFAQs™

CAS # 7439-97-6

This fact sheet answers the most frequently asked health questions (FAQs) about mercury. For more information, call the CDC Information Center at 1-800-232-4636. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It's important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Exposure to mercury occurs from breathing contaminated air, ingesting contaminated water and food, and having dental and medical treatments. Mercury, at high levels, may damage the brain, kidneys, and developing fetus. This chemical has been found in at least 714 of 1,467 National Priorities List (NPL) sites identified by the Environmental Protection Agency (EPA).

What is mercury?

Mercury is a naturally occurring metal which has several forms. The metallic mercury is a shiny, silver-white, odorless liquid. If heated, it is a colorless, odorless gas.

Mercury combines with other elements, such as chlorine, sulfur, or oxygen, to form inorganic mercury compounds or "salts," which are usually white powders or crystals. Mercury also combines with carbon to make organic mercury compounds. The most common one, methylmercury, is produced mainly by microscopic organisms in the water and soil. More mercury in the environment can increase the amounts of methylmercury that these small organisms make.

Metallic mercury is used to produce chlorine gas and caustic soda, and is also used in thermometers, some dental fillings, and batteries. Mercury salts are sometimes used in skin lightening creams and as antiseptic creams and ointments.

What happens to mercury when it enters the environment?

- Inorganic mercury (metallic mercury and inorganic mercury compounds) enters the air from mining ore deposits, burning coal and waste, and from manufacturing plants.
- It enters the water or soil from natural deposits, disposal of wastes, and volcanic activity.
- Methylmercury may be formed in water and soil by small organisms called bacteria.
- Methylmercury builds up in the tissues of fish. Larger and older fish tend to have the highest levels of mercury.

How might I be exposed to mercury?

- Eating fish or shellfish contaminated with methylmercury.
- Breathing vapors in air from spills, incinerators, and industries that burn mercury-containing fossil fuels.
- Release of mercury from dental work and medical treatments.
- Breathing contaminated workplace air or skin contact during use in the workplace.
- Practicing rituals that include mercury.

How can mercury affect my health?

The nervous system is very sensitive to all forms of mercury. Methylmercury and metallic mercury vapors are more harmful than other forms, because more mercury in these forms reaches the brain. Exposure to high levels of metallic, inorganic, or organic mercury can permanently damage the brain, kidneys, and developing fetus. Effects on brain functioning may result in irritability, shyness, tremors, changes in vision or hearing, and memory problems.

Short-term exposure to high levels of metallic mercury vapors may cause effects including lung damage, nausea, vomiting, diarrhea, increases in blood pressure or heart rate, skin rashes, and eye irritation.

Mercury

CAS # 7439-97-6

How likely is mercury to cause cancer?

There are inadequate human cancer data available for all forms of mercury. Mercuric chloride has caused increases in several types of tumors in rats and mice, and methylmercury has caused kidney tumors in male mice. The EPA has determined that mercuric chloride and methylmercury are possible human carcinogens.

How can mercury affect children?

Very young children are more sensitive to mercury than adults. Mercury in the mother's body passes to the fetus and may accumulate there, possibly causing damage to the developing nervous system. It can also pass to a nursing infant through breast milk. However, the benefits of breast feeding may be greater than the possible adverse effects of mercury in breast milk.

Mercury's harmful effects that may affect the fetus include brain damage, mental retardation, incoordination, blindness, seizures, and inability to speak. Children poisoned by mercury may develop problems of their nervous and digestive systems, and kidney damage.

How can families reduce the risk of exposure to mercury?

Carefully handle and dispose of products that contain mercury, such as thermometers or fluorescent light bulbs. Do not vacuum up spilled mercury, because it will vaporize and increase exposure. If a large amount of mercury has been spilled, contact your health department. Teach children not to play with shiny, silver liquids.

Properly dispose of older medicines that contain mercury. Keep all mercury-containing medicines away from children.

Pregnant women and children should keep away from rooms where liquid mercury has been used.

Learn about wildlife and fish advisories in your area from your public health or natural resources department.

Is there a medical test to determine whether I've been exposed to mercury?

Tests are available to measure mercury levels in the body. Blood or urine samples are used to test for exposure to metallic mercury and to inorganic forms of mercury. Mercury in whole blood or in scalp hair is measured to determine exposure to methylmercury. Your doctor can take samples and send them to a testing laboratory.

Has the federal government made recommendations to protect human health?

The EPA has set a limit of 2 parts of mercury per billion parts of drinking water (2 ppb).

The Food and Drug Administration (FDA) has set a maximum permissible level of 1 part of methylmercury in a million parts of seafood (1 ppm).

The Occupational Safety and Health Administration (OSHA) has set limits of 0.1 milligram of organic mercury per cubic meter of workplace air (0.1 mg/m^3) and 0.05 mg/m^3 of metallic mercury vapor for 8-hour shifts and 40-hour work weeks.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 1999. Toxicological profile for mercury. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Where can I get more information?

For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology and Human Health Sciences, 1600 Clifton Road NE, Mailstop F-57, Atlanta, GA 30329-4027.

Phone: 1-800-232-4636.

ToxFAQs^{TM} Internet address via WWW is http://www.atsdr.cdc.gov/toxfaqs/index.asp.

ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

Polycyclic Aromatic Hydrocarbons (PAHs) - ToxFAQs™

This fact sheet answers the most frequently asked health questions (FAQs) about polycyclic aromatic hydrocarbons (PAHs). For more information, call the CDC Information Center at 1-800-232-4636. This fact sheet is one in a series of summaries about hazardous substances and their health effects. This information is important because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Exposure to polycyclic aromatic hydrocarbons usually occurs by breathing air contaminated by wild fires or coal tar, or by eating foods that have been grilled. PAHs have been found in at least 600 of the 1,430 National Priorities List (NPL) sites identified by the Environmental Protection Agency (EPA).

What are polycyclic aromatic hydrocarbons?

(Pronounced pŏl′ĭ-sī′klĭk ăr′ə-măt′ĭk hī′drə-kar′bənz)

Polycyclic aromatic hydrocarbons (PAHs) are a group of over 100 different chemicals that are formed during the incomplete burning of coal, oil and gas, garbage, or other organic substances like tobacco or charbroiled meat. PAHs are usually found as a mixture containing two or more of these compounds, such as soot.

Some PAHs are manufactured. These pure PAHs usually exist as colorless, white, or pale yellow-green solids. PAHs are found in coal tar, crude oil, creosote, and roofing tar, but a few are used in medicines or to make dyes, plastics, and pesticides.

What happens to PAHs when they enter the environment?

- PAHs enter the air mostly as releases from volcanoes, forest fires, burning coal, and automobile exhaust.
- PAHs can occur in air attached to dust particles.
- Some PAH particles can readily evaporate into the air from soil or surface waters.
- PAHs can break down by reacting with sunlight and other chemicals in the air, over a period of days to weeks.
- PAHs enter water through discharges from industrial and wastewater treatment plants.
- Most PAHs do not dissolve easily in water. They stick to solid particles and settle to the bottoms of lakes or rivers.
- Microorganisms can break down PAHs in soil or water after a period of weeks to months.
- In soils, PAHs are most likely to stick tightly to particles; certain PAHs move through soil to contaminate underground water.
- PAH contents of plants and animals may be much higher than PAH contents of soil or water in which they live.

How might I be exposed to PAHs?

- Breathing air containing PAHs in the workplace of coking, coal-tar, and asphalt production plants; smokehouses; and municipal trash incineration facilities.
- Breathing air containing PAHs from cigarette smoke, wood smoke, vehicle exhausts, asphalt roads, or agricultural burn smoke.
- Coming in contact with air, water, or soil near hazardous waste sites.
- Eating grilled or charred meats; contaminated cereals, flour, bread, vegetables, fruits, meats; and processed or pickled foods.
- Drinking contaminated water or cow's milk.
- Nursing infants of mothers living near hazardous waste sites may be exposed to PAHs through their mother's milk.

Polycyclic Aromatic Hydrocarbons

How can PAHs affect my health?

Mice that were fed high levels of one PAH during pregnancy had difficulty reproducing and so did their offspring. These offspring also had higher rates of birth defects and lower body weights. It is not known whether these effects occur in people.

Animal studies have also shown that PAHs can cause harmful effects on the skin, body fluids, and ability to fight disease after both short- and long-term exposure. But these effects have not been seen in people.

How likely are PAHs to cause cancer?

The Department of Health and Human Services (DHHS) has determined that some PAHs may reasonably be expected to be carcinogens.

Some people who have breathed or touched mixtures of PAHs and other chemicals for long periods of time have developed cancer. Some PAHs have caused cancer in laboratory animals when they breathed air containing them (lung cancer), ingested them in food (stomach cancer), or had them applied to their skin (skin cancer).

Is there a medical test to show whether I've been exposed to PAHs?

In the body, PAHs are changed into chemicals that can attach to substances within the body. There are special tests that can detect PAHs attached to these substances in body tissues or blood. However, these tests cannot tell whether any health effects will occur or find out the extent or source of your exposure to the PAHs. The tests aren't usually available in your doctor's office because special equipment is needed to conduct them.

Has the federal government made recommendations to protect human health?

The Occupational Safety and Health Administration (OSHA) has set a limit of 0.2 milligrams of PAHs per cubic meter of air (0.2 mg/m^3). The OSHA Permissible Exposure Limit (PEL) for mineral oil mist that contains PAHs is 5 mg/m^3 averaged over an 8-hour exposure period.

The National Institute for Occupational Safety and Health (NIOSH) recommends that the average workplace air levels for coal tar products not exceed 0.1 mg/m^3 for a 10-hour workday, within a 40-hour workweek. There are other limits for workplace exposure for things that contain PAHs, such as coal, coal tar, and mineral oil.

Glossary

Carcinogen: A substance that can cause cancer.

Ingest: Take food or drink into your body.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 1995. Toxicological profile for polycyclic aromatic hydrocarbons. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Where can I get more information?

For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology and Human Health Sciences, 1600 Clifton Road NE, Mailstop F-57, Atlanta, GA 30329-4027.

Phone: 1-800-232-4636.

ToxFAQs™ Internet address via WWW is http://www.atsdr.cdc.gov/toxfaqs/index.asp.

ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

NJ Health
New Jersey Department of Health

Right to Know

Hazardous Substance Fact Sheet

Common Name: **1,1,2-TRICHLORO-1, 2, 2-TRIFLUOROETHANE**

Synonyms: Freon®113; Genetron®113
Chemical Name: Ethane, 1,1,2-Trichloro-1,2,2,-Trifluoro-
Date: June 2000 Revision: March 2010

CAS Number: 76-13-1
RTK Substance Number: 1904
DOT Number: None

Description and Use

1,1,2-Trichloro-1,2,2-Trifluoroethane is a colorless liquid with a faint, sweet or *Ether*-like odor at high concentrations. It is used as a refrigerant, heat transfer medium, solvent and chemical intermediate.

- **ODOR THRESHOLD = 45 ppm**
- Odor thresholds vary greatly. Do not rely on odor alone to determine potentially hazardous exposures.

Reasons for Citation

- **1,1,2-Trichloro-1,2,2-Trifluoroethane** is on the Right to Know Hazardous Substance List because it is cited by OSHA, ACGIH, NIOSH, DEP, IRIS and EPA.

SEE GLOSSARY ON PAGE 5.

FIRST AID

Eye Contact

- Immediately flush with large amounts of water for at least 15 minutes, lifting upper and lower lids. Remove contact lenses, if worn, while rinsing.

Skin Contact

- Quickly remove contaminated clothing. Immediately wash contaminated skin with large amounts of soap and water.
- Immerse affected part in warm water. Seek medical attention.

Inhalation

- Remove the person from exposure.
- Begin rescue breathing (using universal precautions) if breathing has stopped and CPR if heart action has stopped.
- Transfer promptly to a medical facility.
- Medical observation is recommended for 24 to 48 hours after overexposure, as pulmonary edema may be delayed.

EMERGENCY NUMBERS

Poison Control: 1-800-222-1222
CHEMTREC: 1-800-424-9300
NJDEP Hotline: 1-877-927-6337
National Response Center: 1-800-424-8802

EMERGENCY RESPONDERS >>>> SEE LAST PAGE

Hazard Summary

Hazard Rating	NJDOH	NFPA
HEALTH	2	-
FLAMMABILITY	0	-
REACTIVITY	0	-
DOES NOT BURN POISONOUS GASES ARE PRODUCED IN FIRE		

Hazard Rating Key: 0=minimal; 1=slight; 2=moderate; 3=serious; 4=severe

- **1,1,2-Trichloro-1,2,2-Trifluoroethane** can affect you when inhaled.
- Contact can irritate and burn the skin and cause frostbite. Prolonged or repeated contact can cause a skin rash, dryness and redness.
- Exposure to **1,1,2-Trichloro-1,2,2-Trifluoroethane** can irritate the eyes, nose and throat.
- Inhaling **1,1,2-Trichloro-1,2,2-Trifluoroethane** can irritate the lungs. Higher exposures may cause a build-up of fluid in the lungs (pulmonary edema), a medical emergency.
- **1,1,2-Trichloro-1,2,2-Trifluoroethane** can cause headache, dizziness, lightheadedness and passing out. Exposure to very high levels can cause trouble breathing, collapse, and even death.
- Higher exposure may affect the heartbeat causing irregular rhythms (arrhythmia).
- **1,1,2-Trichloro-1,2,2-Trifluoroethane** may affect the liver.

Workplace Exposure Limits

OSHA: The legal airborne permissible exposure limit (PEL) is **1,000 ppm** averaged over an 8-hour workshift.

NIOSH: The recommended airborne exposure limit (REL) is **1,000 ppm** averaged over a 10-hour workshift and **1,250 ppm**, not to be exceeded during any 15-minute work period.

ACGIH: The threshold limit value (TLV) is **1,000 ppm** averaged over an 8-hour workshift and **1,250 ppm** as a STEL (short-term exposure limit).

Determining Your Exposure

- Read the product manufacturer's Material Safety Data Sheet (MSDS) and the label to determine product ingredients and important safety and health information about the product mixture.
- For each individual hazardous ingredient, read the New Jersey Department of Health Hazardous Substance Fact Sheet, available on the RTK website (www.nj.gov/health/eoh/rtkweb) or in your facility's RTK Central File or Hazard Communication Standard file.
- You have a right to this information under the New Jersey Worker and Community Right to Know Act and the Public Employees Occupational Safety and Health (PEOSH) Act if you are a public worker in New Jersey, and under the federal Occupational Safety and Health Act (OSHA) if you are a private worker.
- The New Jersey Right to Know Act requires most employers to label chemicals in the workplace and requires public employers to provide their employees with information concerning chemical hazards and controls. The federal OSHA Hazard Communication Standard (29 CFR 1910.1200) and the PEOSH Hazard Communication Standard (N.J.A.C. 12:100-7) require employers to provide similar information and training to their employees.

This Fact Sheet is a summary of available information regarding the health hazards that may result from exposure. Duration of exposure, concentration of the substance and other factors will affect your susceptibility to any of the potential effects described below.

Health Hazard Information

Acute Health Effects

The following acute (short-term) health effects may occur immediately or shortly after exposure to **1,1,2-Trichloro-1,2,2-Trifluoroethane**:

- Contact can irritate and burn the skin and cause frostbite. Prolonged or repeated contact can cause a skin rash, dryness and redness.
- Exposure **1,1,2-Trichloro-1,2,2-Trifluoroethane** can irritate the eyes, nose and throat.
- Inhaling **1,1,2-Trichloro-1,2,2-Trifluoroethane** can irritate the lungs causing coughing and/or shortness of breath. Higher exposures may cause a build-up of fluid in the lungs (pulmonary edema), a medical emergency, with severe shortness of breath.
- **1,1,2-Trichloro-1,2,2-Trifluoroethane** can cause headache, dizziness, lightheadedness, fatigue, confusion, recent memory loss, convulsions and passing out. Exposure to very high levels can cause trouble breathing, collapse, and even death.
- Higher exposure may affect the heartbeat causing irregular rhythms (arrhythmia), which can be fatal.

Chronic Health Effects

The following chronic (long-term) health effects can occur at some time after exposure to **1,1,2-Trichloro-1,2,2-Trifluoroethane** and can last for months or years:

Cancer Hazard

- While **1,1,2-Trichloro-1,2,2-Trifluoroethane** has been tested, it is not classifiable as to its potential to cause cancer.

Reproductive Hazard

- There is no evidence that **1,1,2-Trichloro-1,2,2-Trifluoroethane** affects reproduction. This is based on test results presently available to the NJDOH from published studies.

Other Effects

- **1,1,2-Trichloro-1,2,2-Trifluoroethane** can irritate the lungs. Repeated exposure may cause bronchitis to develop with coughing, phlegm, and/or shortness of breath.
- **1,1,2-Trichloro-1,2,2-Trifluoroethane** may affect the liver.

Medical

Medical Testing

Before beginning employment and at regular times thereafter, (at least annually), the following are recommended:

- Liver function tests

If symptoms develop or overexposure is suspected, the following are recommended:

- Consider chest x-ray after acute overexposure
- Special 24-48 hours EKG (Holter monitor) to observe and record abnormal heart rhythms
- Neurological evaluation

Any evaluation should include a careful history of past and present symptoms with an exam. Medical tests that look for damage already done are not a substitute for controlling exposure.

Request copies of your medical testing. You have a legal right to this information under the OSHA Access to Employee Exposure and Medical Records Standard (29 CFR 1910.1020).

Mixed Exposures

- More than light alcohol consumption can cause liver damage. Drinking alcohol may increase the liver damage caused by **1,1,2-Trichloro-1,2,2-Trifluoroethane.**

Workplace Controls and Practices

Very toxic chemicals, or those that are reproductive hazards or sensitizers, require expert advice on control measures if a less toxic chemical cannot be substituted. Control measures include: (1) enclosing chemical processes for severely irritating and corrosive chemicals, (2) using local exhaust ventilation for chemicals that may be harmful with a single exposure, and (3) using general ventilation to control exposures to skin and eye irritants. For further information on workplace controls, consult the NIOSH document on Control Banding at www.cdc.gov/niosh/topics/ctrlbanding/.

The following work practices are also recommended:

- Label process containers.
- Provide employees with hazard information and training.
- Monitor airborne chemical concentrations.
- Use engineering controls if concentrations exceed recommended exposure levels.
- Provide eye wash fountains and emergency showers.
- Wash or shower if skin comes in contact with a hazardous material.
- Always wash at the end of the workshift.
- Change into clean clothing if clothing becomes contaminated.
- Do not take contaminated clothing home.
- Get special training to wash contaminated clothing.
- Do not eat, smoke, or drink in areas where chemicals are being handled, processed or stored.
- Wash hands carefully before eating, smoking, drinking, applying cosmetics or using the toilet.

In addition, the following may be useful or required:

- Before entering a confined space where **1,1,2-Trichloro-1,2,2-Trifluoroethane** is present, check to make sure sufficient *Oxygen* (19.5%) exists.

Personal Protective Equipment

The OSHA Personal Protective Equipment Standard (29 CFR 1910.132) requires employers to determine the appropriate personal protective equipment for each hazard and to train employees on how and when to use protective equipment.

The following recommendations are only guidelines and may not apply to every situation.

Gloves and Clothing

- Avoid skin contact with **1,1,2-Trichloro-1,2,2-Trifluoroethane**. Wear personal protective equipment made from material which can not be permeated or degraded by this substance. Safety equipment suppliers and manufacturers can provide recommendations on the most protective glove and clothing material for your operation.
- Safety equipment manufacturers recommend Butyl, Nitrile, Neoprene and Viton for gloves, and Tychem® CPF 3, BR, Responder®, and TK, or the equivalent, as protective materials for clothing.
- Where exposure to cold equipment, vapors, or liquid may occur, employees should be provided with *insulated* gloves and special clothing designed to prevent the freezing of body tissues.
- All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work.

Eye Protection

- Wear indirect-vent, impact and splash resistant goggles when working with liquids.
- If additional protection is needed for the entire face, use in combination with a face shield. A face shield should not be used without another type of eye protection.

Respiratory Protection

Improper use of respirators is dangerous. Respirators should only be used if the employer has implemented a written program that takes into account workplace conditions, requirements for worker training, respirator fit testing, and medical exams, as described in the OSHA Respiratory Protection Standard (29 CFR 1910.134).

- Where the potential exists for exposure over **1,000 ppm**, use a NIOSH approved supplied-air respirator with a full facepiece operated in a pressure-demand or other positive-pressure mode. For increased protection use in combination with an auxiliary self-contained breathing apparatus or an emergency escape air cylinder.
- Exposure to **2,000 ppm** is immediately dangerous to life and health. If the possibility of exposure above **2,000 ppm** exists, use a NIOSH approved self-contained breathing apparatus with a full facepiece operated in a pressure-demand or other positive-pressure mode equipped with an emergency escape air cylinder.

Fire Hazards

If employees are expected to fight fires, they must be trained and equipped as stated in the OSHA Fire Brigades Standard (29 CFR 1910.156).

- Extinguish fire using an agent suitable for type of surrounding fire. **1,1,2-Trichloro-1,2,2-Trifluoroethane** itself does not burn.
- POISONOUS GASES ARE PRODUCED IN FIRE, including *Hydrogen Chloride*, *Hydrogen Fluoride*, and *Phosgene*.
- Use water spray to keep fire-exposed containers cool.

Spills and Emergencies

If employees are required to clean-up spills, they must be properly trained and equipped. The OSHA Hazardous Waste Operations and Emergency Response Standard (29 CFR 1910.120) may apply.

If **1,1,2-Trichloro-1,2,2-Trifluoroethane** is spilled or leaked, take the following steps:

- Evacuate personnel and secure and control entrance to the area.
- Eliminate all ignition sources.
- Absorb liquids in dry sand, earth, or a similar material and place into sealed containers for disposal.
- Wash all contaminated surfaces with *Alcohol* followed by washing with a strong soap and water solution.
- Ventilate area of spill or leak.
- DO NOT wash into sewer.
- It may be necessary to contain and dispose of **1,1,2-Trichloro-1,2,2-Trifluoroethane** as a HAZARDOUS WASTE. Contact your state Department of Environmental Protection (DEP) or your regional office of the federal Environmental Protection Agency (EPA) for specific recommendations.

Handling and Storage

Prior to working with **1,1,2-Trichloro-1,2,2-Trifluoroethane** you should be trained on its proper handling and storage.

- **1,1,2-Trichloro-1,2,2-Trifluoroethane** may react violently with CHEMICALLY ACTIVE METALS (such as POTASSIUM, SODIUM, MAGNESIUM and ZINC) and their ALLOYS.
- Contact with STRONG ACIDS (such as HYDROCHLORIC, SULFURIC and NITRIC) releases toxic *Chlorine gas*.
- **1,1,2-Trichloro-1,2,2-Trifluoroethane** is not compatible with FINELY POWDERED METALS and OXIDIZING AGENTS (such as PERCHLORATES, PEROXIDES, PERMANGANATES, CHLORATES, NITRATES, CHLORINE, BROMINE and FLUORINE).
- Store in tightly closed containers in a cool, well-ventilated area away from SUNLIGHT.

Occupational Health Information Resources

The New Jersey Department of Health offers multiple services in occupational health. These services include providing informational resources, educational materials, public presentations, and industrial hygiene and medical investigations and evaluations.

For more information, please contact:

New Jersey Department of Health
Right to Know
PO Box 368
Trenton, NJ 08625-0368
Phone: 609-984-2202
Fax: 609-984-7407
E-mail: rtk@doh.state.nj.us
Web address: http://www.nj.gov/health/eoh/rtkweb

The Right to Know Hazardous Substance Fact Sheets are not intended to be copied and sold for commercial purposes.

GLOSSARY

ACGIH is the American Conference of Governmental Industrial Hygienists. They publish guidelines called Threshold Limit Values (TLVs) for exposure to workplace chemicals.

Acute Exposure Guideline Levels (AEGLs) are established by the EPA. They describe the risk to humans resulting from once-in-a lifetime, or rare, exposure to airborne chemicals.

Boiling point is the temperature at which a substance can change its physical state from a liquid to a gas.

A **carcinogen** is a substance that causes cancer.

The **CAS number** is unique, identifying number, assigned by the Chemical Abstracts Service, to a specific chemical.

CFR is the Code of Federal Regulations, which are the regulations of the United States government.

A **combustible** substance is a solid, liquid or gas that will burn.

A **corrosive** substance is a gas, liquid or solid that causes destruction of human skin or severe corrosion of containers.

The **critical temperature** is the temperature above which a gas cannot be liquefied, regardless of the pressure applied.

DEP is the New Jersey Department of Environmental Protection.

DOT is the Department of Transportation, the federal agency that regulates the transportation of chemicals.

EPA is the Environmental Protection Agency, the federal agency responsible for regulating environmental hazards.

ERG is the Emergency Response Guidebook. It is a guide for emergency responders for transportation emergencies involving hazardous substances.

Emergency Response Planning Guideline (ERPG) values provide estimates of concentration ranges where one reasonably might anticipate observing adverse effects.

A **fetus** is an unborn human or animal.

A **flammable** substance is a solid, liquid, vapor or gas that will ignite easily and burn rapidly.

The **flash point** is the temperature at which a liquid or solid gives off vapor that can form a flammable mixture with air.

IARC is the International Agency for Research on Cancer, a scientific group.

Ionization Potential is the amount of energy needed to remove an electron from an atom or molecule. It is measured in electron volts.

IRIS is the Integrated Risk Information System database on human health effects that may result from exposure to various chemicals, maintained by federal EPA.

LEL or **Lower Explosive Limit**, is the lowest concentration of a combustible substance (gas or vapor) in the air capable of continuing an explosion.

mg/m^3 means milligrams of a chemical in a cubic meter of air. It is a measure of concentration (weight/volume).

A **mutagen** is a substance that causes mutations. A **mutation** is a change in the genetic material in a body cell. Mutations can lead to birth defects, miscarriages, or cancer.

NFPA is the National Fire Protection Association. It classifies substances according to their fire and explosion hazard.

NIOSH is the National Institute for Occupational Safety and Health. It tests equipment, evaluates and approves respirators, conducts studies of workplace hazards, and proposes standards to OSHA.

NTP is the National Toxicology Program which tests chemicals and reviews evidence for cancer.

OSHA is the federal Occupational Safety and Health Administration, which adopts and enforces health and safety standards.

PEOSHA is the New Jersey Public Employees Occupational Safety and Health Act, which adopts and enforces health and safety standards in public workplaces.

Permeated is the movement of chemicals through protective materials.

ppm means parts of a substance per million parts of air. It is a measure of concentration by volume in air.

Protective Action Criteria (PAC) are values established by the Department of Energy and are based on AEGLs and ERPGs. They are used for emergency planning of chemical release events.

A **reactive** substance is a solid, liquid or gas that releases energy under certain conditions.

STEL is a Short Term Exposure Limit which is usually a 15-minute exposure that should not be exceeded at any time during a work day.

A **teratogen** is a substance that causes birth defects by damaging the fetus.

UEL or **Upper Explosive Limit** is the highest concentration in air above which there is too much fuel (gas or vapor) to begin a reaction or explosion.

Vapor Density is the ratio of the weight of a given volume of one gas to the weight of another (usually *Air*), at the same temperature and pressure.

The **vapor pressure** is a force exerted by the vapor in equilibrium with the solid or liquid phase of the same substance. The higher the vapor pressure the higher concentration of the substance in air.

NJ Health
New Jersey Department of Health

Right to Know Hazardous Substance Fact Sheet

Emergency Responders Quick Reference

Common Name: **1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE**

Synonyms: Freon®113; Genetron®113
CAS No: 76-13-1
Molecular Formula: $C_2Cl_3F_3$
RTK Substance No: 1904

Description: Colorless liquid with a faint, sweet or *Ether*-like odor at high concentrations

HAZARD DATA

Hazard Rating

2 - Health
0 - Fire
0 - Reactivity
DOT#: None
ERG Guide #: 171
Hazard Class: None

Firefighting

Extinguish fire using an agent suitable for type of surrounding fire. **1,1,2-Trichloro-1,2,2-Trifluoroethane** itself does not burn.

POISONOUS GASES ARE PRODUCED IN FIRE, including *Hydrogen Chloride*, *Hydrogen Fluoride*, and *Phosgene*.

Use water spray to keep fire-exposed containers cool.

Reactivity

1,1,2-Trichloro-1,2,2-Trifluoroethane may react violently with CHEMICALLY ACTIVE METALS (such as POTASSIUM, SODIUM, MAGNESIUM and ZINC) and their ALLOYS.

Contact with STRONG ACIDS (such as HYDROCHLORIC, SULFURIC and NITRIC) releases toxic *Chlorine gas*.

1,1,2-Trichloro-1,2,2-Trifluoroethane is not compatible with FINELY POWDERED METALS and OXIDIZING AGENTS (such as PERCHLORATES, PEROXIDES, PERMANGANATES, CHLORATES, NITRATES, CHLORINE, BROMINE and FLUORINE).

SPILL/LEAKS

Isolation Distance:

Spill: 50 meters (150 feet)
Fire: 800 meters (1/2 mile)

Absorb liquids in vermiculite, dry sand, earth, or a similar material and place into sealed containers for disposal.

Wash all contaminated surfaces with *alcohol* followed by washing with a strong soap and water solution.

DO NOT wash into sewer.

1,1,2-Trichloro-1,2,2-Trifluoroethane is toxic to aquatic life and impacts the ozone layer.

PHYSICAL PROPERTIES

Odor Threshold:	45 ppm
Flash Point:	Noncombustible
Auto Ignition Temp:	1,256°F (680°C)
Vapor Density:	6.5 (air = 1)
Vapor Pressure:	285 mm Hg at 68°F (20°C)
Specific Gravity:	1.57 (water = 1)
Water Solubility:	Insoluble
Boiling Point:	118°F (48°C)
Freezing Point:	-31°F (-35°C)
Ionization Potential:	11.99 eV
Molecular Weight:	187.4

EXPOSURE LIMITS

OSHA:	1,000 ppm, 8-hr TWA
NIOSH:	1,000 ppm, 10-hr TWA; 1,250 ppm STEL
ACGIH:	1,000 ppm, 8-hr TWA; 1,250 ppm STEL
IDLH:	2,000 ppm

The Protective Action Criteria values are:

PAC-1 = 1,250 ppm PAC-2 = 1,500 ppm
PAC-3 = 2,000 ppm

PROTECTIVE EQUIPMENT

Gloves:	Insulated Butyl, Nitrile, Neoprene and Viton (>8-hr breakthrough)
Coveralls:	Tychem® BR, Responder® and TK (>8-hr breakthrough)
Respirator:	>1,000 ppm - SCBA

HEALTH EFFECTS

Eyes:	Irritation
Skin:	Irritation, frostbite, burns, rash and redness
Inhalation:	Nose, throat and lung irritation, with coughing, and severe shortness of breath (pulmonary edema) Headache, dizziness, confusion, recent memory loss, convulsions, and passing out. Very high levels can cause trouble breathing, irregular heart rhythms collapse and even death.

FIRST AID AND DECONTAMINATION

Remove the person from exposure.

Flush eyes with large amounts of water for at least 15 minutes. Remove contact lenses if worn.

Quickly remove contaminated clothing and wash contaminated skin with large amounts of soap and water.

Immerse affected part in warm water. Seek medical attention.

Transfer promptly to a medical facility.

Medical observation is recommended as symptoms may be delayed.

March 2010

APPENDIX B

COLD STRESS PROGRAM

1.0 PURPOSE & INTRODUCTION

The purpose of this document is to educate Site personnel about exposure to cold environments and the effects of hypothermia and other cold-related injuries. Through proper use of personal protective equipment (PPE), engineering and administrative controls, and education, cold injury—both to the extremities and the body's core temperature—can be prevented.

2.0 SCOPE

The program described herein is intended for use by employees engaged in work with the potential for exposure to cold environments. Training will be provided annually to all those potentially affected prior to the start of field work potentially involving cold exposure.

3.0 WORKING IN COLD ENVIRONMENTS

3.1 Metabolic Responses

The human body is designed to function best at a rectal temperature of 99-100 ºF. The body maintains this temperature in two ways: by gaining heat from food and muscular work; or, by losing it through radiation and sweating. By constricting blood vessels of the skin and/or shivering, the body uses its first line of cold defense.

Temperature control of the body is better understood by dividing the body into two main parts: the shell and the core. The shell is comprised of the skin, capillaries, nerves, muscles, and fat. Other internal organs such as the heart, lungs, brain, and kidneys make up the core.

During exposure to cold, the skin is first affected. Blood in the peripheral capillaries is cooled, sending a signal to a portion of the brain called the hypothalamus. Regulating body temperature is one of the many basic body functions of the hypothalamus. Acting like a thermostat, adjustments are performed to maintain normal body temperatures. When a chill signal is received, two processes are begun by the hypothalamus: conserve heat already in the body and generate new heat.

Heat conservation is performed through constriction of the blood vessels in the skin (shell), thus reducing heat loss from the shell and acting as an insulator for the core. Sweat glands are also inhibited, thus preventing heat loss by evaporation.

Additional fuel for the body is provided in the form of glucose. Glucose causes the heart to beat faster, sending oxygen and glucose-rich blood to the tissue where needed. In an attempt to produce heat, the muscles rapidly contract. This process is better known as "shivering," and generates heat similarly to that created by strenuous activity, raising the body's metabolic rate.

During physical activity and fatigue, the body is more prone to heat loss. As exhaustion approaches, blood vessels can suddenly enlarge, resulting in rapid loss of heat. Exposure to extreme cold causes nerve pulses to be slowed, resulting in fumbling, sluggish, and clumsy reactions.

4.0 COLD INJURIES

Cold injuries are classified into two categories: local and general. Local injuries include frostbite, frostnip, chilblain, and trenchfoot. General injuries include hypothermia and blood vessel abnormalities (genetically or chemically induced). Factors contributing to cold injury include: exposure to humidity and high winds;

contact with wetness or metal; inadequate clothing; age; and general health. Allergies, vascular disease, excessive smoking and/or drinking, and certain drugs and medicines are physical conditions that can compound the effects of exposure to a cold environment.

4.1 Hypothermia

Hypothermia is a condition of reduced body temperature. Most cases develop in air temperatures between 30-50 °F, not taking wind-chill factor in consideration.

Symptoms of hypothermia are uncontrolled shivering and the sensation of cold. The heartbeat slows and sometimes becomes irregular, weakening the pulse and changing blood pressure. Changes in the body chemistry cause severe shaking or rigid muscles; vague or slow slurred speech; memory lapses; incoherence; and drowsiness. Cool skin, slow irregular breathing, low blood pressure, apparent exhaustion, and fatigue after rest can be seen before complete collapse.

As the core temperature drops, the victim can become listless, confused, and make little or no effort to keep warm. Pain in the extremities can be the first warning of dangerous exposure to cold. Severe shivering must be taken as a sign of danger. At a core body temperature of about 85 °F, serious problems develop due to significant drops in blood pressure, pulse rate, and respiration. In some cases, the victim may die.

Sedative drugs and alcohol increase the risk of hypothermia. Sedative drugs interfere with the transmission of impulses to the brain. Alcohol dilates blood vessels near the skin's surface, increasing heat loss and lowering body temperature.

Table B1 provides information on the onset of hypothermia and metabolic responses at different body temperatures.

4.2 Raynaud's Phenomenon

Raynaud's Phenomenon is the abnormal constriction of the blood vessels of the fingers on exposure to cold temperatures, resulting in blanching of the ends of the fingers. Numbness, itching, tingling, or a burning sensation may occur during related attacks. The disease is also associated with the use of vibrating hand tools in a condition sometimes called White Finger Disease. Persistent cold sensitivity, ulceration, and amputations can occur in severe cases.

4.3 Acrocyanosis

Acrocyanosis is caused by exposure to the cold and reduces the level of hemoglobin in the blood, resulting in a slightly blue, purple, or gray coloring of the hands and/or feet.

4.4 Thromboangitis Obliterans

Thromboangitis obliterans is clotting of the arteries due to inflammation and fibrosis of connective tissue surrounding medium-sized arteries and veins. This is one of the many disabling diseases that can also result from tobacco use. Gangrene of the affected limb often requires amputation.

4.5 Frostbite

Frostbite is the freezing of the body tissues due to exposure to extremely low temperatures, resulting in damage to and loss of tissue. Frostbite occurs because of inadequate circulation and/or insulation, resulting in freezing of fluids around the cells of the body tissues. Most vulnerable parts of the body are the nose, cheeks, ears, fingers, and toes.

Frostbite can affect outer layers of skin or can include the tissues beneath. Damage can be serious, with permanent loss of movement in the affected parts, scarring, necrotic tissue, and amputation all possibilities. Skin and nails that slough off can grow back.

The freezing point of the skin is about 30 °F. As wind velocity increases, heat loss is greater and frostbite will set in more rapidly.

There are three degrees of frostbite: first degree, freezing without blistering and peeling; second degree, freezing with blistering and peeling; and third degree, freezing with death of skin tissues and possibly the deeper tissues.

The following are symptoms of frostbite:

1. Skin changes color to white or grayish-yellow, progresses to reddish-violet, and finally turns black as the tissue dies;
2. Pain may be felt at first, but subsides;
3. Blisters may appear; and
4. Affected part is cold and numb.

The first symptom of frostbite is usually an uncomfortable sensation of coldness followed by numbness. Tingling, stinging, cramping, and aching feelings will be experienced by the victim. Frostbite of the outer layer of the skin has a waxy or whitish look and is firm to the touch. Cases of deep frostbite cause severe injury. The tissues are cold, pale, and solid. The victim is often unaware of the frostbite until someone else observes these symptoms. It is therefore important to use the "buddy system" when working in cold environments, so that any symptoms of overexposure can be noted.

Table B2 describes the cooling power of wind on exposed flesh. This information can be used as a guide for determining equivalent chill temperatures when the wind is present in cold environments.

4.6 Trench Foot and Chilblains

Trench foot is swelling of the foot caused by long, continuous exposure to cold without freezing, combined with persistent dampness or immersion in water. Edema (swelling), tingling, itching and severe pain occurs, followed by blistering, necrotic tissue, and ulcerations. Chilblains have similar symptoms as trench foot, except that other areas of the body are affected.

4.7 Frostnip

Frostnip occurs when the face or extremities are exposed to a cold wind, causing the skin to turn white.

5.0 PREVENTION OF COLD STRESS

Cold stress can be prevented through a combination of various factors: acclimation; water and salt displacement; medical screening; proper clothing selection; and training and education. Through the use of engineering controls, work practices, work/rest schedules, environmental monitoring, and consideration of the wind-chill temperature, the employee can be protected.

5.1 Acclimation

Acclimation can be achieved to some degree. Sufficient exposure to cold causes the body to undergo changes to increase comfort and reduce the risk of injury. However, these changes are minor and require repeated exposure to cold and uncomfortable temperatures to induce them.

5.2 Dehydration

The dryness of cold air causes the body to lose a significant amount of water through the skin and lungs. It is essential that caffeine-free, non-alcoholic beverages be available at the worksite for fluid replacement. Dehydration also increases the risk of injury due to cold and affects blood flow to the extremities.

5.3 Diet

A well-balanced diet is important for employees working in cold environments. Diets restricted only to certain foods may not provide the necessary elements for the body to withstand cold stress, leaving the worker vulnerable.

5.4 Control Measures

When the wind chill factor results in an equivalent temperature of -26 °F, continuous exposure of the skin will not be permitted. Any worker exposed to temperatures of 36 °F or less who becomes immersed in water will be given dry clothing immediately and treated for hypothermia at the local hospital if any symptoms of hyperthermia are present. Notification of this incident will be provided to the Health and Safety Division immediately after sending the worker to the hospital.

5.5 Environmental Controls

The following are some ways that environmental controls can be used to reduce the effects of a cold environment:

1. General or spot heating should be used to increase temperature in certain areas in the workplace;
2. Warm air jets, radiant heaters, or contact warm plates can be used to warm the worker’s hands if fine work is to be performed with bare hands for 10 to 20 minutes or more;
3. Shield the work area if air velocity at the worksite is increased by wind, draft, or ventilating equipment;
4. Metal handles of tools and control bars should be covered with thermal insulating material at temperatures below 30 °F;
5. Unprotected metal chair seats will not be used in cold environments;
6. When appropriate and feasible, equipment and processes will be substituted, isolated, relocated, or redesigned;
7. Power tools, hoists, cranes, or lifting aids will be used to reduce the metabolic workload;
8. Heated warming shelters will be made available for continuous work being performed in an equivalent temperature of 20 °F or below and workers will be encouraged to use the shelters regularly; and
9. Administrative work practice controls should be implemented.

Work practices and guidelines can be designed and developed to reduce exposure to cold stress. Some of these may include:

1. Create work-rest schedules to reduce the peak of cold stress;
2. Enforce scheduled breaks;
3. Enforce intake of caffeine-free, non-alcoholic beverages;

4. Schedule work that has potential exposure to cold stress for the warmest part of the day;
5. Move work to warmer areas, whenever possible;
6. Assign extra workers for high-demand tasks;
7. Provide relief workers for other workers needing breaks;
8. Teach basic principles of recognizing and preventing cold stress;
9. Use the buddy system for work at 10 °F or below, and keep within eyeshot;
10. Allow new employees to adjust to the conditions before they work full-time in cold environments;
11. Minimize sitting and standing in one place for long periods of time; and
12. Include weight and bulkiness of clothing when estimating work performance requirements and weights to be lifted;

Table B3 provides a work/warm-up schedule for cold environments, with wind chill taken into account.

5.6 Special Considerations

Older workers and workers with circulatory problems should be extra careful in cold environments. Sufficient sleep and good nutrition are important preventive measures for maintenance tolerance to the cold. Double shifts and overtime work should be avoided when working in cold environments.

If any of the following symptoms are observed on-site, the affected worker will immediately go to warm shelter:

- Onset of heavy shivering;
- Frostnip;
- Feeling of excessive fatigue;
- Drowsiness; and
- Euphoria.

After entering the warm shelter, the outer layer of clothing should be removed. If the clothing is wet from sweat and perspiration, dry clothing should be provided. If this is not feasible, then the clothing should be loosened to allow sweat to evaporate.

Anyone working in cold environments and on prescribed medication should consult their physician concerning any possible side effects due to cold stress. Those individuals suffering from diseases and/or taking medication that interferes with normal body temperature regulation or reduces the tolerance to cold will not be allowed to work in temperatures of 30 °F or below.

6.0 PERSONAL PROTECTIVE EQUIPMENT (PPE)

In choosing PPE for cold environments, it is important to maintain airspace between the body and outer layer of clothing to retain body heat. The more air pockets, the better the insulation. The clothing should also allow for the evaporation of sweat if the skin is wet.

The most important parts of the body to protect are the feet, hands, head, and face. Hands and feet become cooled most easily, because of their distance from the heart. Keeping the head covered is equally important. As much as 40% of body heat loss is through the head when it is exposed.

Ideal clothing for exposure to cold environments is made of wool, polypropylene, or other wicking fabrics. Loose-fitted clothing also aids in sweat evaporation. Recommended clothing may include the following:

1. Polypropylene under shirt and shorts under thermal underwear (preferably two-piece);
2. Wool socks;
3. Wool or thermal pants, lapped over boot tops to keep out snow and water;
4. Suspenders (belts can constrict and reduce circulation);
5. Insulated work boots, preferably waterproof. Safety toe, if necessary;
6. Wool or cotton shirt;
7. Parka;
8. Knit cap/hard hat liner;
9. Wool mittens or gloves (depending on the dexterity required); and
10. Face mask or scarf.

Dirty or greasy clothing loses much of its insulation value. Dirty clothing crushes air pockets, allowing air to escape more easily. Also, denim is not a good protective fabric. It is loosely woven and allows water to penetrate and wind to blow away body heat.

Table B1
Progressive Clinical Presentation of Hypothermia

Core Temperature		**Clinical Signs**
°C	**°F**	
37.6	99.6	“Normal” Rectal Temperature
37	98.6	“Normal” Oral Temperature
36	96.8	Metabolic rate increases in an attempt to compensate for heat loss
35	95.0	Maximum shivering
34	93.2	Victim conscious and responsive, with normal blood pressure
33	91.4	Severe hypothermia below this temperature
32	89.6	Consciousness clouded, blood pressure becomes difficult to obtain, pupils dilated but react to light, shivering ceases
31	87.8	
30	86.0	Progressive loss of consciousness, muscular rigidity increases, pulse and blood pressure difficult to obtain, respiratory rate decreases
29	84.2	
28	82.4	Ventricular fibrillation possible with myocardial irritability

Table B1
Progressive Clinical Presentation of Hypothermia

Core Temperature		Clinical Signs
°C	°F	
27	80.6	Voluntary motion ceases, pupils non-reactive to light, deep tendon and superficial reflexes absent
26	78.8	
25	77.0	Ventricular fibrillation may occur spontaneously
24	75.2	Pulmonary edema
22	71.6	Maximum risk of ventricular fibrillation
20	68.0	Cardiac standstill
18	64.4	Lowest accidental hypothermia victim to recover
17	62.6	Isoelectric electroencephalogram
9	48.2	Lowest artificially cooled hypothermia patient to recover
Presentations approximately related to core temperature. Reprinted from the January 1982 issue of American Family Physician, published by the American Academy of Family Physicians.		

Table B2
Cooling Power of Wind on Exposed Flesh as Equivalent Temperature

Estimated Wind Speed (mph)	Actual Temperature Reading (Degrees Fahrenheit)											
	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
	Equivalent Chill Temperature (°F)											
Calm	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
5	48	37	27	16	6	-5	-15	-26	-36	-47	-57	-68
10	40	28	16	4	-9	-24	-33	-46	-58	-70	-83	-95
15	36	22	9	-5	-18	-32	-45	-58	-72	-85	-99	-112
20	32	18	4	-10	-25	-39	-53	-67	-82	-96	-110	-121
25	30	16	0	-15	-29	-44	-59	-74	-88	-104	-118	-133
30	28	13	-2	-18	-33	-48	-63	-79	-94	-109	-125	-140
35	27	11	-4	-20	-35	-51	-67	-82	-98	-113	-129	-145
40	26	10	-6	-21	-37	-53	-69	-85	-100	-116	-132	-148
	LITTLE DANGER In < hr with dry skin. Maximum danger of false sense of security.				INCREASING DANGER Danger from freezing of exposed flesh within one minute.			GREAT DANGER Flesh may freeze within 30 seconds.				
Developed by the U.S. Army Research Institute of Environmental Medicine, Natick, MA. Wind speeds greater than 40 mph have little additional effect. Trenchfoot and immersion foot may occur at any point.												

Table B3
Threshold Limit Values Work/Warm-up Schedule for 4-Hour Shift

Air Temp. Sunny Sky		No Noticeable Wind		5 mph Wind		10 mph Wind		15 mph Wind		20 mph Wind	
˚C (approx)	˚F (approx)	Max. Work Period	No. of Breaks	Max. Work Period	No. of Breaks	Max. Work Period	No. of Breaks	Max. Work Period	No. of Breaks	Max. Work Period	No. of Breaks
-26° to -28°	-15° to -19°	(Norm. Breaks)	1	(Norm.Breaks)	1	75 min.	2	55 min.	3	40 min.	4
-29° to -31°	-20° to -24°	(Norm. Breaks)	1	75 min	2	55 min.	3	40 min.	4	30 min.	5
-32° to -34°	-25° to -29°	75 min	2	55 min.	3	40 min.	4	30 min.	5	Non-emergency work should cease	
-35° to -37°	-30° to -34°	55 min.	3	40 min.	4	30 min.	5	Non-emergency work should cease			
-38° to -39°	-35° to -39°	40 min.	4	30 min.	5	Non-emergency work should cease					
-40° to -42°	-40° to -44°	30 min.	5	Non-emergency work should cease							
-43° & below	-45° & below	Non-emergency work should cease									

Notes:

Schedule applies to moderate to heavy work activity with warm-up breaks of 10 minutes in a warm location. For light to moderate work (limited physical motion), apply the schedule one step lower. For example, at -30 °F with no noticeable wind (step 4, a worker at a job with little physical movement should have a maximum work period of 40 minutes with 4 breaks in a 4-hour period.

The following is suggested as a guide for estimating wind velocity if accurate information is not available: 5 mph, light flag moves; 10 mph, light flag fully extended; 15 mph, raises newspaper sheet; 20 mph, blowing drifting snow.

If only the wind chill cooling rate is available, a rough rule of thumb for applying it rather than the temperature and wind velocity factors given above would be: 1) special warm-up breaks should be initiated at a wind-chill cooling rate of about 17 watts per square meter (W/m^2); 2) all non-emergency work should have ceased at or before a wind-chill of 2250 W/m^2. In general, the warm-up schedule provided above slightly under-compensates for the wind at the warmer temperatures, assuming acclimatization and clothing appropriate for winter work. On the other hand, the chart over-compensates for the actual temperatures in the colder ranges, since windy conditions prevail at extremely low temperatures.

Threshold limit values (TLVs) apply only for workers in dry clothing.

Adapted from Occupational Health and Safety Division, Saskatchewan Department of Labor.

APPENDIX C

HEAT STRESS PROGRAM

1.0 INTRODUCTION

Heat stress is one of the most common (and potentially serious) illnesses at job sites. Although it is caused by a number of interacting factors, donning the proper personal protective equipment (PPE) puts the worker at a much higher risk during warmer environmental conditions. The results of heat stress range from fatigue to serious illness or death. Through regular fluid replacement and other preventive measures, heat stress can be controlled, leading to increased efficiency and a higher level of safety on the job.

2.0 PURPOSE

The purpose of this document is to create an awareness among employees concerning the body's physiologic responses to heat, different types of heat stress that can affect the body, recognition of signs and symptoms, first aid treatment, and preventive measures.

3.0 SOURCES OF HEAT

There are two sources of heat that are important to anyone working in a hot environment:

- Internally generated metabolic heat; and
- Externally imposed environmental heat.

4.0 PHYSIOLOGIC RESPONSES TO HEAT

The human body maintains a fairly constant internal temperature, even though it is exposed to varying environmental temperatures. To keep internal body temperatures within safe limits, the body must get rid of its excess heat, primarily through varying the rate and amount of blood circulation through the skin and the release of fluid onto the skin by the sweat glands. These automatic responses usually occur when the temperature of the blood exceeds 98.6 °F and are kept in balance and controlled by the brain. In this process of lowering internal body temperature, the heart begins to pump more blood, blood vessels expand to accommodate the increased flow, and the microscopic blood vessels (capillaries) which thread through the upper layers of the skin begin to fill with blood. The blood circulates closer to the surface of the skin, and the excess heat is lost to the cooler environment.

If the heat loss from increased blood circulation through the skin is not adequate, the brain continues to sense overheating and signals the sweat glands in the skin to release large quantities of sweat onto the skin surface. Evaporation of sweat cools the skin, eliminating large quantities of heat from the body.

As environmental temperatures approach normal skin temperature, cooling of the body becomes more difficult. If air temperature is as warm as or warmer than the skin, blood brought to the body surface cannot lose its heat. Under these conditions, the heart continues to pump blood to the body surface, the sweat gland pour liquids containing electrolytes onto the surface of the skin, and the evaporation of the sweat becomes the principal effective means of maintaining a constant body temperature. Sweating does not cool the body unless the moisture is removed from the skin by evaporation. In high humidity, the evaporation of sweat from the skin is decreased and the body's efforts to maintain an acceptable body temperature may be significantly impaired. These conditions adversely affect an individual's ability to work in the hot environment. With so much blood going to the external surface of the body, relatively less goes to the active muscles, the brain, and other internal organs; strength declines; and fatigue occurs sooner than it would otherwise. Alertness and mental capacity also may be affected. Workers who must perform delicate or detailed work may find their accuracy suffering, and others may find their comprehension and retention of information lowered.

When temperature differences exist between two or more bodies, heat can be transferred. Net heat transfer is always from the body (or object) of higher temperature to that of lower temperature and occurs by one or more of the following mechanisms:

- Conduction: The transfer of heat from one point to another within the body, or from one body to another when both bodies are in physical contact. Conduction can be a localized source of discomfort from direct physical contact with a hot or cold surface; it is normally not a significant factor to total heat stress.
- Convection: The transfer of heat from one place to another by moving gas or liquid. Natural convection results from differences in density caused by temperature differences. Thus, warm air is less dense than cool air.
- Radiation: The process by which energy, electromagnetic (visible and infrared), is transmitted through space without the presence or movement of matter in or through this space.

5.0 PREDISPOSING FACTORS TO HEAT STRESS

Factors that may predispose an individual to heat stress vary according to the individual. These factors include:

- Lack of physical fitness;
- Lack of acclimatization;
- Age;
- Dehydration;
- Obesity;
- Drug/alcohol abuse;
- Infection;
- Sunburn;
- Diarrhea; and
- Chronic disease.

Predisposing factors and an increased risk of excessive heat stress are both directly influenced by the type and amount of PPE worn. PPE adds weight and bulk, reduces the body's access to normal heat exchange mechanisms (evaporation, convection, and radiation), and increases energy expenditure.

6.0 FORMS OF HEAT STRESS AND FIRST AID

The following excerpts were taken from National Institute for Occupational Safety and Health (NIOSH) Publication No. 86-112, Working in Hot Environments:

"Excessive exposure to a hot work environment can bring about a variety of heat-induced disorders. Among the most common are heat stroke, heat exhaustion, heat cramps, fainting and heat rash.

6.1 Heat Stroke

Heat Stroke is the most serious of health problems associated with working in hot environments. It occurs when the body's temperature regulatory system fails and sweating becomes inadequate. The body's only effective means of removing excess heat is compromised with little warning to the victim that a crisis stage has been reached.

A heat stroke victim's skin is hot, usually dry, and red or spotted. Body temperature is usually 105 °F or higher, and the victim is mentally confused, delirious, perhaps in convulsions, or unconscious. Unless the victim receives quick and appropriate treatment, death can occur.

Individuals with signs or symptoms of heat stroke require immediate hospitalization. First aid should be immediately administered. This includes removing the victim to a cool area, thoroughly soaking the clothing with water, and vigorously fanning the body to increase cooling. Further treatment, at a medical facility, should be directed to the continuation of the cooling process and the monitoring of complications that often accompany heat stroke. Early recognition and treatment are the only means of preventing permanent brain damage or death.

6.2 Heat Exhaustion

Heat exhaustion includes several clinical disorders having symptoms that may resemble the early symptoms of heat stroke. Heat exhaustion is caused by the loss of large amounts of fluid by sweating, sometimes with excessive loss of salt. A worker suffering from heat exhaustion still sweats but experiences weakness or fatigue, giddiness, nausea, or headache. In more serious cases, the victim may vomit or lose consciousness. The skin is clammy and moist, the complexion is pale or flushed, and the body temperature is normal or only slightly elevated.

In most cases, treatment involves having the victim rest in a cool place and drink plenty of liquids. Victims with mild cases of heat exhaustion usually recover spontaneously with this treatment. Those with severe cases may require extended care for several days. There are no known permanent effects.

6.3 Heat Cramps

Heat cramps are painful spasms of the muscles that occur among those who sweat profusely in heat, drink large quantities of water, but do not adequately replace the body's salt loss. The drinking of large amounts of water tends to dilute the body's fluids, while the body continues to lose salt. Shortly after, the low salt level in the muscles causes painful cramps. The affected muscles may be part of the arms, legs, or abdomen, but tired muscles (those used in performing the work) are usually the ones most susceptible to cramps. Cramps may occur during or after work hours and may be relieved by taking salted liquids by mouth.

6.4 Fainting

Fainting occurs in workers not accustomed to hot environments and who stand erect and immobile in the heat.

With enlarged blood vessels in the skin and in the lower part of the body due to the body's attempts to control internal temperature, blood may pool there rather than return to the heart to be pumped to the brain. Upon lying down, the worker should soon recover. By moving around, and thereby preventing blood from pooling, the patient can prevent further fainting.

6.5 Heat Rash (Prickly Heat)

Heat rash, also known as prickly heat, is likely to occur in hot, humid environments where sweat is not as easily removed from the surface of the skin by evaporation and the skin remains wet most of the time. The sweat ducts become plugged, and a skin rash soon appears. When the rash is extensive or when it is complicated by infection, prickly heat can be very uncomfortable and may reduce a worker's performance. The worker can prevent this condition by resting in a cool place part of each day and by regularly bathing and drying the skin.

7.0 SELECTION OF PERSONAL PROTECTIVE EQUIPMENT (PPE)

During work periods where the increased risk of heat stress exists, each item's benefit will be carefully evaluated. Once the PPE is chosen, safe work durations/rest periods will be determined based on the following conditions:

- Anticipated work rate;
- Ambient temperature and humidity; and
- Level of protection.

8.0 PREVENTION OF HEAT STRESS

Prevention of heat stress will be addressed in the following manner:

- Adjustment of work schedules.
- Modification of work/rest schedules.
    1. Enforce work slowdowns, as needed.
    2. Rotate personnel to minimize overstress or overexertion.
    3. When possible, work will be scheduled and performed during cooler hours.
- Providing shelter or shaded areas to protect personnel during rest periods.
- Maintaining workers' body fluids at normal levels.
    1. Drink approximately 12 to 16 ounces of non-caffeinated liquids (preferably water, Gatorade or equivalent) prior to the start of work. Caffeinated fluids act to dehydrate the worker.
    2. Workers will be urged to drink a cup or two every 15 to 20 minutes, or at each break. A total of 1 to 1.5 gallons of water per individual per day is recommended for fluid replacement under heat stress conditions, but more may be required.
- Encouraging physical fitness among the workers.
- Gradually acclimatizing workers on-site to help build up an "immunity" to the conditions.
    1. Heat acclimatization can usually be induced in 5 to 7 days of exposure at a hot job. For workers with previous experience with the job, acclimatization will include exposures of 50% for day one, 60% for day two, 80% for day three, and 100% for the remaining additional days.
- Providing cooling devices during prolonged work or severe heat exposure.
    1. Supply field showers or hose down areas.
    2. Supply personnel with cooling jackets, vests, and suits.
- Training workers in recognition and treatment of heat stress.
- Using the buddy system that depends on the recognition of signs and symptoms of heat stress.
- Identifying heat-intolerant individuals through medical screening.

APPENDIX D

INCIDENT REPORT FORM

Incident Report Form

Supervisor's Name: ______________________________

Basic Rules for Accident Investigation

- Find the cause to prevent future accidents - Use an unbiased approach during investigation.
- Interview witnesses & injured employees at the scene - conduct a walkthrough of the accident.
- Conduct interviews in private - Interview one witness at a time.
- Get signed statements from all involved.
- Take photos or make a sketch of the accident scene.
- What hazards are present - what unsafe acts contributed to accident?
- Ensure hazardous conditions are corrected immediately.

Date & Time		**Location**	
Task Performed		**Witnesses**	
Resulted In	___ **Injury** ___ **Fatality** ___ **Property Damage**	**Property Damage**	
Injured		**Injured**	
Describe Accident Facts & Events			

Supervisors Root Cause Analysis (Check ALL that apply to the accident)			
Unsafe Act		**Unsafe Conditions**	
Improper work technique		Poor workstation design	
Safety rule violation		Unsafe operation method	
Improper PPE or PPE not used		Improper maintenance	
Operating without authority		Lack of direct supervision	
Failure to warn or secure		Insufficient training	
Operating at improper speeds		Lack of experience	
By-passing Safety device		Insufficient knowledge of job	
Protective equipment not in use		Slippery conditions	
Improper loading or placement		Excessive noise	

Improper lifting		Inadequate guarding of hazards	
Servicing Machinery in motion		Defective tools/equipment	
Horseplay		Poor housekeeping	
Drug or alcohol use		Insufficient lighting	
Unsafe Acts require a written warning and re-training before the employee resumes work.			
Date		**Date**	
Retraining Assigned		**Unsafe Condition Guarded**	
Retraining Completed		**Unsafe Condition Corrected**	
Supervisor Signature		**Supervisor Signature**	

APPENDIX C

NYSDOH INDOOR AIR QUALITY QUESTIONNAIRE AND BUILDING INVENTORY FORM

OSR – 3

NEW YORK STATE DEPARTMENT OF HEALTH
INDOOR AIR QUALITY QUESTIONNAIRE AND BUILDING INVENTORY
CENTER FOR ENVIRONMENTAL HEALTH

This form must be completed for each residence involved in indoor air testing.

Preparer's Name ____________________________________ Date/Time Prepared ______________

Preparer's Affiliation ________________________________ Phone No.______________________

Purpose of Investigation____

1. OCCUPANT:

Interviewed: Y / N

Last Name: _________________________ First Name: _________________________

Address: ____

County: _________________

Home Phone: ____________________ Office Phone: ____________________

Number of Occupants/persons at this location _______ Age of Occupants ______________________

2. OWNER OR LANDLORD: (Check if same as occupant ___)

Interviewed: Y / N

Last Name: _________________________ First Name: _________________________

Address: ____

County: _________________

Home Phone: ____________________ Office Phone: ____________________

3. BUILDING CHARACTERISTICS

Type of Building: (Circle appropriate response)

Residential
Industrial

School
Church

Commercial/Multi-use
Other: _________________

If the property is residential, type? (Circle appropriate response)

Ranch
Raised Ranch
Cape Cod
Duplex
Modular
2-Family
Split Level
Contemporary
Apartment House
Log Home
3-Family
Colonial
Mobile Home
Townhouses/Condos
Other:_______________

If multiple units, how many? ________

If the property is commercial, type?

Business Type(s) ______________________________________

Does it include residences (i.e., multi-use)? Y / N If yes, how many? ______

Other characteristics:

Number of floors______ Building age______

Is the building insulated? Y / N How air tight? Tight / Average / Not Tight

4. AIRFLOW

Use air current tubes or tracer smoke to evaluate airflow patterns and qualitatively describe:

Airflow between floors

Airflow near source

Outdoor air infiltration

Infiltration into air ducts

5. BASEMENT AND CONSTRUCTION CHARACTERISTICS (Circle all that apply)

a. Above grade construction:	wood frame	concrete	stone	brick
b. Basement type:	full	crawlspace	slab	other ________
c. Basement floor:	concrete	dirt	stone	other ________
d. Basement floor:	uncovered	covered	covered with _______________	
e. Concrete floor:	unsealed	sealed	sealed with ________________	
f. Foundation walls:	poured	block	stone	other ________
g. Foundation walls:	unsealed	sealed	sealed with ________________	
h. The basement is:	wet	damp	dry	moldy
i. The basement is:	finished	unfinished	partially finished	
j. Sump present?	Y / N			
k. Water in sump?	Y / N / not applicable			

Basement/Lowest level depth below grade: ________(feet)

Identify potential soil vapor entry points and approximate size (e.g., cracks, utility ports, drains)

____

____

6. HEATING, VENTING and AIR CONDITIONING (Circle all that apply)

Type of heating system(s) used in this building: (circle all that apply – note primary)

Hot air circulation
Space Heaters
Electric baseboard
Heat pump
Stream radiation
Wood stove
Hot water baseboard
Radiant floor
Outdoor wood boiler
Other ___________

The primary type of fuel used is:

Natural Gas
Electric
Wood
Fuel Oil
Propane
Coal
Kerosene
Solar

Domestic hot water tank fueled by: ____________________________

Boiler/furnace located in:	Basement	Outdoors	Main Floor	Other___________
Air conditioning:	Central Air	Window units	Open Windows	None

Are there air distribution ducts present? Y / N

Describe the supply and cold air return ductwork, and its condition where visible, including whether there is a cold air return and the tightness of duct joints. Indicate the locations on the floor plan diagram.

____

____

____

____

7. OCCUPANCY

Is basement/lowest level occupied? Full-time Occasionally Seldom Almost Never

Level	**General Use of Each Floor (e.g., familyroom, bedroom, laundry, workshop, storage)**
Basement	______________________________
1st Floor	______________________________
2nd Floor	______________________________
3rd Floor	______________________________
4th Floor	______________________________

8. FACTORS THAT MAY INFLUENCE INDOOR AIR QUALITY

a. Is there an attached garage? Y / N

b. Does the garage have a separate heating unit? Y / N / NA

c. Are petroleum-powered machines or vehicles stored in the garage (e.g., lawnmower, atv, car) Y / N / NA
Please specify___________________

d. Has the building ever had a fire? Y / N When?_________________

e. Is a kerosene or unvented gas space heater present? Y / N Where? _________________

f. Is there a workshop or hobby/craft area? Y / N Where & Type? ________________

g. Is there smoking in the building? Y / N How frequently? ________________

h. Have cleaning products been used recently? Y / N When & Type? ________________

i. Have cosmetic products been used recently? Y / N When & Type? ________________

j. Has painting/staining been done in the last 6 months? Y / N Where & When? _______________

k. Is there new carpet, drapes or other textiles? Y / N Where & When? _______________

l. Have air fresheners been used recently? Y / N When & Type? ________________

m. Is there a kitchen exhaust fan? Y / N If yes, where vented?____________

n. Is there a bathroom exhaust fan? Y / N If yes, where vented?____________

o. Is there a clothes dryer? Y / N If yes, is it vented outside? Y / N

p. Has there been a pesticide application? Y / N When & Type?_________________

Are there odors in the building? Y / N
If yes, please describe: ____

Do any of the building occupants use solvents at work? Y / N
(e.g., chemical manufacturing or laboratory, auto mechanic or auto body shop, painting, fuel oil delivery, boiler mechanic, pesticide application, cosmetologist

If yes, what types of solvents are used? ____

If yes, are their clothes washed at work? Y / N

Do any of the building occupants regularly use or work at a dry-cleaning service? (Circle appropriate response)

Yes, use dry-cleaning regularly (weekly)
Yes, use dry-cleaning infrequently (monthly or less)
Yes, work at a dry-cleaning service
No
Unknown

Is there a radon mitigation system for the building/structure? Y / N Date of Installation: ____________
Is the system active or passive? Active/Passive

9. WATER AND SEWAGE

Water Supply: Public Water Drilled Well Driven Well Dug Well Other: _______

Sewage Disposal: Public Sewer Septic Tank Leach Field Dry Well Other: _______

10. RELOCATION INFORMATION (for oil spill residential emergency)

a. Provide reasons why relocation is recommended: _____________________________________

b. Residents choose to: remain in home relocate to friends/family relocate to hotel/motel

c. Responsibility for costs associated with reimbursement explained? Y / N

d. Relocation package provided and explained to residents? Y / N

11. FLOOR PLANS

Draw a plan view sketch of the basement and first floor of the building. Indicate air sampling locations, possible indoor air pollution sources and PID meter readings. If the building does not have a basement, please note.

Basement:

First Floor:

12. OUTDOOR PLOT

Draw a sketch of the area surrounding the building being sampled. If applicable, provide information on spill locations, potential air contamination sources (industries, gas stations, repair shops, landfills, etc.), outdoor air sampling location(s) and PID meter readings.

Also indicate compass direction, wind direction and speed during sampling, the locations of the well and septic system, if applicable, and a qualifying statement to help locate the site on a topographic map.

13. PRODUCT INVENTORY FORM

Make & Model of field instrument used: ____________________________________

List specific products found in the residence that have the potential to affect indoor air quality.

Location	**Product Description**	**Size** (units)	**Condition**[*]	**Chemical Ingredients**	**Field Instrument Reading** (units)	**Photo**[**] **Y / N**

[*] Describe the condition of the product containers as **Unopened (UO), Used (U),** or **Deteriorated (D)**
[**] Photographs of the **front and back** of product containers can replace the handwritten list of chemical ingredients. However, the photographs must be of good quality and ingredient labels must be legible.